

SIEMENS

SIPROTEC 5

IO-Box

6MD84

V9.50 and higher

Manual

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**NOTE**

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

Disclaimer of Liability

Subject to changes and errors. The information given in this document only contains general descriptions and/or performance features which may not always specifically reflect those described, or which may undergo modification in the course of further development of the products. The requested performance features are binding only when they are expressly agreed upon in the concluded contract.

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Preface

Purpose of the Manual

This manual describes the functions of SIPROTEC 5 IO-Box 6MD84.

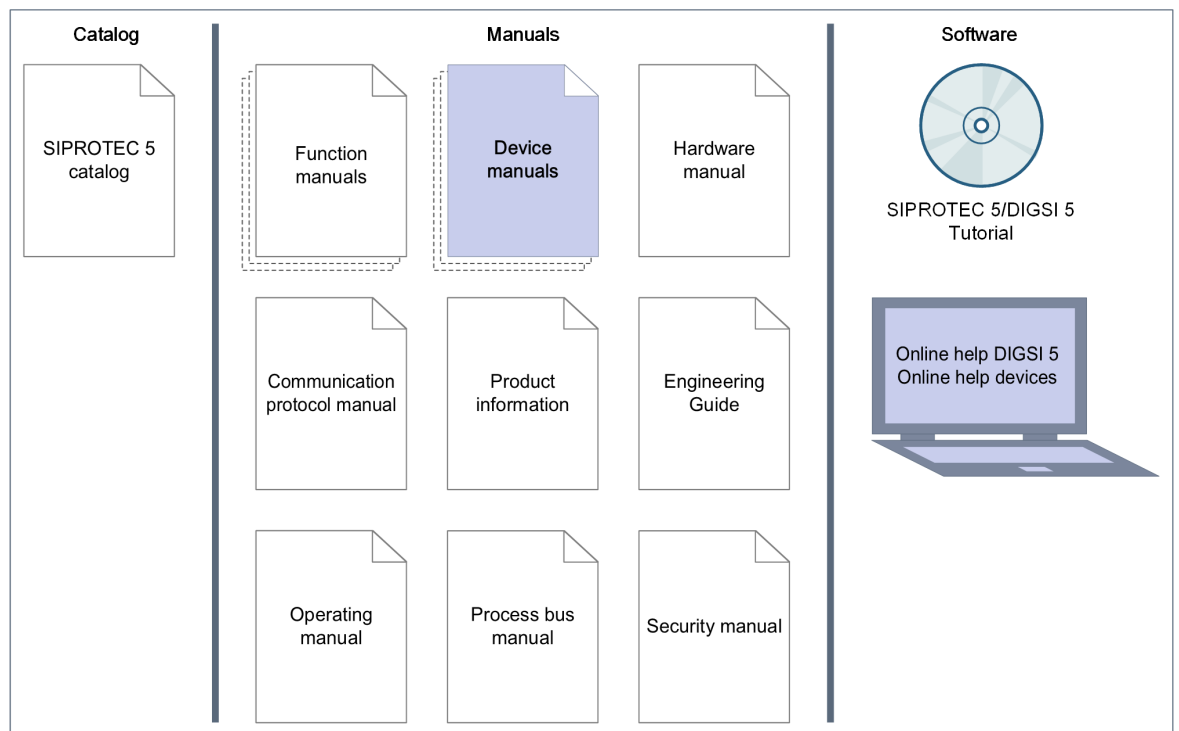
Target Audience

Protection system engineers, commissioning engineers, persons entrusted with the setting, testing and maintenance of automation, selective protection and control equipment, and operational crew in electrical installations and power plants.

Scope

This manual applies to the SIPROTEC 5 device family.

Further Documentation



[dw_product-overview_SIP5_device-manual, 5, en_US]

- **Device manuals**
Each Device manual describes the functions and applications of a specific SIPROTEC 5 device. The printed manual and the online help for the device have the same informational structure.
- **Hardware manual**
The Hardware manual describes the hardware building blocks and device combinations of the SIPROTEC 5 device family.

- **Operating manual**
The Operating manual describes the basic principles and procedures for operating and assembling the devices of the SIPROTEC 5 range.
- **Communication protocol manual**
The Communication protocol manual contains a description of the protocols for communication within the SIPROTEC 5 device family and to higher-level network control centers.
- **Security manual**
The Security manual describes the security features of the SIPROTEC 5 devices and DIGSI 5.
- **Process bus manual**
The process bus manual describes the functions and applications specific for process bus in SIPROTEC 5.
- **Product information**
The Product information includes general information about device installation, technical data, limiting values for input and output modules, and conditions when preparing for operation. This document is provided with each SIPROTEC 5 device.
- **Engineering Guide**
The Engineering Guide describes the essential steps when engineering with DIGSI 5. In addition, the Engineering Guide shows you how to load a planned configuration to a SIPROTEC 5 device and update the functionality of the SIPROTEC 5 device.
- **DIGSI 5 online help**
The DIGSI 5 online help contains a help package for DIGSI 5 and CFC.
The help package for DIGSI 5 includes a description of the basic operation of software, the DIGSI principles and editors. The help package for CFC includes an introduction to CFC programming, basic examples of working with CFC, and a reference chapter with all the CFC blocks available for the SIPROTEC 5 range.
- **SIPROTEC 5/DIGSI 5 Tutorial**
The tutorial on the DVD contains brief information about important product features, more detailed information about the individual technical areas, as well as operating sequences with tasks based on practical operation and a brief explanation.
- **SIPROTEC 5 catalog**
The SIPROTEC 5 catalog describes the system features and the devices of SIPROTEC 5.

Indication of Conformity



This product complies with the directive of the Council of the European Communities on harmonization of the laws of the Member States concerning electromagnetic compatibility (EMC Directive 2014/30/EU), restriction on usage of hazardous substances in electrical and electronic equipment (RoHS Directive 2011/65/EU), and electrical equipment for use within specified voltage limits (Low Voltage Directive 2014/35/EU).

This conformity has been proved by tests performed according to the Council Directive in accordance with the product standard EN 60255-26 (for EMC directive), the standard EN IEC 63000 (for RoHS directive), and with the product standard EN 60255-27 (for Low Voltage Directive) by Siemens.

The device is designed and manufactured for application in an industrial environment.

The product conforms with the international standards of IEC 60255 and the German standard VDE 0435.

Standards

IEEE Std C 37.90

The technical data of the product is approved in accordance with UL.

For more information about the UL database, see ul.com

You can find the product with the **UL File Number E194016**.



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Additional Support

For questions about the system, contact your Siemens sales partner.

Customer Support Center

Our Customer Support Center provides a 24-hour service.

Siemens AG

Smart Infrastructure – Protection Automation

Customer Support Center

Tel.: +49 911 2155 4466

E-Mail: energy.automation@siemens.com

Training Courses

Inquiries regarding individual training courses should be addressed to our Training Center:

Siemens AG

Siemens Power Academy TD

Humboldtstraße 59

90459 Nuremberg

Germany

Phone: +49 911 9582 7100

E-mail: poweracademy@siemens.com

Internet: www.siemens.com/poweracademy

Notes on Safety

This document is not a complete index of all safety measures required for operation of the equipment (module or device). However, it comprises important information that must be followed for personal safety, as well as to avoid material damage. Information is highlighted and illustrated as follows according to the degree of danger:



DANGER

DANGER means that death or severe injury **will** result if the measures specified are not taken.

- ✧ Comply with all instructions, in order to avoid death or severe injuries.



WARNING

WARNING means that death or severe injury **may** result if the measures specified are not taken.

- ✧ Comply with all instructions, in order to avoid death or severe injuries.



CAUTION

CAUTION means that medium-severe or slight injuries **can** occur if the specified measures are not taken.

- ✧ Comply with all instructions, in order to avoid moderate or minor injuries.
-

NOTICE

NOTICE means that property damage **can** result if the measures specified are not taken.

- ✧ Comply with all instructions, in order to avoid property damage.



NOTE

Important information about the product, product handling or a certain section of the documentation which must be given attention.

Qualified Electrical Engineering Personnel

Only qualified electrical engineering personnel may commission and operate the equipment (module, device) described in this document. Qualified electrical engineering personnel in the sense of this document are people who can demonstrate technical qualifications as electrical technicians. These persons may commission, isolate, ground and label devices, systems and circuits according to the standards of safety engineering.

Proper Use

The equipment (device, module) may be used only for such applications as set out in the catalogs and the technical description, and only in combination with third-party equipment recommended and approved by Siemens.

Problem-free and safe operation of the product depends on the following:

- Proper transport
- Proper storage, setup and installation
- Proper operation and maintenance

When electrical equipment is operated, hazardous voltages are inevitably present in certain parts. If proper action is not taken, death, severe injury or property damage can result:

- The equipment must be grounded at the grounding terminal before any connections are made.
- All circuit components connected to the power supply may be subject to dangerous voltage.
- Hazardous voltages may be present in equipment even after the supply voltage has been disconnected (capacitors can still be charged).
- Operation of equipment with exposed current-transformer circuits is prohibited. Before disconnecting the equipment, ensure that the current-transformer circuits are short-circuited.
- The limiting values stated in the document must not be exceeded. This must also be considered during testing and commissioning.

Selection of Used Symbols on the Device

No.	Symbol	Description
1		Direct current, IEC 60417, 5031
2		Alternating current, IEC 60417, 5032
3		Direct and alternating current, IEC 60417, 5033
4		Earth (ground) terminal, IEC 60417, 5017
5		Protective conductor terminal, IEC 60417, 5019

No.	Symbol	Description
6		Caution, risk of electric shock
7		Caution, risk of danger, ISO 7000, 0434
8		Protective insulation, IEC 60417, 5172, safety class II devices
9		Guideline 2002/96/EC for electrical and electronic devices
10		Guideline for the Eurasian market
11		Mandatory conformity mark for electronics and electrotechnical products in Morocco

OpenSSL

This product includes software developed by the OpenSSL Project for use in OpenSSL Toolkit (<http://www.openssl.org/>).

This product includes software written by Tim Hudson (tjh@cryptsoft.com).

This product includes cryptographic software written by Eric Young (ey@cryptsoft.com).

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1 Introduction

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1.1 General

The digital multifunctional protection and bay controllers of the SIPROTEC 5 device series are fitted with a powerful microprocessor. As a result, all tasks, from acquiring measurands to entering commands in the circuit breaker, are processed digitally.

Microprocessor System

All device functions are processed in the microprocessor system.

This includes, for example:

- Filtering and preparation of the measurands
- Constant monitoring of the measurands
- Monitoring of the pickup conditions for the individual protection functions
- Querying of limiting values and time sequences
- Control of signals for logic functions
- Control of open and close commands
- Recording of indications, fault data, and fault values for fault analysis
- Administration of the operating system and its functions, for example data storage, real-time clock, communication, interfaces
- External distribution of information

Binary Inputs and Outputs

Using the binary inputs and outputs, the device receives information from the system or from other devices (such as locking commands). The most important outputs include the commands to the switching devices and the indications for remote signaling of important events and states.

Front Elements

For devices with an integrated or offset operation panel, LEDs and an LC display on the front provide information on the device function and report events, states, and measured values. In conjunction with the LC display, the integrated keypad enables on-site operation of the device. All device information such as setting parameters, operating and fault indications or measured values can be displayed, and setting parameters changed. In addition, system equipment can be controlled via the user interface of the device.

Serial Interfaces

The serial interface in the front panel enables communication with a personal computer when using the DIGSI operating program. As a result, the operation of all device functions is possible. Additional interfaces on the rear are used to implement various communication protocols.

Power Supply

The individual functional units of the device are powered by an internal power supply. Brief interruptions in the supply voltage, which can occur during short circuits in the system auxiliary voltage supply, are bridged by capacitor storage (see also the Technical Data).

1.2 Properties of SIPROTEC 5

The SIPROTEC 5 devices at the bay level are compact and can be installed directly in medium and high-voltage switchgear. They are characterized by comprehensive integration of protection and control functions.



NOTE

The **6MD84 I/O box** has no current or voltage transformer inputs and does not support the common protection functions.

General Properties

- Powerful microprocessor
- Fully digital measured-value processing and control, from sampling and digitizing of measurands to closing and tripping decisions for the circuit breaker
- Complete galvanic and interference-free isolation of the internal processing circuits from the system measuring, control, and supply circuits through instrument transformers, binary input and output modules, and DC and AC voltage converters
- Easy operation using an integrated operator and display panel, or using a connected personal computer with user interface
- Continuous display of measured and metered values at the front
- Continuous monitoring of the measurands as well as the device hardware and software
- Communication with central control and storage devices possible via the device interface
- Battery-buffered, synchronizable clock

Modular Concept

The SIPROTEC 5 modular concept ensures the consistency and integrity of all functionalities across the entire device series. Significant features here include:

- Modular system design in hardware, software, and communication
- Functional integration of various applications, such as protection, control, and fault recorder
- The same expansion and communication modules for all devices in the family
- Innovative terminal technology with easy assembly and interchangeability and the highest possible degree of safety
- The same functions can be configured individually across the entire family of devices
- Ability to upgrade with innovations possible at all times through libraries
- Open, scalable architecture for IT integration and new functions
- Multi-layered security mechanisms in all links of the security chain
- Self-monitoring routines for reliable localization and indication of device faults
- Automatic logging of access attempts and security-critical operations on the devices and systems

Available Modules

The 6MD84 I/O box can be complemented with the following modules:

- CB202 for 3 plug-in modules, port positions: M, N, and P
- IO204 with 10 binary inputs and 8 binary outputs (4 standard relays and 4 power relays)
- IO205 with 12 binary inputs and 16 binary outputs (16 standard relays)
- IO206 with 6 binary inputs and 7 binary outputs (7 standard relays)

- IO207 with 16 binary inputs and 8 binary outputs (8 standard relays)
- IO209 with 8 binary inputs and 4 binary outputs (4 high-speed relays)
- IO212 with 8 binary inputs and 8 analog inputs 20 mA/10 V
- IO216 with 16 binary inputs with extremely robust design for special applications; fixed pickup threshold value of DC 170 V, fixed dropout threshold value of DC 132 V
- IO218 analog inputs 20 mA/10 V
- IO230 with 48 binary inputs
- IO231 with 24 binary inputs (common potential in blocks of 4 inputs), 24 binary outputs (standard relays, common potential in blocks of 8 relays)
- IO232 with 24 binary inputs and 15 binary outputs
- IO233 with 48 binary inputs; a fixed pickup threshold value of DC 105 V is valid for all binary inputs
- PS203 power supply for 2nd device row (plugged in position 7)
- PS204 redundant power supply for PS203
- ANAI-CA-4EL: 4 analog inputs 20 mA, screw terminals
- ANAI-CE-2EL: 1 analog input DC 0 V to 300 V (CH2), screw terminals

Redundant Communication

SIPROTEC 5 devices maintain full communication redundancy:

- Multiple redundant communication interfaces
- Redundant and independent protocols to control centers possible (such as IEC 60870-5-103 and IEC 61850, either single or redundant)
- Redundant time synchronization (such as IRIG B, SNTP or IEEE 1588).

2 Basic Structure of the Function

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2.1 Embedding of Functions in the Device

General

SIPROTEC 5 devices offer great flexibility in the handling of functions. Functions can be individually loaded into the device. Additionally, it is possible to copy functions within a device or between devices. The necessary integration of functions in the device is illustrated by the following example.



NOTE

The availability of certain settings and setting options depends on the device type and the functions available on the device!

Several predefined function packages that are tailored to specific applications exist for each device family. A predefined functional scope is called an **application template**. The existing application templates are offered for selection automatically when you create a new device in DIGSI 5.

Function Groups (FG)

Functions are arranged in function groups. This simplifies handling of functions (adding and copying). The function groups are assigned to primary objects, such as transformer, or circuit breaker.

2.2 Application Templates/Adaptation of Functional Scope

Application Template

The application template defines the preconfigured functional scope of the device for a specific use case. A certain number of application templates is predefined for each device type. DIGSI 5 automatically offers the application templates for selection when a new device is installed. The available application templates with the respective functional scope are described in more detail in [4 Applications](#).

The selection of the application template first predefines which function groups and functions are present in the device (see also in [2.1 Embedding of Functions in the Device](#)).

You can adjust the functional scope to your specific application.

Adjusting the Functional Scope

Adjust the functional scope based on the selected application template. You can add, copy or delete functions, tripping stages, function blocks, or complete function groups.

In the DIGSI 5 project tree, this can be done via the following Editors:

- Single-line configuration
- Information routing
- Function settings

Siemens recommends the **Single-line configuration** Editor to adjust the functional scope.

Complete missing functionalities from the Global DIGSI 5 Library. Then, the default settings of the added functionality are active. You can copy within a device and between devices as well. Settings and routings are also copied when you copy functionalities.



NOTE

If you delete a parameterized function group, function, or stage from the device, all settings and routings will be lost. The function group, function, or tripping stage can be added again, but then the default settings are active.

In most cases, the adaptation of the functional scope consists of adding and deleting functions, stages, and function blocks. As previously described, the functions, tripping stages, and function blocks automatically connect themselves to the measuring points assigned to the function group.

In few cases, it may be necessary to add a protection or circuit-breaker function group. These newly added function groups do not contain (protection) functions. You must individually load the (protection) functions for your specific application. You must also connect the protection or circuit-breaker function group to one or more measuring points (see [2.1 Embedding of Functions in the Device](#)). You must connect newly added protection function groups to a circuit-breaker function group (see [2.1 Embedding of Functions in the Device](#)).

Functions, tripping stages, function blocks, and function groups can be added up to a certain maximum number. The maximum number can be found in the respective function and function-group descriptions.

Function Points

Function points (FP) are assigned to specific functions, but not to other functions. You can find more detailed information in the description of application templates, in [4 Applications](#).

The device is supplied with the acquired function-point credit. Functions with function points can be loaded into the device only within the available function-point credit. The functional scope cannot be loaded into the device if the required number of points of the functional scope is higher than the function-point credit. You must either delete functions or upgrade the function-point credit of the device.

In addition to function-point classes (10, 20, 30, 40, 50, 75, 100 to 1400) beginning with firmware version V09.20, any function-point values in the range from 0 to 5000 are supported as a credit in the device. Thus, the precise function-point credit required can be loaded into the device by the Function-Point Manager. Alternatively, you can order classless devices with 0 points (new option beginning with V09.20) or class-bound with the required function-point class.

Extending the Function-Point Credit

You can reorder function points if the function-point credit for the device is not enough or if you have ordered a classless device with 0 points. Proceed as follows:

- Determine the function-point requirement of certain functions, for example, with DIGSI 5 or the SIPROTEC 5 Configurator.
- Create a signed license file for your device with the SIPROTEC Function-Point Manager at www.siprotec-function-point-manager.siemens.com or order the license file from your sales partner.
- Once you have ordered the license file using the Function-Point Manager, you can download it from there directly.
- Once you have ordered the license file from your sales partner, you will receive it by e-mail or to download.
- Use DIGSI 5 to load the signed license file onto your device. The procedure is described in the Online Help of DIGSI 5.

2.3 Function Control

Function control is used for:

- Functions that do not contain stages or function blocks
- Stages within functions
- Function blocks within functions



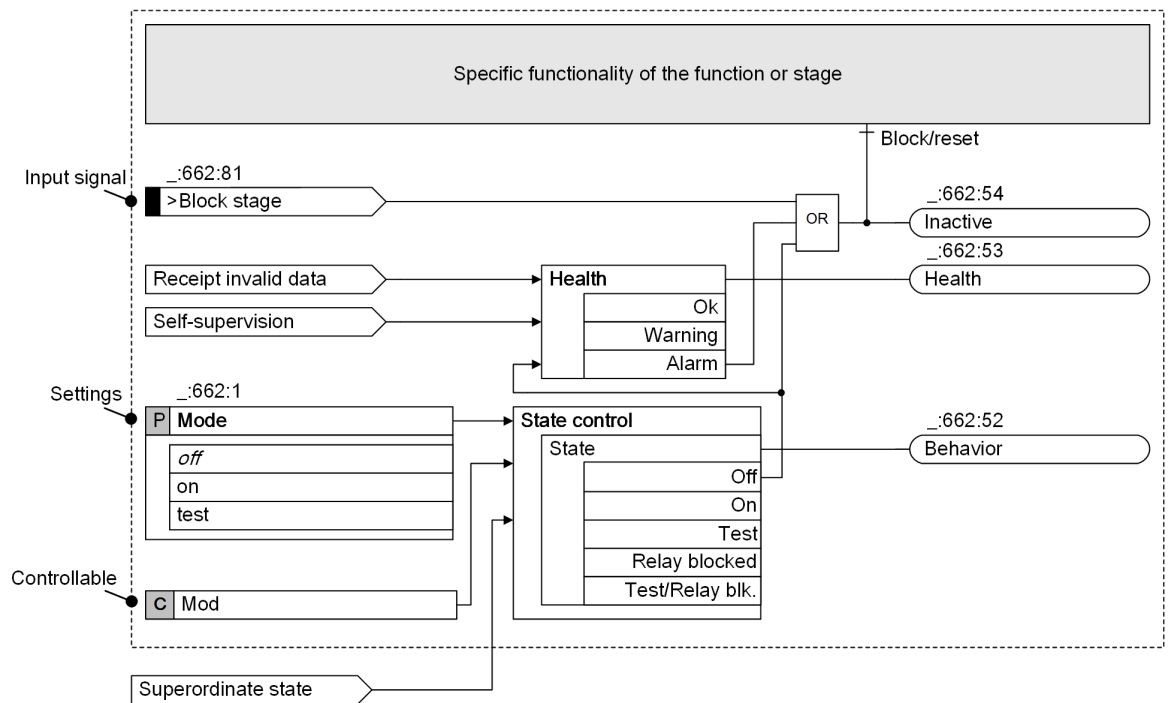
NOTE

Simplifying **functions** and **function control** will be discussed in the following. The description also applies to tripping stage control and function block control.

Functions can be switched to different operating modes. You use the parameter **Mode** to define whether you want a function to run (**on**) or not (**off**). In addition, you can temporarily block a function or switch it into test mode for the purpose of commissioning (parameter **Mode** = **test**). Furthermore, the state of the tripping stage can be influenced with the help of the controllable **Mod** in the IEC 61850 representation. The controllable **Mod** (in the DIGSI 5 information routing **_:51 Mode (controllable)**) supports the states **On**, **Off**, **Test**, **Relay blocked**, and **Test/Relay blk.**.

The function shows the current status – such as an **Alarm** – via the **Health** signal.

The following explains the different operating modes and mechanisms and how you set the functions into these modes. The function control is shown in [Figure 2-1](#). It is standardized for all functions. Therefore, this control is not discussed further in the individual function descriptions.



[io_steurg, 2, en_US]

Figure 2-1 General Control of a Function

State Control

You can control the state of a function via the parameter **Mode**, the controllable **Mod** and the input **Superordinate state**.

You set the specified operating state of the function via the parameter **Mode**. You can set the function mode to **on**, **off** and **test**. The operating principle is described in [Table 2-2](#). You can set the parameter **Mode** via:

- DIGSI 5
- On-site operation at the device
- Browser-based user interface
- Certain systems control protocols (IEC 61850, IEC 60870-5-103)

You can also set the setpoint operating state of the function through the controllable **Mod**. You can set the function mode to **On**, **Off**, **Test**, **Relay blocked** and **Test/Relay blk.**. The operating principle is described in [Table 2-2](#). You can set the controllable **Mod** via:

- IEC 61850-8-1
- CFC

The **superordinate state** can accept the values **On**, **Relay blocked**, **Test** and **Test/Relay blk.**.

The state of the function resulting from the parameter **Mode**, the controllable **Mod** and the **Superordinate state** is shown in the following table. The resulting state of the function results from the combination of all sources (parameters **Mode**, Controllable **Mod** and **Superordinate state**). For simplicity, the table represents only the combination of 2 sources.

Table 2-1 Resulting State of the Function

Inputs		State of the Function
Source A	Source N	
On	On	On
On	Off	Off
On	Test	Test ¹
On	Relay blocked	Relay blocked
On	Test/Relay blk.	Test/Relay blk.
Test	On	Test ¹
Test	Off	Off
Test	Test	Test ¹
Test	Relay blocked	Test/Relay blk.
Test	Test/Relay blk.	Test/Relay blk.
Off	On	Off
Off	Off	Off
Off	Test	Off
Off	Relay blocked	Off
Off	Test/Relay blk.	Off
Relay blocked	On	Relay blocked
Relay blocked	Off	Off
Relay blocked	Test	Test/Relay blk.
Relay blocked	Relay blocked	Relay blocked
Relay blocked	Test/Relay blk.	Test/Relay blk.
Test/Relay blk.	On	Test/Relay blk.
Test/Relay blk.	Off	Off
Test/Relay blk.	Test	Test/Relay blk.

¹ With the parameter (_:151) Oper.bin.outp. under test, you can fix the settings whether the relay outputs are to be picked up by functions in the state **Test**. If this parameter is inactive (default setting), the state **Test** of a function is modified to **Test/Relay blk.**.

Inputs		State of the Function
Test/Relay blk.	Relay blocked	Test/Relay blk.
Test/Relay blk.	Test/Relay blk.	Test/Relay blk.



NOTE

The browser-based user interface shows an easy-to-read list of the states of all functions if they deviate from the state **On**.

The following table describes the possible states of a function:

Table 2-2 Possible States of a Function

State of the Function	Explanation
On	The function is activated and operating as defined. The prerequisite is that the health of the function is OK .
Relay blocked	The function is activated and operating as defined. The prerequisite is that the health of the function is OK. All outputs of indications of this function to relays are blocked. Note: Logics outside this function block, for example, superordinate group indications, are not affected by the blocking. Their output to a relay still leads to an activation.
Off	The function is turned off. It does not create any information. The health of a disabled function always has the value OK .

State of the Function	Explanation	
Test	The function is set to test mode. This state supports the commissioning. All outgoing information from the function (indications and, if present, measured values) is provided with a test bit. This test bit significantly influences the further processing of the information, depending on the target. For instance, among other things, it is possible to implement the functionality Blocking of the command relay known from SIPROTEC 4.	
	Target of the Information	Processing
	Log	The indication is labeled Test in the log.
	Contact	An indication routed to contact is not triggering the contact.
	Light-emitting diode (LED)	An indication routed to the LED triggers the LED (normal processing)
	CFC	Here, the behavior depends on the state of the CFC chart. - CFC chart itself is not in test state: The CFC chart is not triggered by a status change of information with a set test bit. The initial state of the information (state before test bit was set) is not processed during execution of the CFC chart. - CFC chart itself is in test state: The CFC chart continues to process the information (indication or measured value) normally. The CFC outgoing information is provided with a test bit. The definitions in this table apply to its continued processing. A CFC chart can be set to the test state only by switching the entire device to test mode.
	Protocol	Indication and measured value are transmitted with set test bit, provided that the protocol supports this functionality. If an object is transmitted as a GOOSE message, the test bit is set spontaneously and the GOOSE message is transmitted immediately. The receiver of the GOOSE message is automatically notified of transmitter test mode. If an object is transmitted via the protection interface, the test bit is not transmitted. The <i>Test</i> state must also be transmitted as information for this state to be taken into account in the application on the receiver side. You must route the <i>Test</i> signal in the DIGSI 5 project tree → Device → Communication routing . The test mode of the differential protection is dealt with separately in the application.
Test/Relay blk.	The function works as described under Test . All output information (indications) of this function which is routed to a relay is blocked. All output information from the function (indications and, if available, measured values) is provided with a test bit. This test bit significantly influences the further processing of the information, depending on the target. Logics outside this function block, for example, superordinate group indications, are not affected by the blocking. If the state of these functions allows the processing of indications with a test bit (target function in the state Test or Test/Relay blk.), the output information routed to a relay continues to the control of the relays.	

Health

Health signals if a selected function can perform its designated functionality. If so, the health is *OK*. In case the functionality is only possible in a limited way or not at all, due to state or problems within the device, the health will signal *warning* (limited functionality) or *Alarm* (no functionality).

Internal self-monitoring can cause functions to assume the health *Alarm* (see [7 Supervision Functions](#)). If a function assumes the health state *Alarm*, it is no longer active (indication *not active* is generated).

Only a few functions can signal the health state *warning*. The health state *warning* results from function-specific supervision and - where it occurs - it is explained in the function description. If a function assumes the *warning* status, it will remain active, that is, the function can continue to work in a conditional manner and trip in the case of a protection function.

Not Active

The indication *Not active* signals that a function is currently not working. The indication *Not active* is active in the following cases:

- Function is disabled
- The function is in the health state *Alarm*
- Function is blocked by an input signal (see [Figure 2-1](#))
- All protection-function steps are disabled via the *Enable protection* controllable (state = false). The indication *Protection inactive* is active.

2.4 Text Structure and Reference Number for Settings and Indications

Each parameter and each indication has a unique reference number within every SIPROTEC 5 device. The reference number gives you a clear reference, for example, between an indication entry in the buffer of the device and the corresponding description in the manual. You can find the reference numbers in this document, for example, in the application and setting notes, in the logic diagrams, and in the parameter and information lists.

In order to form unique texts and reference numbers, each function group, function, function block/stage, and indication or parameter has a text and a number. This means that structured overall texts and numbers are created.

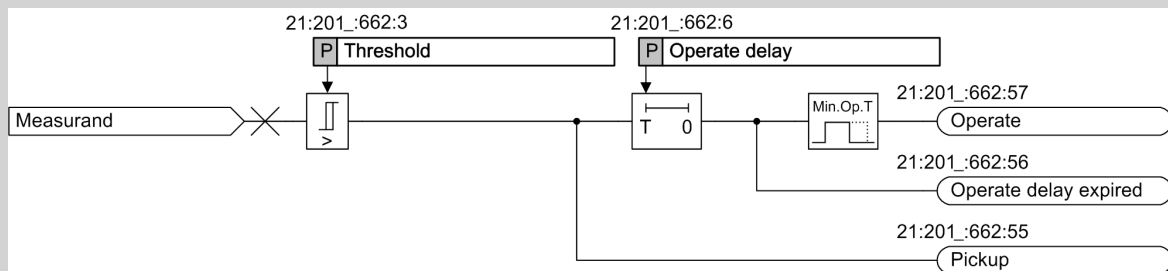
The structure of the texts and reference numbers follows the hierarchy:

- Function group:Function:Stage/Function Block:Indication
- Function group:Function:Stage/Function Block:Parameter

The colon serves as a structure element to separate the hierarchy levels. Depending on the functionality, not all hierarchy levels are always available. Function Group and Stage/Function block are optional. Since the function groups, functions as well as tripping stages/function blocks of the same type can be created multiple times, a so-called instance number is added to these elements.

EXAMPLE

The structure of the text and reference number is shown in the protection-function group **Line** as an example of the parameter **Threshold value** and the indication **Pickup** of the 2nd definite-time overcurrent protection stage of the function **Overcurrent protection, phases** (see [Figure 2-2](#)). Only one function and one function group exist in the device. The representation of the stage is simplified.



[lo_stuamz, 1_en_US]

Figure 2-2 Stage of the Overcurrent Protection Function, Phases (without Representation of Stage Control)

The following table shows the texts and numbers of the hierarchy elements concerned:

	Name	Number of the Type	Instance Number
Protection function group	Line	2	1
Function	Overcurrent 3ph	20	1
Stage	Definite-time overcurrent protection	66	2
Settings	Threshold value	3	—
Indication	Pickup	55	—

The instance numbers arise as follows:

- Function group: Line 1
1 instance, because only one **Line** function group exists in the device
- Function: Overcurrent 3ph 1
1 instance, because only one **Overcurrent 3ph** function exists in the **Line** function group

- Stage: Definite-time overcurrent protection **2**
2 instances, because 2 definite-time overcurrent protection stages exist in the **Overcurrent 3ph** function (here the 2nd instance as an example)

This results in the following texts and numbers (including the instance numbers):

Parameter:	Number
Line 1:Overcurrent 3-ph 1:Definite-time overcurrent protection 2:Threshold value	21:201:662:3
Indication:	Number
Line 1:Overcurrent 3-ph 1:Definite-time overcurrent protection 2:Pickup	21:201:662:55

The structure is simplified accordingly for parameters and indications with fewer hierarchy levels.

2.5 Information Lists

For the function groups, functions, and function blocks, settings and miscellaneous signals are defined that are shown in the settings and information lists.

The information lists merge the signals. The data type of the information may differ. Possible data types are ENS, ACD, ACT, SPS and MV.

One type is assigned to the individual data types. The following table shows the possible types:

Type	Meaning
I	Input – input signal
O	Output – output signal
C	Controllable – control signal

EXAMPLE:

The following table shows the types for some data types as examples:

Data Type	Type
ENS	O
ACD	O
ACT	O
SPS	I or O
SPC	C
MV	O

For further information, refer to [3.6.2 Basic Data Types](#).

3 System Functions

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3.1 Indications

3.1.1 General

During operation, indications deliver information about operational states. These include:

- Measured data
- Power-system data
- Device supervisions
- Device functions
- Function procedures during testing and commissioning of the device

In addition, indications give an overview of important fault events after a failure in the system. All indications are furnished with a time stamp at the time of their occurrence.

Indications are saved in logs inside the device and are available for later analyses. The following number of indications are saved at least in the respective buffer (depending on the scope of the indications):

- Operational log 2000 indications
- Switching-device log 2000 indications
- User-defined log 200 indications

If the maximum capacity of the user-defined log or of the operational log is exhausted, the newest entries overwrite the oldest entries. If indications in the information routing of DIGSI 5 are routed to a log, then they are also saved. During a supply-voltage failure, recorded data are securely held by means of battery buffering or storage in the flash memory. You can read and analyze the log from the device with DIGSI 5. The device display and navigation using keys allow you to read and analyze the logs on site.

Indications can be output spontaneously via the communication interfaces of the device and through external request via general interrogation. In DIGSI 5, indications can be tracked spontaneously during online mode in a special indication window. Indications can be made accessible to higher-level control systems through mapping on various communication protocols.



NOTE

All indications are assigned to certain device functions. The text of each indication contains the corresponding function designation. You can find explanations of the meaning of indications in the corresponding device functions. However, you can also define indications yourself and group them into your own function blocks. These can be set by binary inputs or CFC logic.

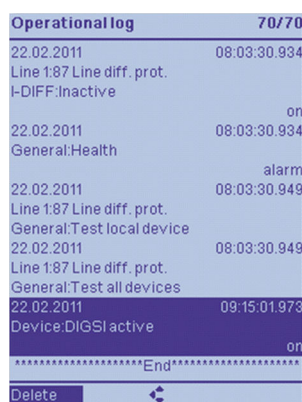
Reading Indications

To read the indications of your SIPROTEC 5 device you can use the on-site operation panel of the device or a PC on which you have installed DIGSI 5. The subsequent section describes the general procedure.

3.1.2 Reading Indications on the On-Site Operation Panel

Procedure

The menus of the logs begin with a header and 2 numbers at the top right corner of the display. The number after the slash signifies the number of indications that are available. The number before the slash indicates how many indications have just been selected or shown. The end of the indication list is closed with the entry ***END***.



[sc_oprlog, 1, en_US]

Figure 3-1 On-Site Display of an Indication List (Example: Operational Indications)

Menu Path	Log
Main menu → Indications →	Operational log Fault log Switch. device log Ground-fault log Setting-history log User log 1 User log 2 Motor-starting log Com supervision log
Main Menu → Test & Diagnosis → Log →	Device diagnosis Security log Communication log

To reach the desired log from the main menu, use the navigation keys of the on-site operation panel.

- ✧ Navigate inside the log using the navigation keys (top/bottom). You will find the most current indication at the top of the list. The selected indication is shown with a dark background.

Which indications can be shown in the selected log depends on the assignments in the DIGSI 5 information routing matrix or is predefined. Every indication contains date, time, and its state as additional information. You will find information about this in chapter [3.1.5.1 General](#).

In some logs, you are given the option of deleting the entire indication list by softkey in the footer of the display. To learn more about this, read chapter [3.1.6 Saving and Deleting the Logs](#).



NOTE

No password entry is necessary to read indications from the device.

3.1.3 Reading Indications from the PC with DIGSI 5

Procedure

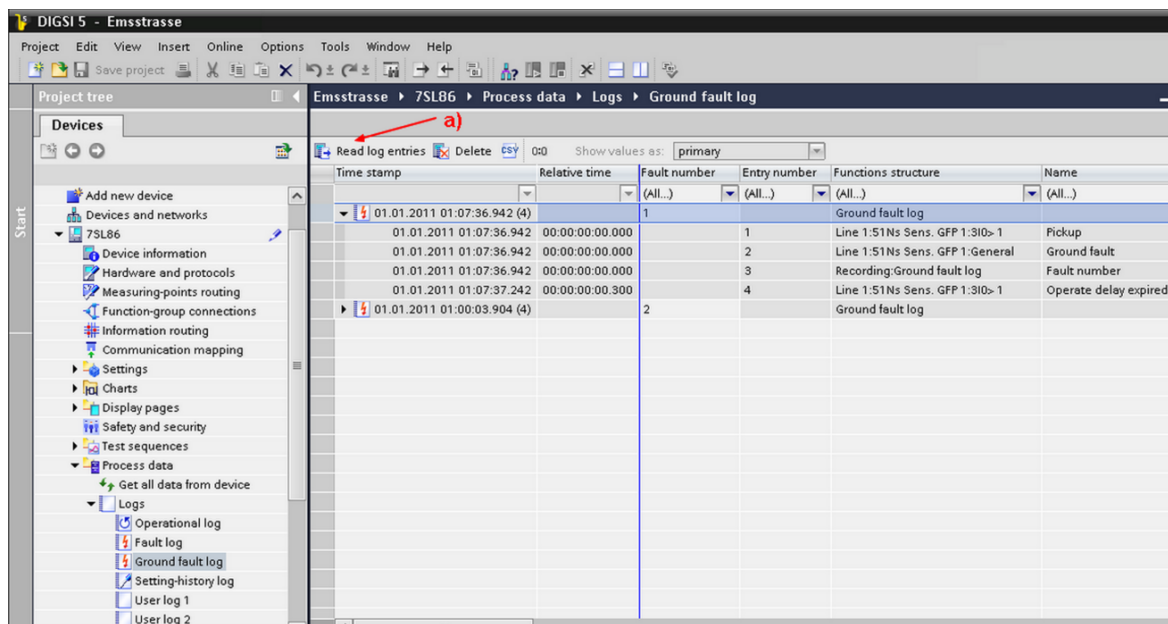
Menu Path (Project)	Log
Project → Device → Process data → Log →	Operational log Fault log Switch. device log Ground-fault log Setting-history log User log 1 User log 2 Motor-starting log Com supervision log
Online access → Device → Device information → Logs tab →	Device-diagnosis log Security indications
Online access → Device → Test suite → Communica- tion module → Hardware ²	Communication log

To read the indications with DIGSI 5 your PC must be connected via the **USB user interface** of the on-site operation panel or via an **Ethernet interface** of the device. You can establish a direct connection to your PC via the Ethernet interfaces. It is also possible to access all connected SIPROTEC 5 devices via a data network from your DIGSI 5 PC.

- ✧ You reach the desired logs of the SIPROTEC 5 device using the project-tree window. If you have not created the device within a project, you can also do this via the **Online access** menu item.

After selecting the desired log, you are shown the last state of the log loaded from the device. To update, it is necessary to synchronize with the log in the device.

- ✧ Synchronize the log. For this purpose, click the appropriate button in the headline of the log (see the ground-fault indications example in [Figure 3-2 a\)](#)).



[sc_grfimd, 1, en_US]

Figure 3-2 DIGSI 5 Display of an Indication List (Example of Ground-Fault Log)

² There may potentially be several communication modules to select from

You will find additional information about deleting and saving logs in chapter [3.1.6 Saving and Deleting the Logs](#).

Which indications can be shown in the selected log depends on the assignments in the DIGSI 5 information routing matrix or is predefined. You will find information about this in chapter [3.1.5.1 General](#).

Setting Relative Time Reference

- ✧ Reference the display of log entries, if needed, to the real time of a specific entry. In this way, you determine a relative time for all other indications. The real-time stamps of events remain unaffected.

3.1.4 Displaying Indications

Displayed indications are supplemented in DIGSI 5 and on the on-site operation panel with the following information:

Table 3-1 Overview of Additional Information

Indications in	DIGSI 5 Information	Device Display Information
Log for operational indications and log for user-defined and switching-device indications	Time stamp (date and time), Relative time, Entry number, Function structure, Name, Value, Quality, Cause, Number	Time stamp (date and time), Function structure, Name, Value
Log for parameter changes	Time stamp (date and time), Relative time, Entry number, Function structure, Name, Value, Quality, Cause, Number	Time stamp (date and time), Function structure, Name, Value
Spontaneous indication window (DIGSI 5)	Time stamp (date and time), Relative time, Indication, Value, Quality, Additional Information	Time stamp (date and time), Fault number, Value
Log for safety indications ³	Time stamp (date and time), Indication number, Indication	Time stamp (date and time), Indication
Log for device-diagnostic indications ³	Time stamp (date and time), Indication number, Indication	Time stamp (date and time), Indication

³ Only online access

Indications in	DIGSI 5 Information	Device Display Information
Log for communication indications ³	Time stamp (date and time), Indication number, Indication	Time stamp (date and time), Indication
Log for communication supervision (GOOSE)	Time stamp (date and time), Relative time, Entry number, Function structure, Name, Value, Quality, Cause, Number	Time stamp (date and time), Function structure, Name, Value

Overview of Displayed Quality Attributes

If values are shown on the device display or in DIGSI, the following quality attributes are different for measured values and metered values.

Table 3-2 Measured Values

IEC 61850				Device Display/ DIGSI	Description
Detail Quality	Validity				
	Good	Invalid	Questionable		
–	X			Value	The measured value is valid.
Failure		X		Fault	The device is defective. Contact Support.
Inaccurate			X	---	The measured value was not calculated (for example, the angle between current and voltage if 1 of the 2 variables is missing).
Bad Reference			X	≈ Value	The measured value can be inaccurate (for example, outside the frequency-tracking range).
Out of Range			X	> Value	The measured value exceeds the measuring range.

Table 3-3 Metered Values

IEC 61850			Device Display/ DIGSI	Description
Validity				
Good	Invalid	Questionable		
X			Value	The metered value is invalid.
	X		---	The metered value was not calculated.
		X	≈ Value	The metered value has no reference.

Indication Columns

The following table shows the meaning of the individual columns in the log:

Indication Column	Meaning
Time stamp	Time stamp of the indication in device time using the local time zone of the device or the query time for the motor log
Relative time	Relative time to a reference entry
Error number	Number of the error that occurred in the device. This number increments continuously.
Entry number	Entry identification of buffer entries. This identification displays the sequence of buffer entries.
Indication number	Number of the indication that occurred in the device. This number increments continuously and is necessary for an analysis by Siemens.
Indication	Indication text
Function structure	Path of the signal with the signal name
Name	Signal name
Value	Current state of the command. Also pay attention to the value quality to check whether the value is up to date.
Quality	The quality of the value shows the source of the value and whether the value is up to date.
Cause	Additional information such as the cause and validity
Number	DIGSI address of the signal

3.1.5 Logs

3.1.5.1 General

Indications are saved in logs inside the device and are available for later analyses. Different logs allow categorization of indication logging based on operating states (for example, operational and fault logs) and based on fields of application.

Table 3-4 Log Overview

Log	Logging
Operational log	Operational indications
Fault log	Fault indications
Switching-device log	Switching operation and circuit-breaker statistics
Ground-fault log	Ground-fault indications
Setting-history log	Setting changes
User-defined log	User-defined indication scope
Security log	Access with safety relevance
Device-diagnosis log	Error of the device (software, hardware) and the connection circuits
Communication log	Status of communication interfaces
Motor-starting log	Information on the motor starting
Communication-supervision log	Communication supervision (GOOSE)

Log Management

Logs have a ring structure and are automatically managed. If the maximum capacity of a log is exhausted, the oldest entries disappear before the newest entries. If the maximum capacity of the fault or ground-fault log is reached, the number of the last fault is output via the signal **Fault recording buffer is full**. You can route this signal in the information routing. If indications in the information routing of DIGSI 5 are routed to a log, then they are also saved. During a supply-voltage failure, recorded data are securely held by means of battery buffering or storage in the flash memory. You can read and analyze the log from the device with DIGSI 5. The device display and the navigation allow you to read and evaluate the logs on site using keys.

Configurability of Logs

The indication capacity to be recorded in configurable logs (for example, ground-fault log) is laid down in columns of the information routing (matrix) of DIGSI 5 specifically defined for this purpose.

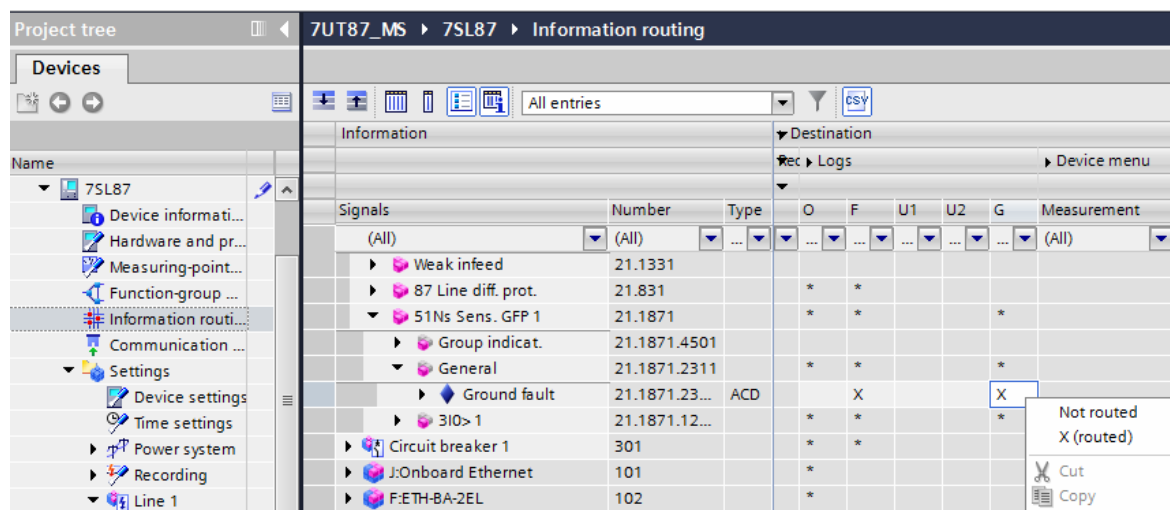
Procedure

To reach the information routing of your SIPROTEC 5 device, use the project-tree window. Access is only through the project:

- Open the information routing.
Project → Device → **Information routing**
- Select the appropriate routing column.
Destination → Logs → Column **Ground-fault log (G)**

The routing of the selected indication is done via right click.

- Select one of the options in the list box shown:
 - Routed (X)
 - Unrouted



[sc_infpu1, 2, en_US]

Figure 3-3 Indication Configuration in DIGSI 5 (Example: Ground-Fault Log, Column G)

For non-configurable logs (for example, setting-history logs) scope and type of logged indications are described separately (see following chapter about logs).

3.1.5.2 Operational Log

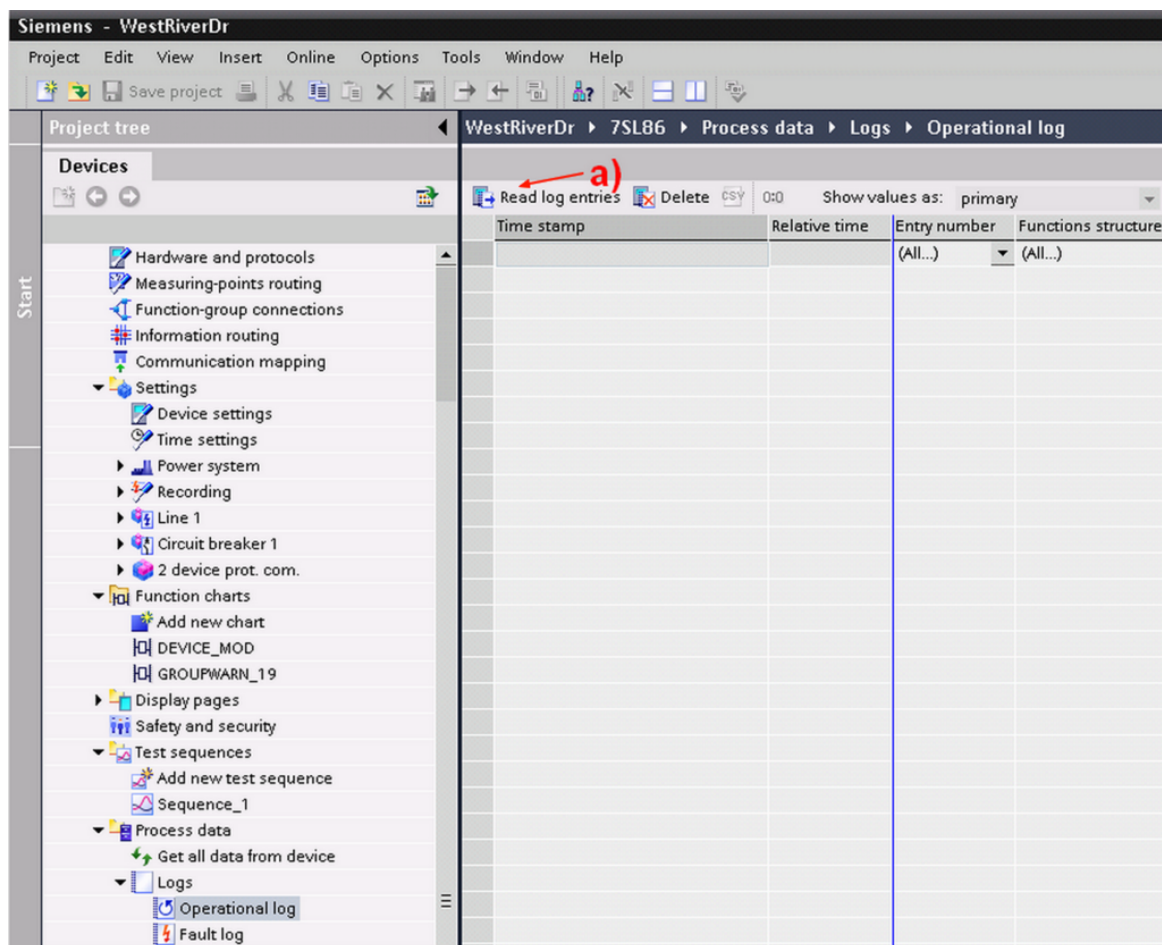
Operational indications are information that the device generates during operation. This includes information about:

- State of device functions
- Measured data
- Power-system data

Exceeding or dropping below limiting values is output as an operational indication. Up to 2000 indications can be stored in the operational log.

Reading from the PC with DIGSI 5

- To reach the operational log of your SIPROTEC 5 device, use the project-tree window.
Project → Device → Process Data → Log → **Operational log**
- The status of the operational log last loaded from the device is shown to you. To update (synchronization with the device), click the button **Read log entries** in the headline of the indication list (Figure 3-4 a)).



[sc_betrmtd, 1, en_US]

Figure 3-4 Reading the Operational Log with DIGSI 5

Reading on the Device via the On-Site Operation Panel

- To reach the operational log via the main menu, use the navigation keys of the on-site operation panel.
Main Menu → Indications → **Operational log**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.
- Using the **Info** softkey, you can retrieve auxiliary information on the entry depending on the context.

Operational log		117/222
08.12.2016	08:19:24.117	
Tap changer 1		
Tap changer:Position		
08.12.2016	08:19:25.616	OPR+ lower
Tap changer 1		
Tap changer:Lower command		off
08.12.2016	08:19:34.116	
Tap changer 1		
Tap changer:Position failure		on
08.12.2016	08:19:34.116	
Tap changer 1		
Tap changer:Position		invalid
		CMT-

[sc_operlog1, 2, en_US]

Operational log		117/222
08.12.2016	08:19:24.117	
Tap changer 1		
Tap changer:Position		
08.12.2016	08:19:25.616	OPR+ lower
Tap changer 1		
Tap changer:Lower command		off
08.12.2016	08:19:34.116	
Tap changer 1		
Tap changer:Position failure		on
Additional information		
bay control		
superv. time expired		

Figure 3-5 On-Site Display of an Indication List (Example: Operational Indications)

Deletability

The operational log of your SIPROTEC 5 device can be deleted. This is done usually after testing or commissioning the device. To know more about this, read chapter [3.1.6 Saving and Deleting the Logs](#).

Configurability

The indication scope of the operational log is configured in a specifically defined column of the information routing (matrix) of DIGSI 5:

Target → Log → **Operational log** column

Selected application templates and functions from the library bring with them a predefined set of operational indications which you can adjust individually at any time.

3.1.5.3 Setting-History Log

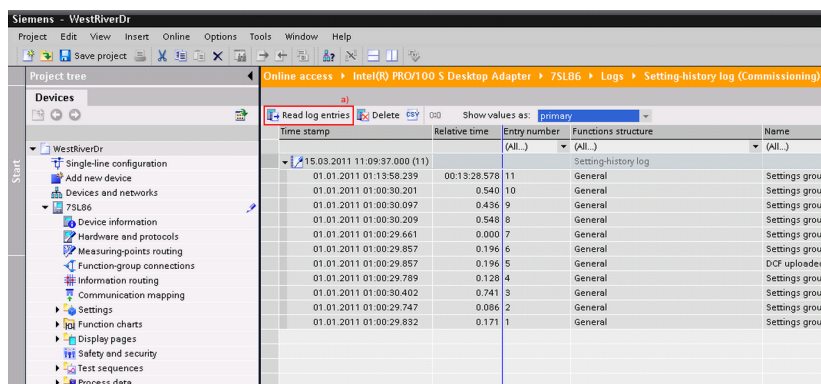
All individual setting changes and the downloaded files of entire parameter sets are recorded in the log for setting changes. This enables you to determine setting changes made are associated with events logged (for example faults). On the other hand, it is possible to obtain verification with fault analyses, for example, that the current status of all settings truly corresponds to their status at the time of the fault. Up to 200 indications can be stored in the setting-history log.

Reading from the PC with DIGSI 5

- To reach the log for setting changes of your SIPROTEC 5 device, use the project-tree window.
Project → Device → Process data → Log → **Setting changes**

The status of the setting-history log last loaded from the device is shown to you.

- To update (synchronization with the device), click the **Read log entries** button in the headline of the indication list ([Figure 3-6](#)).



[sc_paramd, 1, en_US]

Figure 3-6 Reading the Setting-History Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel

- To reach the setting-history log from the main menu, use the navigation keys of the on-site operation panel.
Main menu → Indications → **Setting changes**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.



[sc_hislog, 1, en_US]

Figure 3-7 Reading the Setting-History Log on the On-Site Operation Panel of the Device

Indication Categories in the Setting-History Log

For this log, there is selected information that is stored in case of successful as well as unsuccessful setting changes. The following list gives you an overview of this information.

Table 3-5 Overview of Indication Types

Displayed Information	Explanation
Selection edit+	Selection of settings group to be edited
Cancellation+	Cancelling of all changes successful
SG activation+	SG activation via command successful
SG activation-	SG activation via command failed
Set+	Parameter value was changed
Confirmation+	Confirmation of change successful
Confirmation-	Confirmation of change failed
DCF uploaded	DCF loaded into device
SG 1	Settings group 1

Displayed Information	Explanation
SG 2	Settings group 2
SG 3	Settings group 3
SG 4	Settings group 4
SG 5	Settings group 5
SG 6	Settings group 6
SG 7	Settings group 7
SG 8	Settings group 8

**NOTE**

- The logged indications are preconfigured and cannot be changed!
- The log, which is organized as a ring buffer, cannot be deleted by the user!
- If you want to archive security-relevant information of the device without loss of information, you must regularly read this log.
- You cannot route additional indication objects to the setting-history log.

3.1.5.4 User Log

With the user-defined log (up to 2), you have the possibility of individual indication logging parallel to the operational log. This is helpful, for example, in special monitoring tasks but also in the classification into different areas of responsibility of the logs. Up to 200 indications can be stored in the user-defined log.

Reading from the PC with DIGSI 5

- To reach the user-defined log of your SIPROTEC 5 device, use the project-tree window.
Project → Device → Process Data → Log → **User log 1/2**

The status of the user-defined log last loaded from the device is shown to you.

- To update (synchronization with the device), click the **Read log entries** button in the headline of the indication list ([Figure 3-8 a](#)).

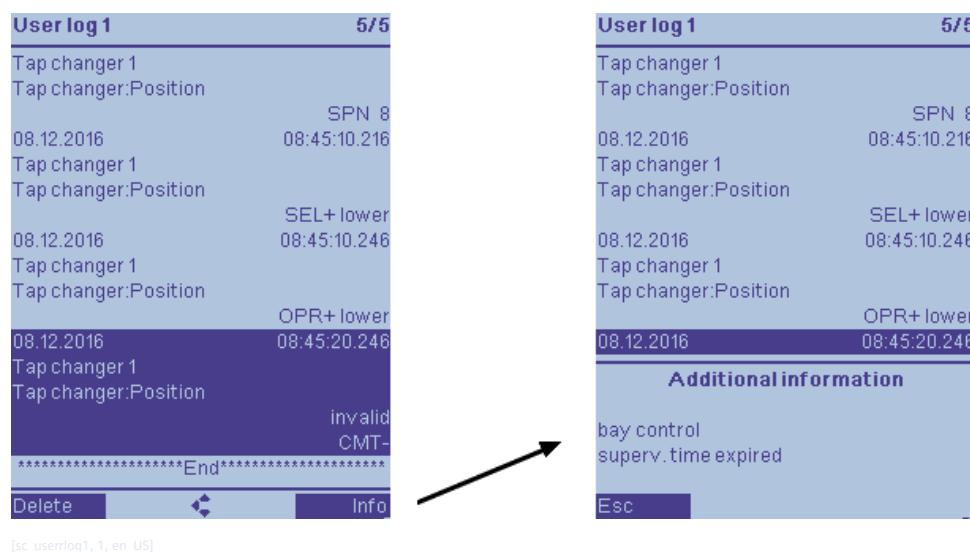
Time stamp	Relative time	Entry nr	Functions structure	Name	Value	Quality
14.09.2016 07:44:17.959 (...)				User log 2		
14.09.2016 07:38:58.025 (...)				User log 2		
14.09.2016 07:37:26.3...	00:00:0...	8	Transformer diff. 1:87T diff. pr...	Adapt. adjustm. in...	on	good (process)
14.09.2016 07:37:26.1...	00:00:0...	7	General	LED reset	unwahr	good (process)
14.09.2016 07:37:26.1...	00:00:0...	6	General	Test mode	off	good (process)
14.09.2016 07:36:15.9...	00:00:0...	5	General	LED reset	unwahr	good (process)
14.09.2016 07:36:15.9...	00:00:0...	4	General	Test mode	off	good (process)
14.09.2016 07:28:55.2...	00:00:0...	3	General	Protection inactive	on	good (process/te...
14.09.2016 07:28:23.3...	00:00:0...	2	General	LED reset	unwahr	good (process)
14.09.2016 07:28:23.3...	00:00:0...	1	General	Test mode	off	good (process)

[sc_application_md, 2, en_US]

Figure 3-8 Reading the User-Defined Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel

- To reach user-specific logs from the main menu, use the navigation keys of the on-site operation panel.
Main Menu → Indications → **User-defined log 1/2**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.
- Using the **Info** softkey, you can retrieve auxiliary information on the entry depending on the context.



[sc_userlog1, 1, en_US]

Figure 3-9 Reading the User-Defined Log on the On-Site Operation Panel of the Device

Deletability

The user-defined log of your SIPROTEC 5 device can be deleted. You will find details about this in chapter [3.1.6 Saving and Deleting the Logs](#).

Configuration of a User-Defined Log

The indication capacity of a created user-defined log can be configured freely in the associated column of the information routing (matrix) of DIGSI 5:

Target → Log → U1 or U2

All entries															
Information			Destination												
			LEDs				Recorder				Logs				Device
			Basismodul												
Signals		Number	Type	2	1.13	1.14	1.15	1.16	Signal	O	F	U1	U2	G	Measure
(All)	(All)								(All)						(All)
▶ Switch onto fault 1	21.1341								*	*	*				
▶ External trip 1pole 1	21.291								*	*	*				
▶ 50/51 OC-3ph 1p 1	21.221								*	*	*				
▶ 50N/51N OC-gnd-A1	21.211								*	*	*				
▶ 50 high-speed 1pol 1	21.981								*	*	*				
▼ 67N GFP gnd.sys.1	21.1111								*	*	*	*	*		
▶ Group indicat.	21.1111.4501								*						
▼ General	21.1111.2311								*						
▶ >Test of direction	21.1111.23...	SPS								X					
▶ Test direction	21.1111.23...	ACD													
▼ Definite-T1	21.1111.4861									*	*	*	*		
▶ >Block stage	21.1111.48...	SPS								X					
▶ Inactive	21.1111.48...	SPS								X					
▶ Behavior	21.1111.48...	ENS								X					
▶ Health	21.1111.48...	ENS								X					
▶ Mode 1p dead-tm...	21.1111.48...	SPS										X			
▶ Prot.PU blocks op...	21.1111.48...	SPS											X		
▶ Pickup	21.1111.48...	ACD									X				
▶ Operate delay exp...	21.1111.48...	ACT													
▶ Operate	21.1111.48...	ACT									X				

[sc_dliu2, 1, en_US]

Figure 3-10 Indication Configuration in DIGSI 5 (Example: User-Defined Log U1/U2)

3.1.5.5 Security Log

Access to areas of the device with restricted access rights is recorded in the security log. Unsuccessful and unauthorized access attempts are also recorded. Up to 2048 indications can be stored in the security log.

Reading from the PC with DIGSI 5

- To reach the security log of your SIPROTEC 5 device, use the project-tree window. The device must be in Online access.

Project → Online access → Device → Device Information → **Logs** tab → Security logs

The state of the security log last loaded from the device is displayed.

- Before this, refresh the contents by clicking the update arrows in the headline.

Time stamp	Message number	Severity	Indication
26.06.2018 10:02:40...	9	Warning	'7UT85_S': A user has ended an interactive session.
26.06.2018 10:02:40...	4	Warning	'7UT85_S': A user has initiated a remote session from '...
26.06.2018 10:12:38...	4	Warning	'7UT85_S': A user has initiated a remote session from '...
26.06.2018 10:12:45...	9	Warning	'7UT85_S': A user has ended an interactive session.
26.06.2018 10:29:36...	4	Warning	'7UT85_S': A user has initiated a remote session from '...
26.06.2018 10:30:46...	9	Warning	'7UT85_S': A user has ended an interactive session.
26.06.2018 11:36:56...	4	Warning	'7UT85_S': A user has initiated a remote session from '...
26.06.2018 11:37:04...	63	Alert	'7UT85_S': Restart initiated from '192.168.100.100' [...]
26.06.2018 11:38:01...	29	Warning	'7UT85_S': Configuration settings were uploaded from...
26.06.2018 11:38:01...	63	Alert	'7UT85_S': Restart initiated from '192.168.100.100' [...]
26.06.2018 11:38:01...	9	Warning	'7UT85_S': A user has ended an interactive session.
26.06.2018 11:38:04...	4	Warning	'7UT85_S': A user has initiated a remote session from '...
26.06.2018 11:38:41...	4	Warning	'7UT85_S': A user has initiated a remote session from '...
26.06.2018 11:38:47...	9	Warning	'7UT85_S': A user has ended an interactive session.

[sc_secmlid, 2, en_US]

Figure 3-11 Reading the Security Indications with DIGSI 5

Reading on the Device through the On-Site Operation Panel

- To reach the security log from the main menu, use the navigation keys of the on-site operation panel.
Main menu → Test & Diagnosis → Logs → **Security log**
- You can navigate on the on-site operation panel using the navigation keys (top/bottom) inside the displayed indication list.

Time stamp	Indication
26.06.2018 13:14:31.570	'7UT85_S': User 'Siemens' changed settings related to user authentication: 'Module port' [set to value '1'].
26.06.2018 13:14:31.591	'7UT85_S': Configuration settings were uploaded from '192.168.100.100'.
27.06.2018 08:00:20.550	'7UT85_S': A user has ended an interactive session.
28.06.2018 06:55:12.480	'7UT85_S': A user has ended an interactive session.
28.06.2018 07:01:41.260	'7UT85_S': Audit log was viewed.
28.06.2018 07:01:41.260	'7UT85_S': Audit log was viewed.

[sc_seclog, 1, en_US]

Figure 3-12 Reading the Security Log on the On-Site Operation Panel of the Device

**NOTE**

- The logged indications are preconfigured and cannot be changed!
- This log, which is organized as a ring buffer, cannot be deleted by the user!
- If you want to archive security-relevant information of the device without loss of information, you must regularly read this log.

3.1.5.6 Device-Diagnosis Log

Concrete take-action instructions are logged and displayed in the device-diagnosis log for the following items:

- Required maintenance (for example, battery supervision)
- Identified hardware defects
- Compatibility problems

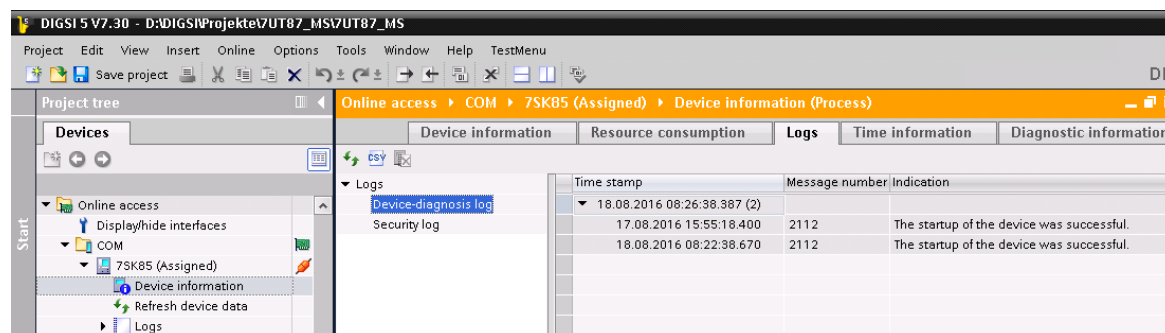
Up to 500 indications can be stored in the device-diagnosis log. In normal operation of the device, it is sufficient for diagnostic purposes to follow the entries of the operational log. This specific significance is assumed by the device-diagnosis log when the device is no longer ready for operation due to hardware defect or compatibility problems and the fallback system is active.

Reading from the PC with DIGSI 5 in Normal Operation

- To reach the device-diagnosis log of your SIPROTEC 5 device, use the project-tree window.
Project → Online access → Device → Device information → **Logs** tab → Device-diagnosis log

The status of the device-diagnosis log last loaded from the device is shown to you.

- Before this, refresh the contents by clicking the update arrows in the headline.

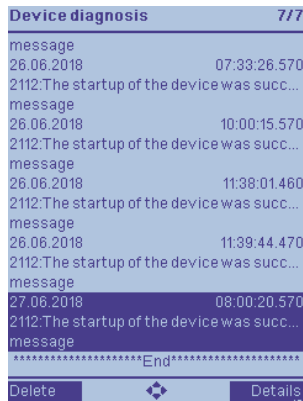


[sc_devdia, 1, en_US]

Figure 3-13 Reading the Device-Diagnosis Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel in Normal Operation

- To reach the diagnosis log from the main menu, use the navigation keys of the on-site operation panel.
Main Menu → Test & Diagnosis → Logs → **Device diagnosis**
- You can navigate on the on-site operation panel using the navigation keys (top/bottom) inside the displayed indication list.



[sc_devdia_01, 1, en_US]

Figure 3-14 Reading the Device-Diagnosis Log on the On-Site Operation Panel of the Device

**NOTE**

- The device-diagnosis log cannot be deleted!
- The logged indications are preconfigured and cannot be changed!

3.1.5.7 Communication Log

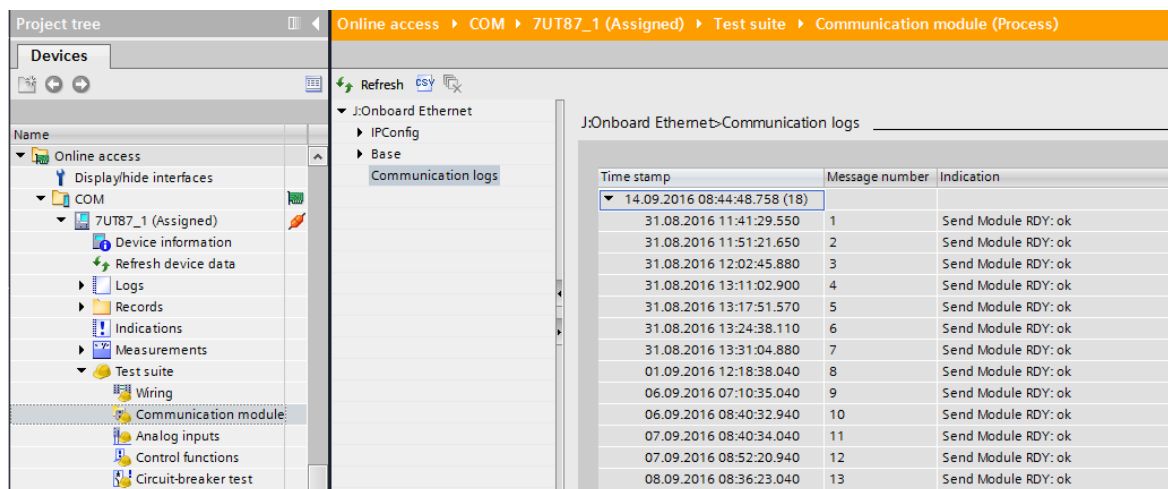
The logging of the respective status such as ensuing faults, test and diagnosis operation, and communication capacity utilizations is done for all hardware-based configured communication interfaces. Up to 500 indications can be stored in the communication log. Logging occurs separately for each communication port of the configured communication modules.

Reading from the PC with DIGSI 5

- Use the project-tree window to reach the communication logs of your SIPROTEC 5 device.
Online access → Device → Test suite → Communication module
- Then select:
J:Onboard Ethernet → **Communication log**

The communication log is shown to you in the state last loaded from the device.

- Before this, refresh the contents by clicking the update arrows in the headline.

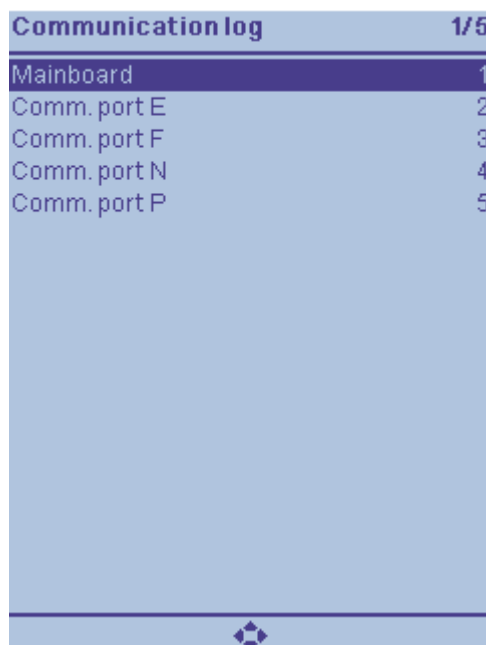


[sc_compuif, 2, en_US]

Figure 3-15 Reading the Communication Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel

- To reach the communication log from the main menu, use the navigation keys on the on-site operation panel.
Main Menu → Test & Diagnosis → Logs → **Communication logs**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.



[sc_commlog, 1, en_US]

Figure 3-16 Reading the Communication Log on the On-Site Operation Panel of the Device

Deletability

The communication logs of your SIPROTEC 5 device can be deleted. Read details about this in chapter [3.1.6 Saving and Deleting the Logs](#).

Configurability

The communication logs are not freely configurable. The entries are preconfigured.

3.1.5.8 Communication-Supervision Log

The communication-supervision log is used to log communication events.

The following events are currently logged:

- Status for each GOOSE subscription (if configured)
A log is kept of whether the GOOSE subscription has received valid messages or not.
- Aggregated status for all GOOSE subscriptions
The status is **TRUE** if at least one GOOSE subscription does not receive any valid message.
- Subscriber in simulation mode
GOOSE messages are processed with a simulation flag. The status is **TRUE** if at least one GOOSE subscription processes simulated messages.

Reading from the PC with DIGSI 5

- To reach the communication-supervision log of your SIPROTEC 5 device, use the project-tree window.
Project → Device → Process data → Logs → **Com supervision log**

The status of the communication-supervision log last loaded from the device is shown.

- To update (synchronization with the device), click the button **Read log entries** in the headline of the indication list.

Time stamp	Relative time	Entry number	Functions structure
28.06.2018 08:55:51.181 ...		(All)	(All)
27.06.2018 08:00:20.5...	00:20:22:19.110	3	Com. supervision:GOOSE supervis.:Group In. C
26.06.2018 11:39:44.4...	00:00:01:43.010	2	Com. supervision:GOOSE supervis.:Group In. C
26.06.2018 11:38:01.4...	00:00:00:00.000	1	Com. supervision:GOOSE supervis.:Group In. C
26.06.2018 10:01:48.298 ...			Com supervision log
26.06.2018 07:01:29.424 ...			Com supervision log
26.06.2018 06:36:34.683 ...			Com supervision log
21.06.2018 14:33:09.1...	02:07:09:48.265	7	Com. supervision:GOOSE supervis.:Group In. C
20.06.2018 07:28:41.1...	01:00:05:20.256	6	Com. supervision:GOOSE supervis.:Group In. C
19.06.2018 13:30:41.1...	00:06:07:20.268	5	Com. supervision:GOOSE supervis.:Group In. C
19.06.2018 13:28:00.2...	00:06:04:39.336	4	Com. supervision:GOOSE supervis.:Group In. C
19.06.2018 13:24:52.1...	00:06:01:31.281	3	Com. supervision:GOOSE supervis.:Group In. C
19.06.2018 12:54:46.2...	00:05:31:25.294	2	Com. supervision:GOOSE supervis.:Group In. C
19.06.2018 07:23:20.9...	00:00:00:00.000	1	Com. supervision:GOOSE supervis.:Group In. C

[sc_comsuperv, 1, en_US]

Figure 3-17 Reading the Communication-Supervision Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel

- To reach the communication-supervision log from the main menu, use the navigation keys on the on-site operation panel.
Main menu → Logs → **Com supervision log**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.

Com supervision log 3/3	
26.06.2018 11:38:01.460	Com. supervision:GOOSE supervis. Group Indicat.:Group alarm
26.06.2018 11:39:44.470	Com. supervision:GOOSE supervis. Group Indicat.:Group alarm
27.06.2018 08:00:20.570	Com. supervision:GOOSE supervis. Group Indicat.:Group alarm
*****End*****	

[sc_comsupervlg, 1, en_US]

Figure 3-18 Reading the Communication-Supervision Log on the On-Site Operation Panel of the Device

Deletability

The communication-supervision log of your SIPROTEC 5 device can be deleted. Read details about this in chapter [3.1.6 Saving and Deleting the Logs](#).

Configurability

The communication-supervision log cannot be freely configured. The entries are preconfigured.

3.1.6 Saving and Deleting the Logs

Deleting the logs of the device in the operating state is unnecessary. If storage capacity is no longer sufficient for new indications, the oldest indications are automatically overwritten with new incoming events. In order for the memory to contain information about the new faults in the future, for example, after a revision of the system, a deletion of the log makes sense. Resetting the logs is done separately for the various logs.



NOTE

Before you delete the content of a log on your SIPROTEC 5 device, save the log with DIGSI 5 on the hard disk drive of your PC.



NOTE

Not all logs of your SIPROTEC 5 device can be deleted. These limitations apply especially to logs with relevance for security and after-sales (security log, device-diagnosis log, setting-history log).



NOTE

If the device executes an initial start, for example after an update of the device software, the following logs are automatically deleted:

- Operational log
- Switching-device log
- Setting-history log
- User-defined log
- Communication-supervision log

Back up the deletable logs using DIGSI 5.



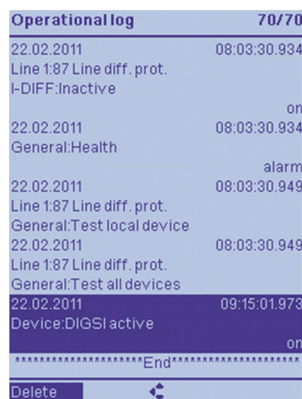
NOTE

If a ground fault is currently active, the ground-fault log cannot be deleted.

Deleting Logs on the On-Site Operation Panel

- To reach the selected log from the main menu, use the navigation keys of the on-site operation panel (example operational log):

Main menu → Logs → **Operational log**



[sc_oprlog, 1, en_US]

Figure 3-19 Deleting the Operational Log on the On-Site Operation Panel

- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.
- The option to delete the entire log is offered to you in the footer of the display at the bottom left. Use the softkeys below under the display to activate the command prompts. Confirm the request to **Delete**.
- After being requested, enter the password and confirm with **Enter**.
- After being requested, confirm the **Deletion of all entries** with **Ok**.

Deleting Logs from the PC with DIGSI 5

- To reach the selected log of your SIPROTEC 5 device, use the project-tree window (for example operational log).
Project → Device → Process data → Logs → **Operational log**

3.1.7 Spontaneous Indication Display in DIGSI 5

With DIGSI 5 you have the possibility of displaying all currently transmitted indications of the selected device in a special indication window.

Procedure

- Call up the spontaneous indications of your selected device in the navigation window under Online access.
- Click **Indications** in the path:
Online access → Interface → Device → **Indications**
- The raising indications appear immediately without you having to wait for a cyclical update or initiate the manual update.

Time stamp	Relative time	Indication	Value	Quality	Additional info
(All)	(All)	(All)	(All)	(All)	(All)
21.09.2016 08:23:25.905	00:00:01:08....	Time sync.:Time sync. error	on	good (process)	Data change
21.09.2016 08:22:18.925	00:00:00:01....	General:LED reset	unwahr	good (process)	Data change
21.09.2016 08:22:18.925	00:00:00:01....	General:LED have been reset	off	good (process)	Data change
21.09.2016 08:22:17.727	00:00:00:00....	General:LED have been reset	on	good (process)	Data change
21.09.2016 08:22:17.727	00:00:00:00....	General:LED reset	wahr	good (process)	Data change

[sc_spmild, 2, en_US]

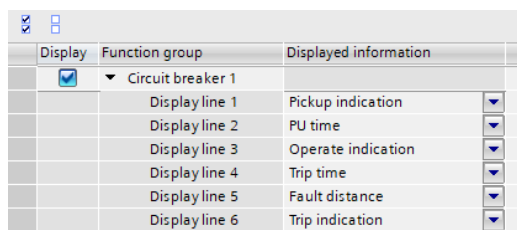
Figure 3-20 Displaying Spontaneous Device Indications in DIGSI 5

3.1.8 Spontaneous Fault Display on the On-Site Operation Panel

After a fault, the most important data of the last fault can be displayed automatically on the device display without further operational measures. In SIPROTEC 5 devices, protected objects and even circuit breakers can be freely created and configured depending on the application (even several instances). In DIGSI 5, several spontaneous fault displays can be configured, depending on the application, with each individual one being assigned a particular circuit breaker. These displays remain stored in the device until they are manually confirmed or released by LED reset.

Configuration of a Spontaneous Fault Display with DIGSI 5

- To reach the **Fault-display configuration** of your SIPROTEC 5 device, use the project-tree window. Project → Device → Display pages → **Fault-display configuration**
- In the main window, all configured circuit breakers are displayed. A list of a maximum of 6 configurable display lines is offered for each circuit breaker. The activation of a spontaneous fault display occurs for each circuit breaker by selection via checkmark in the column **Display**.
- With the parameter (**_:139**) **Fault-display** (under Device → Parameter → Device settings) you determine whether spontaneous fault displays should be shown for each pickup or only pickups with the trip command.



[sc_konstf, 2, en_US]

Figure 3-21 Configuration of the Spontaneous Fault Display on the Device

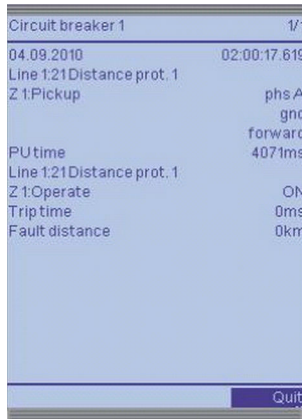
For every display line the following display options can be selected:

Table 3-6 Overview of Display Options

Displayed Information	Explanation
Pickup indication	Display of the first function stage picked up in a fault, as needed with auxiliary information (phases, ground, direction)
PU time	Display of the entire pickup duration of the fault
Operate indication	Display of the first function stage triggered in a fault, as needed with auxiliary information (phases)
Trip time	Display of the operate time related to the beginning of the fault (pickup start)
Fault distance	Display of the measured fault-location distance
Operate result indication	Display of the control or switching device triggered in a fault, with auxiliary information (phases) where necessary

Acknowledgment of the Spontaneous Fault Display on the Device

After faults, the last occurred fault is always displayed to you. In cases where more than one circuit breaker is configured, several stored fault displays can be present after faults, with the latest being displayed. These displays remain stored in the device until manual acknowledgment or release by LED reset.



[sc_stfanz, 1_en_US]

Figure 3-22 Spontaneous Fault Display on the Device

Method 1: Manual acknowledgment

- Press the softkey button **Quit** in the base bar of the display. The display is irretrievably closed. Repeat this step until no further spontaneous fault displays appear.
- After completion of all confirmations the last display view is showed before the faults.

Method 2: Acknowledgment via LED reset

- An LED reset (device) causes the reset of all stored LEDs and binary output contacts of the device and also to the confirmation of all fault displays stored in the display.

You can find more details on the topic of LED reset in chapter [3.1.9 Stored Indications in the SIPROTEC 5 Device](#)

3.1.9 Stored Indications in the SIPROTEC 5 Device

In your SIPROTEC 5 device, you can also configure indications as **stored**. This type of configuration can be used for LEDs as well as for output contacts. The configured output (LED or contact) is activated until it is acknowledged. Acknowledgment occurs via:

- On-site operation panel
- DIGSI 5
- Binary input
- Protocol of substation automation technology

Configuration of Stored Indications with DIGSI 5

In the **Information Routing** of each device set up in DIGSI 5, you can route binary signals, among others, to LEDs and output contacts.

- To do this, proceed in the project tree to:
Project → Device → **Information routing**
- Right-click the routing field of your binary indication in the desired LED or binary output column in the routing range of the targets.

You are offered the following options:

Table 3-7 Overview of Routing Options

Routing Options		LEDs	BOs	Bls	Description
H	(active)			X	The signal is routed as active with voltage.
L	(active)			X	The signal is routed as active without voltage.
V	(unlatched)	X	X		The signal is routed as unlatched. Activation and reset of the output (LED, BO) occurs automatically via the binary-signal value.
G	(latched)	X	X		The binary signal is latched when the output (LED) is activated. To reset, a targeted confirmation must occur.
NT	(conditioned latching)	X			Fault indications are stored during control of the output (LED) as a function of the parameter (<code>_ : 91:139</code>) Fault-display. In the event of a new fault, the previously stored states are reset. - If the fault gets terminated via a trip command from the assigned circuit breaker, the status of an indication remains as latched with the setting option with trip. Without a trip command, the status is displayed before the fault (if necessary, the status of the last fault) is restored. - With the setting option with pickup the current indication image of a pickup gets stored. The image comprises all indications of functions that are effective in the event of tripping on the same circuit breaker, like the picked up function.
TL	(stored only with tripping)		X		Routing option TL (tripping stored) is only possible for the switching object circuit breaker. The output is saved with protection tripping. The contact remains activated until acknowledged. Control commands are not affected. A control command is pending above the parameterized command period until feedback has been successfully received. Note: You can realize the functionality of the Lockout (ANSI 86) by storing the output relay with the routing option TL.

3.1.10 Resetting Stored Indications of the Function Group

You can configure indications of individual functions as "stored" in a function group. This type of configuration can be used for LEDs as well as for output contacts. The configured output (LED or contact) is activated until it is acknowledged.

The protection and the circuit-breaker function groups contain the block **Reset LED FG**. The block **Reset LED FG** is visible only in the Information routing under the corresponding function group in DIGSI 5. You use the binary input signal `>Reset LED` to reset the stored LEDs in the respective function group. The configured outputs (contacts) are not reset.

3.1.11 Application Mode/Test Mode and Influence of Indications on Substation Automation Technology

With the controllable *Application mode = Test* or *Test/Relay blk.*, you switch on or off the test mode for the entire device.

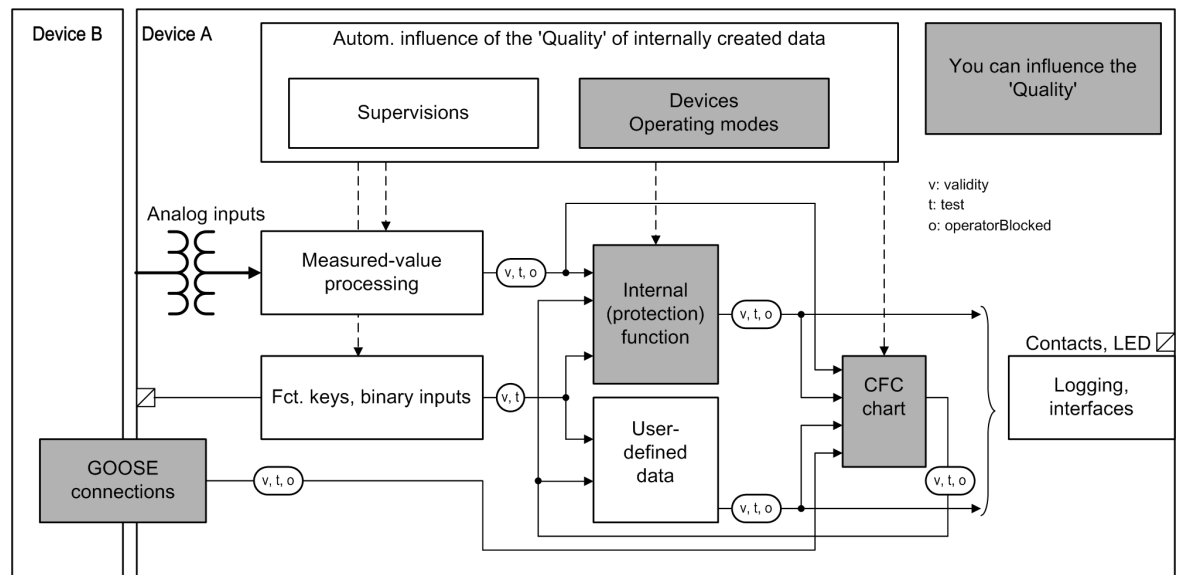
If the test mode of the device or of individual functions is switched on, the SIPROTEC 5 device marks indications sent to substation automation technology station control system with an additional test bit. This test bit makes it possible to determine that an indication was set during a test.

3.2 Processing Quality Attributes

3.2.1 Overview

The IEC 61850 standard defines certain quality attributes for data objects (DO), the so-called Quality. The SIPROTEC 5 system automatically processes some of these quality attributes. In order to handle different applications, you can influence certain quality attributes and also the values of the data objects depending on these quality attributes. This is how you can ensure the necessary functionality.

The following figure describes roughly the general data flow within a SIPROTEC 5 device. The following figure also shows at which points the quality can be influenced. The building blocks presented in the figure are described in more detail in the following.



[to_quali1, 2, en_US]

Figure 3-23 Data Flow within a SIPROTEC 5 Device

Supported Quality Attributes

The following quality attributes are automatically processed within the SIPROTEC 5 system.

- **Validity** using the values *good* or *invalid*

The **Validity** quality attribute shows if an object transferred via a GOOSE message is received (valid, invalid) or not received (invalid). The *invalid* state can be suppressed in the receiver device by also setting a substitute value for the object that is not received (see [3.2.2 Quality Processing/Affected by the User for Received GOOSE Values](#)). The substitute value is forwarded to the functions.

If the device receives one of these values, it is replaced by the *invalid* value and thus processed further as *invalid*.

If one of the detailed quality attributes (detailQual) has the value *TRUE*, then **Validity** is set to the *invalid* value, unless this was already done at the transmitter end.

- **Test** using the values *TRUE*, *FALSE*

The **Test** quality attribute indicates to the receiver device that the object received via a GOOSE message was created under test conditions and not operating conditions.

- **OperatorBlocked** using the values *TRUE*, *FALSE*
The **OperatorBlocked** quality attribute indicates whether an object transferred via GOOSE message originates from a device that is in a *functional logoff* state. When the sending device is switched off, the object is no longer being received and assumes the *invalid* state. However, since the **OperatorBlocked** quality was previously identified on the receiver device, the object can be treated differently at the receiving end (see [3.2.2 Quality Processing/Affected by the User for Received GOOSE Values](#)). At the receiving end, the object may be treated like a dropped signal.
- **Source** using the values *process*, *substituted*
The **Source** quality attribute indicates whether the object was updated in the sending device. You can find more detailed information in [3.7.2 Acquisition Blocking and Manual Updating](#).

Influencing Quality by the Operating Modes

In addition to the normal operation, the device also supports further operating modes that influence quality:

- **Test mode of the device**
You can switch the entire device to test mode. In this case, all data objects generated in the device (state values and measured values) receive the quality attribute **Test** = *TRUE*.
The CFC charts are also in test mode and all output data receive the quality attribute **Test** = *TRUE*.
- **Test mode for individual functions, stages, or function blocks**
You can switch individual functions, stages, or function blocks into test mode. In this case, all data objects generated by the function, stage, or function block (state values and measured values) receive the quality attribute **Test** = *True*.
- **Functional logoff of the device**
If you take the device out of operation and want to isolate it from the supply voltage, you can functionally log off the device ahead of time. Once you functionally log off the device, all data objects generated in the device (state values and measured values) receive the quality attribute **OperatorBlocked** = *TRUE*. This also applies to the output from CFC charts.
If objects are transferred via a GOOSE message, the receiver devices can assess the quality. The receiver device detects a functional logoff of the transmitting device. After shutting down the sending device, the receiver device identifies that the sending device has been logged off operationally and did not fail. Now the receiving objects can automatically be set to defined states (see chapter [3.2.2 Quality Processing/Affected by the User for Received GOOSE Values](#)).
- **Switching off individual functions, stages, or function blocks**
You can switch off individual functions, stages, or function blocks. In this case, all data objects generated by the function, stage, or function block (state values or measured values) receive the device-internal quality attribute **Off**. The states of the inputs and measured values remain unchanged in this case; input changes are not processed. As the quality attribute **Off** is not provided for in communication protocol IEC 61850, the data objects are transferred with the quality attribute *Invalid*.

Influencing the Quality through Hardware Supervision

Supervision functions monitor the device hardware (see [7.3 Supervision of the Device Hardware](#)). If the supervision functions identify failures in the data acquisition of the device, then all recorded data will receive the quality attribute **Validity** = *invalid*.

Influencing the Quality by the User

You can influence the processing of data and their quality differently. In DIGSI 5, this is possible at the following 3 locations:

- In the **Information routing** editor for external signals from GOOSE connections
- In the CFC chart
- In the **Information routing** editor for binary input signals of device-internal functions

The following chapters describe in more detail the options regarding this influence as well as the automatic quality processing.

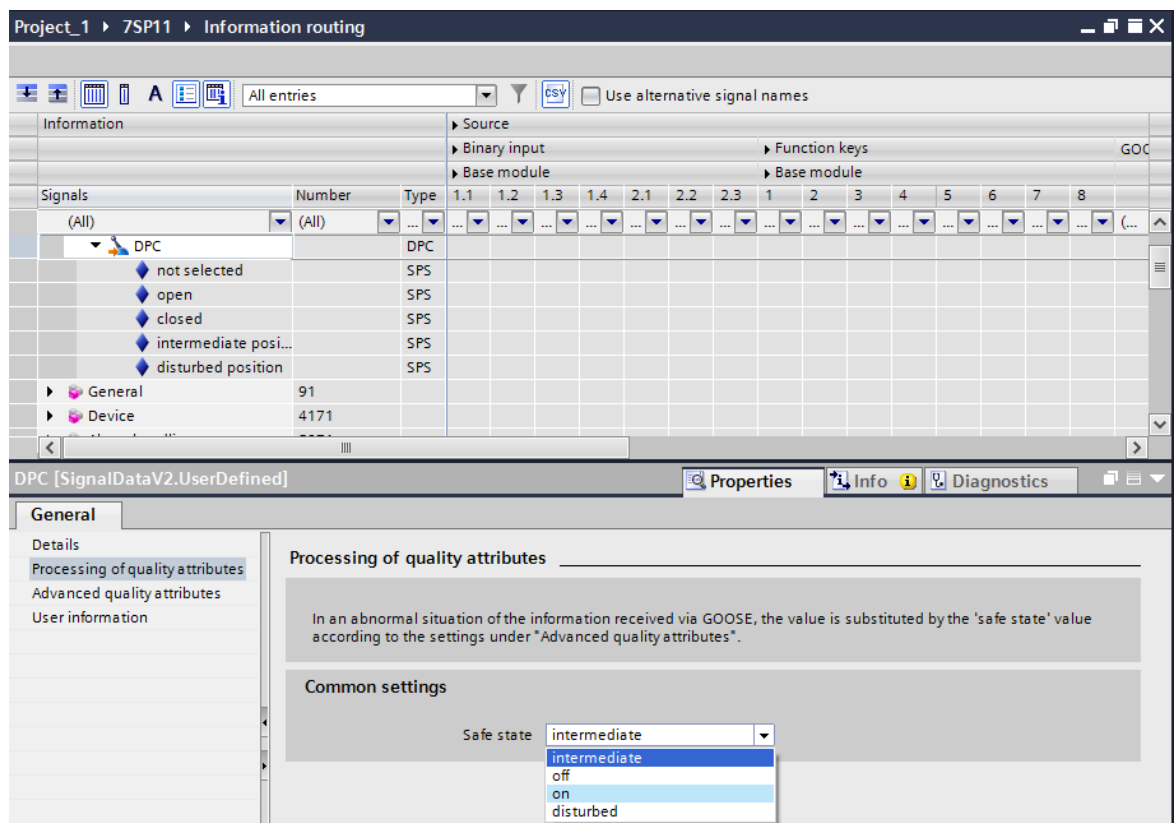
If a GOOSE connection is the data source of a binary input signal of a device-internal function, you can influence processing of the quality at 2 locations: at the GOOSE connection and at the input signal of the function. This is based on the following: A GOOSE data can be distributed within the receiving device to several functions. The GOOSE connection setting (influence) affects all functions. However, if different functions require customized settings, these are then set directly at the binary input signal of the function.

3.2.2 Quality Processing/Affected by the User for Received GOOSE Values

The properties of quality processing have changed with the introduction of GOOSE Later Binding. You can find information about the former quality processing in [Previous Quality Processing/Affected by the User for Received GOOSE Values, Page 62](#).

In the **Information Routing** Editor, you can influence the data value and quality of all data types. The following figure shows the possible influence using the example of a DPC data type. All setting options are effective for the device receiving the data.

- In the DIGSI 5 project tree, double-click **Information Routing**.
- Select either the desired signal in the **External Signals** group or the signal of a function activated via the GOOSE column.
- Open the **Properties** window and select the **Processing Quality Attributes** sheet.



[sc_LB_GOOSE_2_2_en_US]

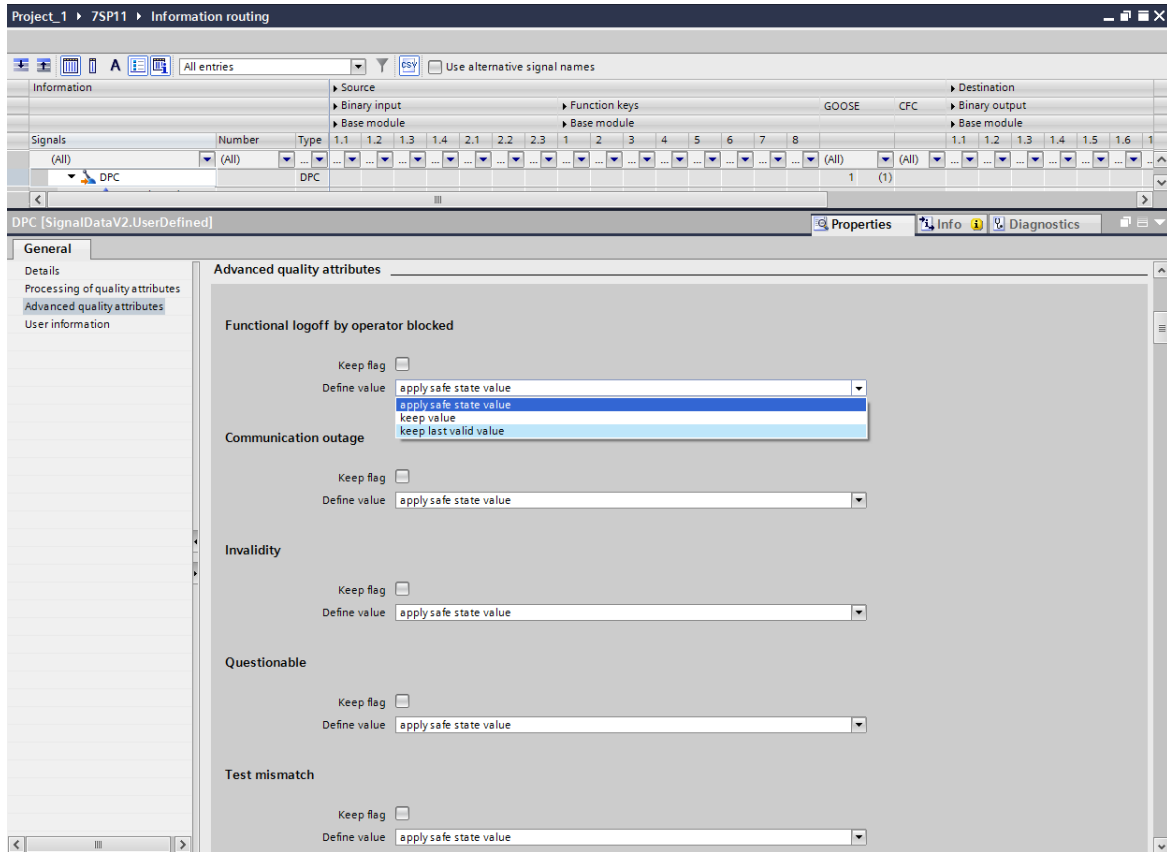
Figure 3-24 Influence Option When Linking a DPC Type Data Object

Depending on the selected data type of the object, various selection options are offered to you for the **Safe state** item in the **Common settings** section. At this point, you select the manually updated values that allow a safe operating state as soon as the data access via the communication path is disturbed.

- Select the property for the selected data object.

You can also set the **Advanced quality attributes** of the data object for GOOSE Later Binding. The following figure shows the advanced quality attributes using the example of a DPC data type.

- Open the **Properties** window and select the **Advanced quality attributes** sheet.



[sc_L8_GOOSE_1, 2, en_US]

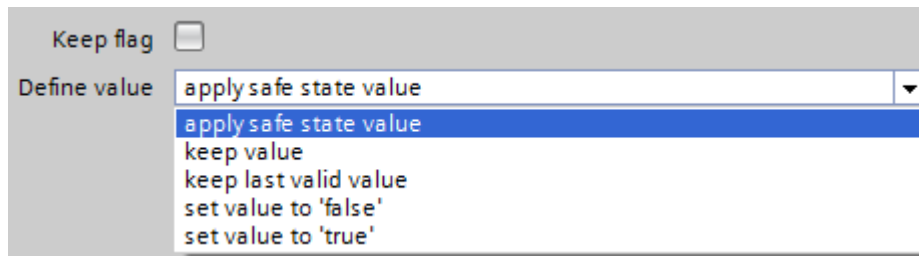
Figure 3-25 Advanced Quality Attributes for GOOSE Later Binding

With the following advanced quality attributes, you can filter the transmitted GOOSE indications and check and set their quality. The values that have been adapted, if necessary, are forwarded to the receiver. For the tests, you can select from the following setting options depending on the data type.

Table 3-8 Value Definitions

Setting Value	Description
<i>Apply safe state value</i>	The value configured in the Safe state is forwarded as valid to the application as soon as communication disturbance occurs.
<i>Keep value</i>	The disturbed quality attribute is overwritten with <i>good</i> and the received value is forwarded as valid to the application. If no value was received, the output value is assumed being in safe state.
<i>Keep last valid value</i>	If an invalid quality attribute is received, the last valid value is forwarded to the application. If no value has yet been received, the output value is assumed being in safe state.
<i>Set value to "false"</i>	Applies only to Boolean communication objects. Every invalid quality attribute causes the valid value <i>false</i> to be forwarded to the application.
<i>Set value to "true"</i>	Applies only to Boolean communication objects. Every invalid quality attribute causes the valid value <i>true</i> to be forwarded to the application.

These settings of the **Advanced quality attributes** apply to the advanced quality attributes listed below. The selection can vary depending on the data type.



[sc_LB_GOOSE_3_2, en_US]

Figure 3-26 Value Definition of a Data Object of the SPS Type

You can also forward the quality attributes unchanged. To do this, you must mark the **Keep flag** check box.

Functional Logoff by Operator Blocked

You have set the *Operation mode* to *Device logoff = true* in the transmitting device. As a result, every indication issued from the functions and subject to *Device logoff* is transmitted with the quality information *operator blocked* and **Validity = good**. The receiver recognizes this for this indication and reacts according to the settings (Table 3-8). A different quality processing can take place only once you have set the *Operation mode* to *Device logoff = false* in the transmitting device.

Communication Outage

There is communication disturbance (time allowed to live) between the transmitter and the receiver indicated by the transmitter. The indication is set in accordance with the settings (Table 3-8).

Invalidity

The transmitting device sends this indication with the quality information **Validity = invalid**. The receiver recognizes this for this indication and reacts according to the settings (Table 3-8).

Questionable

The transmitting device sends this indication with the quality information **Validity = questionable**. The receiver recognizes this for this indication and reacts according to the settings (Table 3-8).

Test Mismatch

The transmitting device or the function in the transmitting device that issues this indication is in test mode. As a result, the indication is transmitted with the quality information **test**. The receiving function block recognizes this for this indication and reacts, depending on its own test-mode state (specified in IEC 61850-7-4 Annex A), according to the settings (Table 3-8).



NOTE

Follow the sequence of tests. First, the **Functional logoff by operator blocked** is tested. Then comes **Communication outage** and so on. If a case is recognized as *active*, the test chain is canceled with the configured setting for the active case.

In the case of **Invalidity**, the tests are first performed for **Functional logoff by operator blocked** (not applicable) and then for **Communication outage** (not applicable) and canceled with the configured action for **Invalidity**.

If an indication is routed into the log, manual updating of a value is also logged based on the conditions listed above and on the reason for the manual update. Manually updating a value based on the conditions listed above causes a change in the *Health warning* function block, inherited up to *Device health* (specified in IEC 61850-7-4).

Keep Flag

The quality attributes and values indicated by the transmitter are accepted without change. Quality processing must be performed by the user via a logic diagram. The outputs of the logic diagram following the user-specific quality processing can be connected to the function-block inputs as before.

Data Substitute Values

Depending on the data type, different data substitute values must be used.

Data Type	Possible Data Substitute Values	
ACD, ACT	general	0 (False), 1 (True) The directional information is manually updated with <i>unknown</i> if the option Apply safe state value, Set value to "false" , and Set value to "true" are selected; or maintain the received value with the options Keep value or Keep last valid value selected. PhsA, phsB, phsC, and neut are manually updated with the same value just like how the general value is set.)
BAC, APC	mxVal	Floating-point range and range of values according to IEEE 754 (single precision)
BCR	actVal	-2^{63} to $2^{63} - 1$
CMV	mag, ang	Floating-point range and range of values according to IEEE 754 (single precision)
DPC, DPS	stVal	0, 1, 2, 3 (intermediate-state, off, on, bad-state)
INC	stVal	$-2\ 147\ 483\ 648$ to $2\ 147\ 483\ 647$
INS	stVal	$-2\ 147\ 483\ 648$ to $2\ 147\ 483\ 647$
ISC, BSC	valWTr.posVal	-64 to 64
	valWTr.transInd	0 (False), 1 (True)
SPC, SPS	stVal	0 (False), 1 (True)
MV	mag	Floating-point range and range of values according to IEEE 754 (single precision)

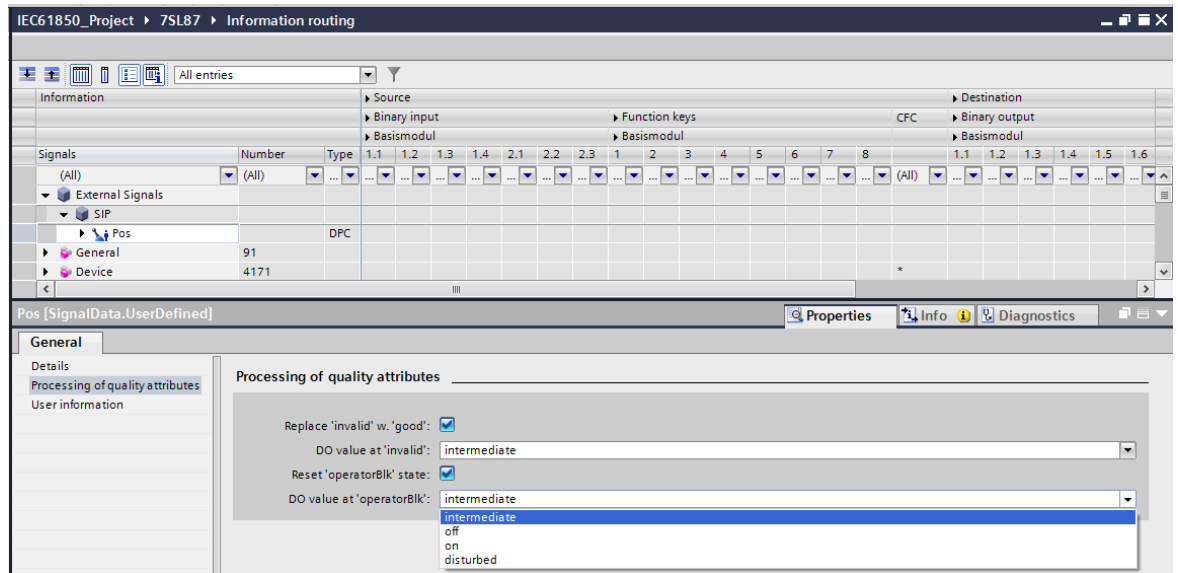
For controllable types, the following substitute values apply in addition to the settable state values or measured values:

ctrlNum = 0
 stSeld = False
 origin.orIdent = Substituted by quality processing
 origin.orCat = AUTOMATIC_BAY

Previous Quality Processing/Affected by the User for Received GOOSE Values

In the **Information Routing** editor, you can influence the data value and quality of all data types. The following figure shows the possible influence using the example of a DPC data type.

- In the DIGSI 5 project tree, double-click **Information Routing**.
- Select the desired signal in the **External Signals** group.
- Open the **Properties** window and select the **Processing Quality Attributes** sheet.



[sc_GOOSE values, 1, en_US]

Figure 3-27 Influence Option When Linking a DPC Type Data Object

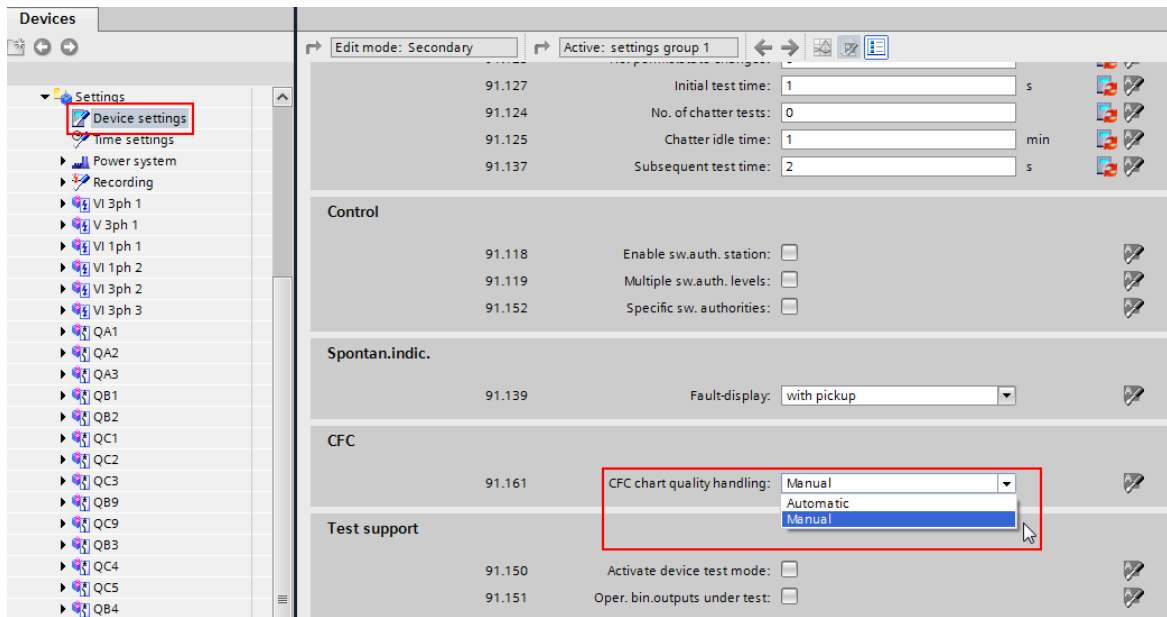
The setting options work for the device receiving the data.

Quality Attribute: Validity	
The validity values <i>reserved</i> and <i>questionable</i> are replaced at the receiving end by the <i>invalid</i> value.	
- Check box is not set. - Check box is set and receipt of Validity = good	The validity attribute and data value are forwarded without change.
Check box is set and receipt of Validity = invalid is set (also applies to values <i>reserved</i> and <i>questionable</i>).	- The validity attribute is set to <i>good</i> and processed further using this value. - The data value is set to the defined substitute value and processed further using this substitute value.
Quality Attribute: OperatorBlocked (opBlk)	
- Check box is not set. - Check box is set and received OperatorBlocked = FALSE	The OperatorBlocked attribute and data value are forwarded without change.
Check box is set and received OperatorBlocked = TRUE	- The OperatorBlocked attribute is set to <i>FALSE</i> and processed further using this value. - The data value is set to the defined substitute value and processed further using this substitute value.

Interaction of the Quality Attribute Validity and OperatorBlocked	
OperatorBlocked check box is set and receipt of OperatorBlocked = <i>TRUE</i>	Regardless of whether the validity check box is set or not, and regardless of the current validity, the validity attribute is set to <i>good</i> and the substitute value of the OperatorBlocked data object is set. That is, the OperatorBlocked settings overwrite the Validity settings.
OperatorBlocked check box is not set and receipt of OperatorBlocked = <i>TRUE</i>	The OperatorBlocked attribute remains set and is forwarded. If the Validity check box is set and the receipt of validity = <i>invalid</i> is set, the respective data object substitute value is used. For continued signal processing and influence, it must be taken into account that in this configuration the data object substitute value for validity = <i>invalid</i> is set, but the quality attribute OperatorBlocked is not yet set.

3.2.3 Quality Processing/Affected by the User in CFC Charts

In DIGSI 5, you can control the quality processing of CFC charts. In the project tree, you can find the **CFC** building block (see the following figure) under **Device name** → **Settings** → **Device settings** in the editor:



[sc_quali_cfc, 1, en_US]

Figure 3-28 Influencing CFC Quality Handling in DIGSI 5

With the **CFC chart quality handling** parameter, you control whether you want to influence the quality of CFC charts in a **Manual** or **Automatic** (default setting) manner.

If you select **Manual**, the quality attribute of the CFC chart is always valid regardless of the quality of individual signals (**Validity** = *good*)!

Only the **Test** quality attribute of the CFC chart is processed. If the device is in test mode or the input TEST of the CHART_STATE CFC building block is set, the quality attribute of the CFC chart is set to **Test**.

If you select **Automatic**, the quality processing of the CFC charts is influenced as follows:

In the case of CFC charts, a distinction has to be made between the general quality processing and certain CFC building blocks that are specifically designed for quality processing.

General Processing

Most of the CFC building blocks do not have an explicit quality processing. For these building blocks, the following general mechanisms shall apply.

Quality Attribute: Validity

If one *invalid* signal is received in the case of CFC input data, then **all** CFC output data will also be set to *invalid* if they originate from building blocks without explicit quality processing. In other words, the quality is not processed sequentially from building block to building block but the output data are set globally.

This does not apply to CFC output data that originate from building blocks with explicit quality processing (see next section).

Quality Attribute: Test

CFC chart is in normal state.	CFC input data with the Test = TRUE attribute are ignored. When the CFC chart is executed, then the data value that was used before the Test = TRUE attribute is used. The quality of this old value is also processed. This means that on the output side, the attribute Test = FALSE .
CFC chart is in Test ¹⁾ state.	If the CFC chart is executed, then the attribute Test = TRUE is set for all data leaving the CFC chart. This does not depend on whether the data are formed via CFC building blocks with or without quality processing.

¹⁾A CFC chart can be switched to the test state by switching the entire device to test mode or the input TEST of the CFC building block CHART_STATE is set.

Quality Attribute: OperatorBlocked

CFC chart is in normal state.	In CFC charts for incoming data, the OperatorBlocked attribute is ignored.
CFC chart is in functionally logged off ¹⁾ state .	In CFC charts for incoming data, the OperatorBlocked attribute is ignored. All CFC output data are labeled as functionally logged off.

¹⁾ This state only occurs if the device is functionally logged off. In this case, the quality attributes of all CFC outputs are labeled as **functionally logged off**.

Quality Processing Building Blocks (Condition Processing)

The first 3 building blocks (x_SPS) process the quality automatically according to the stated logic. The other building blocks are used to isolate the quality from a data object and add them back after separate logical processing.

Building Blocks	Description																																																
OR_SPS AND_SPS NEG_SPS	The building blocks also process the supported quality attributes according to their logic. The following tables describe the logic using input values in connection with the quality attribute Validity. The input values are 0 or 1, the quality attribute Validity can have the value <i>good</i>(=g) or <i>invalid</i>(=i). x = placeholder for the input value and quality attribute Validity OR_SPS <table><tr><th>A (Value, Attribute)</th><th>B (Value, Attribute)</th><th>Q (Value, Attribute)</th></tr><tr><td>0, i</td><td>0, x</td><td>0, i</td></tr><tr><td>0, g</td><td>0, g</td><td>0, g</td></tr><tr><td>1, g</td><td>x, x</td><td>1, g</td></tr><tr><td>1, i</td><td>0, x</td><td>1, i</td></tr><tr><td>1, i</td><td>1, i</td><td>1, i</td></tr></table> The output thus has the logical value 1 with Validity = <i>good</i> as soon as at least 1 input has the logical value 1 with Validity = <i>good</i>. Otherwise, the inputs are treated according to the OR operation and the INVALID bit is OR-gated for the quality. AND_SPS <table><tr><th>A (Value, Attribute)</th><th>B (Value, Attribute)</th><th>Q (Value, Attribute)</th></tr><tr><td>0, g</td><td>x, x</td><td>0, g</td></tr><tr><td>0, i</td><td>1, x</td><td>0, i</td></tr><tr><td>1, i</td><td>1, x</td><td>1, i</td></tr><tr><td>1, g</td><td>1, g</td><td>1, g</td></tr></table> The output thus has the logical value 0 with Validity = <i>good</i> as soon as at least 1 input has the logical value 0 with Validity = <i>good</i>. Otherwise, the inputs are treated according to the AND operation and the INVALID bit is OR-gated for the quality. NEG_SPS <table><tr><th>A (Value, Attribute)</th><th>Q (Value, Attribute)</th><th></th></tr><tr><td>0, i</td><td>1, i</td><td></td></tr><tr><td>0, g</td><td>1, g</td><td></td></tr><tr><td>1, i</td><td>0, i</td><td></td></tr><tr><td>1, g</td><td>0, g</td><td></td></tr></table>	A (Value, Attribute)	B (Value, Attribute)	Q (Value, Attribute)	0, i	0, x	0, i	0, g	0, g	0, g	1, g	x, x	1, g	1, i	0, x	1, i	1, i	1, i	1, i	A (Value, Attribute)	B (Value, Attribute)	Q (Value, Attribute)	0, g	x, x	0, g	0, i	1, x	0, i	1, i	1, x	1, i	1, g	1, g	1, g	A (Value, Attribute)	Q (Value, Attribute)		0, i	1, i		0, g	1, g		1, i	0, i		1, g	0, g	
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SPLIT_SPS SPLIT_DPS SPLI_XMV	The building blocks isolate the data value and quality of a data object. The requirement is that the quality is available from the input end. This is the case if the building block is interconnected with CFC input data, or is connected downstream with a quality processing building block (x_SPS). In other cases, the CFC editor does not allow a connection.																																																
SPLIT_Q	The building block performs binary separation of the quality into <i>good</i>, <i>bad</i>(= <i>invalid</i>), <i>test</i>, <i>off</i> and <i>operatorBlocked</i>. These 5 attributes can then be processed individually in a binary operation. The building block must be connected downstream to a SPLIT_(DO) building block.																																																

Building Blocks	Description
BUILD_Q	The building block enters a binary value for <i>good</i> and <i>bad</i> (= <i>invalid</i>) in each quality structure. Thus, with this building block the quality attributes <i>good</i> and <i>bad</i> (= <i>invalid</i>) can be set explicitly, for example, as the result of a monitoring logic. All other quality attributes are set to the default state, for instance, Test = <i>FALSE</i> . If, for example, the entire CFC chart is in the test state (see <i>Quality Attribute: Test Under General Processing</i>), this default status can again be overwritten on the CFC output side. The building block is normally connected downstream to a BUILD_(DO) building block.
BUILD_ACD	These building blocks merge data value and quality. The building-block output is generally used as a CFC output. Generally, the BUILD_Q building block is connected upstream from these building blocks.
BUILD_ACT	
BUILD_BSC	
BUILD_DPS	
BUILD_ENS	
BUILD_SPS BUILD_XMV	

CFC charts have a standard behavior in the processing of signals. If an input signal of the CFC chart has the quality *invalid*, all output signals of the CFC chart also get the quality *invalid*. This standard behavior is not desirable in some applications. If you use the building blocks for quality processing, the quality attributes of the input signals in the CFC chart are processed.

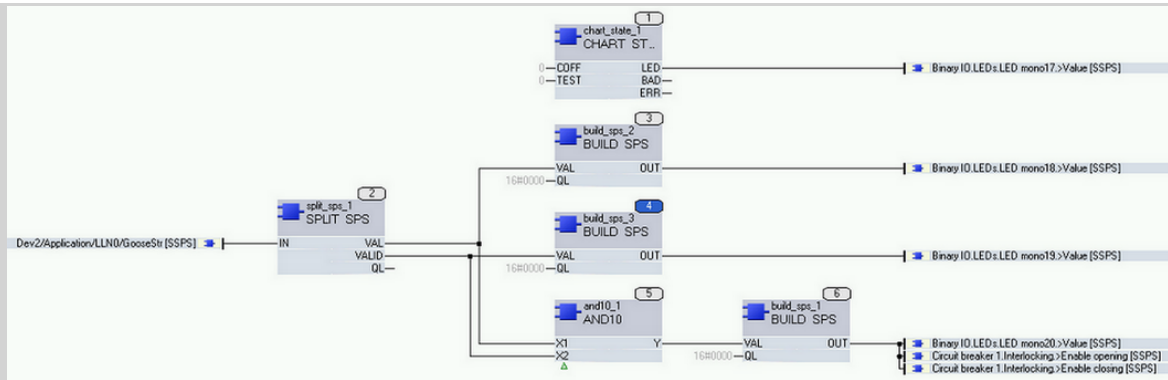
EXAMPLE: Switchgear Interlocking via GOOSE

The following conditions apply to the example:

- The interlocking condition for switchgear interlocking protection is stored in the device as a CFC chart.
- The removed device sends the release signal for the interlocking condition via a GOOSE telegram.

If the communication connection has been interrupted, the release signal (**GOOSEStr**) incoming via the GOOSE telegram gets the quality *invalid*. If the CFC chart obtains an invalid input signal, there are the following possibilities: The last signal valid before the communication interruption is used (quality = *good*) or a substitute data value with the quality *good* is used (True, False).

To do this, you have to create a separate CFC chart in addition to the interlocking plan of the switchgear interlocking. Use the building blocks for quality processing in a separate CFC chart. With the **SPLIT_SPS** building block, split the input signal (data type = SPS) into data value and quality information. You can then continue to process these signals separately in the CFC chart. Use the quality information as an input signal for a **BUILD_SPS** building block and assign the quality *good* to the signal. You obtain an SPS signal as a result, with the quality *good*. You can use this to process release messages correctly. You can process the release messages with the quality *good* in the CFC chart of the actual interlocking. Therefore, the release signal for a switch illustrated in the interlocking logic is available as a valid result with the quality *good*. The following figure shows an example of the CFC chart with the building blocks for quality processing:



[sc_cfc_ran_1_en_US]

Figure 3-29 CFC Chart with Building Blocks for Quality Processing (Switchgear Interlocking via GOOSE)

If you do not want to convert the invalid release signal to a valid signal, as described, during the communication interruption, you can also assign a defined data value to the release signal. Proceed as follows: With the SPLIT_SPS building block, split the input signal (data type = SPS) into data value and quality information. Link the VALID output of the SPLIT_SPS building block with the data value of the input signal (AND gate). This way, you can set the value to a non-risk state with the valid input signals. In the example, the output of the CFC chart is set to the value *FALSE* when the input signal is invalid.

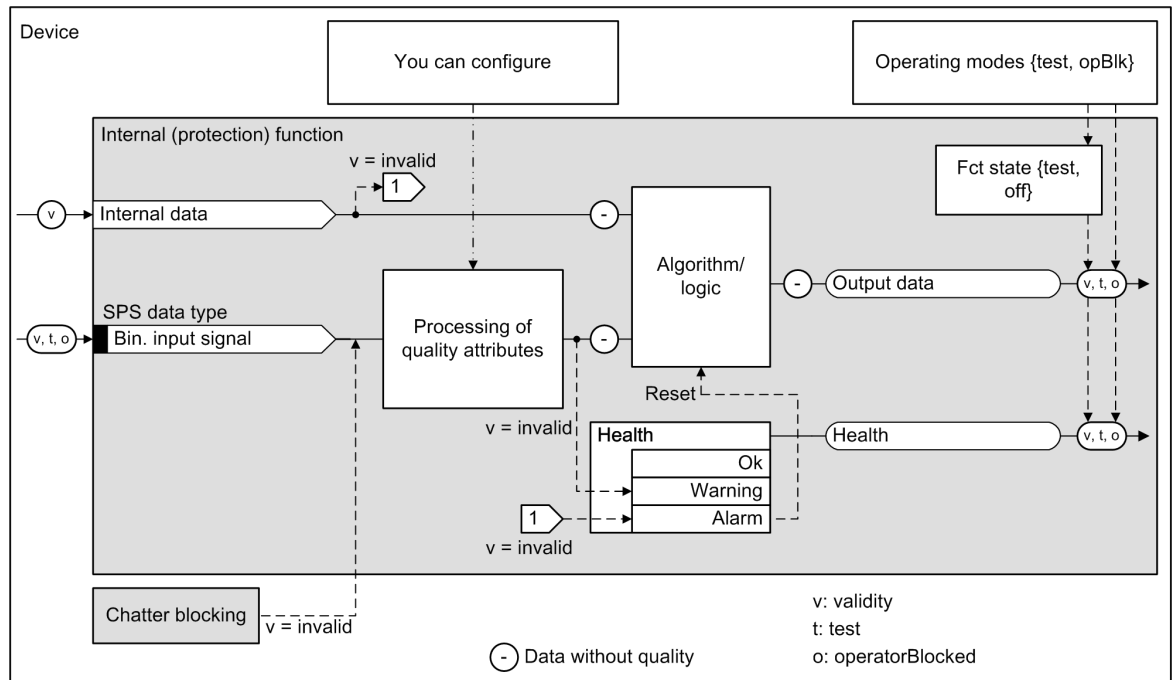
3.2.4 Quality Processing/Affected by the User in Internal Device Functions

[Figure 3-30](#) provides an overview for processing the quality of data objects within a device-internal function. A function can receive internal data or input data that is routable by the user (binary input signal or double commands). The respective quality attributes supported are evaluated by the function on the input side. The attributes are not passed through the specific algorithm/the specific logic of the function. The output data are supplied with a quality that is specified by the function state and device-operating mode.



NOTE

Take into account that pickup of chatter blocking (see chapter [3.7.1 Signal Filtering and Chatter Blocking for Input Signals](#)) sets the corresponding **Validity** attribute to *invalid*.



[io_quali3, 2, en_US]

Figure 3-30 Overview for Processing Quality within an Internal Function

Internal Input Data

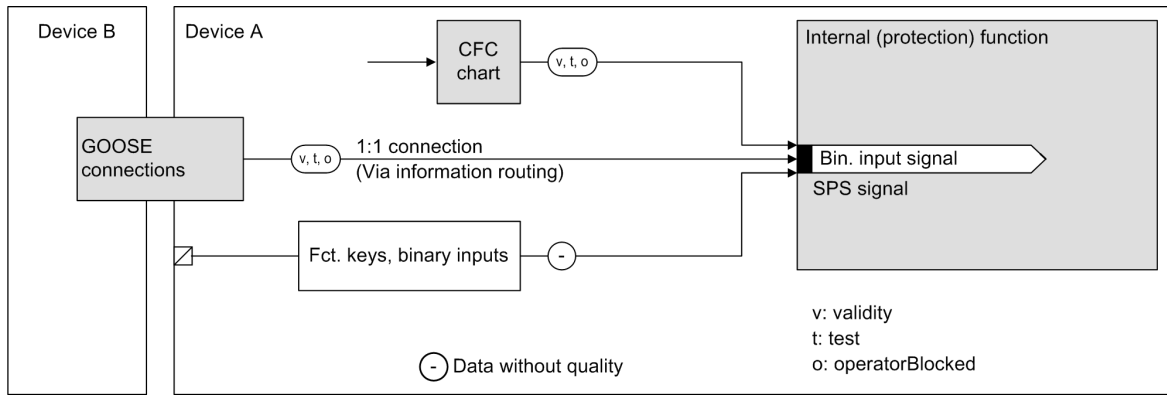
The quality processing is automatic for internal input data.

Supported Quality Attributes	Description
Validity	- At the receiving end, internal values can only be <i>invalid</i> or <i>good</i>. - If <i>invalid</i>, the function health is set to Alarm and the function is reset. Causes for invalid internal data are, for example: - The frequency operating range of the device was left. - The device is not calibrated. - The A/D converter monitoring identified an error.

Routable Binary Input Signals (SPS Data Type)

Figure 3-31 shows the possible sources for connecting a binary input signal. Depending on the source, different quality attributes can be set:

- CFC chart: See description in chapter [3.2.3 Quality Processing/Affected by the User in CFC Charts](#)
- GOOSE connection: See description in chapter [3.2.2 Quality Processing/Affected by the User for Received GOOSE Values](#)
- Device hardware: No quality attributes are set and supported.

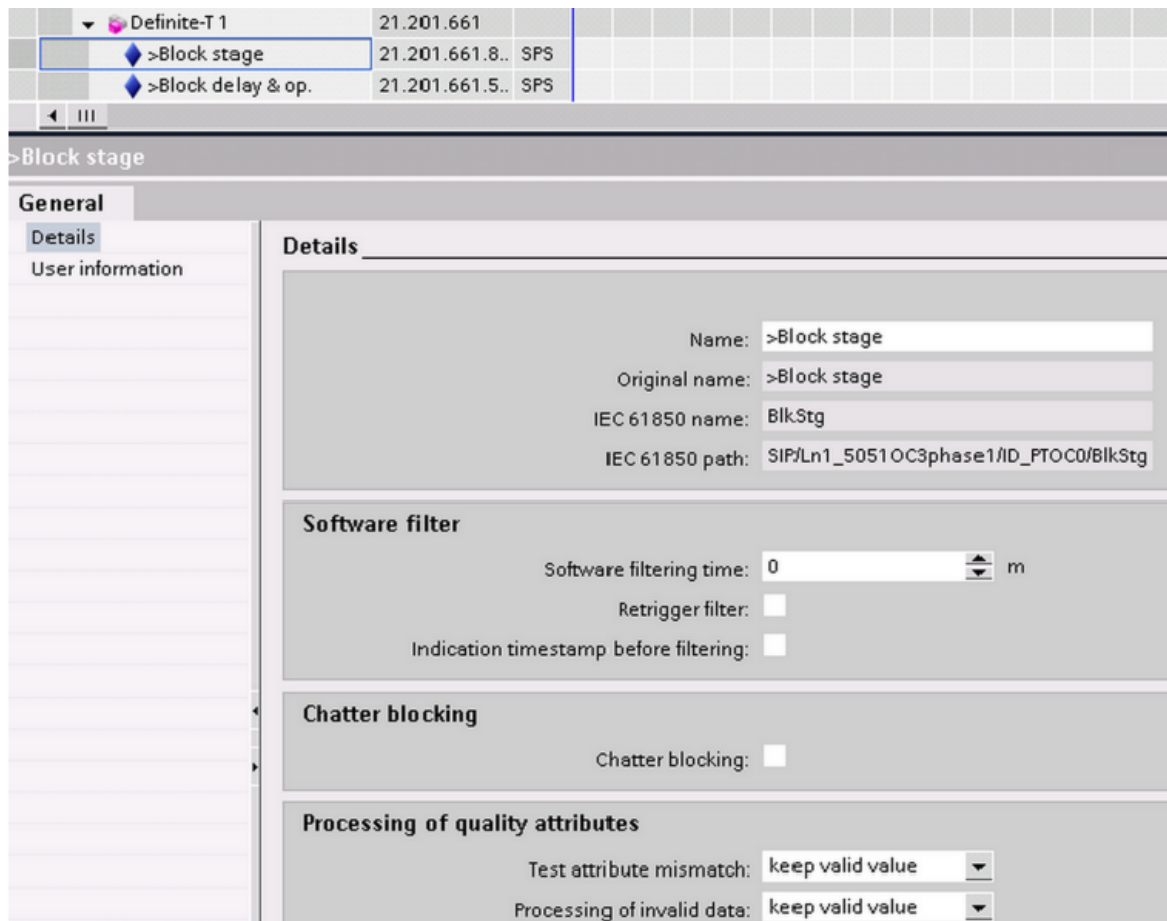


[lo_quali2, 2, en_US]

Figure 3-31 Sources for Connecting a Binary Input Signal

For this signal type (SPS), you can influence the processing of the quality, see overview in [Figure 3-30](#). The following figure shows the possible influence on a binary input signal of a protection stage.

- In the DIGSI 5 project tree, double-click **Information routing**.
- In the operating range, select the desired binary input signal.
- In the **Properties** window, select the **Details** entry. There, you will find the item **Processing quality attributes**.



[sc_influence, 1, en_US]

Figure 3-32 Influence Options for a Binary Input Signal (SPS Input Signal)

Quality Attribute: Validity	
The Validity attribute can have the values <i>good</i> or <i>invalid</i> (<i>reserved</i> and <i>questionable</i> were already replaced at the input end of the device by the value <i>invalid</i>).	
The input signal source is <i>invalid</i> .	The current data value of the source signal is ignored. You can select between the following options: • Further process last valid data value of the source signal (this is the default setting with only a few exceptions) • Set the binary value to be processed further to 0. • Set the binary value to be processed further to 1. This configuration option is necessary to satisfy different applications. The function health switches to Warning.
The input signal source is <i>good</i> .	The source signal data value is processed further.
Quality Attribute: Test	
• The input signal source and processed function are in test state. • The input signal source is not in test state and the function to be processed is in test state.	The source signal data value is processed further.
The input signal source is in a test state and the function to be processed is in normal state.	The data value of the source signal is ignored. You can select between the following options: • Further processing of the last valid source signal data value, before the source switches to the test state (that is the default setting) • The binary value to be processed further is set to 0. • The binary value to be processed further is set to 1. This configuration option is necessary to satisfy different applications.
Quality Attribute OperatorBlocked	
The quality cannot be influenced at this position and does not lead to a response within the logic	

Output Data

The quality is not processed through the actual algorithm/logic of the function. The following table displays the conditions required to set the quality of output signals of a function.

Cause	D0 Value	Quality Attribute	
		After internal (to the SIPROTEC 5 system, for example, in the direction of a CFC chart)	To the IEC 61850 interface, in buffer
Functional state = Test (thus, result of device operating mode = Test or function mode = Test)	Unchanged	Test = <i>TRUE</i>	Test = <i>TRUE</i>
Functional state = Off (thus, result of device operating mode = Off)	Function-specific, corresponding to the definition for switched off	Validity = <i>good</i>	Validity = <i>invalid</i>

Cause	D0 Value	Quality Attribute	
Function health = Alarm (for example, result of invalid receive data)	Function-specific, corresponding to the definition for reset	Validity = <i>good</i>	Validity = <i>invalid</i>
Device operating mode = functionally logged off	Unchanged	Validity = <i>good</i> OperatorBlocked = <i>TRUE</i>	Validity = <i>good</i> detailQual = <i>oldData</i> OperatorBlocked = <i>TRUE</i>

3.3 Trend Recorder

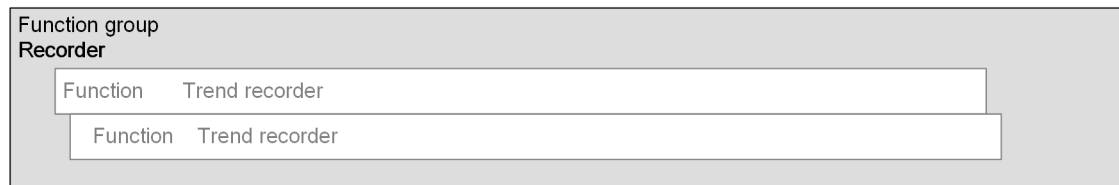
3.3.1 Overview of Functions

Trend recorders are used for long-term recording and monitoring the following processes or measurement:

- Voltage change within tolerance ranges that can be set using parameters
- Frequency change within tolerance ranges that can be set using parameters
- SPS-binary change
- Flicker measurement

3.3.2 Structure of the Function

The **Trend recorder** function is not preconfigured at the factory. Within the **Recorder** function group, the **Trend recorder** can be operated a maximum of 2 times.

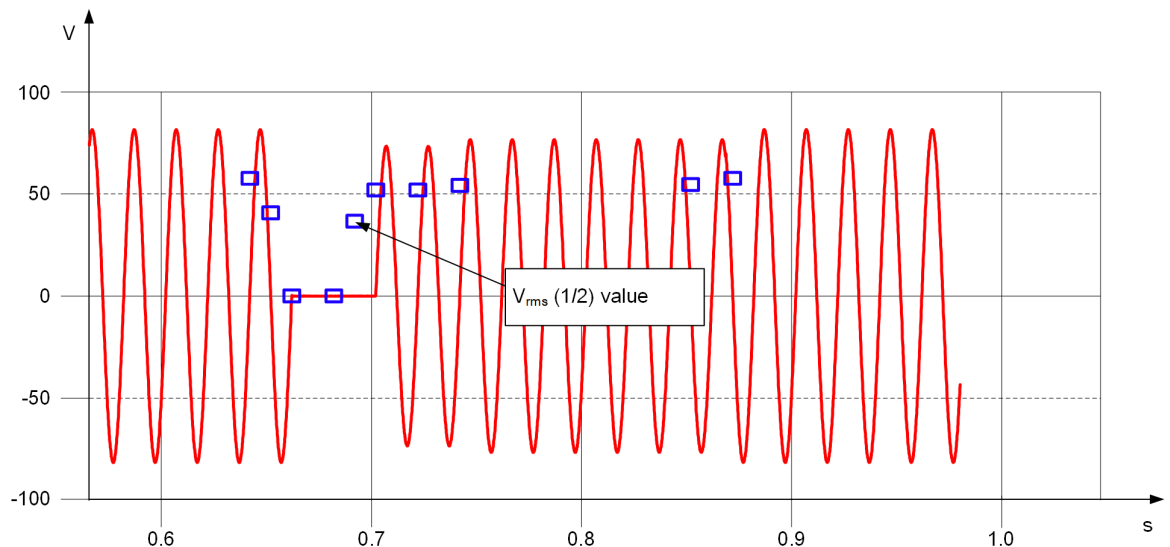


[dw_trend7k, 2, en_US]

Figure 3-33 Structure/Embedding of the Function

3.3.3 Function Description

The trend recorder ensures capture and long-term supervision of frequency and voltage when the voltage and frequency change. If a change occurs in the measurand with respect to the last captured RMS value during the parameterized measuring interval, and this change exceeds the set tolerance range, the new RMS value is recorded.



[dw_trend_def, 2, en_US]

Figure 3-34 Operation of the Trend Recorder, Voltage Interruption

For the parameterization, specify a maximum memory capacity for the storage of recordings. The trend recorder is organized as a ring buffer. When the memory is filled completely, the oldest data are overwritten automatically.

Mode

The trend recorder operates only if the **Mode** is set to **on**.

Recording is interrupted if **Mode** is set to **off** during recording. Recording starts again if **Mode** is set again to **on**.



NOTE

In the mode **off**, the continuous recorder no longer records any measured values, but continues to record device statuses (time jumps, modes **on/off**, as well as disconnection and recovery of the supply voltage). PQDif recordings are still generated, even though the trend recorder is set to the mode **off**. It is recommended to delete the recorder instance in case of long-term non-use.

Ring-Buffer Mode

With the trend recorder, data is stored on the flash memory in blocks. The new data of the last 10-minute interval are available every 10 minutes. If, while recording of a record, the device determines that the free space remaining on the recorder partition is too small, the oldest data block is erased automatically. During this process, complete time segments in the specified grid are always lost.

Disconnection and Recovery of Supply Voltage

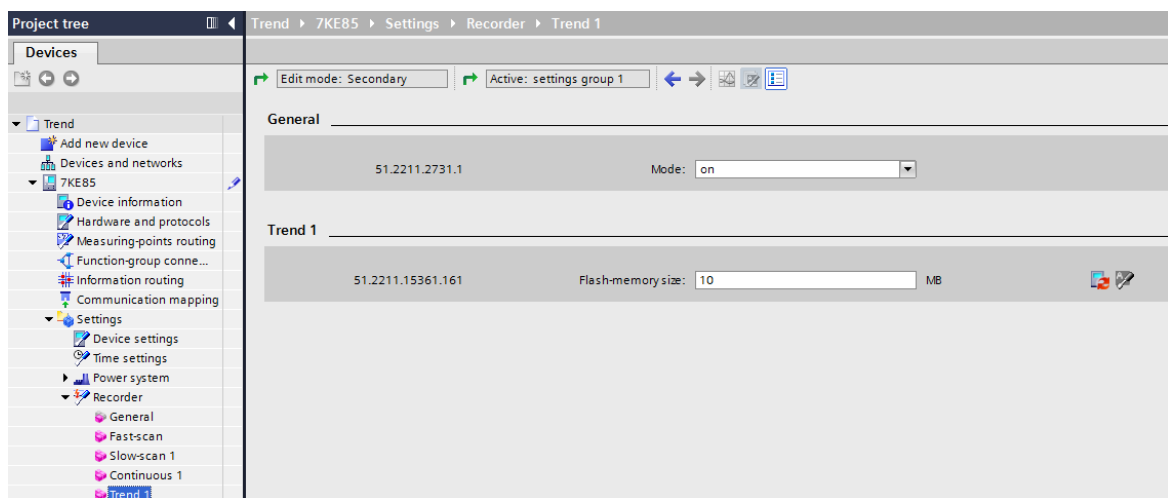


NOTE

If the supply voltage of the device is disconnected intentionally or by mistake, measuring gaps appear for the period of the disconnection. However, the recorded data remains stored and can be read after recovery of the supply voltage.

3.3.4 Application and Setting Notes

Settings of the Trend-Recorder Function



[sc_trend6md84, 1, en_US]

Figure 3-35 Settings of the Trend Recorder Function (as an Example)

Parameter: Flash-Memory Size

- Recommended setting value (`_:10111:161`) **Flash-memory size = 10 MB**

With the parameter **Flash-memory size**, you specify a maximum memory capacity of the trend recorder on the mass storage.

If the flash memory becomes full while recording new fault records, the device automatically deletes the oldest data in order to continue recording (ring buffer).

The record time is limited by the set flash-memory size and the number of events occurring.



NOTE

If you change the capacity of the recorder or delete a recorder instance, the flash memory of the device is reorganized and all recordings of the device – not just those of the changed recorder – are automatically and irrevocably deleted.

Before this, save your recordings by exporting them manually in DIGSI 5 or archiving them in SICAM PQS. Then, delete your recordings in DIGSI 5 to avoid inconsistencies between new and old recordings.

3.3.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2731:1	General:Mode		- off - on	on
Control				
_:15361:161	Trend 1:Flash-memory size		2 MB to 25 MB	10 MB

3.3.6 Information List

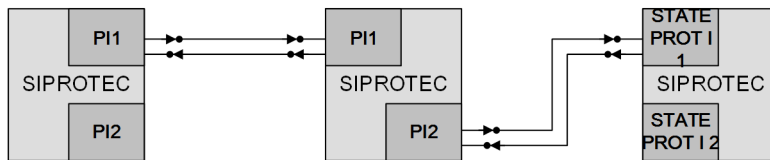
No.	Information	Data Class (Type)	Type
Binary IO			
_:2731:51	General:Mode (controllable)	ENC	C
_:2731:52	General:Behavior	ENS	O
_:2731:53	General:Health	ENS	O
Binary IO			
_:15361:322	Trend 1:Recorder formatted	SPS	O

3.4 Protection Communication

3.4.1 Overview

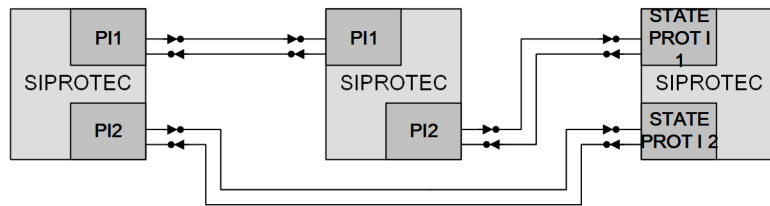
The **Protection communication** includes all functionalities necessary for data exchange via the protection interface (PI).

Devices that communicate with each other via protection interfaces form a device combination. A device combination consists of 2 to 6 devices. The devices communicate via point-to-point connections (protection connections). In this case, a device has only one connection to another device via a protection interface (PI). With a 2nd protection interface, you can establish a connection to another device or a redundant connection to the same device. With their protection connections, the devices form a protection topology in the form of a redundant ring (ring topology) or as a chain structure (chain topology).



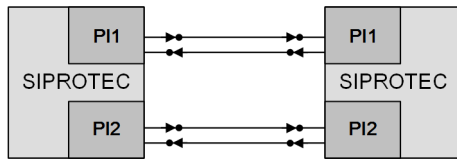
[dw_PDC_chain_3devices, 1, en_US]

Figure 3-36 Device Combination of 3 Devices in a Chain Topology



[dw_PDC_ring_3devices, 1, en_US]

Figure 3-37 Device Combination of 3 Devices in a Ring Topology



[dw_PDC_ring_2devices, 1, en_US]

Figure 3-38 Device Combination of 2 Devices in a Ring Topology

Within a device combination, the point-to-point connections can have different bandwidths. Depending on the bandwidth, a certain amount of binary information and measured values can be transmitted bidirectionally between the devices. The connection with the lowest bandwidth defines the amount of binary information and measured values.

The following information is important for protection communication and is transmitted additionally. You cannot change this information:

- Topology data and values are exchanged for monitoring and testing the connection and displayed on the device or with DIGSI 5.
- Protection data and measured values, such as line differential protection data or binary data of the teleprotection schemes for distance protection and ground-fault protection are transmitted.
- The time synchronization of the devices is possible directly via the connection, whereby a device of the protection topology assumes the role of the timing master.

The point-to-point connection between the devices is continuously monitored for data faults and failure and the signal-transit time of the data is measured.

The protection communication is typically used for line differential protection and with the teleprotection schemes for distance protection and ground-fault protection. In SIPROTEC 5, you can configure the protection communication in all devices and use it for further protection applications. At the same time, any binary information and measured values can be transferred between the devices.

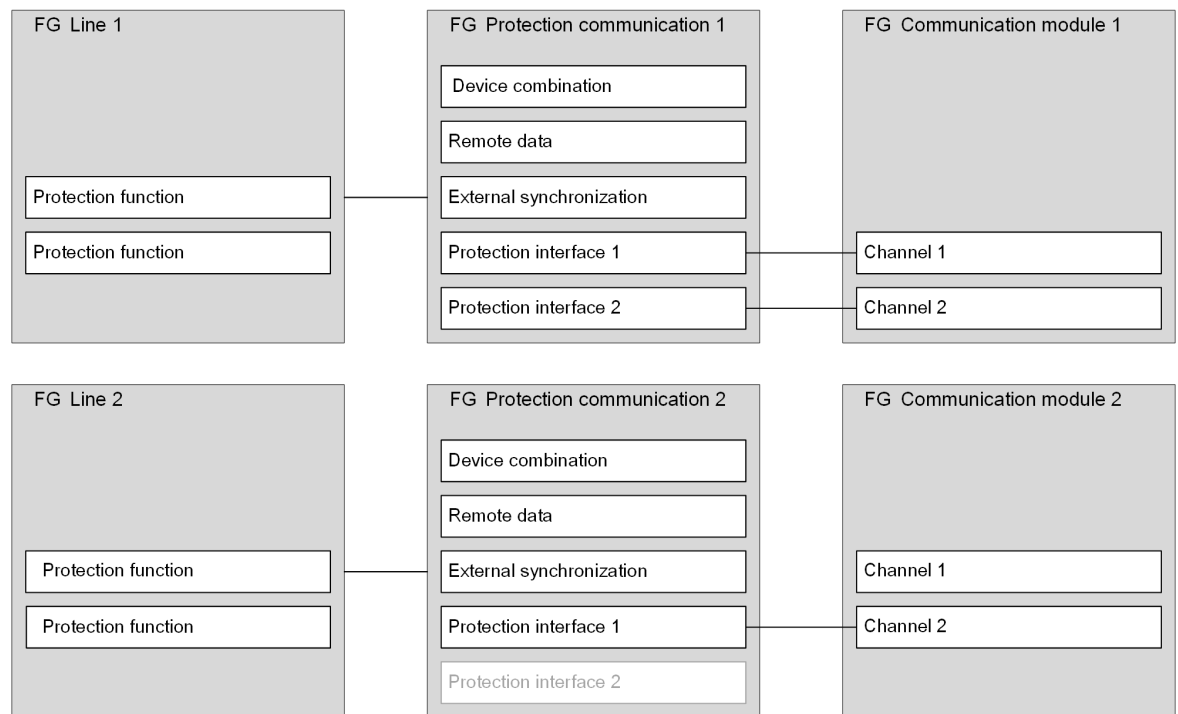


NOTE

The protection communication is compatible with the successor versions from firmware version V04.00 and higher.

3.4.2 Protection Communication in the Overall System

The following figure illustrates the interaction of protection communication, protection function groups, and communication modules. The **Protection communication** is integrated as follows in the overall system:



[dw_protcom_compl_system, 2, en_US]

Figure 3-39 Protection Communication in the Overall System

If protection functions want to use the protection interfaces, their superordinate protection function group, for example, the FG **Line 1**, must be connected to a **Protection communication** function group. With this connection, each protection function in the FG **Line 1** can use protection communication.

In addition, a connection must be configured between the logical protection interface in the FG **Protection communication** and a channel on the physical communication module. The physical communication module must support the protection-interface protocol.

The following chapters describe the configuration of the connections.

3.4.3 Function Description

Type of Protection Communication

The protection communication in a device can be either type 1 or type 2. The following table shows the typical applications:

Types	Description
Type 1 Application during use of Line differential protection	With type 1, the Line differential protection function is the primary application. This application requires the greatest portion of the bandwidth, so that with type 1 the quantity of customer-specific remote data available is lower. This becomes noticeable with a 64 kBit/s protection connection via a G703.1 or X21 interface. If a multiple-end line differential protection application is realized, all protection communications in the devices must be of type 1. A maximum of 6 line ends (devices) is possible. If the Line differential protection and Teleprotection scheme functions are to operate in parallel in the device, the bit rate must not be less than 512 kBit/s!
Type 2 Application without use of Line differential protection	Type 2 provides considerably more bandwidth for customer-specific remote data, as the line differential protection application is not used in this example. The transmission of protection data and other data, such as measured values as well as the teleprotection scheme, is predominant here. Using type 2 protection communication, a maximum of 6 devices can be connected to one another and different device types (for example, 6MD, 7VK, 7SA, and 7SJ) can exchange data.

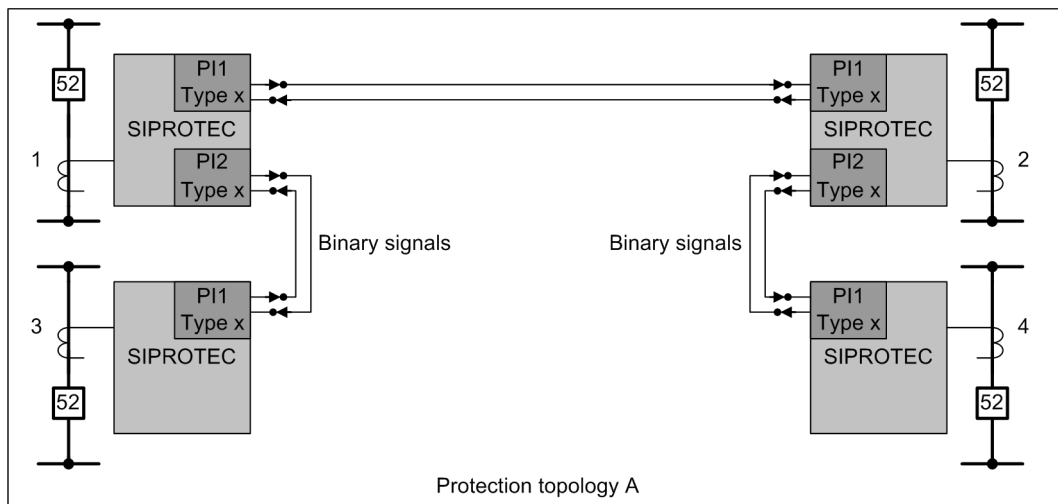


NOTE

In the case of devices with the **Line differential protection** function, for instance 7SD and 7SL, protection communication type 1 is preset in the application templates of the devices. Type 2 is preset in the application templates for other devices, and is used for other data transmission.

Type 1 and type 2 protection communication do not work together in pairs via a protection function.

The protection interfaces (PI) establish a direct point-to-point connection between devices via different communication media. Devices connected to one another via protection interfaces form a protection topology. See following figure.



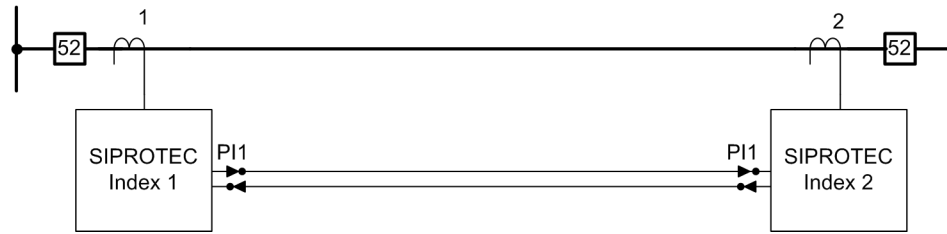
[dsw_intert, 1, en_US]

Figure 3-40 Data Exchange between 4 Devices with Protection Communication of Type 1 or Type 2 in a Protection Topology

Device Combination with 2 Devices: Simple or Redundant Transmission

In a device combination with 2 devices, one protection communication with a protection interface is required per device to establish a protection connection (see next figure).

The most frequent application is the two-line-end differential protection (the protection communication is of type 1) or the point-to-point exchange of data between 2 devices (the protection communication is of type 2), as performed by protection transmission devices.



[dw_interface, 1, en_US]

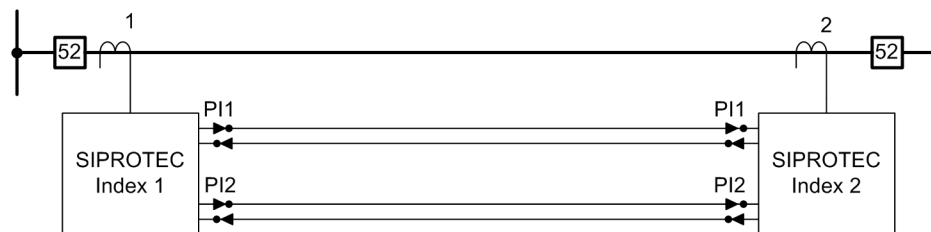
Figure 3-41 Data Exchange for 2 Devices, Each with Protection Connection



NOTE

The index describes the consecutive numbering of the devices in a device combination (see parameter (`_:5131:101`) **Local device is device**).

A maximum of 2 protection interfaces per FG **Protection communication** are possible in one device, see following figure. If the **Protection communication** function groups are connected to each other in the devices via 2 protection connections of the same type, this results in 100 % redundancy regarding the transmission route. The devices then search for the communication connection with the highest bandwidth (for example, optical fiber). If this protection connection fails, the system switches over automatically to the 2nd protection connection until the 1st protection connection is available again. As the protection connection with lower bandwidth defines the maximum amount of transferable information, the same information is exchanged via both protection connections. One application of this is line differential protection routed via a redundant communication connection. Both protection communications in the device are then of type 1.



[dw_intera, 1, en_US]

Figure 3-42 Data Exchange for 2 Devices, Each Having 2 Protection Connections, Redundant Transmission Route

Device Combination with more than 2 Devices: Ring or Chain Topology

When there are more than 2 devices, a communication chain (chain topology) or a communication ring (ring topology) can be established. An arrangement with a maximum of 6 devices is possible.

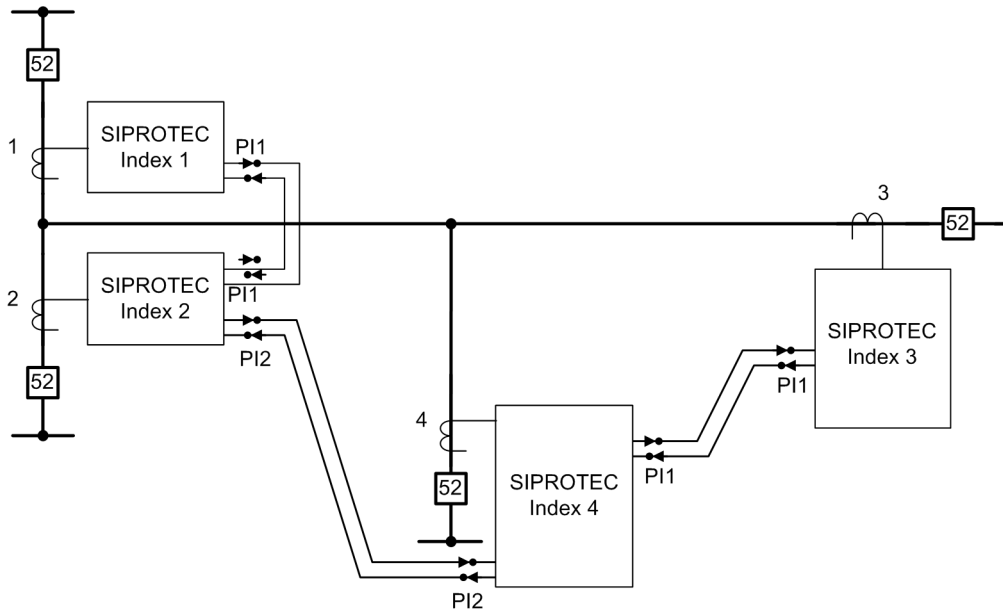
To enable the devices in their device combination to communicate with one another, all devices must contain the FG **Protection communication** of the same type. The devices automatically detect the type of topology and their position within this topology.

A distinction is made between the following types of topology:

- Chain topology
- Ring topology

The chain topology is shown in the following figure.

This configuration shows that the indexing of the devices does not have to correspond to the order in the communication chain.



[dw_chaint, 1, en_US]

Figure 3-43 4 SIPROTEC Devices in a Chain Topology

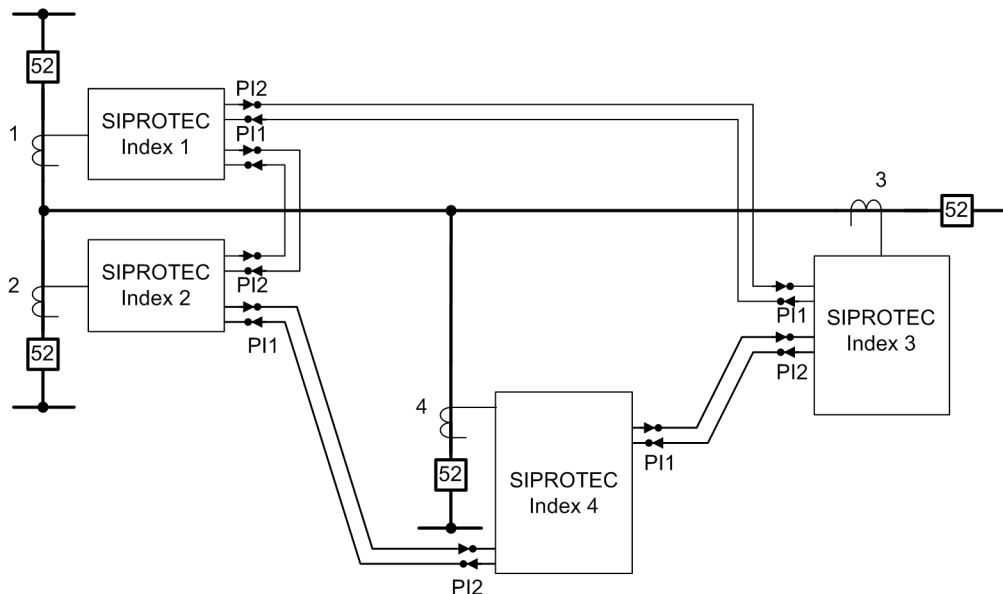
The ring topology is shown in the following figure.

The communication ring has the advantage over the communication chain that the entire communications system and, for example, the **Line differential protection** function also works if one of the communication connections fails or if any desired device in the device combination is taken out of operation.

For more information, refer to [3.4.5.5 Setting Notes for the Device Combination](#).

The devices detect failure or logging off, and switch over automatically to the remaining transmission routes.

The following figure shows, for example, a four-line-end differential-protection application if all FGs **Protection communication** are of type 1 in the devices. A typical application with protection communications of type 2 is the exchange of indications and measured values between 4 devices, for example, between switchgears, whereby the protection connection can occur via different communication media. This is the application for a protection-data transmission device.



[dw_ringto, 1, en_US]

Figure 3-44 4 SIPROTEC Devices in a Ring Topology



NOTE

If a connection fails in the ring topology, this configuration continues to function as a chain topology. In a ring topology, any device can be logged off from the device combination, for example, during inspection works at a line end without current flow (open disconnectors).

Remote Data

With the **Remote data** function, customer-specific indications and measured values can be communicated via the protection interface with settable update cycles (priorities).

There are 3 different priorities for the transmission of remote data:

- **Priority 1:** Use **Priority 1** for the transmission of fast protection signals that are transferred and updated at a maximum of every 20 ms in a telegram.
- **Priority 2:** Use **Priority 2** for the transmission of fast single-point or double-point indications that are transferred and updated at a maximum of every 40 ms.
- **Priority 3:** Use **Priority 3** for all indications, measured, and metered values that are transferred and updated at a maximum of every 100 ms.

The number of customer-specific signals, indications, and measured values available conform with the remaining bandwidth. The remaining bandwidth is lower when using Line differential protection (type 1) than with all other protection functions (type 2). Customer-specific measured values consume more bandwidth than single-point indications.

Communication Media

The communication takes place via direct fiber-optic connections, via communication networks or via 2-wire copper conductors. Siemens recommends a direct fiber-optic connection, as this offers a high transmission rate and is immune to failures in the transmission route while offering the shortest transmission time. This also enables the transmission of a large amount of remote data in line differential protection applications and the remote control of remote devices with DIGSI 5.

The distance to be bridged and the transmission paths (communication media) available determine the settings of the protection interface. External communication converters are used for the connection to communication networks via G703.1-, X21-, or G703.6 interfaces. The connection to 2-wire copper cores also takes place via a communication converter. The C37.94 interface, for example, with 2 MBit/s, offers a direct fiber-optic connection to a multiplexer with the corresponding interface.

[Table 3-9](#) to [Table 3-10](#) show examples of communication connections.

In the case of a direct connection, the transmission distance depends on the fiber type of the optical fiber. This distance can also be extended via external repeaters.

The modules in the device can be replaced from outside, so that adaptation to a transmission route is possible. In the case of the 820-nm double module USART-AE-2FO, 2 protection-interface channels can be operated on one module.

The modules can be located at slots E and F in the base device, and at slots N and P in the plug-in module assembly with integrated power supply.

When using communication converters, the connection from the device to the communication converter by a module is established via optical fibers.

Table 3-9 Plug-In Modules for Applications with Protection Communication

Plug-In Modules	Module Type: USART-AF-1LDFO	Module Type: USART-AW-2LDFO	Module Type: USART-AG-1LDFO	Module Type: USART-AU-2LDFO	Module Type: USART-AK-1LDFO	Module Type: USART-AV-2LDFO	Module Type: USART-AH-1LDFO ⁴	Module Type: USART-AJ-1LDFO ⁵	Module Type: USART-AX-2LDFO ⁶	Module Type: USART-AY-2LDFO ⁷	Module Type: ETH-BD-2F0 ⁸
Physical Connection											
1 x optical serial, 1300 nm, duplex LC plug, 24 km via 9/125 µm singlemode optical fiber or 4 km via 62.5/125 µm multimode optical fiber	●										
2 x optical serial, 1300 nm, duplex LC plug, 24 km via 9/125 µm singlemode optical fiber or 4 km via 62.5/125 µm multimode optical fiber		●									
1 x optical serial, 1300 nm, duplex LC plug, 60 km via 9/125 µm singlemode optical fiber			●								
2 x optical serial, 1300 nm, duplex LC plug, 60 km via 9/125 µm singlemode optical fiber				●							
1 x optical serial, 1550 nm, duplex LC plug, 100 km via 9/125 µm singlemode optical fiber					●						
2 x optical serial, 1550 nm, duplex LC plug, 100 km via 9/125 µm singlemode optical fiber						●					
1 x optical serial, bidirectional using 1 optical fiber, 1300/1550 nm (Tx/Rx), simplex LC plug, 40 km using 9/125 µm singlemode optical fiber							●				
1 x optical serial, bidirectional using 1 optical fiber, 1550/1300 nm (Tx/Rx), simplex LC plug, 40 km using 9/125 µm singlemode optical fiber								●			
2 x optical serial, bidirectional using 1 optical fiber, 1300/1550 nm (Tx/Rx), 2 x simplex LC plug, 40 km using 9/125 µm singlemode optical fiber									●		
2 x optical serial, bidirectional using 1 optical fiber, 1550/1300 nm (Tx/Rx), 2 x simplex LC plug, 40 km using 9/125 µm singlemode optical fiber										●	
2 x optical Ethernet 100 Mbit/s, 1300 nm, duplex LC plug, 2 km via 50/125 µm or 62.5/125 µm multimode optical fiber											●

⁴ USART-AH-1LDFO only pairs with USART-AJ-1LDFO or USART-AY-2LDFO

⁵ USART-AJ-1LDFO only pairs with USART-AH-1LDFO or USART-AX-2LDFO

⁶ USART-AX-2LDFO only pairs with USART-AJ-1LDFO or USART-AY-2LDFO

⁷ USART-AY-2LDFO only pairs with USART-AH-1LDFO or USART-AX-2LDFO

⁸ Suitable for DIGSI 5, IEC 61850, process bus, busbar protection etc.

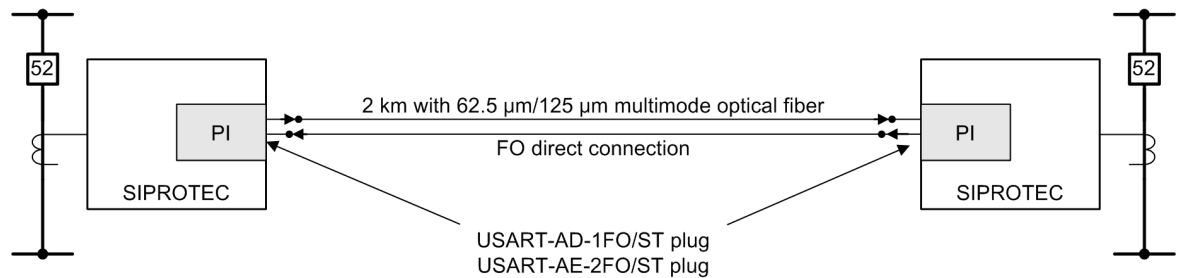
Table 3-10 Plug-In Modules USART-AD-1FO and USART-AE-2FO

Plug-In Module	USART-AD-1FO	USART-AE-2FO
Physical Connection		
1 x optical serial, 820 nm, ST connector, 2 km via 62.5/125 μ m multimode optical fiber	●	
2 x optical serial, 820 nm, ST connector, 2 km via 62.5/125 μ m multimode optical fiber		●
Application		
Protection interface (Sync. HDLC, IEEE C37.94)	●	●



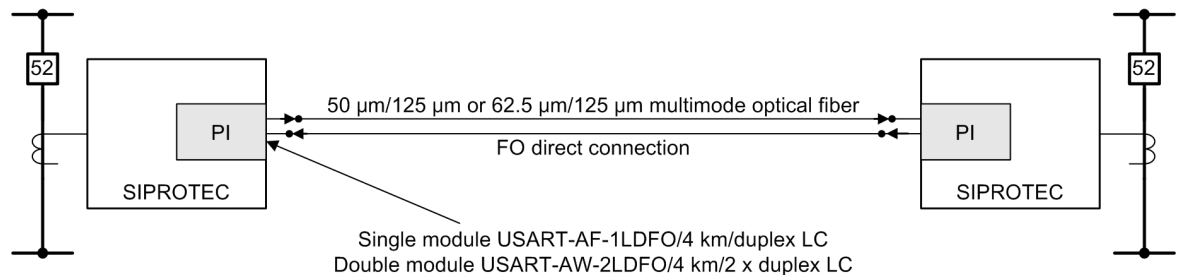
NOTE

The **USART** plug-in module types can be used in slots **E** and **F** in the base module as well as in slots **N** and **P** in the **CB202** expansion module. They are not suitable for use in port **M** in the **CB202** expansion module.



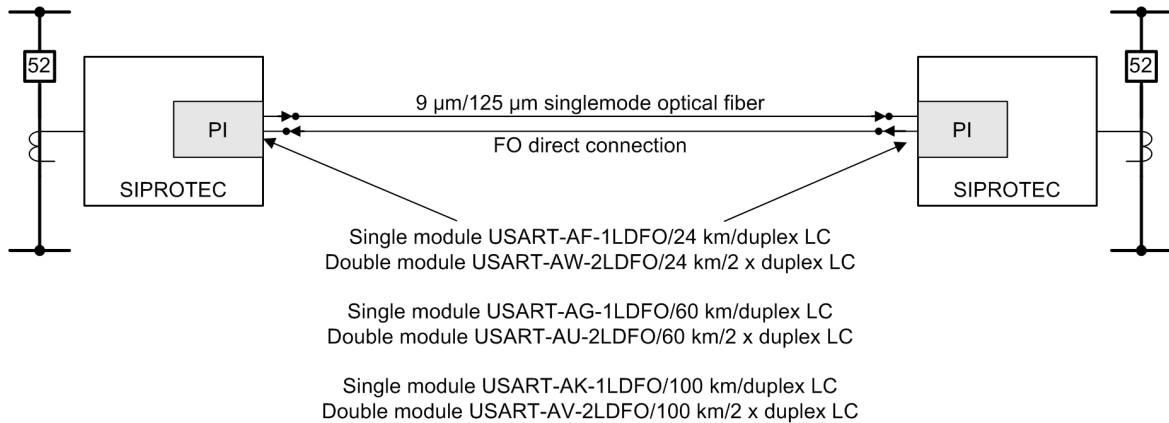
[dw_multim-1, en_US]

Figure 3-45 Connection over Short Distances, up to 2 km via Multimode Optical Fiber



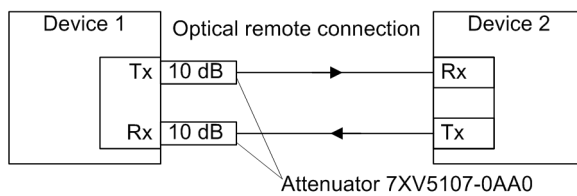
[dw_multim-02, 1, en_US]

Figure 3-46 Connection over Maximum 4 km via Multimode Optical Fiber



[dw_single2, 1, en_US]

Figure 3-47 Connection via Different Distances via Singlemode Optical Fiber



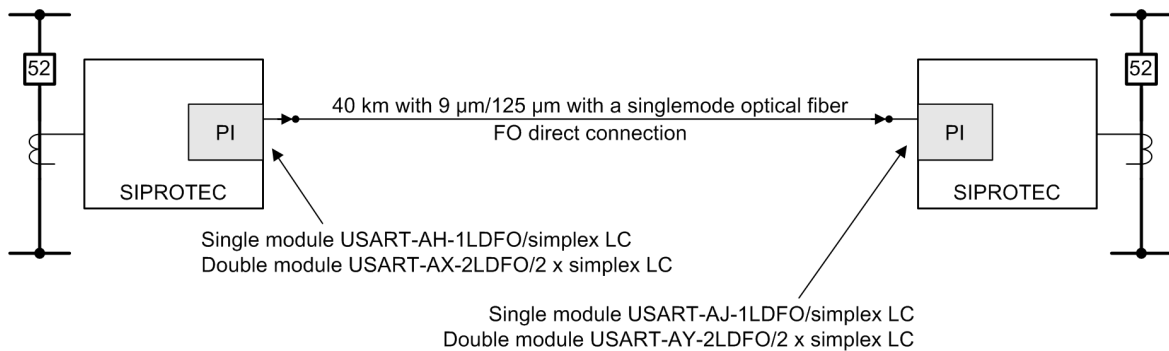
[dw_attenuator, 2, en_US]

Figure 3-48 Optical Remote Connection with Attenuators



NOTE

Connect two 7XV5107-0AA00 attenuators if you use the communication modules USART-AV-2LDFO or USART-AK-1LDFO for transmission routes of less than 30 km. To continue using the duplex LC plug, attach both attenuators to one end of the protection connection (see [Figure 3-48](#)).



[dw_single, 1, en_US]

Figure 3-49 Connection via Singlemode Optical Fiber

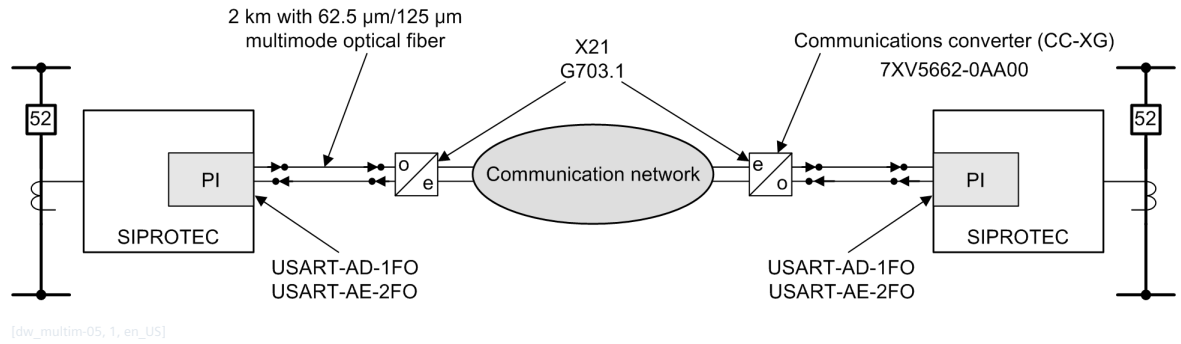


Figure 3-50 Connection via Communication Network with a G703.1 Interface

The connection to the multiplexer is established via a communication converter with a G703.1 interface (64 kBit/s) or X21 interface (64 kBit/s to 512 kBit/s). You can set the bit rate for the KU-XG-512 (for X21), KU-XG-256 (for X21), KU-XG-128 (for X21), and KU-XG-64 (for X21 or G703.1) with the parameter **Connection via**.

You can find more detailed information in [Table 3-11](#).

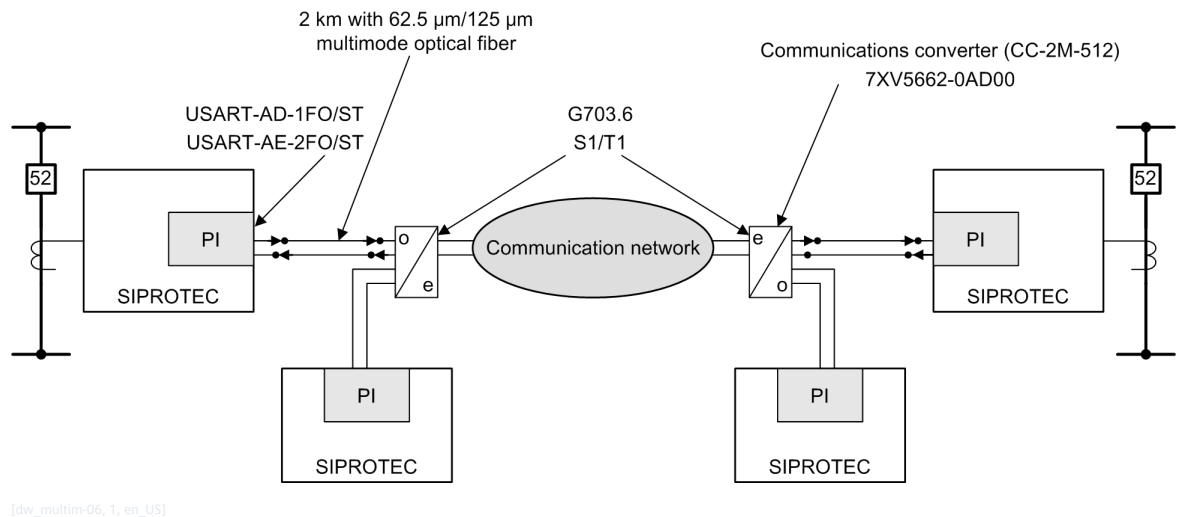


Figure 3-51 Connection via Communication Network with a G703.6 Interface

The connection to the multiplexer is established with 512 kBit/s via a communication converter with a G703.6 interface (E1 with 2 MBit/s or T1 with 1.44 MBit/s). The communication converter offers a 2nd interface for connecting an additional protection interface.

Adjust the setting for the bit rate with KU-2M-512 at 512 kBit/s in accordance with [Table 3-11](#) with the parameter (**_:105**) **Connection via**.

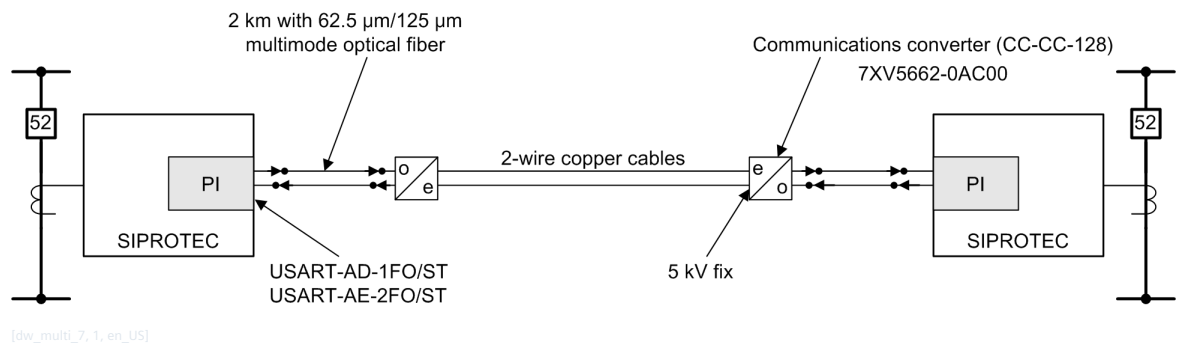
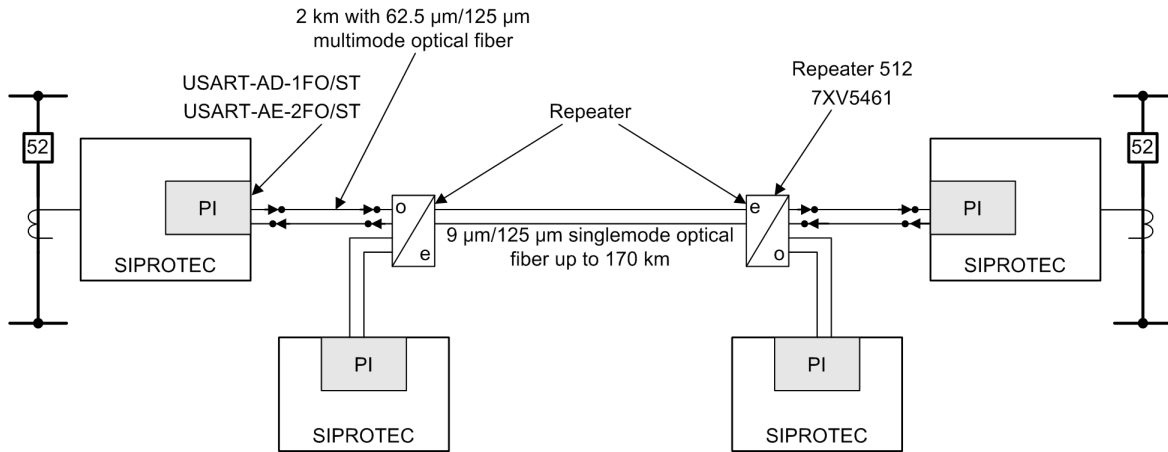


Figure 3-52 Connection via 2-Wire Copper Cables

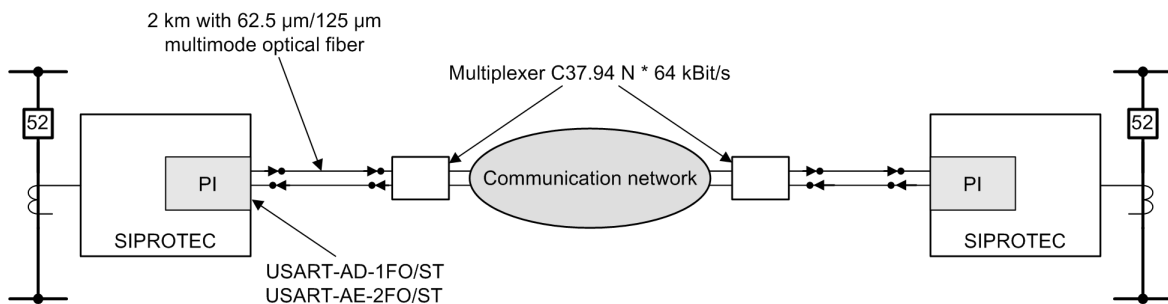
The connection to a communication converter with an integrated isolation voltage of 5 kV is established with 128 kBit/s (KU-KU-128 setting in accordance with [Table 3-11](#)). An isolation of 20 kV of the 2-wire connection is possible via an external 7XR9516 isolating transformer.



[dw_repeat, 1, en_US]

Figure 3-53 Direct Fiber-Optic Connection via an External Repeater

The repeater offers an interface for connecting an additional protection interface. The connection to a repeater is established with 512 kBit/s (repeater 512 kBit/s setting in accordance with [Table 3-11](#)).



[dw_multip8, 1, en_US]

Figure 3-54 Direct Optical Connection to a Multiplexer with a C37.94 N * 64 kBit/s Interface (Time Slot N = 1; 2 or 8)



NOTE

The redundancy of different communication connections (for the ring topology) requires rigorous separation of all devices involved in the communication. Therefore, avoid different transmission routes via the same multiplexer board, as no more substitute paths are possible if the board fails.

Supervision of the Communication

Communication is continuously monitored by the devices and displayed with indications and measured values.

If a number of defective data telegrams, or no data telegrams at all, are received, this is regarded as a **failure** in the communication as soon as a failure time of 100 ms (default setting can be changed) is exceeded. For each protection interface, a list of the measured values is shown in a window in DIGSI 5 (defective telegrams per minute/hour; transmitted and received telegrams per minute/hour, percentage fault rate per minute/hour). A corresponding failure indication is always available. If no alternative transmission route exists (as in the ring topology), the protection function operating with the protection interface is not operating and remote data is not updated on the receiver side.

If the communication is interrupted for longer than an adjustable time **Data-connection failure**, this is regarded as a communication failure. A corresponding failure indication is always available.

Time Synchronization via the Protection Interface, Timing Master

All devices in a device combination can synchronize their time with each other. Synchronization is carried out with millisecond accuracy. The synchronization works independently of the protection function and is used exclusively for simultaneous time keeping in the devices of a device combination.

The device you set in the parameter (**_ :5131:102**) **Address of device 1** is the device with index 1. This device functions takes on the role of the timing master in a device combination. If the timing master is logged off and switched off, the device with the next highest device index takes on the function of the timing master. The timing master synchronizes the clocks of the other devices via the protection interfaces.

The time of the timing master itself can be synchronized via the following time sources:

- IRIG B
- DCF77
- IEEE 1588
- SNTP

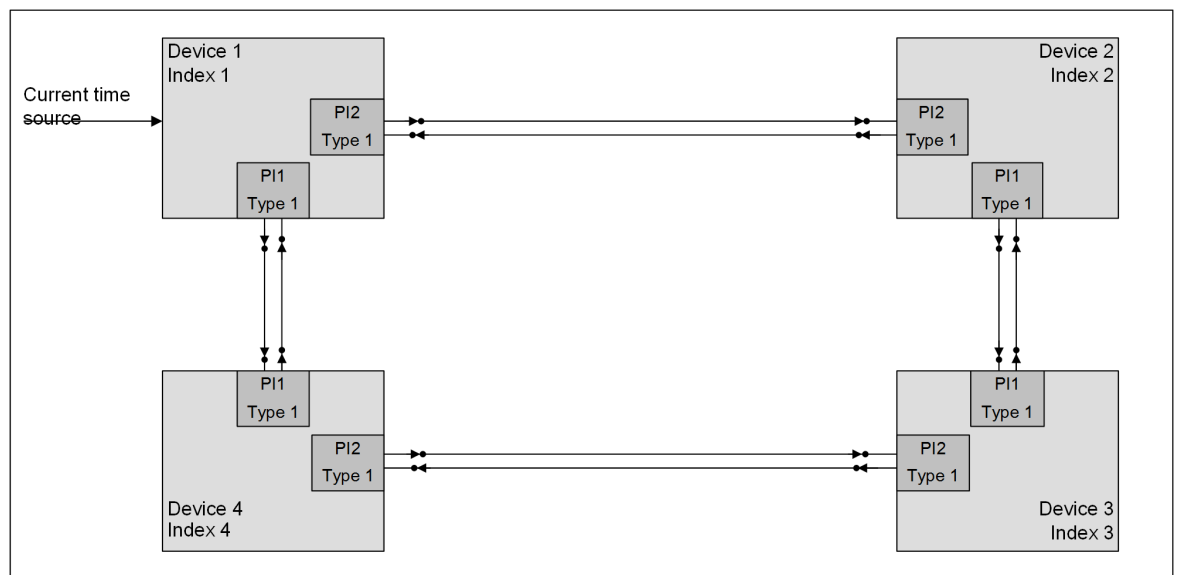
For this, these time sources must be set as the 1st time source and optionally as the 2nd time source in the timing master. If available, the system switches over to the 2nd time source upon failure of the 1st time source in the timing master.

The following chapters describe how a device is set as a timing master:

- For classic protection communication, see [Parameter: Address of Device x, Page 97](#).
- For advanced protection communication, see [Parameter: Device index, Page 135](#).

Set the protection interface as the 1st time source in the other devices of the device combination. You can find the setting value in DIGSI 5 via the **Project tree** → **Parameters** → **Time settings** → **Timer** → **Time source 1** → **PI**.

In this way, all events in the devices of the device combination are recorded with the same time and are time-synchronized even across different switchgears. This simplifies fault analysis and the fault records are recorded with the same time in all devices.



[dw_time_sy, 2, en_US]

Figure 3-55 Time Synchronization in a Device Combination

[Figure 3-55](#) shows how device 1 with index 1 is synchronized with devices 2, 3, and 4 via the protection interface. Device 1 is the timing master, whose time is synchronized with a selectable, external time source.

Time Synchronization of the Line Differential Protection Measured Values with Millisecond Accuracy

The measured values of the devices connected via the protection interfaces are synchronized via telegram measurement with microsecond accuracy ($1 \cdot 10^{-6}$ s). The protection interface displays this state with the indication *PI synchronized*RAISING.

If communications problems occur, it is possible that the measured values may not be properly synchronized. In this case, the protection interface generates the indication *PI synchronized*CLEARED. The line differential protection is blocked. This state can be corrected only manually.



NOTE

You can reset the synchronization of the protection interface directly in the device. Proceed as follows:

Device functions > x Device protection comm. > Protection interface y > Reset synchron.

For special line differential protection applications or synchrophasor measuring devices, you can also time-synchronize the measured values with microsecond accuracy as follows:

- Via a high-precision electrical synchronization pulse (**PPS electrical**, 1-second pulse) from a satellite receiver at time-synchronization port G
- Via a high-precision optical synchronization pulse (**PPS optical**, 1-second pulse) from a satellite receiver at a USART communication module
- Via the **IEEE 1588** time-synchronization protocol

This allows you to measure and display the signal-transit time of the transmission route in transmit and receive direction separately. This lets you achieve the maximum responsivity with the line differential protection in communication networks even with differences in the signal-transit time in the transmit and receive direction (unbalanced runtimes). For the transmission of protection data in **type 2** protection communication, different signal-transit times are irrelevant.

Log Off the Device

A device can be logged off for protection-function tests, system inspections, or disconnection of a feeder for operational reasons from the device combination. The logged off device no longer participates in the distributed functionality and is therefore no longer an active component of the device combination. The protection functions are still in operation for the other end or ends.

The following conditions are necessary for a successful logoff of the device from the point of view of protection communication:

- The device combination is not in a transient state and is stable in operation without switchovers of the protection connections. This displays the message of the device combination *Status of topo. recog.* with the value **Valid**.
- In a given chain topology, the device to be logged off is one of the 2 devices at the end of the communication chain.
- The circuit breaker must be open on the side of the device to be logged off and current must not be flowing.



NOTE

If one of these conditions is not fulfilled, the device cannot be logged off.

You can find more detailed information in [3.7.4 Device Logout](#).

Constellation Measured Values

Constellation measured values are measured values predefined by Siemens with the following properties:

- They are synchronized in the devices in a device combination.
- They are substituted using the protection interface.
- They are available on every device.

You can view the constellation measured values with DIGSI 5.

In the device, current and voltage measured values are displayed in absolute value and phase as a percentage. 100 % conform to the rated current or the rated voltage of the line (see next figure). These measured values are recorded every 2 seconds by the devices participating in the device combination and then sent to the other respective devices. At the same time, the current and voltage values of the different devices are time-synchronous with one another.

When displaying the constellation measured values the local device is prioritized. The device connected directly with DIGSI 5 is the local device.

For the protection communication, the display of the constellation measured values differs between **Type 1** and **Type 2**.

- **Protection communication Type 1:**
The phasors of the current and voltage measured values of the local device have an angle of 0°. The angles of the measured values of the other devices relate to the local values, meaning that the angle difference to the remote ends is displayed.
- **Protection communication Type 2:**
The voltage phasor V_A of the local device has an angle of 0°. The angles of the other local measured values and the measured values of the remote devices relate to V_A (0°).

You can find these measured values in the device under the following DIGSI mask:

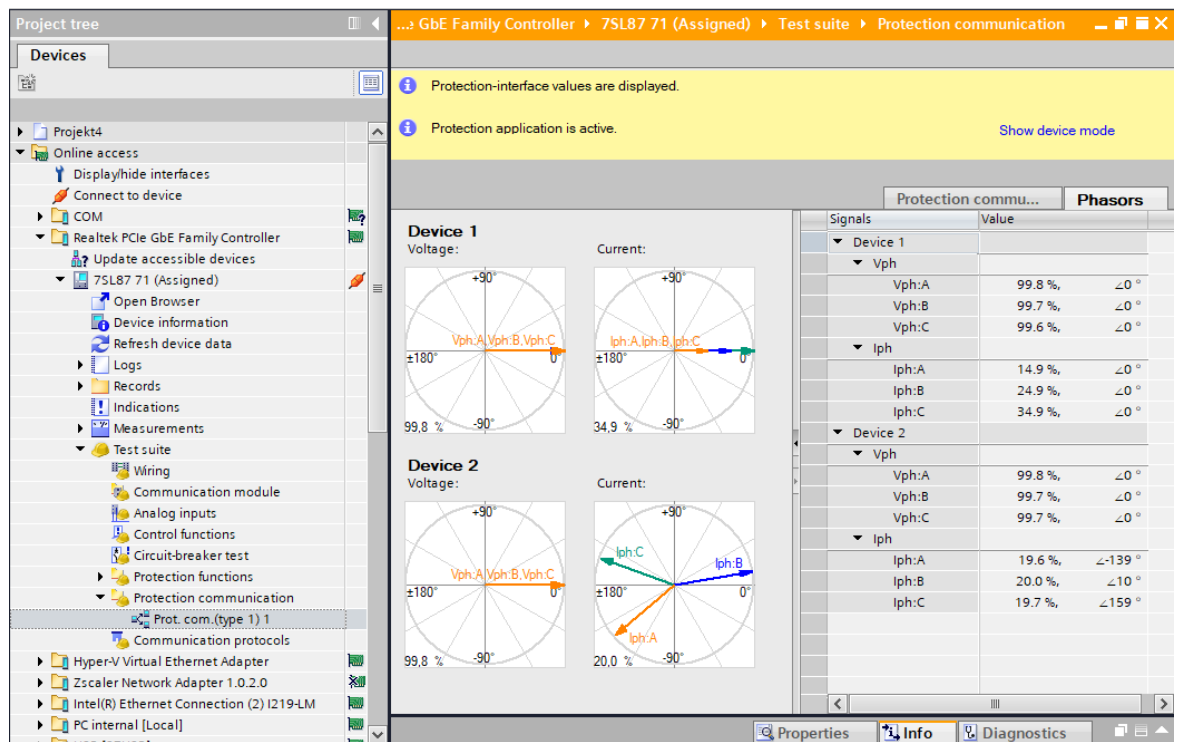
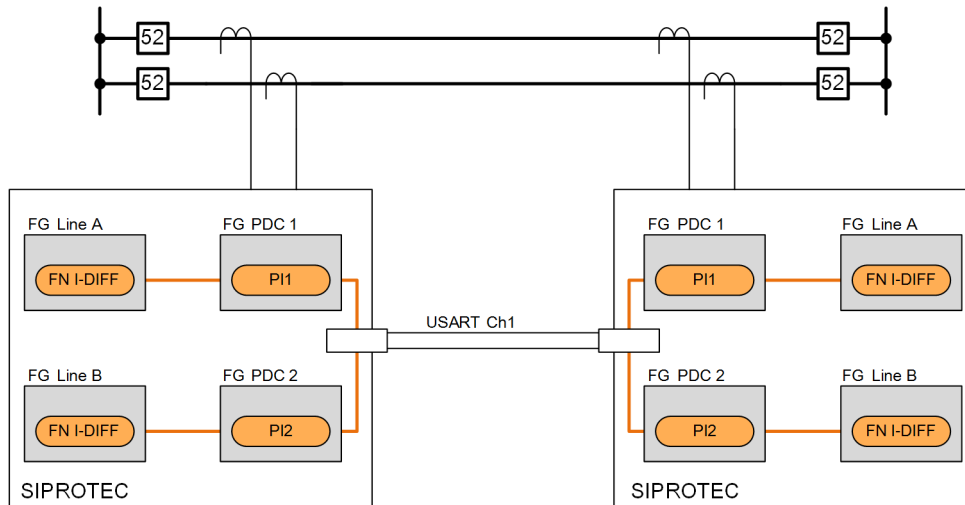


Figure 3-56 Example of Constellation Measured Values with Phases

Multiplex Operation

With extended protection communication, you have the option of having a physical USART channel used by 2 logical protection interfaces. In this way, a transmission route can be double used, for example to implement **Parallel line protection** with **Line differential protection** without additional hardware. To do this, configure the channel according to chapter [3.4.6.4 Configuration of the Advanced Protection Communication in DIGSI 5](#).



[dw_channel-mux_1_en_US]

Figure 3-57 Multiplex Operation



NOTE

Note that in case of multiple use of a physical channel, the available bandwidth is divided equally between the logical protection interfaces. Therefore, this operating mode is not suitable for baud rates under 128 kBit/s.



NOTE

In case of multiple use of a physical USART connection – for example, for protection of a double line – you must provide further redundancy concepts.

3.4.4 Available Variants for the Protection Communication

The following variants are available for protection communication:

- **Classic protection communication**
The scope of parameterization is small for the classic protection communication. The following constraints exist:
 - IP-based communication protocols are not supported.
 - Increased parameterization effort when changing the number of devices in the device combination subsequently, for example, protection of a multi-terminal line.

- **Advanced protection communication**

The advanced protection communication provides greater flexibility and is used with IP-based communication protocols. For this purpose, the devices must be equipped with an Ethernet BD module. The following advantages also exist for devices equipped with USART communication modules:

- Easy subsequent expansion of the number of devices in a device combination
- Multiple function groups **Protection communication** can be instantiated
- Multiplex operation of a physical protection connection
- Hierarchically structured representation in DIGSI 5 project tree

For further information on the 2 variants, refer to [3.4.5 Classic Protection Communication](#) and [3.4.6 Advanced Protection Communication](#).



NOTE

Do not confuse the 2 variants of the protection communication with type 1 and type 2 of the protection communication!



NOTE

If you are unsure about the suitable variant for your use case during selection, use the advanced protection communication.



NOTE

If you want to change an existing classic protection communication to an advanced protection communication or vice versa, a window appears in DIGSI where you are asked whether you want to keep the mapping or not - that is, the communication settings or communication-information routing that has previously been set. In this case, click **No**

3.4.5 Classic Protection Communication

3.4.5.1 Overview

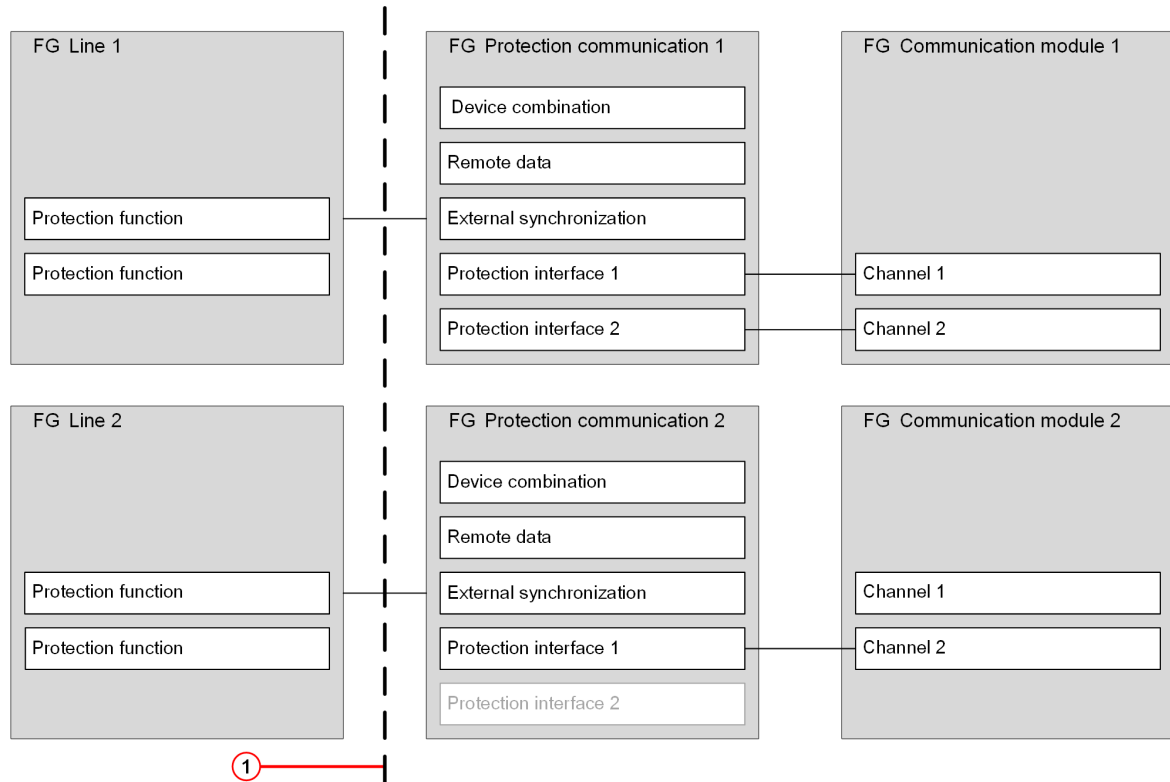
The classic protection communication enables the data exchange between the devices via synchronous serial point-to-point connections from 64 kBit/s to 2 mBit/s. These connections can be directly via optical fiber or via other communication media, for example, via dedicated lines or via communication networks. IP-based communication is not supported.

The function groups of the classic protection communication always support a fixed number of devices in the device combination:

- 2-device protection communication
- 3-device protection communication
- 4-device protection communication
- 5-device protection communication
- 6-device protection communication

3.4.5.2 Classic Protection Communication in the Overall System

The classic **protection communication** is integrated as follows in the overall system:



[dw_simple_protcom_compl_system, 2, en_US]

Figure 3-58 Classic Protection Communication in the Overall System

- (1) The device automatically routes the connection between the protection FG and the **Protection communication** FG in DIGSI 5.

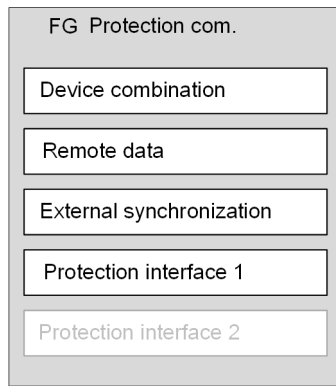
3.4.5.3 Structure of the Function Group

If you select the communication protocol **Protection interface** and the **number of devices** on a channel in the communication module, the classic function group **Protection communication** is automatically created in the DIGSI 5 information routing.

The classic function group **Protection communication** contains the following functionalities and function blocks (FB):

- **Device combination**
- **Protection interface**
- FBs for **Remote data**
- FB **External synchronization** for the synchronization of the transferred data through an external synchronous pulse (1-second-pulse, PPS⁹)

⁹ PPS - Pulse Per Second



[dw_structure_FG_protcom_simple, 1, en_US]

Figure 3-59 Structure of the Classic FG Protection Communication

The function **Device combination** manages the devices that exchange data via protection communication. In the device-combination settings, you set the general settings for the device combination and the device addresses.

The function **Device combination** issues the following indications:

- General indications like the
 - Number of devices
 - Type and status of the device topology
- Indications of the devices in the device combination like:
 - The availability of the device
 - The state of the device, that is whether the device is logged on or off in the device combination

Measured values are transmitted via protection communication and are acquired and exchanged at the same time in the devices. The synchronization of the measured-value acquisition can be done either internally via the telegram measurement or via an external synchronous pulse (1-second pulse, PPS) using the function block **External synchronization**. The external synchronization is switched on in the function block of the protection interface. You can find the indications of the external synchronization in the function block **External synchronization**.

The function block **Remote data** is used to transfer selected and user-specific signals and measured values from the SIPROTEC 5 system. You select the signals and measured values to be transmitted in the communication mapping of DIGSI. The remote data does not issue status indications.

The function block **Protection interface** is automatically connected to a physical channel of a communication module and can therefore send signals and measured values to the neighboring device or receive them from the neighboring device. You can find the status indications of the FB **Protection interface** in the DIGSI 5 information routing in the function group **Protection communication**.



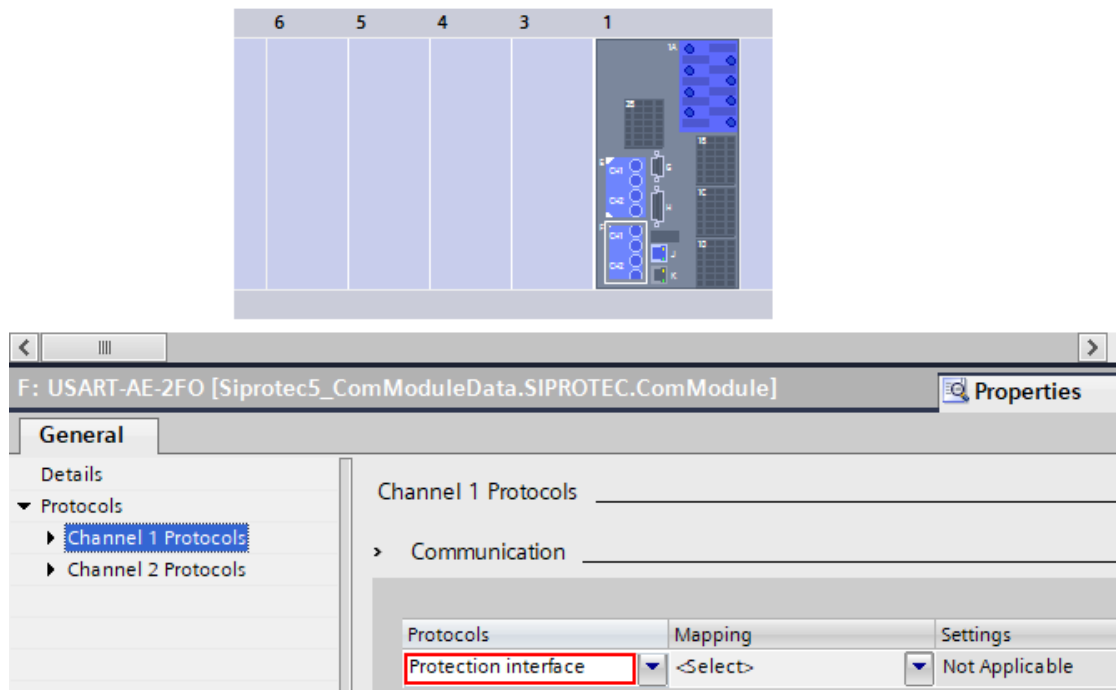
NOTE

In contrast to the protection interface in extended protection communication, the protection interface in classic protection communication is automatically connected to a physical channel of the communication module (refer to [Figure 3-58](#)).

3.4.5.4 Configuration of the Protection Interface in DIGSI 5

If the device is provided with modules, proceed as follows:

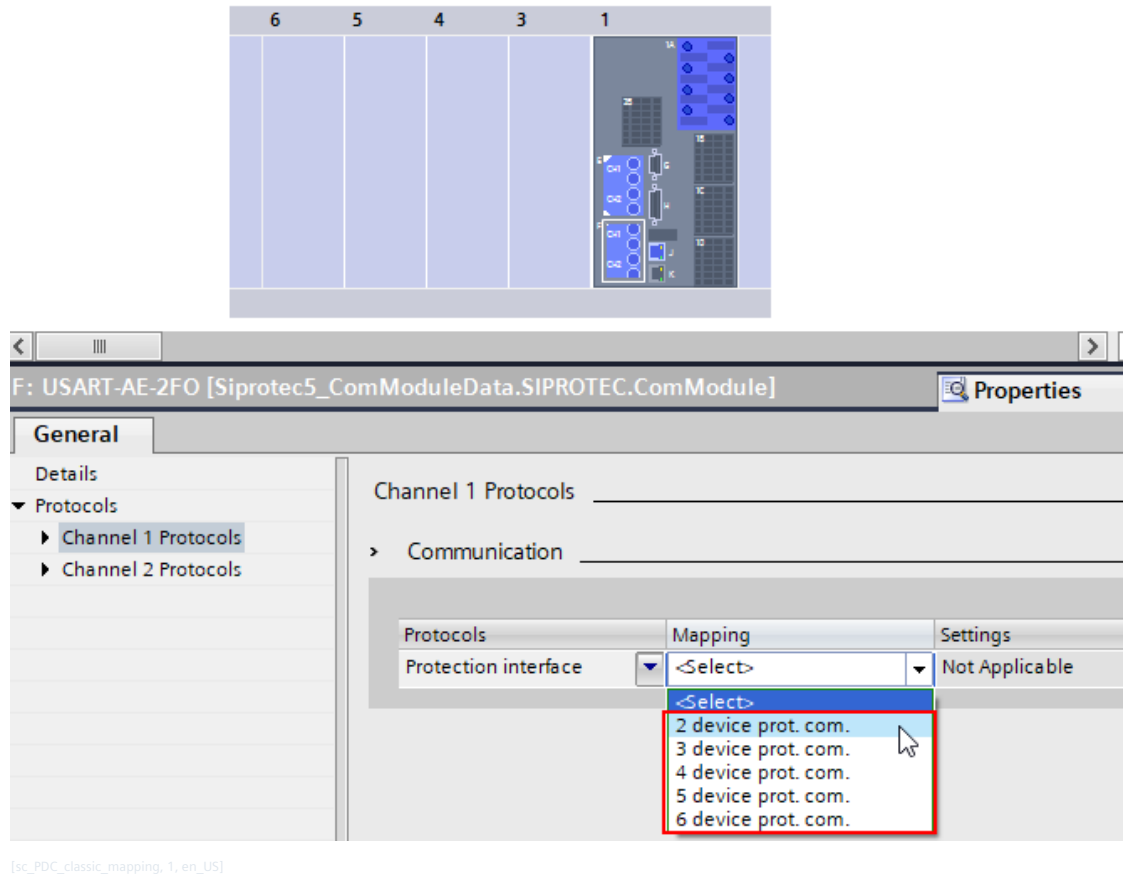
- Select the desired communication module in the rear view of the device.
- In the **Properties of the communication module > Protocols > Channel x Protocols**, select the **Protection interface** protocol.



[sc_PDC_classic_protocol, 1, en_US]

Figure 3-60 Selection of the Communication Protocol

- Then select the number of devices under **Mapping** (see next figure).
Depending on the device, the selection of device combinations can be restricted to 2 or 3 devices.
The number of devices is an order option with regard to the line differential protection.



[sc_PDC_classic_mapping_1_en_US]

Figure 3-61 Selecting the Device Combination



NOTE

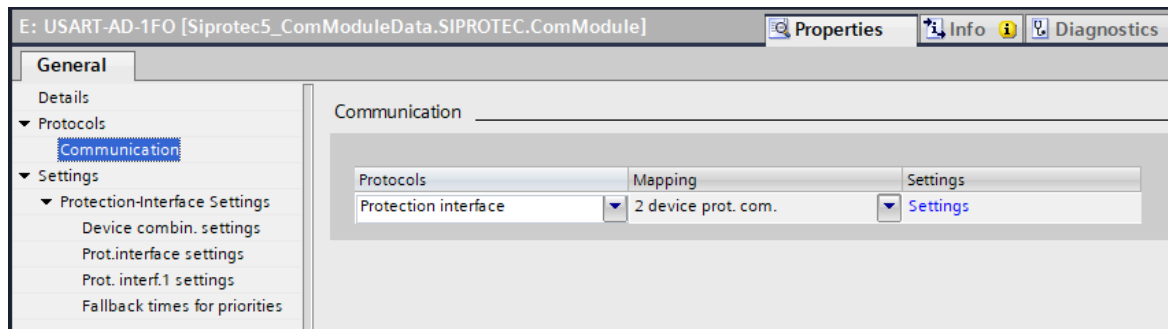
The function groups shown in [Figure 3-61](#) are not available in the DIGSI library.
You can change the number of devices (for example **2 protection communication devices**) depending on the product code any way you like via the **Mapping** text box.
If you change the number of devices via the **Mapping** text box, all activated remote data, settings of the device combination and of the protection interface are lost.

If the module slot is not yet provided with modules, proceed as follows:

- Select the desired communication module in the rear view of the device.
- Select the module from the catalog and drag it to a channel. Thus is the channel configured with a module. DIGSI 5 indicates whether the module can be used for protection communication under **Device Information**.
- Use the **Protocols** text box to select the **Protection interface**, see [Figure 3-60](#).
- Then use the **Mapping** text box to select the number of devices, for example **2 devices protection com.**, see [Figure 3-61](#).

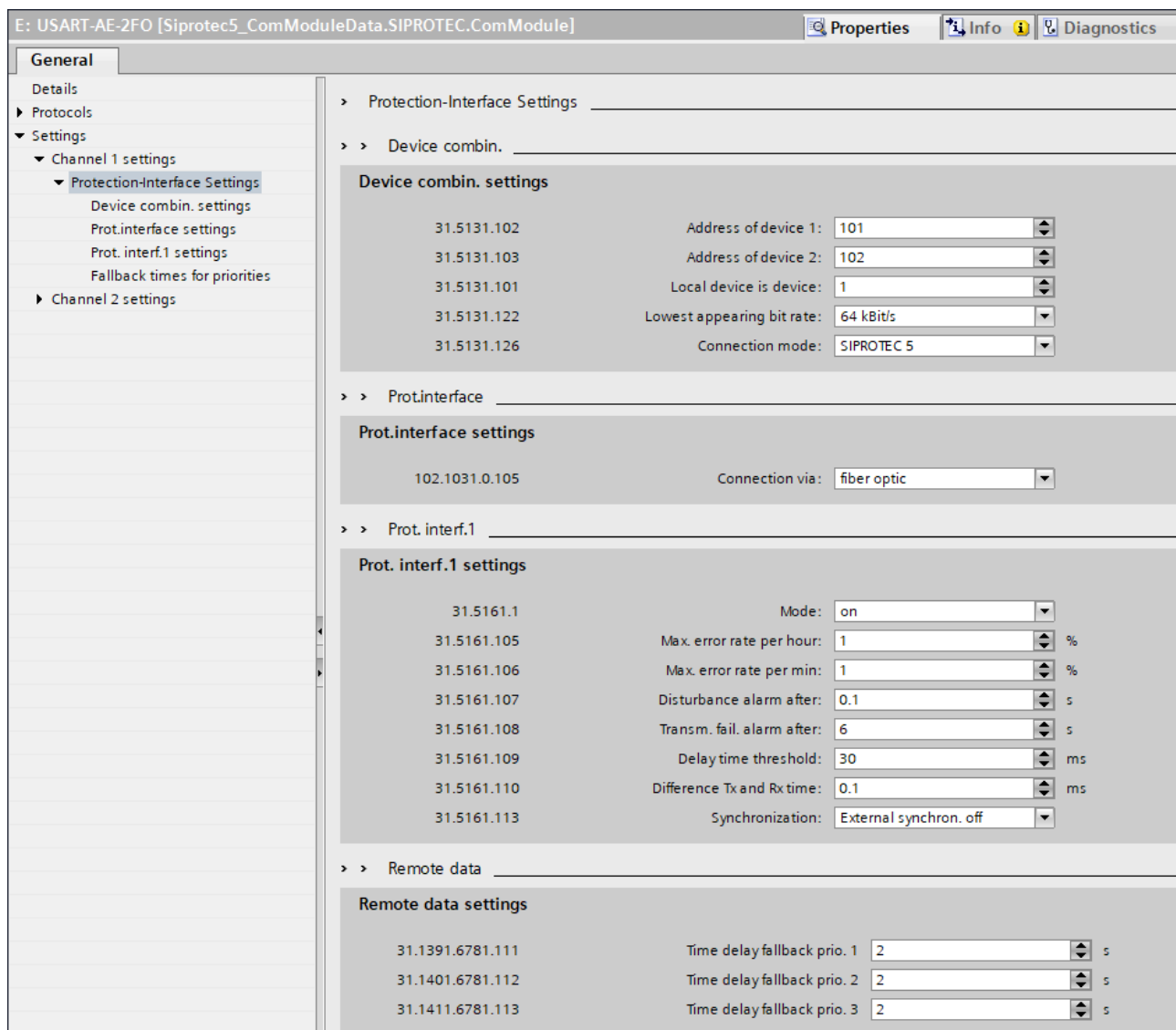
3.4.5.5 Setting Notes for the Device Combination

Select the communication module in the **Project tree > Hardware and protocols** in the **Device view**. In the properties of the communication module, you can find the setting sheets for the parameterization of the device-combination settings and the settings for protection communication.



[sc_config1, 1, en_US]

Figure 3-62 Selection of the Protocol: Communication via the Protection Interface



[sc_config, 4, en_US]

Figure 3-63 Protection-Interface Initialization and Configuration

Changes in the device-combination settings are always visible on the other channel as well. All further parameters can be set separately for individual channels.

Parameter: Address of Device x

- Default setting (`_:5131:102`) **Address of device 1 = 101**
- Default setting (`_:5131:103`) **Address of device 2 = 102**
- Default setting (`_:5131:104`) **Address of device 3 = 103**
- Default setting (`_:5131:105`) **Address of device 4 = 104**
- Default setting (`_:5131:106`) **Address of device 5 = 105**
- Default setting (`_:5131:107`) **Address of device 6 = 106**

The parameters **Address of device 1** to **Address of device 6** can be used to give an address to each device. Set a unique and unambiguous address for each device.



NOTE

The number of device addresses displayed corresponds to that of the number selected during the device-combination configuration.



NOTE

The device **1** is the timing master device in a device combination.

If all other devices in the device combination are to obtain their time from the timing master device, note the following:

- Under **Address of device 1** set the address for the timing master device.
- Parameterize the other devices such that they get their time from the timing master device via the protection connections.

For more information, refer to [3.5.3 Function Description](#). Select as the adjustable synchronization option **Protection interface**.

In the timing master device you must **not** set the protection interface as the synchronization source!

Parameter: Local device is device

- Default setting (`_:5131:101`) **Local device is device = 1**

With the parameter **Local device is device**, you set the index (number) of your device in the device combination. A maximum of 6 devices can be present in one device combination.

APPLICATION EXAMPLE

You have a device combination with 2 devices.

For example, in DIGSI 5, select the parameter setting **Address of device 1** with the parameter value **101** for device 1 and the parameter setting **Address of device 2** with the parameter value **102** for device 2.

Then, use the **Local device is device** parameter to set the index of the local device. The local device is the device that you parametrize.

The addresses must be set identically for all devices in the device combination. Functional protection communication requires that you also assign the same index in all devices of the device combination for a device with a unique address.

Parameter: Lowest appearing bit rate

- Default setting (`_:5131:122`) **Lowest appearing bit rate = 64 kBit/s**

With the parameter **Lowest appearing bit rate**, you set the lowest bit rate occurring in the device group. Set the lowest value in each device with a three-end constellation with 2 fiber-optic connections (2 MBit/s) and one 64 kBit/s connection with the lowest value (64 kBit/s). This value determines the maximum number of selected and self-created signals and measured values which are to be transmitted within the device combination (refer to [3.4.5.9 Configuring Remote Data](#)).

Apart from the default value, you can also set the following bit rates:

- **128 kBit/s**
- **512 kBit/s**
- **2048 kBit/s**



NOTE

If you use optical fibers for a connection between the devices, set the value to **2048 kBit/s**.

Parameter: Number of devices

- Default setting (**_:5131:125**) **Number of devices = 6**

With the parameter **Number of devices**, you set the number of devices actually connected via protection interfaces. This parameter is set by default to the maximum number of devices permitted in the device combination.

This parameter lets you configure a planned final expansion of a system with a planned number of devices already at this point in time and to put it into operation with a lower number of devices. When configuring the protection interface, select the number of devices present in the final phase of the system in the **Mapping** text box. If you set the parameter **Number of devices** to a smaller value than the maximum value, you achieve functional protection communication with fewer devices. In this procedure, all settings, for example, routing, you made for the device combination are retained, even if you subsequently increase the number of devices. If you wish to operate, for example, a planned 3-device protection communication as a 2-device protection communication, you must set the parameter **Number of devices** to **2**. If you expand the system later, change the **Number of devices** parameter to the planned maximum number.

For more detailed information regarding the configuration of the protection interface, refer to [3.4.5.4 Configuration of the Protection Interface in DIGSI 5](#).



NOTE

The **Number of devices** parameter is only visible for device combinations with more than 2 devices. Set the same number of devices used in all devices that are part of the device combination.

Connection mode

- Default setting **Connection mode = SIPROTEC 5**

With the parameter **Connection mode**, you select the device type with which the SIPROTEC 5 device is to work in the device combination. As soon as a SIPROTEC 4 device works in the device combination, you must set the parameter **Connection mode** accordingly.

Parameter Value	Description
SIPROTEC 5	The SIPROTEC 5 device only works with SIPROTEC 5 devices in the device combination.
SIPROTEC 4 7SD610	The SIPROTEC 5 device works with at least one SIPROTEC 4 Differential protection device 7SD610 with firmware version V4.72 and higher in the device combination.

Parameter Value	Description
SIPROTEC 4 7SD5	The SIPROTEC 5 device works with at least one SIPROTEC 4 Differential protection device 7SD5x with firmware version V4.72 and higher in the device combination.
SIPROTEC 4 7SA5/6	The SIPROTEC 5 device works with at least one SIPROTEC 4 Distance protection device 7SA522 and 7SA6x with firmware version V4.72 and higher in the device combination.

3.4.5.6 Setting Notes on Selecting the Communication Medium

- Default setting (`_:105`) **Connection via** = *fiber optic*

The **Connection via** parameter is used to set the bit rate required for the protection interface. Different discrete values can be entered depending on the means of communication (see following table).

Also refer to [Communication Media, Page 81](#)

Table 3-11 Means of Communication

Means of Communication	See	Setting Value	Bit Rate
Fiber-optic direct connection	Figure 3-4 5 to Figure 3-4 9	<i>fiber optic</i>	2 MBit/s
CC-XG-512 communication converter	Figure 3-5 0	<i>CCXG 512 kBit/s</i>	512 kBit/s
CC-XG-128 communication converter	Figure 3-5 0	<i>CCXG 128 kBit/s</i>	128 kBit/s
CC-XG-64 communication converter	Figure 3-5 0	<i>CCXG 64 kBit/s</i>	64 kBit/s
Repeater 512 communication converter	Figure 3-5 3	<i>repeater 512 kBit/s</i>	512 kBit/s
CC-CC-128 Communication converter	Figure 3-5 2	<i>CCPW 128 kBit/s</i>	128 kBit/s
CC-2M-512 Communication converter	Figure 3-5 1	<i>CC2M 512 kBit/s</i>	512 kBit/s
Multiplexer with C37.94 interface	Figure 3-5 4	<i>C37.94 1 * 64 kBit/s</i> <i>C37.94 2 * 64 kBit/s</i> <i>C37.94 8 * 64 kBit/s</i>	64 kBit/s 128 kBit/s 512 kBit/s
Other (freely adjustable bit rates for a direct connection for special applications)		<i>64 kBit/s</i> <i>128 kBit/s</i> <i>512 kBit/s</i> <i>2048 kBit/s</i>	64 kBit/s 128 kBit/s 512 kBit/s 2,048 kBit/s

3.4.5.7 Setting Notes for the Classic Protection Interface

Parameter: Max. error rate per hour

- Default setting (`_:5161:105`) **Max. error rate per hour** = 1.0%

If the number of faulty telegrams per hour exceeds the value set in the parameter **Max. error rate per hour**, you receive the error message *Error rate / hour exc..*

Parameter: Max. error rate per min

- Default setting (`_:5161:106`) **Max. error rate per min** = 1.0%

If the number of faulty telegrams per minute exceeds the value set in the parameter **Max. error rate per min**, you receive the error message *Error rate / min exc.*

Parameter: Disturbance alarm after

- Default setting (**_:5161:107**) **Disturbance alarm after** = 100 ms

With the parameter **Disturbance alarm after**, you determine the time delay after which defective or missing telegrams are signaled as faulty where the indication *Status of lay. 1 and 2* is **PI data fault**.

Parameter: Transm. fail. alarm after

- Default setting (**_:5161:108**) **Transm. fail. alarm after** = 6.0 s

With the parameter **Transm. fail. alarm after**, you determine the time delay after which a communication failure is signaled where the indication *Status of lay. 1 and 2* is **PI data failure**.

Parameter: Delay time threshold

- Default setting (**_:5161:109**) **Delay time threshold** = 30.0 ms

The time taken to transmit and receive a signal via a protection connection is the signal-transit time. You can monitor the signal-transit time. For the **Delay time threshold**, the default setting is selected in such a way that normal communication networks do not exceed the signal-transit time. If this signal-transit time is exceeded during operation (for example upon switchover to another transmission route), the indication **Time delay exceeded** is issued.

Increased runtimes only affect the operate time, and therefore the fault-clearing time of the protection functions using the protection interface. If you use the **Line differential protection** function, this remains in effect.

Parameter: Difference Tx and Rx time

- Default setting (**_:5161:110**) **Difference Tx and Rx time** = 0.1 ms

For time synchronization of the measured values with microsecond accuracy using telegram measurement, the signal-transit times in the send and reception direction must be approximately the same. The device monitors the signal-transit times in the send and reception direction.

With the parameter **Difference Tx and Rx time**, you set a maximum permitted signal-transit time difference between the send and reception paths (runtimes unbalanced). Set the parameter **Difference Tx and Rx time** to the maximum difference expected.

Set this value to 0 for a direct fiber-optic connection. A higher value is necessary for transmission via communication networks. Reference value: 0.1 ms (recommended setting value).

If the difference in the signal-transit times between the send and reception path exceeds the value set, the indication *Time delay jump* is issued.

If the difference from consecutive measurements of the signal-transit times between the send and reception paths exceeds the set value and remains for more than 5 s, the indication *Time delay different* is issued. The **Line differential protection** function is no longer working properly and is **ineffective**.



NOTE

The parameter **Difference Tx and Rx time** only shows when the function **Line differential protection** is instantiated and the parameter **Synchronization** is not set to **External synch. only**.



NOTE

If you use a multiplexer with a C37.94 interface as a means of communication, Siemens recommends a setting value of 0.25 ms to 0.6 ms.

Parameter: Synchronization

- Default setting (`_:5161:113`) **Synchronization** = **External synchron. off**

With the parameter **Synchronization**, you control the time synchronization of the measured values with microsecond accuracy.

If the SIPROTEC device operates with the external synchronization, use the **Synchronization** parameter to define how the protection is activated after restoration of the communication connection (basic state or after transmission fault). See [Figure 3-65](#).

Parameter Value	Description
External synchron. off	The external synchronization is disabled: No external synchronization is performed at the protection interface. Select this setting value if you do not expect any differences between the signal-transit times in the transmission and reception directions. Then the measured values are only synchronized internally with the telegram measurement.
Telegr. and ext. synch.	Synchronization via telegram measurement and external synchronization: The measured values are synchronized internally with the telegram measurement, supported by the external synchronization. You can set the external synchronization with the parameter External synchronization . The synchronization is possible via the IEEE 1588 protocol or via the synchronous pulse of a satellite receiver. In this case, an existing line differential protection is only released when a new connection is established and one of the following conditions is met. • The protection connection is synchronized with the help of the external synchronization. • Symmetric signal-transit times are signaled via the binary input signal >Sync reset or the controllable Reset synchronization. This means that the signal-transit times are the same in the send and receive direction.
Telegr. or ext. synch.	Synchronization via telegram measurement or external synchronization: The measured values are synchronized internally with the telegram measurement, supported by the external synchronization. You can set the external synchronization with the parameter External synchronization . The synchronization is possible via the IEEE 1588 protocol or via the synchronous pulse of a satellite receiver. An available line differential protection is enabled immediately upon renewed establishment of connection (data telegrams are received). The internal synchronization is used up to synchronization.
External synch. only	External synchronization only: The measured values are synchronized only through the external synchronization. You can set the external synchronization with the parameter External synchronization . The synchronization is possible via the IEEE 1588 protocol or via the synchronous pulse of a satellite receiver.

Parameter: External synchronization

- Default setting (`_:5161:117`) **External synchronization** = **PPS electrical (Port G)**

The parameter **External synchronization** is visible only if the parameter **Synchronization** is not set to **External synchron. off**.

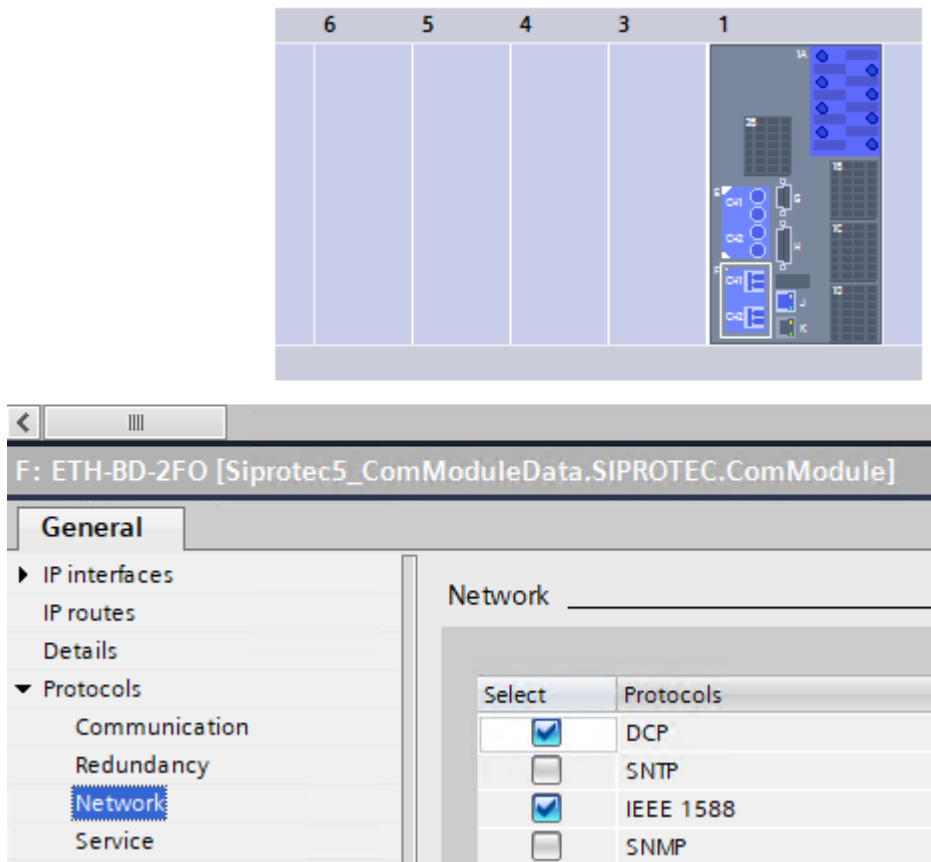
External synchronization is possible separately for each protection interface.

Parameter Value	Description
PPS electrical (Port G)	The electrical synchronous pulse of a satellite receiver (1-second-pulse, PPS ¹⁰) is the synchronization source on the port G , the time synchronization interface.
IEEE 1588	The time synchronization protocol IEEE 1588 for an Ethernet-BD communication module is used for synchronization.



NOTE

The configuration option **IEEE 1588** is only visible if the device has an Ethernet-BD communication module and you have selected the communication protocol IEEE 1588, see following figure.



[sc_BD_1588, 1, en_US]

Figure 3-64 Ethernet-BD Communication Module: Selection of the IEEE 1588 Protocol



NOTE

External synchronization takes into account the signal-transit time in the transmission and reception directions. If external synchronization fails for a short time, for example, due to a receiving interference or an unfavorable satellite position for a brief period, internal synchronization via telegram measurement is still active.

¹⁰ PPS - Pulse Per Second



NOTE

In contrast to the protection interface in extended protection communication, the protection interface in classic protection communication is automatically connected to a channel of a communication module (see [Figure 3-58](#)).

Parameter: Max. inaccuracy

- Default setting (`_:5161:119`) **Max. inaccuracy** = *0.500 ms*

With the parameter **Max. inaccuracy**, you configure the maximum expected inaccuracy of the synchronization source used. The set value is only effective if the synchronization source used does not supply any information on the current inaccuracy in the synchronization signals. If you have not used any of the information on the inaccuracy of the synchronization source used, use the default setting.



NOTE

The inaccuracy of the synchronization source enters the stabilization of the **Line differential protection** as an error signal.

This means that a greater inaccuracy increases the calculated restraining quantity and makes the **Line differential protection** less sensitive.

If **IEEE 1588** is used as the synchronization source in the synchronization status **SmpSynch** = *global*, accuracy values are supplied with the synchronization signals and the parameter **Max. inaccuracy** is not used. If the supplied accuracy values become invalid, the value set in the parameter **Max. inaccuracy** is used.

If the synchronization source **IEEE 1588** works in the synchronization status **SmpSynch** = *local*, then the value set in the parameter **Max. inaccuracy** is used as permanently available inaccuracy.

If the synchronization source **PPS electrical (Port G)** or **PPS optical (USART)** is used, then the value set in the parameter **Max. inaccuracy** is used as permanent inaccuracy.

If a USART communication module with the **PPS** protocol and the **PPS generator** operating mode is also used as a synchronization source at the same time, the value set in the parameter **Max. inaccuracy** is used as permanent inaccuracy.

Parameter: Check synchron.-source

- Default setting (`_:5161:121`) **Check synchron.-source** = *yes*

With the parameter **Check synchron.-source**, you can switch on or off the synchronization-sources check. During the check of the synchronization sources on the ends of a protection connection, a check is conducted as to whether both synchronization sources are working in the same synchronization status **SmpSynch**.

If both synchronization sources are working in the synchronization status **SmpSynch** = *global*, the check has been passed.

If both synchronization sources are working in the synchronization status **SmpSynch** = *local*, that is decoupled from a global reference time, an additional check is conducted as to whether the synchronization source (**gmIdentity**) is the same. Synchronicity can only be guaranteed if the synchronization sources are the same.

If the synchronization sources display a different synchronization status, that is one displays the synchronization status **SmpSynch** = *local* and the other the synchronization status **SmpSynch** = *global*, synchronization cannot be guaranteed.

Siemens recommends using the default setting **Check synchron.-source** = *yes*.

If you have problems with the synchronization-source check, you can switch off the synchronization-source check. Switch off the synchronization-source check only if the synchronization sources are synchronous at the end of their protection connection.

The parameter **Check synchron.-source** is visible only if the parameter (`_:5161:113`) **Synchroni-**
zation is set to **External synch. only**.



NOTE

If you use **PPS electrical (port G)** as the synchronization source, the synchronization status (**SmpSynch**) is permanently set to **global**.

If you use **PPS optical (USART)** as the synchronization source, you can use the setting (**_:107**) **Received. SmpSynch** to set the synchronization status to (**SmpSynch**) **local** or **global**.

For synchronization with microsecond accuracy, for example with **Line differential protection**, adjust the parameter (**_:107**) to **Accepted. SmpSynch = global**.

3.4.5.8 Indications and Measured Values in the Classic Protection Interface

Each individual protection interface provides different indications for commissioning and diagnostics of communication:

Indication (**_:5161:301**) *Status of lay. 1 and 2*

The indication (**_:5161:301**) *Status of lay. 1 and 2* informs you about the status of the connection. The following indications are possible:

Table 3-12 Status Indications Status of lay. 1 and 2

Indication	Description
<i>initialized:</i>	The protection interface is not connected and is in the Initial state.
<i>PI connected:</i>	The protection interface is connected to the protection interface of the partner device.
<i>PI data fault:</i>	The protection interface has not received any valid telegrams for the time set in parameter (_:5161:107) Disturbance alarm after .
<i>PI data failure:</i>	The protection interface has not received any valid telegrams for the time set in parameter (_:5161:108) Transm. fail. alarm after .
<i>not existing:</i>	The protection interface has not been assigned to a communication channel.

Indication (**_:5161:302**) *Status of lay. 3 and 4*

The indication (**_:5161:302**) *Status of lay. 3 and 4* informs about errors during the connection establishment. The following indications values are possible:

Status Indication	Description
<i>no error:</i>	No errors occurred during the connection establishment.
<i>Sw ver. incomp.:</i>	The connection is not established because the firmware versions of the devices are incompatible. Update the firmware.
<i>wrong dev. ID:</i>	The connection is not established because the device address of the local device or the partner device is incorrect or set incorrectly. Check the settings for the parameters Address of device 1 to Address of device n (_:5131:102 and following).
<i>const.sett.error:</i>	The connection is not established because the parameters are set differently. Check whether the parameter (_:5131:122) Lowest appearing bit rate has been set the same in all devices in the device combination.

Status Indication	Description
<i>diff.sett error.</i>	The connection is not established because the parameters are set differently. The line differential protection settings for the connected devices are incompatible. Check whether the devices are set to operate with or without line differential protection. The rated current of the line (parameter (_:9001:101) Rated current) must have the same setting in all devices. With a transformer in the line, the (_:9001:103) Rated apparent power must be set to the same value in all devices.
<i>net mirroring</i>	The connection is not established. The protection interface is receiving its own data. Check the wiring.
<i>wrong dev. idx.</i>	The connection is not established because the device index of the local device or the partner device is incorrect. Check the setting for the parameter (_:5131:101) Local device is device.

Furthermore, the following output signals are available:

Output Signal	Description
(_:5161:303) <i>Connection broken</i>	The signal <i>Connection broken</i> indicates that during a parameterized time (parameter (_:5161:107) Disturbance alarm after) no telegrams or faulty telegrams were continuously received. If the indication <i>Connection broken</i> is issued, the affected protection connection is reset. This can cause the blocking of an active line differential protection or a ring topology can change to a chain topology.
(_:5161:316) <i>Error rate / min exc.</i>	The signal <i>Error rate / min exc.</i> indicates that the set maximum error rate per minute (parameter (_:5161:106) Max. error rate per min) has been exceeded. In this manner, a brief increase of the operate time and thus of the fault-clearing time is possible for the protection functions using the protection interface. If you use the Line differential protection function, this remains in effect.
(_:5161:317) <i>Error rate / hour exc.</i>	The signal <i>Error rate / hour exc.</i> indicates that the set maximum error rate per hour (parameter (_:5161:105) Max. error rate per hour) has been exceeded. In this manner, a brief increase of the operate time and thus of the fault-clearing time is possible for the protection functions using the protection interface. If you use the Line differential protection function, this remains in effect.
(_:5161:318) <i>Time delay exceeded</i>	The signal <i>Time delay exceeded</i> indicates that the threshold value for the set signal-transit time (parameter (_:5161:109) Delay time threshold) has been exceeded. Increased transmission times only affect the operate time, and therefore the fault-clearing time of the protection functions using the protection interface. If you use the Line differential protection function, this remains in effect.

Output Signal	Description
(_:5161:319) <i>Time delay different</i>	The signal <i>Time delay different</i> indicates that the threshold value for the difference in signal runtimes in the transmission and reception direction (asymmetrical runtimes) has been exceeded. The setting value results from the setting value of the parameter (_:5161:110) Difference Tx and Rx time. The indication is visible only if the parameter (_:5161:113) Synchronization is not set to External synch. only. If the indication <i>Time delay different</i> appears, the Line differential protection function is no longer working properly and is ineffective.
(_:5161:320) <i>Time delay jump</i>	The signal <i>Time delay jump</i> indicates that the signal runtimes of the data changed abruptly. This is caused by a switchover of the communication path in the communication network. The indication is visible only if the parameter (_:5161:113) Synchronization is not set to External synch. only.
(_:5161:321) <i>PI synchronized</i>	The signal <i>PI synchronized</i> indicates that the synchronization with microsecond accuracy of the measured values transferred between the local device and partner device is working correctly. The indication is visible only if the parameter (_:5161:113) Synchronization is not set to External synch. only.
(_:5161:340) <i>Telegram lost</i>	The signal <i>Telegram lost</i> indicates that an expected telegram has failed to arrive or a faulty telegram has been received. Reasons for this can be for example switching operations in the primary system or operations on the components of the communication network. If you want to assign the communication failures or faults to other events, route the signal <i>Telegram lost</i> temporarily into the operational log. Note: If the signal is constantly routed, the operational log can overflow. Siemens recommends routing the signal only for clarification of problems.
(_:5161:343) <i>Partner</i>	The indication shows the address of the partner device. A value of 0 means that no partner address is available.
(_:5161:323) <i>PPS: time del. unsym.</i>	This indication is only visible if you are working with a synchronous pulse. The indication shows that the difference in the signal runtimes between the sending and receiving path exceeds the value set with the parameter (_:5161:110) Difference Tx and Rx time. Note: The Line differential protection function remains effective.
(_:5161:324) <i>PI with PPS synchron.</i>	This indication is only visible if you are working with a synchronous pulse. This indication is only visible if, in parallel to synchronization with the synchronization pulse, you are also working with the synchronization via telegram measurement. If both synchronization methods are working properly, the indication <i>PI with PPS synchron.</i> = RAISING is generated.

Measured Values of the Protection Interface

The protection interface provides the following measured value for the diagnosis of the protection-interface communication:

Measured Value	Description
(_:5161:308) <i>Tx tel/h</i>	Telegrams transmitted during the last hour
(_:5161:309) <i>Rx tel/h</i>	Telegrams received during the last hour
(_:5161:310) <i>Tx tel/min</i>	Telegrams transmitted during the last minute
(_:5161:311) <i>Rx tel/min</i>	Telegrams received during the last minute
(_:5161:312) <i>Tx err/h</i>	Transmission failure rate during the last hour
(_:5161:313) <i>Rx err/h</i>	Receive error rate during the last hour
(_:5161:314) <i>Tx err/min</i>	Transmission failure rate during the last minute

Measured Value	Description
(_:5161:315) <i>Rx err/min</i>	Receive error rate during the last minute
(_:5161:325) <i>Aver. Δt</i>	Average signal runtime (average value of the runtime in transmission and reception path divided by 2, without external synchronization)
(_:5161:326) <i>Rec. Δt</i>	Signal runtime for reception path (with external synchronization)
(_:5161:327) <i>Sen. Δt</i>	Signal runtime for transmission path (with external synchronization)
(_:5161:334) <i>Miss. tel/min</i>	Number of telegram failures within the last minute
(_:5161:335) <i>Miss. tel/h</i>	Number of telegram failures within the last hour
(_:5161:336) <i>Miss. tel/d</i>	Number of telegram failures within the last day
(_:5161:337) <i>Miss. tel/w</i>	Number of telegram failures within the last week
(_:5161:338) <i>M. loss/d</i>	Longest lasting telegram failure within the last day
(_:5161:339) <i>M. loss/w</i>	Longest lasting telegram failures within the last week
(_:5161:331) <i>Recept.</i>	Receipt of a telegram (0 = no receipt, 1 = receipt) You can use this indication to make the telegram exchange visible in the fault record.



NOTE

You can reset the measured values of the protection interface directly in the device. Proceed as follows:
Device functions > x Device protection comm. > Protection interface y > Release measured values.

Indications of External Synchronization

The following indications are visible only if the parameter (_:5161:117) **External synchronization** is set to **PPS electrical (Port G)**.

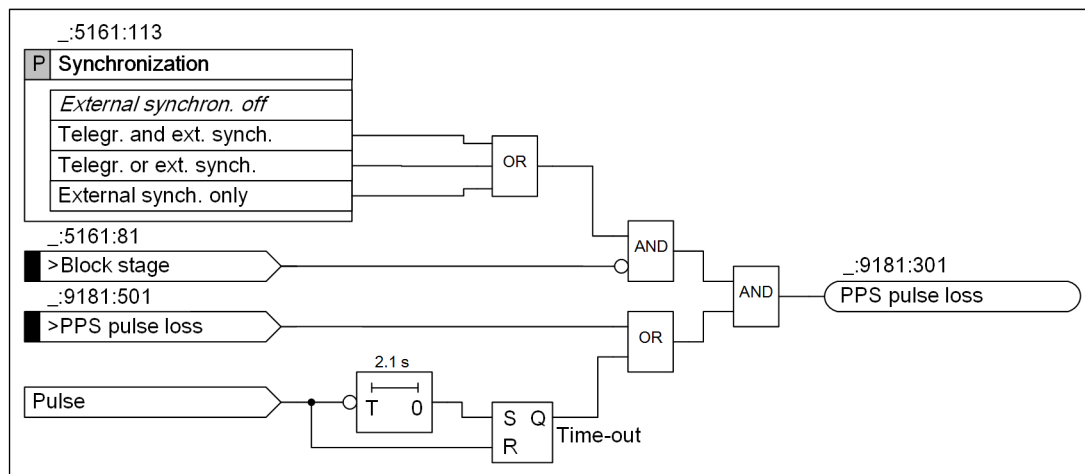
- (_:9181:501) *>PPS pulse loss*
- (_:9181:301) *PPS pulse loss*
- (_:9181:302) *PPS pulse*
- (_:9181:303) *PPS pulse OK*

The following indications are visible only if the parameter (_:5161:117) **External synchronization** is set to **IEEE 1588**.

- (_:304) *Synchronization loss*
- (_:305) *Synchronization OK*
- (_:306) *Synchronization pulse*

Indication	Description
(_:9181:500) <i>>Block stage</i>	This indication shows the blocking of the external synchronization via a binary input. The external synchronization can be set to inactive through this binary input indication.
(_:9181:501) <i>>PPS pulse loss</i>	The binary input (_:9181:501) <i>>PPS pulse loss</i> can be used to signal an externally detected failure in the PPS synchronous pulse (for example, an error message from the satellite receiver). Setting this binary input also leads to the indication (_:9181:301) <i>PPS pulse loss</i> . The external synchronization detects immediately that there is a problem with the connected synchronization pulse. Otherwise, the problem will only be noticed after approx. 2.1 s – after the test for synchronous-pulse failure.

Indication	Description
<i>(_:9181:301) PPS pulse loss</i>	This indication shows that the synchronization has failed. This can be due to the following reasons: • The input indication <i>(_:9181:501) >PPS pulse loss</i> has occurred. • The synchronous pulse has failed. • The quality of the synchronous pulse is inadequate. • There is another problem with the synchronization source. If no further PPS synchronous pulse is received within 2.1 s, the time-out monitoring responds. If no new second pulse occurs after the expiry of the monitoring time, the indication <i>(_:9181:301) PPS pulse loss</i> is issued (see Figure 3-65).
<i>(_:9181:302) PPS pulse</i>	This indication displays the synchronous pulse directly. As a rule, one pulse is generated per second. This indication works well to make the synchronous pulse visible.
<i>(_:9181:303) PPS pulse OK</i>	This indication shows that the synchronization is working properly.
<i>(_:9181:304) Synchronization loss</i>	The synchronization has failed. This can be due to a problem with the synchronization source.
<i>(_:9181:305) Synchronization OK</i>	The synchronization is working properly.
<i>(_:9181:306) Synchronization pulse</i>	You can use this indication to make the virtual synchronous pulse visible. As a rule, one pulse is generated per second.
<i>(_:9181:307) Synchron. imprecise</i>	If the set synchronization source operates in the global synchronization status (SmpSynch) and the time of the synchronization source deviates from the global time by more than 0.5 ms, the indication Synchron. imprecise is generated and the Line differential protection becomes ineffective. The indication Synchron. imprecise is visible only if the parameter External synchronization is set to IEEE 1588.



[io_pps_syn, Z, en_US]

Figure 3-65 Logic for the Generation of the Indication *PPS pulse loss*

3.4.5.9 Configuring Remote Data

Between the devices in a device combination, a data bar is exchanged which can be described or read by the devices. This can be used for exchanging various signals between the devices. In this case, each signal demands a certain number of data fields.

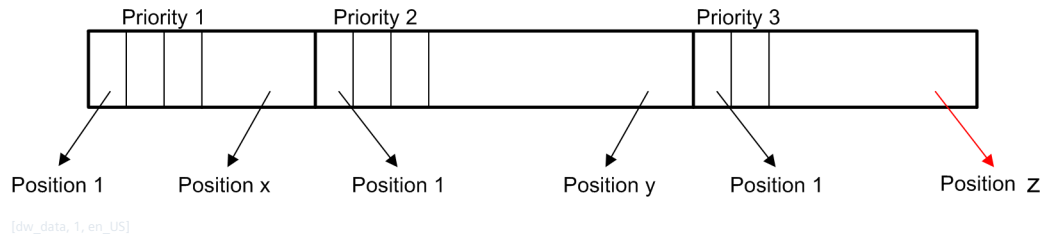


Figure 3-66 Data Bar Exchanged Between Devices

The data bar is divided into 3 priorities, which also have different transmission rates and data volumes. For all signals to be sent, the basic principle is that only pure data contents are transmitted. The quality (for example, *valid*) is not automatically transmitted as well. If you want to transmit the quality as well (for example, for further processing of GOOSE messages), the quality must be transmitted separately (for example, by using CFC). If a signal that has a test flag is transmitted (because its function is in test mode, for example), all signals are provided with a test flag on the receiving side. If the connection is broken, all received signals are flagged with the quality *Invalid*. If desired, the value can also be set to a predefined state after a selectable dropout time or the last value received can be retained (*Hold* setting). This can be configured separately for each received signal (see [Table 3-16](#)).



NOTE

For **ACT** type signals, only the phase information is transmitted.

Signals that are transferred data fields of priority 1 are sent with every telegram. They are preferably used for the transmission of rapid signals, for example, release for circuit-breaker intertripping. A strictly deterministic, rapid transmission is required there.

Signals of priority 2 are transmitted with at least every 2nd telegram. For bit rates >256 kBit, there are no differences between priority 1 and priority 2.

Priority 3 signals are transmitted at least every 100 ms. This priority is used for transmission of measured and metered values. Complex values must be routed separately as the real and the imaginary part for transmission. Measured-value thresholds that lead to an updating of a measured value are set centrally as a property of the measured value. These measured-value thresholds apply with the corresponding reporting, for example, also for the transfer via IEC 61850 to a substation automation technology.

Signals which are written to a data area x under a priority on the data bar must be routed to an indication of the same type in the device reading this information. Otherwise, they are processed incorrectly on the receiving side. The data bar is organized in terms of bits. For information on the bit requirement of each signal type, refer to [Table 3-15](#).

[Table 3-13](#) and [Table 3-14](#) show the number of data areas in the data bar in relation to the available baud rate.



NOTE

Adjust the parameter (**_:5131:122**) **Lowest appearing bit rate** in each device for the protection interfaces in a device combination. This determines the number of data areas.

If, for example, in a device combination with 3 devices with a type 2 chain topology 2 devices are connected via direct optical fibers and 2 devices with a bit rate of 64 kBit/s, the 64 kBit/s section is the limiting factor for the entire device combination.

Table 3-13 Available Bits – Minimum Constellation Baud Rate 64/128 kBit/s

	Priority 1	Priority 2	Priority 3
Type 1	8 bits	24 bits	128 bits
Type 2	32 bits	64 bits	256 bits

Table 3-14 Available Bits - Minimum Constellation Baud Rate 512/2048 kBit/s

	Priority 1	Priority 2	Priority 3
Type 1	48 bits	128 bits	384 bits
Type 2	96 bits	200 bits	1024 bits

Table 3-15 Requirement in Bits

Signal Type	Size in Bits
SP (single-point indication)	1 bit
DP (double-point indication)	2 bits
IN (metered values)	32 bits
MW (measured values) ¹¹	32 bits
ACT	4 bits

Table 3-16 Possible Dropout Values

Signal Type	Dropout Thresholds
SP (single-point indication)	Outgoing, Incoming, Hold
DP (double-point indication)	On, Off, Intermediate Position, Disturbed Position, Hold
IN (metered values)	0, Hold
MW (measured values)	0, Hold
ACT	Hold

**NOTE**

If the protection link fails, these values can be set on the receiver side.

EXAMPLE

2 devices are connected with line differential protection via a 64-kBit channel. This is a type 1 protection communication. There are 8 bits available for priority 1. Now, for example, 4 SPS and 2 DPS can be routed:
 $4 \times 1 \text{ Bit} + 2 \times 2 \text{ Bits} = 8 \text{ Bits}$

**NOTE**

Measured values are transmitted as primary values.

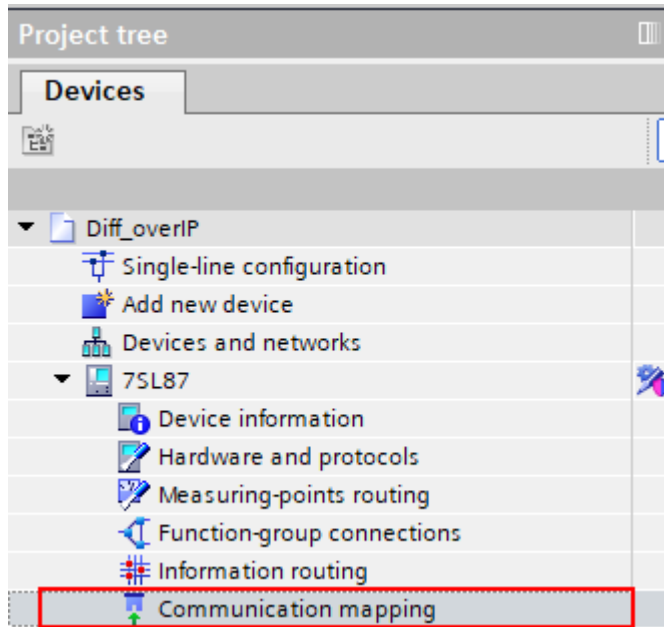
EXAMPLE**For the display of the rated current in the receiving device**

When $I_{\text{rated}} = 1000 \text{ A}$ in the transmitting device and $I_{\text{Load}} = 200 \text{ A}$, the number 200 is displayed in the receiving device.

Configuration of Remote Data in DIGSI 5:

To configure remote data, navigate in DIGSI 5 through the project tree to the communication mapping.

¹¹ The complex phasors of a measuring point are prerouted



[sc_comm_select, 1, en_US]
Figure 3-67 Communication Mapping in DIGSI 5

Figure 3-68 to Figure 3-72 show the routing for a type 1 protection communication.

To transmit signals to other devices, these signals must be routed in the communication matrix under **Transmit**. Binary inputs 1 and 2 are single-point indications (SPS) and are routed to bit position 1 and bit position 2 of the transmission with the highest priority (priority 1). For 64 kBit/s, for example, only 8 of these data areas are available for type 1 protection communication; they are exchanged between the devices with each telegram. Signals 3 and 4 are double-point indications (DPS), for example, a switch position that is transmitted by device 1. A double-point indication occupies 2 bit positions on the data bar. In addition, a measured and metered value are communicated with priority 3.

As a measured or metered value uses 32 bits, value 2 starts at bit position 33. DIGSI 5 shows the next free bit position.

Information			Fault records ▶ F:USART-AE-2FO:Ch1:2 device prot. com.							
			Fault records ▶ Receive				▶ Transmit			
Signals	Number	Type	Recorder	R	Priority level	Bit position	Fallback value	T	Priority level	Bit position
(All...)	(All...)	(..)	(All...)	..	(All...)	(All...)	(All...)	..	(All...)	(All...)
▶ General	91									
▶ Device	4171									
▶ Alarm handling	5971									
▶ Time managem.	8821									
▶ Time sync.	8851									
▶ Power system	11									
▶ Recording	51									
▶ Binary IO	61							*		
▶ Binary inputs	61.1051							*		
▶ Binary input1	61.1051.3151							*		
▶ Value	61.1051.315...	SPS						X	1	1
▶ Binary input2	61.1051.3152							*		
▶ Value	61.1051.315...	SPS						X	1	2

[sc_ran_sps, 1, en_US]
Figure 3-68 Routing of Single-Point Indications to Protection Communication in Device 1

Information			Fault records ▶ F:USART-AE-2FO:Ch1:2 device prot. com.							
			Fault records ▶ Receive				▶ Transmit			
Signals	Number	Type	Recorder	R	Priority level	Bit position	Fallback value	T	Priority level	Bit position
(All...)	(All...)	(...)	(All...)	...	(All...)	(All...)	(All...)	...	(All...)	(All...)
▶ General	91									
▶ Device	4171									
▶ Alarm handling	5971									
▶ Time managem.	8821									
▶ Time sync.	8851									
▶ Power system	11									
▶ Recording	51									
▶ Binary IO	61							*		
▶ F:USART-AE-2FO	101									
▶ J:Integrated Ethernet interface	102									
▶ Circuit breaker 1	201									
▼ Line 1	21							*		
▶ General	21.9001									
▶ Group indicat.	21.4501									
▶ Process monitor	21.1131									
▼ Operational values	21.761							*		
▶ Behavior	21.761.1147...	ENS								
▶ Health	21.761.1147...	ENS								
▶ f	21.761.1021...	MV						X	3	1

[sc_rang_mw, 1, en_US]

Figure 3-69 Routing of Measured Values to Protection Communication in Device 1

Information			Fault records ▶ F:USART-AE-2FO:Ch1:2 device prot. com.							
			Fault records ▶ Receive				▶ Transmit			
Signals	Number	Type	Recorder	R	Priority level	Bit position	Fallback value	T	Priority level	Bit position
(All...)	(All...)	(...)	(All...)	...	(All...)	(All...)	(All...)	...	(All...)	(All...)
▶ General	91									
▶ Device	4171									
▶ Alarm handling	5971									
▶ Time managem.	8821									
▶ Time sync.	8851									
▶ Power system	11									
▶ Recording	51									
▶ Binary IO	61							*		
▶ F:USART-AE-2FO	101									
▶ J:Integrated Ethernet interface	102									
▶ Circuit breaker 1	201									
▼ Line 1	21							*		
▼ 2 device prot. com.	31							*		
▼ Device combin.	31.5131							*		
▶ Behavior	31.5131.52	ENS								
▶ Health	31.5131.53	ENS								
▶ Status of topo. recog.	31.5131.301	ENS								
▶ Topology is	31.5131.302	ENS								
▶ Devices form	31.5131.303	ENS								
▶ Number of detect. dev.	31.5131.304	INS						X	3	33

[sc_rang_zw, 1, en_US]

Figure 3-70 Routing of Metered Values to Protection Communication in Device 1

Device 1 also receives signals (in the communication mapping under **Receive**, see next figure). These signals must be routed with the other devices under **Transmit**. The binary outputs 1 and 2 in device 1 receive their information via the protection communication. This is priority 1 information, which has been routed in another device to position 3 and 4 of the data bar for transmission. The secure state is predefined in the **Fallback value** column. If the protection connection fails, the single-point indication is reset to **raising** or **cleared** as the **fallback value** or its value is retained (**Hold**). For signals of the various priorities, you can also set a dropout time after which the reset (see following figure) to the fallback value occurs, in order to retain the original state for a short time in the event of brief interruptions. These 3 dropout times apply for all signals of one transmission priority and are set as parameters.



[sc_remotedata, 2, en_US]

Figure 3-71 Parameterization of Dropout Time for Signals of Different Priorities

Information			F:\USART-AE-2FO:Ch1:2 device prot. com.							
			Fault records				Receive			
			Fault records				Transmit			
Signals	Number	Type	Recorder	R	Priority level	Bit position	Fallback value	T	Priority level	Bit position
(All...)	(All...)	(...)	(All...)	..	(All...)	(All...)	(All...)	..	(All...)	(All...)
General	91									
Device	4171									
Alarm handling	5971									
Time managem.	8821									
Time sync.	8851									
Power system	11									
Recording	51									
Binary IO	61			*						
Binary inputs	61.1051									
Binary outputs	61.1061			*						
Binary output1	61.1061.3181			*						
Value	61.1061.318...	SPS	X	1	3	Hold				
Binary output2	61.1061.3182			*						
Value	61.1061.318...	SPS	X	1	4	Hold				

[sc_spoemp, 1, en_US]

Figure 3-72 Routing of Single-Point Indications (Receive) to Protection Communication in Device 1

The following figure shows the routing in the 2nd device. Binary inputs 1 and 2 are routed with priority 1 to bit positions 3 and 4 there. In device 1, bit positions 1 and 2 are already occupied (see [Figure 3-68](#)). If you also route the signals to bit positions 1 and 2, the signals of both devices are then connected to the corresponding bit position with a logical **OR** operation. If measured and metered values are routed in the same data areas, this results in implausible values for the receivers. As a user, you are therefore responsible for the correct routing.

Information			Fault records ▶ F:USART-AE-2FO:Ch1:2 device prot. com.							
			Fault records ▶ Receive				▶ Transmit			
Signals	Number	Type	Recorder	R	Priority level	Bit position	Fallback value	T	Priority level	Bit position
(All...)	(All...)	(...)	(All...)	..	(All...)	(All...)	(All...)	..	(All...)	(All...)
▶ General	91									
▶ Device	4171									
▶ Alarm handling	5971									
▶ Time managem.	8821									
▶ Time sync.	8851									
▶ Power system	11									
▶ Recording	51									
▶ Binary IO	61							*		
▶ Binary inputs	61.1051							*		
▶ Binary input1	61.1051.3151							*		
▶ Value	61.1051.315...	SPS						X	1	3
▶ Binary input2	61.1051.3152							*		
▶ Value	61.1051.315...	SPS						X	1	4
▶ Binary input3	61.1051.3153									

[sc_baspsr, 1, en_US]

Figure 3-73 Routing of Single-Point Indications to be Sent to Protection Communication in Device 2

The binary outputs 1 and 2 (**Receive**) in the 2nd device are connected to priority 1 signals 1 and 2 from the 1st device. This takes place via the data areas at positions 1 and 2 of the data bar, which transfer the state of the signals. Other devices can also read this information and logically link it to their internal signals. Here, too, the secure state, which is assumed when the protection connection is interrupted, is entered. This state depends on the information. With single-point indications, states 0 or 1 make sense. In the case of double-point indications, bit combinations 00, 01, 10, or 11 are possible to directly signal a disturbed position upon failure of the protection connection, for example.

Hold is used to retain the state before the failure of the protection connection.

Information			Fault records ▶ F:USART-AE-2FO:Ch1:2 device prot. com.							
			Fault records ▶ Receive				▶ Transmit			
Signals	Number	Type	Recorder	R	Priority level	Bit position	Fallback value	T	Priority level	Bit position
(All...)	(All...)	(...)	(All...)	..	(All...)	(All...)	(All...)	..	(All...)	(All...)
▶ General	91									
▶ Device	4171									
▶ Alarm handling	5971									
▶ Time managem.	8821									
▶ Time sync.	8851									
▶ Power system	11									
▶ Recording	51									
▶ Binary IO	61			*				*		
▶ Binary inputs	61.1051			*				*		
▶ Binary outputs	61.1061			*						
▶ Binary output1	61.1061.3181			*						
▶ Value	61.1061.318...	SPS		X	1	1	Hold			
▶ Binary output2	61.1061.3182			*						
▶ Value	61.1061.318...	SPS		X	1	2	Hold			

[sc_bausps, 1, en_US]

Figure 3-74 Routing of Received Single-Point Indications to Protection Communication in Device 2

Information			Fault records ▶ F:USART-AE-2FO:Ch1:2 device prot. com.							
			Fault records ▶ Receive				▶ Transmit			
Signals	Number	Type	Recorder	R	Priority level	Bit position	Fallback value	T	Priority level	Bit position
(All...)	(All...)	(...)	(All...)	..	(All...)	(All...)	(All...)	..	(All...)	(All...)
▶ Power system	11									
▶ Circuit breaker 1	201									
▶ Line 1	21			*						
▶ General	21.9001			*						
▶ userdefined MV		MV		X	3	1	Hold			
▶ Operational values	21.761									
▶ Fund./sym.comp.	21.771									
▶ 87 Line diff. prot.	21.821									
▶ 2 device prot. com.	31							*		

[sc_bausmw, 1, en_US]

Figure 3-75 Routing of Received Measured Values to Protection Communication in Device 2

Information			Fault records ▶ F:USART-AE-2FO:Ch1:2 device prot. com.							
			Fault records ▶ Receive				▶ Transmit			
Signals	Number	Type	Recorder	R	Priority level	Bit position	Fallback value	T	Priority level	Bit position
(All...)	(All...)	(All...)	(All...)	..	(All...)	(All...)	(All...)	..	(All...)	(All...)
▶ Recording	51									
▶ Circuit breaker 1	201									
▶ Line 1	21			*						
▶ General	21.9001			*						
▶ userdefined INS		INS		×	3	33	Hold			
▶ 2 device prot. com.	31									
▶ Device combin.	31.5131									
▶ Number of detect. dev.	31.5131.304	INS								

[sc_bauszw, 1, en_US]

Figure 3-76 Routing of Metered Values to Protection Communication in Device 2

3.4.5.10 Constellation Measured Values for Type 1 and Type 2



NOTE

The constellation measured values are only available for the **FG Line**.

Each device in the device combination determines measured values predefined by Siemens, known as constellation measured values. You can find the constellation measured values in the DIGSI 5 information routing under the **FG n Device protection comm. > Constell. measured values**. The following measured values and indications are issued for each device:

Measured Value	Meaning
(_:1351:6811:302) Vph	This measured value shows the voltage of the 3 phases that is synchronized with all devices of the device combination. The absolute value and angle are issued for each phase.
(_:1351:6811:303) lph	This measured value shows the current of the 3 phases that is synchronized with all devices of the device combination. The absolute value and angle are issued for each phase.
(_:1351:6811:300) Dev.adr.	This indication shows the device address. This allows you to assign the measured values and the circuit-breaker position in a better way.
(_:1351:6811:301) CB	This indication shows the position of the local circuit breaker and can have the following values: 0: The switch position of the local circuit breaker is unknown. 1 The local circuit breaker is open. 2 The local circuit breaker is closed.

The constellation measured values have the following properties:

- They are synchronized in the devices in a device combination.
- They are substituted using the protection interface.
- They are available on every device in the device combination.

You can view the constellation measured values with DIGSI 5.

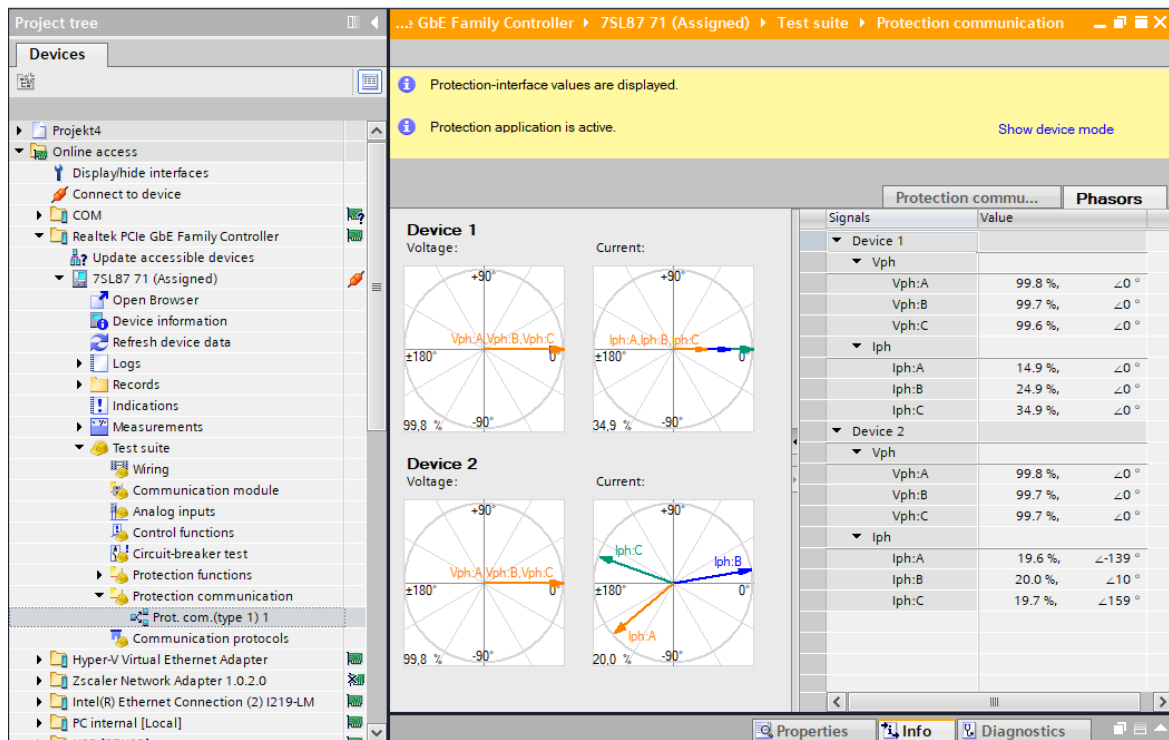
In the device, current and voltage measured values are displayed in absolute value and phase as a percentage. 100 % conform to the rated current or the rated voltage of the line (see [Figure 3-77](#)). These measured values are recorded every 2 seconds by the devices and then sent to the other respective devices. At the same time, the current and voltage values of the different devices are time-synchronous with one another.

When displaying the constellation measured values, the local device is prioritized. The device connected directly with DIGSI 5 is the local device.

The angle reference depends on the type of the FG **Protection communication** used:

- Protection communication **Type 1**:
 - The angle values of the voltages show the angle difference between the local and the remote voltage. The local voltage serves as the reference with an angle of 0°.
 - The angle values of the currents show the angle difference between the local and the remote current. The local current serves as the reference with an angle of 0°.
- Protection communication **Type 2**:
The angles of the phase-to-ground voltages and the phase currents relate to the voltage V_A of the remote device.

You can find these measured values in the device under the following DIGSI mask:



[sc_const mv, 2, en_US]

Figure 3-77 Example of Constellation Measured Values with Phases

3.4.5.11 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Device combin.				
_:5131:102	Device combin.:Address of device 1		1 to 65534	101
_:5131:103	Device combin.:Address of device 2		1 to 65534	102
_:5131:104	Device combin.:Address of device 3		1 to 65534	103
_:5131:105	Device combin.:Address of device 4		1 to 65534	104
_:5131:106	Device combin.:Address of device 5		1 to 65534	105
_:5131:107	Device combin.:Address of device 6		1 to 65534	106

Addr.	Parameter	C	Setting Options	Default Setting
_:5131:101	Device combin.:Local device is device		1 to 6	1
_:5131:122	Device combin.:Lowest appearing bit rate		64 kBit/s 128 kBit/s 512 kBit/s 2048 kBit/s	64 kBit/s
_:5131:125	Device combin.:Number of devices		2 to 6	6
_:5131:127	Device combin.:Dev. comb. is time source		- no - yes	yes
Prot. interf.1				
_:5161:1	Prot. interf.1:Mode		- off - on	on
_:5161:105	Prot. interf.1:Max. error rate per hour		0.000 % to 100.000 %	1.000 %
_:5161:106	Prot. interf.1:Max. error rate per min		0.000 % to 100.000 %	1.000 %
_:5161:107	Prot. interf.1:Disturbance alarm after		0.05 s to 2.00 s	0.10 s
_:5161:108	Prot. interf.1:Transm. fail. alarm after		0.0 s to 6.0 s	6.0 s
_:5161:109	Prot. interf.1:Delay time threshold		0.1 ms to 30.0 ms	30.0 ms
_:5161:110	Prot. interf.1:Difference Tx and Rx time		0.000 ms to 3.000 ms	0.100 ms
_:5161:113	Prot. interf.1:Synchronization		- External synchron. off - Telegr. and ext. synch. - Telegr. or ext. synch. - External synch. only	External synchron. off
_:5161:117	Prot. interf.1:External synchronization		- PPS electrical (Port G) - IEEE 1588	PPS electrical (Port G)

3.4.5.12 Information List

No.	Information	Data Class (Type)	Type
Device combin.			
_:5131:52	Device combin.:Behavior	ENS	O
_:5131:53	Device combin.:Health	ENS	O
_:5131:301	Device combin.:Status of topo. recog.	ENS	O
_:5131:302	Device combin.:Topology is	ENS	O
_:5131:303	Device combin.:Devices form	ENS	O
_:5131:304	Device combin.:Number of detect. dev.	INS	O
_:5131:305	Device combin.:Fct. logout device 1	SPS	O
_:5131:306	Device combin.:Fct. logout device 2	SPS	O
_:5131:307	Device combin.:Fct. logout device 3	SPS	O
_:5131:309	Device combin.:Fct. logout device 4	SPS	O
_:5131:310	Device combin.:Fct. logout device 5	SPS	O

No.	Information	Data Class (Type)	Type
_:5131:311	Device combin.:Fct. logout device 6	SPS	O
_:5131:312	Device combin.:Device 1 available	SPS	O
_:5131:313	Device combin.:Device 2 available	SPS	O
_:5131:314	Device combin.:Device 3 available	SPS	O
_:5131:315	Device combin.:Device 4 available	SPS	O
_:5131:316	Device combin.:Device 5 available	SPS	O
_:5131:317	Device combin.:Device 6 available	SPS	O
Prot. interf.1			
_:5161:81	Prot. interf.1:>Block stage	SPS	I
_:5161:500	Prot. interf.1:>Sync reset	SPS	I
_:5161:341	Prot. interf.1:Reset synchronization	SPC	C
_:5161:342	Prot. interf.1:Reset measurements	SPC	C
_:5161:52	Prot. interf.1:Behavior	ENS	O
_:5161:53	Prot. interf.1:Health	ENS	O
_:5161:301	Prot. interf.1:Status of lay. 1 and 2	ENS	O
_:5161:302	Prot. interf.1:Status of lay. 3 and 4	ENS	O
_:5161:303	Prot. interf.1:Connection broken	SPS	O
_:5161:316	Prot. interf.1>Error rate / min exc.	SPS	O
_:5161:317	Prot. interf.1>Error rate / hour exc.	SPS	O
_:5161:318	Prot. interf.1:Time delay exceeded	SPS	O
_:5161:319	Prot. interf.1:Time delay different	SPS	O
_:5161:320	Prot. interf.1:Time delay jump	SPS	O
_:5161:321	Prot. interf.1:PI synchronized	SPS	O
_:5161:340	Prot. interf.1:Telegram lost	SPS	O
_:5161:308	Prot. interf.1:Tx tel/h	MV	O
_:5161:309	Prot. interf.1:Rx tel/h	MV	O
_:5161:310	Prot. interf.1:Tx tel/min	MV	O
_:5161:311	Prot. interf.1:Rx tel/min	MV	O
_:5161:312	Prot. interf.1:Tx err/h	MV	O
_:5161:313	Prot. interf.1:Rx err/h	MV	O
_:5161:314	Prot. interf.1:Tx err/min	MV	O
_:5161:315	Prot. interf.1:Rx err/min	MV	O
_:5161:334	Prot. interf.1:Miss.tel/min	MV	O
_:5161:335	Prot. interf.1:Miss.tel/h	MV	O
_:5161:336	Prot. interf.1:Miss.tel/d	MV	O
_:5161:337	Prot. interf.1:Miss.tel/w	MV	O
_:5161:338	Prot. interf.1:M. loss/d	MV	O
_:5161:339	Prot. interf.1:M. loss/w	MV	O
_:5161:331	Prot. interf.1:Recept.	MV	O
_:5161:323	Prot. interf.1:PPS: time del. unsym.	SPS	O
_:5161:324	Prot. interf.1:PI with PPS synchron.	SPS	O
_:5161:325	Prot. interf.1:Aver.Δt	MV	O
_:5161:326	Prot. interf.1:Rec. Δt	MV	O
_:5161:327	Prot. interf.1:Sen. Δt	MV	O
Ext. Synchron.			
_:9181:500	Ext. Synchron.:>Block stage	SPS	I

No.	Information	Data Class (Type)	Type
_:9181:501	Ext. Synchron.:>PPS pulse loss	SPS	I
_:9181:52	Ext. Synchron.:Behavior	ENS	O
_:9181:54	Ext. Synchron.:Inactive	SPS	O
_:9181:53	Ext. Synchron.:Health	ENS	O
_:9181:301	Ext. Synchron.:PPS pulse loss	SPS	O
_:9181:303	Ext. Synchron.:PPS pulse OK	SPS	O
_:9181:302	Ext. Synchron.:PPS pulse	SPS	O
_:9181:304	Ext. Synchron.:Synchronization loss	SPS	O
_:9181:305	Ext. Synchron.:Synchronization OK	SPS	O
_:9181:306	Ext. Synchron.:Synchronization pulse	SPS	O
Meas.val.dev.1			
_:1351:6811:300	Meas.val.dev.1:Dev.adr.	INS	O
_:1351:6811:301	Meas.val.dev.1:CB	ENS	O
_:1351:6811:302	Meas.val.dev.1:Vph	WYE	O
_:1351:6811:303	Meas.val.dev.1:lph	WYE	O
Meas.val.dev.2			
_:1351:6841:300	Meas.val.dev.2:Dev.adr.	INS	O
_:1351:6841:301	Meas.val.dev.2:CB	ENS	O
_:1351:6841:302	Meas.val.dev.2:Vph	WYE	O
_:1351:6841:303	Meas.val.dev.2:lph	WYE	O
Meas.val.dev.3			
_:1351:6871:300	Meas.val.dev.3:Dev.adr.	INS	O
_:1351:6871:301	Meas.val.dev.3:CB	ENS	O
_:1351:6871:302	Meas.val.dev.3:Vph	WYE	O
_:1351:6871:303	Meas.val.dev.3:lph	WYE	O
Meas.val.dev.4			
_:1351:6901:300	Meas.val.dev.4:Dev.adr.	INS	O
_:1351:6901:301	Meas.val.dev.4:CB	ENS	O
_:1351:6901:302	Meas.val.dev.4:Vph	WYE	O
_:1351:6901:303	Meas.val.dev.4:lph	WYE	O
Meas.val.dev.5			
_:1351:6931:300	Meas.val.dev.5:Dev.adr.	INS	O
_:1351:6931:301	Meas.val.dev.5:CB	ENS	O
_:1351:6931:302	Meas.val.dev.5:Vph	WYE	O
_:1351:6931:303	Meas.val.dev.5:lph	WYE	O
Meas.val.dev.6			
_:1351:6961:300	Meas.val.dev.6:Dev.adr.	INS	O
_:1351:6961:301	Meas.val.dev.6:CB	ENS	O
_:1351:6961:302	Meas.val.dev.6:Vph	WYE	O
_:1351:6961:303	Meas.val.dev.6:lph	WYE	O

3.4.6 Advanced Protection Communication

3.4.6.1 Overview

The advanced protection communication contains all functionalities of classic protection communication. The view of parameters and indications is structured differently in DIGSI 5. In addition, the advanced protection communication supports the IP-based communication protocol.

You can easily change the number of devices in the device combination. Further differences include support for external synchronization sources and an exchange of phase-selective information while sending and receiving.

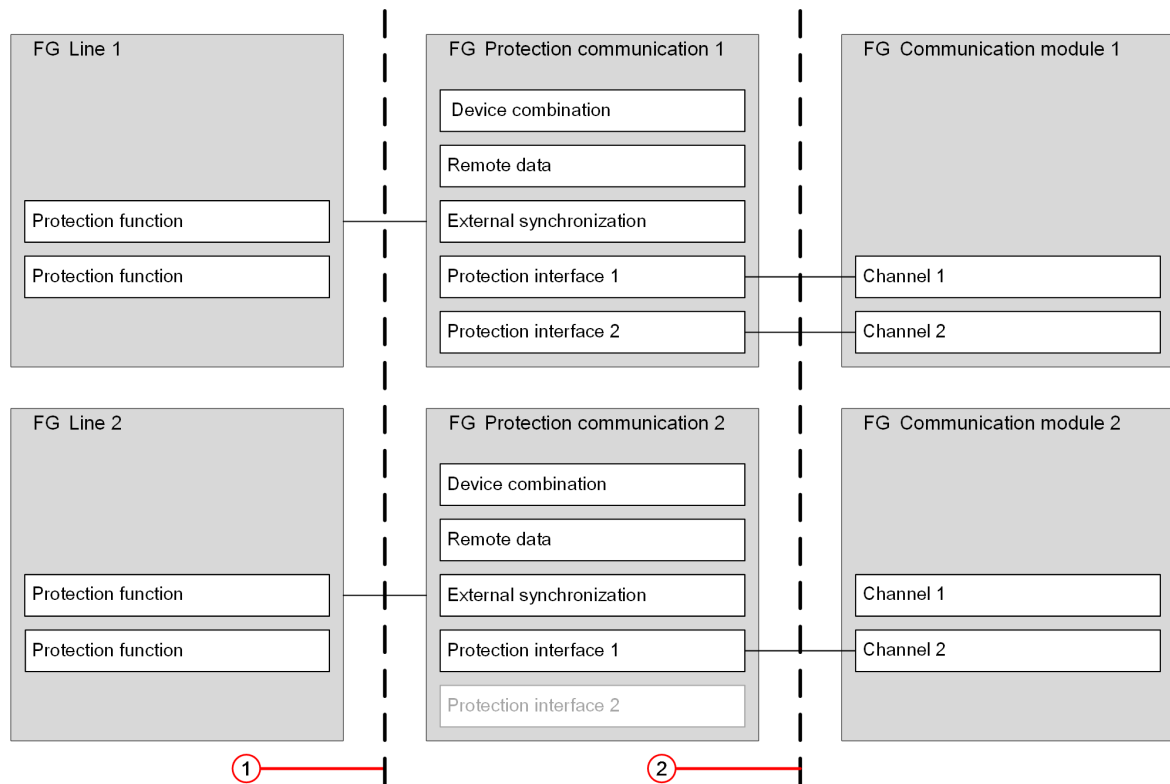
In the DIGSI 5 library, you can find the available function groups for the advanced protection communication in the **Advanced protection communication** folder. The following function-group types can be instantiated:

- **FG Protection communication type 1 (line differential protection)**
- **FG Protection communication type 2**

For configurations with line differential protection, instantiate the **FG Protection communication type 1 (line differential protection)**. In all other cases, instantiate the **FG Protection communication type 2**.

3.4.6.2 Advanced Protection Communication in the Overall System

The **Advanced protection communication** is integrated as follows in the overall system:



[dw_advanced_protcom_compl_system, 2, en_US]

Figure 3-78 Advanced Protection Communication in the Overall System

- (1) The following applies for the **FG Line** and the **FG Voltage/Current 3-phase**: You must route the connection between the protection FG and the **FG Protection communication** in DIGSI 5.
- (2) You must assign a channel to the protection interface, see [Parameter: PI assignment, Page 126](#).

3.4.6.3 Structure of the FG Protection Communication 916fc571a17ec17e9da35239179b658b

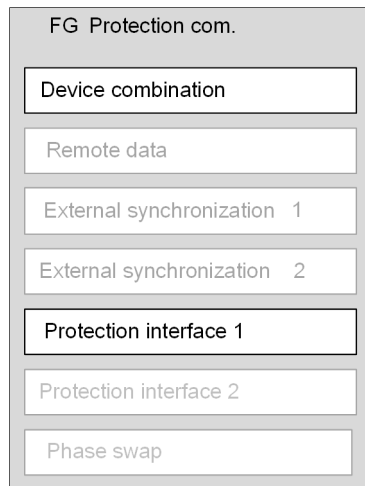
The instantiated FG **Protection communication** contains the FBs for a protection interface and for the device combination. If you need a 2nd protection interface, add another instance.

The FG **Protection communication** contains the following functionalities and function blocks (FB):

- FB **Device combination**
- FB for the **Protection interface**

In addition, the following FBs can be instantiated:

- A 2nd protection interface
You can find the 2nd protection interface in the Global DIGSI 5 library under **Extended protection communication > Second protection interface**.
- 1 or 2 FBs for the **External synchronization** of the transmitted measured values by an external synchronization pulse (1-second pulse, PPS) or via the IEEE 1588 synchronization protocol
You can find the FB **External synchronization** in the Global DIGSI 5 library under **Extended protection communication > Synchronization**.
- The FB **Remote data** is instantiated automatically, as soon as you configure remote data.
- The FB **Phase swap**



[dw_structure_fg_protcom_advanced, 2, en_US]

Figure 3-79 Structure of the FG Extended Protection Communication

Device Combination

The function **Device combination** manages the devices that exchange data via the protection communication.

The following FBs are preconfigured in the device combination:

- FB **General**
- FBs for each device in the device combination

In the **Device combination**, you configure general settings for the protection communication and the device addresses. The function **Device combination** issues the following indications:

- General indications like the
 - Amount of devices
 - Type and status of the device topology

- Indications of the devices in the device combination like:
 - The availability of the device
 - The state of the device, that is whether the device is logged on or off in the device combination
 - Measured values of the device that have been recorded and synchronized through the device combination (constellation measured values)
 - Test of the function **Line differential protection** in the device combination (only for protection communication type 1)
 - Test of the function **Line differential protection** in the local device (only for protection communication type 1)

Protection Interface

The FB **Protection interface** transmits and receives signals and measured values to/from the partner device. For this, the protection interface uses the channel of a communication module.

External Synchronization

Measured values that are acquired and exchanged in the devices at the same time, with microsecond accuracy are transmitted via the protection communication. The measured values can be synchronized as follows:

- Internally via the telegram measurement with the Ping-Pong method
- Externally via
 - An external, synchronous pulse 1-second-pulse (PPS)
 - Via the **IEEE 1588** protocol

If you want to use an external synchronization, you must instantiate the FB **External synchronization**.

You can use a different synchronization procedure for the 2nd protection interface than for the 1st protection interface.

Remote Data

If you want to exchange selected and user-specific data or measured values via the protection communication, you must use the **Remote data** function. If you route a specific signal or a measured value to the protection communication, the device automatically creates the **Remote data** functionality. The routed signals are then transmitted and received via the protection interface. The available bandwidth limits the amount of remote data that can be transmitted.

Phase Swap

If you want to exchange information via the protection communication with a device showing phases with a different sequence but with the same rotating field as your device, the SIPROTEC 5 device can swap the phase information when sending and receiving. It is no longer necessary to swap phases when connecting the current transformers.

This use case exists on some tie lines of different power-system operators.

For more information, refer to [3.4.6.12 Description Phase Swapping](#) and [3.4.6.13 Setting Notes for Phase Swapping](#).

3.4.6.4 Configuration of the Advanced Protection Communication in DIGSI 5

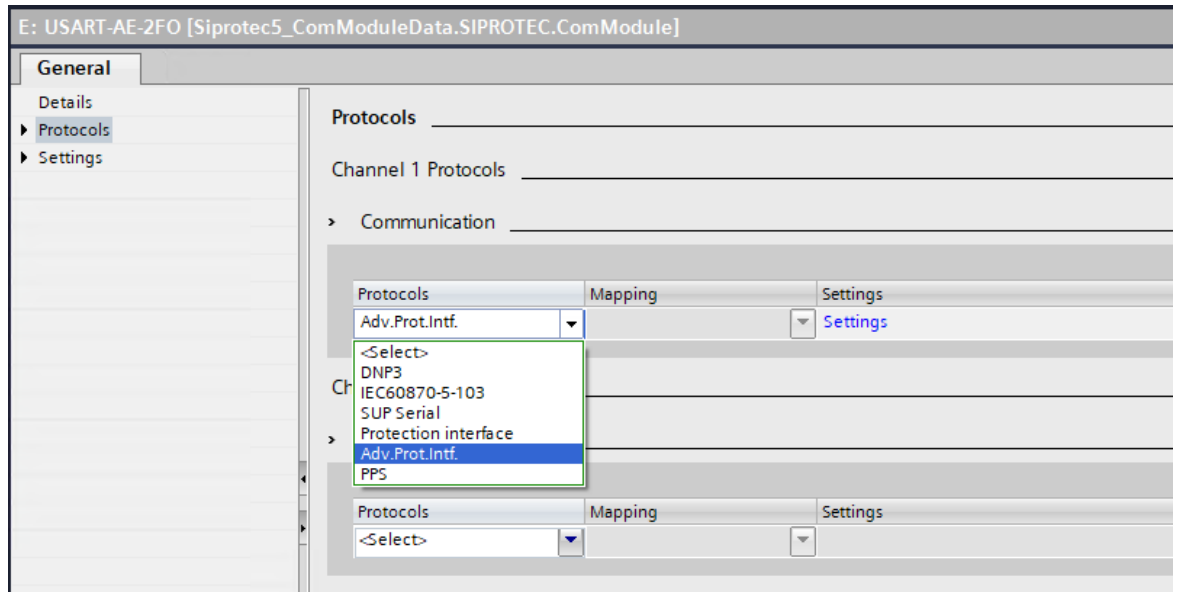
Steps during Configuration

Siemens recommends the following procedure when configuring the advanced protection communication:

- Select the desired communication module.
- Select the protocol **Adv. Prot. Intf..**

- The further parameterization depends on the selected communication module and is described in the following under:
 - [Advanced Protection Interface for a USART Communication Module, Page 123](#)
 - [Advanced Protection Interface for an Ethernet-BD Communication Module, Page 125](#)

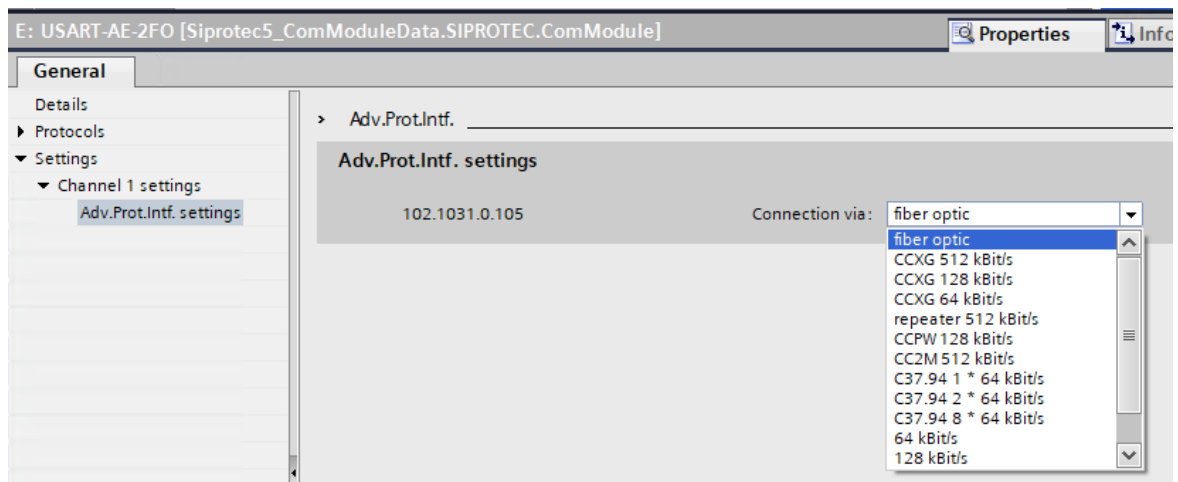
Advanced Protection Interface for a USART Communication Module



[sc_USART_01, 1, en_US]

Figure 3-80 USART Communication Module: Selection of the Protocol Advanced Protection Interface

After selecting the protocol, click **Settings** in the right column to get to the connection settings of the USART protection-interface module for channel 1.



[sc_USART_02, 1, en_US]

Figure 3-81 USART Communication Module: Settings for the Advanced Protection Interface

Parameter: Connection via

- Default setting (`_:105`) **Connection via** = *fiber optic*

The **Connection via** parameter is used to set the bit rate required for the protection interface. Different discrete values can be entered depending on the means of communication (see following table).

Table 3-17 Communication Media

Communication Media	See	Setting Value	Bit Rate
Fiber-optic direct connection	Figure 3-4 5 to Figure 3-4 9	<i>fiber optic</i>	2 MBit/s
CC-XG-512 communication converter	Figure 3-5 0	<i>CCXG 512 kBit/s</i>	512 kBit/s
CC-XG-128 communication converter	Figure 3-5 0	<i>CCXG 128 kBit/s</i>	128 kBit/s
CC-XG-64 communication converter	Figure 3-5 0	<i>CCXG 64 kBit/s</i>	64 kBit/s
Repeater 512 communication converter	Figure 3-5 3	<i>repeater 512 kBit/s</i>	512 kBit/s
CC-CC-128 communication converter	Figure 3-5 2	<i>CCPW 128 kBit/s</i>	128 kBit/s
CC-2M-512 communication converter	Figure 3-5 1	<i>CC2M 512 kBit/s</i>	512 kBit/s
Multiplexer with C37.94 interface	Figure 3-5 4	<i>C37.94 1 * 64 kBit/s</i> <i>C37.94 2 * 64 kBit/s</i> <i>C37.94 8 * 64 kBit/s</i>	64 kBit/s 128 kBit/s 512 kBit/s
Other (freely adjustable bit rates for a direct connection for special applications)		<i>64 kBit/s</i> <i>128 kBit/s</i> <i>512 kBit/s</i> <i>2048 kBit/s</i>	64 kBit/s 128 kBit/s 512 kBit/s 2048 kbit/s

Parameter: Multiplex operation

- Default setting (`_:112`) **Multiplex operation** = *no*

With the parameter **Multiplex operation**, you can designate the physical channel for multiplex operation. You can then route 2 protection interfaces to this channel.

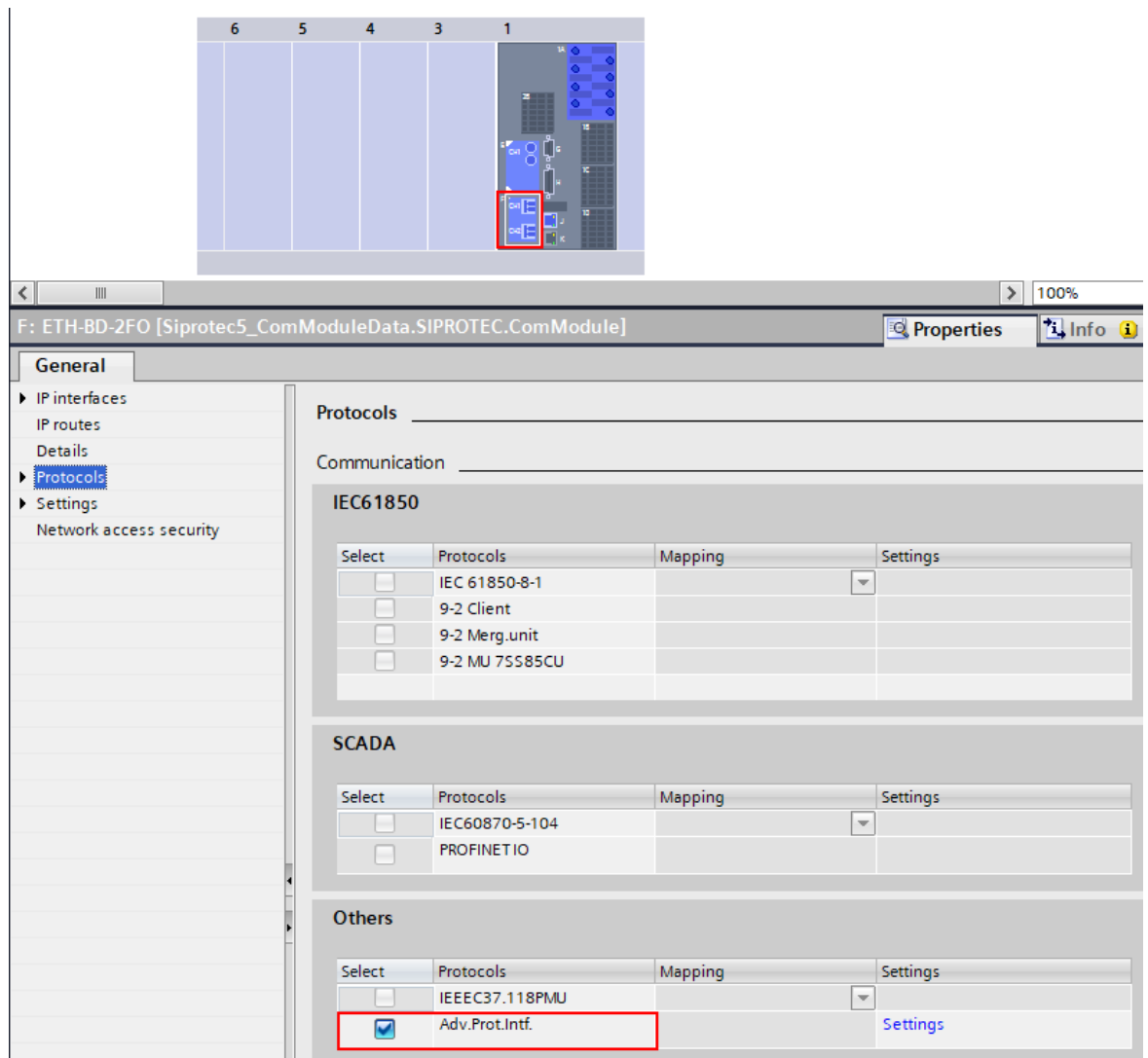
Refer to [3.4.3 Function Description](#).



NOTE

For safety reasons, you cannot route 2 protection interfaces from the same device combination to one channel, as this results in apparent redundancy.

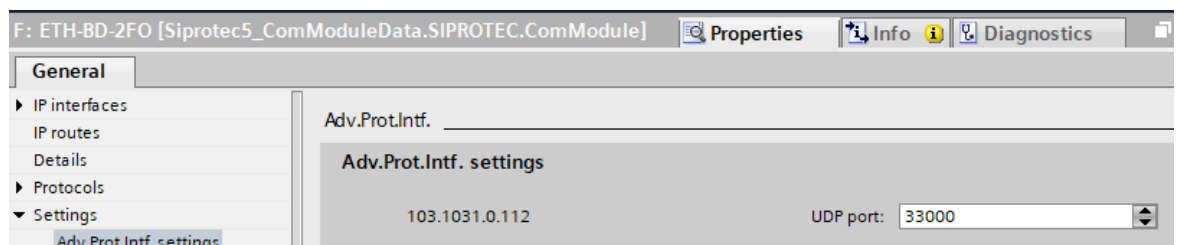
Advanced Protection Interface for an Ethernet-BD Communication Module



[sc_ETH-BD_01, 1, en_US]

Figure 3-82 Ethernet-BD Communication Module: Selection of the Protocol Advanced Protection Interface

After selecting the protocol, click **Settings** in the right column to get to the connection settings of the Ethernet-BD communication module for channel 1.



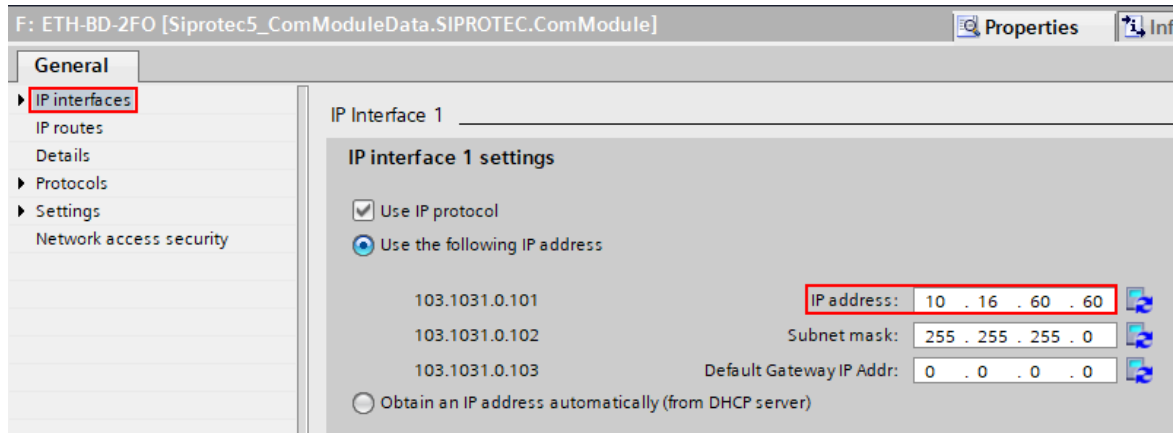
[sc_ETH-BD_02, 1, en_US]

Figure 3-83 Ethernet-BD Communication Module: Settings for the Advanced Protection Interface

Parameter: UDP Port

- Default setting (_:112) **User port = 33000**

With the **UDP port** parameter, you set the value of the destination port in the UDP header of the protection-interface IP messages. You must set the same value for the parameter **UDP port** for all protection devices of a device combination that use the IP-based protection interface. Different device combinations can use the same value for the **UDP port** parameter. Normally, the default setting can always be applied. It can be necessary, for example, due to firewall policies, to configure a UDP port that differs from the default setting. Parameterize the IP address of the Ethernet-BD communication module in the properties of the module.



[sc_IPadr, 1, en_US]

Figure 3-84 Parameterization of the IP Address for the Ethernet-BD Communication Module

The configuration and parameterization of the protection-interface communication module is now complete.

3.4.6.5 Setting Notes for the Protection Interface

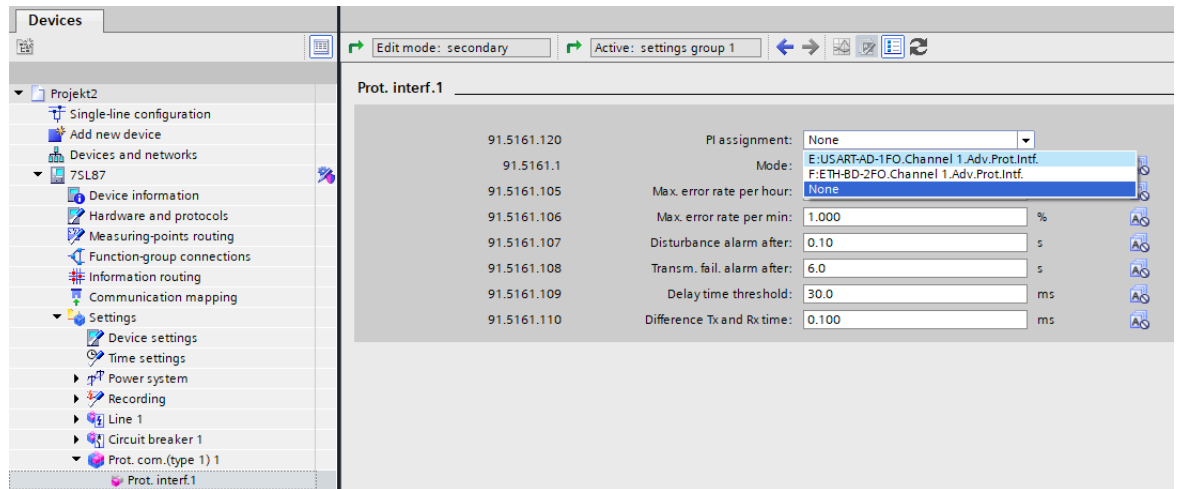
The chapters provides setting notes for the logical protection interface (**FB Protection interface**).

Parameter: PI assignment

- Default setting (`_:5161:120`) **PI assignment** = *Setting options depend on configuration*

In addition, you must select the channel for the protection interface in DIGSI 5 as follows: **Project tree > Prot. com. > Prot. interf..**

In the input area under **PI assignment**, select the channel of a communication module that supports the required protection-interface protocol. As a prerequisite for this, you must have selected the protocol **Advanced protection interface** for the channel of the desired communication module, see [3.4.6.4 Configuration of the Advanced Protection Communication in DIGSI 5](#).



[sc_W5select, 1, en_US]

Figure 3-85 Assignment of the Protection-Interface Channel to the Protection Interface

Parameter: Max. error rate per hour

- Default setting (`_:5161:105`) **Max. error rate per hour** = 1.0%

If the number of faulty telegrams per hour exceeds the value set in the parameter **Max. error rate per hour**, you receive the error message *Error rate / hour exc..*

Parameter: Max. error rate per min

- Default setting (`_:5161:106`) **Max. error rate per min** = 1.0%

If the number of faulty telegrams per minute exceeds the value set in the parameter **Max. error rate per min**, you receive the error message *Error rate / min exc..*

Parameter: Disturbance alarm after

- Default setting (`_:5161:107`) **Disturbance alarm after** = 100 ms

With the parameter **Disturbance alarm after**, you determine the time delay after which faulty or missing telegrams are signaled as disturbed with the indication *Status of lay. 1 and 2 = PI data fault.*

Parameter: Transm. fail. alarm after

- Default setting (`_:5161:108`) **Transm. fail. alarm after** = 6.0 s

With the parameter **Transm. fail. alarm after**, you determine the time delay after which a communication failure is signaled with the indication *Status of lay. 1 and 2 = PI data failure.*

Parameter: Delay time threshold

- Default setting (`_:5161:109`) **Delay time threshold** = 30.0 ms

The time taken to transmit and receive a signal via a protection connection is called the signal-transit time. You can monitor the signal-transit time. For the **Delay time threshold**, the default setting is selected in such a way that it is not exceeded by normal communication networks. If the signal-transit time is exceeded during operation (for example, upon switchover to another transmission path), the indication **Time delay exceeded** is issued.

Increased runtimes only affect the operate time, and therefore the fault-clearing time of the protection functions that use the protection interface. If you use the **Line differential protection** function, this remains in effect.

Parameter: Difference Tx and Rx time

- Default setting (`_:5161:110`) **Difference Tx and Rx time** = *0.1 ms*

For a time synchronization of the measured values with microsecond accuracy by means of telegram measurement, the signal-transit times in the transmission and receive direction must be approximately the same. The device monitors the signal-transit times in the transmission and reception direction.

With the **Difference Tx and Rx time** parameter, you can set a maximum permitted signal-transit time difference between the transmission and reception paths (runtimes unbalanced). Set the parameter **Difference Tx and Rx time** to the maximum difference expected.

Set this value to *0* for a direct fiber-optic connection. A higher value is necessary for transmission via communication networks. *0.1 ms* (recommended setting value) is the reference value.

If the difference in the signal-transit times between the transmission and reception path exceeds the set value, the indication *Time delay jump* is issued.

If the difference in the signal-transit times between the transmission and reception path exceeds the set value and remains for more than 5 s, the indication *Time delay different* is issued. The **Line differential protection** function is no longer working properly and is *ineffective*.



NOTE

The **Difference Tx and Rx time** parameter only visible if the **Line differential protection** function is instantiated and the parameter **Synchronization** is not set to *External synch. only*.



NOTE

If you use a multiplexer with a C37.94 interface as a communication medium, Siemens recommends a setting value of *0.25 ms* to *0.6 ms*.

Parameter: Synchronization

- Default setting (`_:5161:113`) **Synchronization** = *External synchron. off*

With the parameter **Synchronization**, you control the time synchronization of the measured values with microsecond accuracy.

The parameter **Synchronization** is only visible if you have instantiated the FB **External synchronization** from the Global DIGSI 5 library in the FG **Protection communication**.

If you have not instantiated the FB **External synchronization**, the measured values are time-synchronized internally with microsecond accuracy.

Parameter Value	Description
External synchron. off	The external synchronization is disabled: No external synchronization is performed on the protection interface. Select this setting value if you do not expect any differences between the signal-transit times in the transmission and reception directions. Then, the measured values are only synchronized internally with the telegram measurement.
Telegr. and ext. synch.	Synchronization via telegram measurement and external synchronization: The measured values are synchronized internally with the telegram measurement, supported by the external synchronization. The synchronization is possible via the IEEE 1588 protocol or via the synchronous pulse of a satellite receiver and configurable in the FB External synchronization . In this case, an existing line differential protection is only enabled when a new connection is established and one of the following conditions is met. • The protection connection is synchronized with the help of the external synchronization. • Symmetric signal-transit times are signaled via the binary input signal <i><Sync-Reset</i> or the controllable <i>Resetting sync.</i>. This means that the signal-transit times are the same in the send and receive direction.
Telegr. or ext. synch.	Telegram measurement or external synchronization: The measured values are synchronized internally with the telegram measurement, supported by the external synchronization. The synchronization is possible via the IEEE 1588 protocol or via the synchronous pulse of a satellite receiver and configurable in the FB External synchronization . An existing line differential protection is enabled immediately upon renewed establishment of a connection (data telegrams are received). The internal synchronization is used up to synchronization.
External synchron. only	External synchronization only: The measured values are synchronized only via the external synchronization. You can set the external synchronization in the FB External synchronization . This enables synchronization via the IEEE 1588 protocol or via the synchronous pulse of a satellite receiver.



NOTE

If the protection interface is connected to a channel on a USART communication module (see [Parameter: PI assignment, Page 126](#)), the external synchronization is used to take into account the signal-transit times in the transmission and receive direction.

If the external synchronization fails for a short time, for example, due to a receiving interference or an unfavorable satellite position for a brief period, the internal synchronization via the telegram measurement is still active.



NOTE

If the protection interface is connected to a channel on an Ethernet-BD communication module (see [Parameter: PI assignment, Page 126](#)), the parameter **Synchronization** is permanently set to **External synchron. only**.

Parameter: FB External synchron.

- Default setting (`_:5161:117`) **FB External synchron. = Ext. synchronization 1**

With the external synchronization, the time synchronization of the measured values with microsecond accuracy is possible through an external synchronization source.

The parameter **FB External synchron.** is only visible if you have instantiated at least 1 **FB External synchronization** from the Global DIGSI 5 library into the **FG Protection communication**. You can instantiate a maximum of 2 FBs for external synchronization.

With the parameter **FB External synchron.**, you specify whether the protection interface uses the **FB Ext. synchronization 1** or the **FB Ext. synchronization 2** for the synchronization. You parameterize the synchronization source in the corresponding **FB External synchronization**, see [3.4.6.9 Setting Notes for External Synchronization](#).



NOTE

The external synchronization is possible separately for each protection interface.

Parameter: Check synchron.-source

- Default setting (**_:5161:121**) **Check synchron.-source** = **yes**

With the parameter **Check synchron.-source**, you can switch the synchronization-sources check on or off. During the check of the synchronization sources on the ends of a protection connection, a check is conducted as to whether both synchronization sources are working in the same synchronization status **SmpSynch**.

If both synchronization sources are working in the synchronization status **SmpSynch = global**, the inspection has been passed.

If both synchronization sources are working in the synchronization status **SmpSynch = local**, that is decoupled from a global reference time, an additional check is conducted as to whether the synchronization source (**gmIdentity**) is the same. Synchronicity can only be guaranteed if the synchronization sources are the same.

If the synchronization sources display a different synchronization status, that is one displays the synchronization status **SmpSynch = local** and the other the synchronization status **SmpSynch = global**, synchronization cannot be guaranteed.

Siemens recommends using the default setting **Check synchron.-source** = **yes**.

If you have problems with the synchronization-source check, you can switch off the synchronization-source check. Switch off the synchronization-source check only if the synchronization sources are synchronous at the end of their protection connection.

The parameter **Check synchron.-source** is visible only if the parameter (**_:5161:113**) **Synchronization** is set to **External synch. only**.



NOTE

If you use **PPS electrical (port G)** as the synchronization source, the synchronization status (**SmpSynch**) is permanently set to **global**.

If you use **PPS optical (USART)** as the synchronization source, you can use the parameter (**_:107**) **Received. SmpSynch** to set the synchronization status to (**SmpSynch**) **local** or **global**.

For a synchronization with microsecond accuracy, for example, for the **Line differential protection**, set the parameter (**_:107**) **Received. SmpSynch** = **global**.

3.4.6.6 Indications and Measured Values of the Advanced Protection Interface

Each individual protection interface provides different indications for commissioning and diagnostics of communication:

Indication (**_:5161:301**) **Status of lay. 1 and 2**

The indication (**_:5161:301**) **Status of lay. 1 and 2** informs you about the status of the connection. The following indications are possible:

Table 3-18 Status Indications Status of lay. 1 and 2

Indication	Description
<i>initialized:</i>	The protection interface is not connected and is in the Initial state.
<i>PI connected:</i>	The protection interface is connected to the protection interface of the partner device.
<i>PI data fault:</i>	The protection interface has not received any valid telegrams for the time set in parameter (_:5161:107) Disturbance alarm after .
<i>PI data failure:</i>	The protection interface has not received any valid telegrams for the time set in parameter (_:5161:108) Transm. fail. alarm after .
<i>not existing:</i>	The protection interface has not been assigned to a communication channel.

Indication (**_:5161:302**) *Status of lay. 3 and 4*

The indication (**_:5161:302**) *Status of lay. 3 and 4* informs about errors during the connection establishment. The following indications are possible:

Status indication	Description
<i>no error:</i>	No errors occurred during the connection establishment.
<i>SW ver.incomp.:</i>	The connection is not established because the firmware versions of the devices are incompatible. Update the firmware.
<i>wrong dev. ID:</i>	The connection is not established because the device address of the local device or the partner device is incorrect or set incorrectly. Check the settings for the parameters Address of device 1 to Address of device n (_:5131:102 and following).
<i>const.sett.error:</i>	The connection is not established because the parameters are set differently. Check whether the parameter (_:5131:122) Lowest appearing bit rate has been set the same in all devices in the device combination.
<i>diff.sett error:</i>	The connection is not established because the parameters are set differently. The line differential protection settings for the connected devices are incompatible. Check whether both devices are set to operate with or without line differential protection. The rated current of the line (parameter (_:9001:101) Rated current) must have the same setting in all devices. With a transformer in the line, the (_:9001:103) Rated apparent power must be set to the same value in all devices.
<i>net mirroring</i>	The connection is not established. The protection interface is receiving its own data. Check the wiring.
<i>wrong dev. idx.</i>	The connection is not established because the device index of the local device or the partner device is incorrect. Check the setting for the parameter (_:5131:101) Local device is device .

Furthermore, the following output signals are available:

Output Signal	Description
(_:5161:303) <i>Connection broken</i>	The signal <i>Connection broken</i> indicates that during a parameterized time (parameter (_:5161:107) Disturbance alarm after) no telegrams or faulty telegrams were continuously received. If the indication <i>Connection broken</i> is issued, the affected protection connection is reset. This can cause the blocking of an active line differential protection or a ring topology can change to a chain topology.
(_:5161:316) <i>Error rate / min exc.</i>	The signal <i>Error rate / min exc.</i> indicates that the set maximum error rate per minute (Parameter (_:5161:106) Max. error rate per min) has been exceeded. In this manner, a brief increase of the operate time and thus of the fault-clearing time is possible for the protection functions using the protection interface. If you use the Line differential protection function, this remains in effect.
(_:5161:317) <i>Error rate / hour exc.</i>	The signal <i>Error rate / hour exc.</i> indicates that the set maximum error rate per hour (Parameter (_:5161:105) Max. error rate per hour) has been exceeded. In this manner, a brief increase in operate time and thus the fault-clearing time is possible for the protection functions using the protection interface. If you use the Line differential protection function, this remains in effect.
(_:5161:318) <i>Time delay exceeded</i>	The signal <i>Time delay exceeded</i> indicates that the threshold value for the set signal runtime (parameter (_:5161:109) Delay time threshold) has been exceeded. Increased runtimes only affect the operate time, and therefore the fault-clearing time of the protection functions using the protection interface. If you use the Line differential protection function, this remains in effect.
(_:5161:319) <i>Time delay different</i>	The signal <i>Time delay different</i> indicates that the threshold value for the difference in signal runtimes in the transmission and reception direction (asymmetrical runtimes) has been exceeded. The setting value results from the setting value of the parameter (_:5161:110) Difference Tx and Rx time . The indication is visible only if the parameter (_:5161:113) Synchronization is not set to External synch. only . If the indication <i>Time delay different</i> appears, the Line differential protection function is no longer working properly and is ineffective .
(_:5161:320) <i>Time delay jump</i>	The signal <i>Time delay jump</i> indicates that the signal runtimes of the data changed abruptly. This is caused by a switchover of the communication path in the communication network. The indication is visible only if the parameter (_:5161:113) Synchronization is not set to External synch. only .
(_:5161:321) <i>PI synchronized</i>	The signal <i>PI synchronized</i> indicates that the synchronization with microsecond accuracy of the measured values transferred between the local device and partner device is working correctly. The indication is visible only if the parameter (_:5161:113) Synchronization is not set to External synch. only .
(_:5161:340) <i>Telegram lost</i>	The signal <i>Telegram lost</i> indicates that an expected telegram has failed to arrive or a faulty telegram has been received. If you want to assign the communication failures or faults to other events, route the signal <i>Telegram lost</i> temporarily into the operational log. Such events can be switching operations in the primary system or operations on the components of the communication network. Note: If the signal is constantly routed, the operational log can overflow. Siemens recommends routing the signal only for clarification of problems.

Output Signal	Description
(_:5161:343) <i>Partner</i>	The indication shows the address of the partner device. A value of 0 means that no partner address is available.
(_:5161:323) <i>PPS: time del. unsym.</i>	This indication is only visible if you are working with a synchronous pulse. The indication shows that the difference in the signal runtimes between the sending and receiving path exceeds the value set with the parameter (_:5161:110) Difference Tx and Rx time . Note: The Line differential protection function remains effective .
(_:5161:324) <i>PI with PPS synchron.</i>	This indication is only visible if you are working with a synchronous pulse. This indication is only visible if, in parallel to synchronization with the synchronization pulse, you are also working with the synchronization via telegram measurement. If both synchronization methods are working properly, the indication <i>PI with PPS synchron.</i> = RAISING is generated.

Measured Values of the Protection Interface

The protection interface provides the following measured value for the diagnosis of the protection-interface communication:

Measured Value	Description
(_:5161:308) <i>Tx tel/h</i>	Telegrams transmitted during the last hour
(_:5161:309) <i>Rx tel/h</i>	Telegrams received during the last hour
(_:5161:310) <i>Tx tel/min</i>	Telegrams transmitted during the last minute
(_:5161:311) <i>Rx tel/min</i>	Telegrams received during the last minute
(_:5161:312) <i>Tx err/h</i>	Transmission failure rate during the last hour
(_:5161:313) <i>Rx err/h</i>	Receive error rate during the last hour
(_:5161:314) <i>Tx err/min</i>	Transmission failure rate during the last minute
(_:5161:315) <i>Rx err/min</i>	Receive error rate during the last minute
(_:5161:325) <i>Aver. Δt</i>	Average signal runtime (average value of the runtime in transmission and reception direction divided by 2, without external synchronization)
(_:5161:326) <i>Rec. Δt</i>	Signal runtime for reception path (with external synchronization)
(_:5161:327) <i>Sen. Δt</i>	Signal runtime for transmission path (with external synchronization)
(_:5161:334) <i>Miss. tel/min</i>	Number of telegram failures within the last minute
(_:5161:335) <i>Miss. tel/h</i>	Number of telegram failures within the last hour
(_:5161:336) <i>Miss. tel/d</i>	Number of telegram failures within the last day
(_:5161:337) <i>Miss. tel/w</i>	Number of telegram failures within the last week
(_:5161:338) <i>M. loss/d</i>	Longest lasting telegram failure within the last day
(_:5161:339) <i>M. loss/w</i>	Longest lasting telegram failures within the last week
(_:5161:331) <i>Recept.</i>	Receipt of a telegram (0 = no receipt, 1 = receipt) You can use this indication to make the telegram exchange visible in the fault record.



NOTE

You can reset the measured values of the protection interface directly in the device. Proceed as follows:
Device functions > Protection comm. (Type x) > Protection interface y > Reset measured values.

3.4.6.7 Setting Notes for the Device Combination

In the **Project tree > Settings > Protection comm. (type 1) or Protection comm. (type 2)**, select the function block **Device combination**. In the input area, you parameterize the general settings for the device combination, instantiate the number of devices in the device combination, and set the parameters for each device. A device combination consists of at least 2 devices.

Parameter: Local device is device

- Default setting (`_:2311:101`) **Local device is device** = 1

With the **Local device is device** parameter, you set the index (number) of your device in the device combination. A maximum of 6 devices can be present in a device combination.

Parameter: Lowest appearing bit rate

- Default setting (`_:2311:122`) **Lowest appearing bit rate** = 64 kBit/s

With the parameter **Lowest appearing bit rate**, you set the lowest bit rate occurring in the device combination. This value determines the maximum number of signals and measured values to be transferred in the **Remote data** function within the device combination.

EXAMPLE:

For a device combination consisting of 3 devices in a ring topology with 2 fiber-optic connections (2 MBit/s) and a 64-kBit/s connection, set the smallest value (64 kBit/s) in each device.

Apart from the default value, you can set the following bit rates:

- 128 kBit/s
- 512 kBit/s
- 2048 kBit/s



NOTE

If you use optical fibers for all protection connections, set the value to **2048 kBit/s**.

Connection mode

- Default setting (`_:2311:126`) **Connection mode** = *SIPROTEC 5*

With the parameter **Connection mode**, you select the device type with which the SIPROTEC 5 device works in the device combination via the protection connections.



NOTE

As soon as a SIPROTEC 4 device is present in the device combination, the SIPROTEC 5 devices must operate in a compatibility mode. For this reason, the parameter **Connection mode** must be set to the same value in all SIPROTEC 5 devices in the device combination. Select the type of SIPROTEC 4 device from the following table:

Parameter Value	Description
<i>SIPROTEC 5</i>	The SIPROTEC 5 device works with a SIPROTEC 5 device in the device combination.
<i>SIPROTEC 4 7SD610</i>	The SIPROTEC 5 device works with a SIPROTEC 4 differential protection device 7SD610 with firmware version V4.72 and higher in the device combination.
<i>SIPROTEC 4 7SD5</i>	The SIPROTEC 5 device works with a SIPROTEC 4 differential protection device 7SD5x with firmware version V4.72 and higher in the device combination.
<i>SIPROTEC 4 7SA5/6</i>	The SIPROTEC 5 device works with a SIPROTEC 4 distance protection device 7SA522 and 7SA6x with firmware version V4.70 and higher in the device combination.

Parameter: Dev. comb. is time source

- Default setting (`_:2311:129`) **Dev. comb. is time source** = **yes**

The parameter **Dev. comb. is time source** is only visible if you have instantiated several function groups **Protection comm.** and you have selected the setting value **PI** for the parameters **Time source 1** or **Time source 2**.

The parameter **Dev. comb. is time source** determines from which FG **Protection comm.** the time is taken over.

Parameter: Protection com.

- Default setting (`_:2311:128`) **Protection com.** = **Type 1 (Line diff. prot.)**

The parameter **Protection com.** is write-protected and displays only the type of the instantiated device combination.

The device combination **Type 1 (Line diff. prot.)** supports the function **Line differential protection**. The device combination **Type 2 (no Line diff. pr.)** does not support the function **Line differential protection**.



NOTE

In the Global DIGSI 5 library, the function groups **Protection communication type 1 (line diff. protection)** and **Protection com. Type 2** are available for the advanced protection communication. When instantiating the respective function group, the corresponding type of the device combination is automatically pre-instantiated.



NOTE

If you have instantiated the FG **Protection com. Type 2**, the **Device combination Type 2** is automatically pre-instantiated in this FG and the **Line differential protection** function is not supported.

If you subsequently want to use the **Line differential protection** function in the device combination of the FG **Protection com. Type 2**, proceed as follows:

- In the DIGSI 5 project tree, delete the function block **Device combination** from the **FG protection comm. (type 2)**.
- Instantiate the function block **Device combination type 1 (line diff. protection)** from the Global DIGSI 5 library into the FG **Protection com. Type 2**.
- Parameterize the **device combination** in the input area again.
- Reroute the indications of the device combination in the DIGSI 5 information routing.

All other parameterizations and routings are retained!

Parameter: Device index

- Default setting (`_:22711:101`) **Device index** = **1**
- Default setting (`_:22712:101`) **Device index** = **2**
- Default setting (`_:22713:101`) **Device index** = **3**
- Default setting (`_:22714:101`) **Device index** = **4**
- Default setting (`_:22715:101`) **Device index** = **5**
- Default setting (`_:22716:101`) **Device index** = **6**

The value of the parameter **Device index** is the number of the device in the device combination. Set the device index in all devices of a device combination for the same devices in the same way. The device indices must start with 1 and be incremented continuously. DIGSI 5 assigns the device indices automatically. You can change the device indices if necessary.



NOTE

The device with the **Device index** = 1 is the timing-master device in a device combination. If all other devices in the device combination are to obtain their time from the timing-master device, consider the following

- Set the **Device index** to 1 for the timing-master device.
- Parameterize the other devices in such a way that they get their time from the timing-master device via the protection connections.

For more information, refer to [3.5.3 Function Description](#). Select **Protection interface** as the adjustable synchronization option.

In the timing-master device, you must **not** set the protection interface as the synchronization source!

Parameter: Address in Device combi.

- Default setting (`_:22711:102`) **Address in Device combi.** = 101
- Default setting (`_:22712:102`) **Address in Device combi.** = 102
- Default setting (`_:22713:102`) **Address in Device combi.** = 103
- Default setting (`_:22714:102`) **Address in Device combi.** = 104
- Default setting (`_:22715:102`) **Address in Device combi.** = 105
- Default setting (`_:22716:102`) **Address in Device combi.** = 106

With the parameter **Address in Device combi.**, you assign a unique and unambiguous address for each device.



NOTE

If the preset values do not fit, Siemens recommends the following procedure:

Define a number for the device combination that is unambiguous in your area of responsibility and that must be at least 2 digits, for example, 100. The setting value of the parameter **Address in Device combi.** is then calculated as follows: **Number in the device combination + Device index**.

For device 2, this leads to **Address in Device combi.** = 102.

Parameter: IP Address

- Default setting (`_:22711.103`) **IP address** = 0.0.0.0
- Default setting (`_:22712.103`) **IP address** = 0.0.0.0
- Default setting (`_:22713.103`) **IP address** = 0.0.0.0
- Default setting (`_:22714.103`) **IP address** = 0.0.0.0
- Default setting (`_:22715.103`) **IP address** = 0.0.0.0
- Default setting (`_:22716.103`) **IP address** = 0.0.0.0

The IP address of the local device is taken from the settings of the Ethernet-BD communication module and displayed. The local IP address cannot be edited at this point.



NOTE

If all devices of a device combination are equipped with an Ethernet-BD communication module and use the IP communication, you must enter the IP addresses for all other devices in the device combination here. The topology detection automatically sets a ring or chain topology.



NOTE

If you have a hybrid configuration, that is not all protection connections of a device combination use the IP communication, you must observe the following when setting the IP addresses:

- The topology detection does not generate the topology automatically.
- First define the order for the communication between the devices. Define chain or ring topologies for this purpose.
The defined topology results in the partner devices for each device, with which the device communicates directly.
Only set the IP addresses for the partner devices that are equipped with an Ethernet-BD communication module here.
- You can find examples of the parameterization of the IP addresses in hybrid configurations in the chapters [3.4.8.4 Device Combination of 3 Devices and Hybrid Communication Media](#) and [3.4.8.5 Device Combination of 6 Devices and Hybrid Communication Media](#).

Indications and Measured Values in the Device Combination

Indication	Meaning
(_:3321:2311:301) <i>Status of topo. recog.</i>	The devices form a topology via the protection connections. This indication shows the status of the topology detection and can have the following values: • <i>Unknown:</i> The topology is unknown. • <i>Invalid:</i> The detected topology is not supported. • <i>Transient:</i> The topology has just been modified. • <i>Valid:</i> The topology has been detected. The indication <i>Devices form</i> shows the type of the detected topology.
(_:3321:2311:302) <i>Topology is</i>	The indication shows whether all configured devices in the device combination communicate with each other via the protection connections. The indication can have the following values: • <i>Unknown:</i> The topology is unknown. • <i>Incomplete:</i> At least one device in the device combination does not communicate via the protection connections. • <i>Complete:</i> All configured devices in the device combination communicate via the protection connections.

Indication	Meaning
(_:3321:2311:303) <i>Devices form</i>	This indication shows the type of the detected topology that the devices in the device combination form via the protection connections. The indication can have the following values: <i>unknown topo1</i>: The topology is unknown. <i>chain topology</i>: The devices and their protection connections form a chain topology. <i>ring topology</i>: The devices and their protection connections form a ring topology.
(_:3321:2311:304) <i>Number of detect. dev.</i>	The indication shows the number of devices that communicate via the protection connections in the device combination.

Indication and Measured Values of the Devices

The following indications and measured values are displayed for each device in the device combination and are explained using the example of a device.

Indication	Meaning
(_:22711:300) <i>Dev. addr.</i>	This indication shows the address of the device.
(_:22711:318) <i>is present</i>	This indication shows whether the device is involved in protection communication.
(_:22711:317) <i>is logged off</i>	This indication shows whether the local device has been logged off. If the device has been logged off, it is no longer involved in communication via the protection interfaces. If a device has been logged off, information relevant for the protection functions is no longer exchanged.
(_:22711:301) <i>circuit breaker</i>	This indication shows the position of the circuit breaker and can have the following values: <i>0</i>: The switch position of the circuit breaker is unknown. <i>1</i>: The circuit breaker is open. <i>2</i>: The circuit breaker is closed.
(_:22711:328) <i>Line diff. test</i> ¹²	This message indicates whether the function Line differential protection is in the state Test or Test/Relay blk..
(_:22711:329) <i>Local Line diff. test</i> ¹²	This message indicates whether the function Line differential protection is in the special test mode Test local device .

3.4.6.8 Constellation Measured Values for Type 1 and Type 2



NOTE

The constellation measured values are only available for the FG **Line**.

Each device in the device combination determines measured values predefined by Siemens, known as constellation measured values. You can find the constellation measured values in the DIGSI 5 information routing under the FG **Protection comm. (Type x) > Device combination > Device x**. The following measured values and indications are issued for each device:

¹² This message is only available in the FG Protection communication type 1 (line diff. protection).

Measured value	Meaning
(_:3321:22711:302) <i>vph</i>	This measured value shows the voltage of the 3 phases that is synchronized with all devices of the device combination. The absolute value and angle are issued for each phase.
(_:3321:22711:303) <i>Iph</i>	This measured value shows the current of the 3 phases that is synchronized with all devices of the device combination. The absolute value and angle are issued for each phase.
(_:3321:22711:304) <i>f</i>	The measured value supplies the locally calculated frequency of the measured voltage or the current.

The constellation measured values have the following properties:

- They are synchronized in the devices in a device combination.
- They are substituted using the protection interface.
- They are available on every device.

You can view the constellation measured values with DIGSI 5.

In the device, current and voltage measured values are displayed in absolute value and phase as a percentage. 100 % conform to the rated current or the rated voltage of the line (see [Figure 3-86](#)). These measured values are recorded every 2 seconds by the devices involved in the device combination and then sent to the other respective devices. At the same time, the current and voltage values of the different devices are time-synchronous with one another.

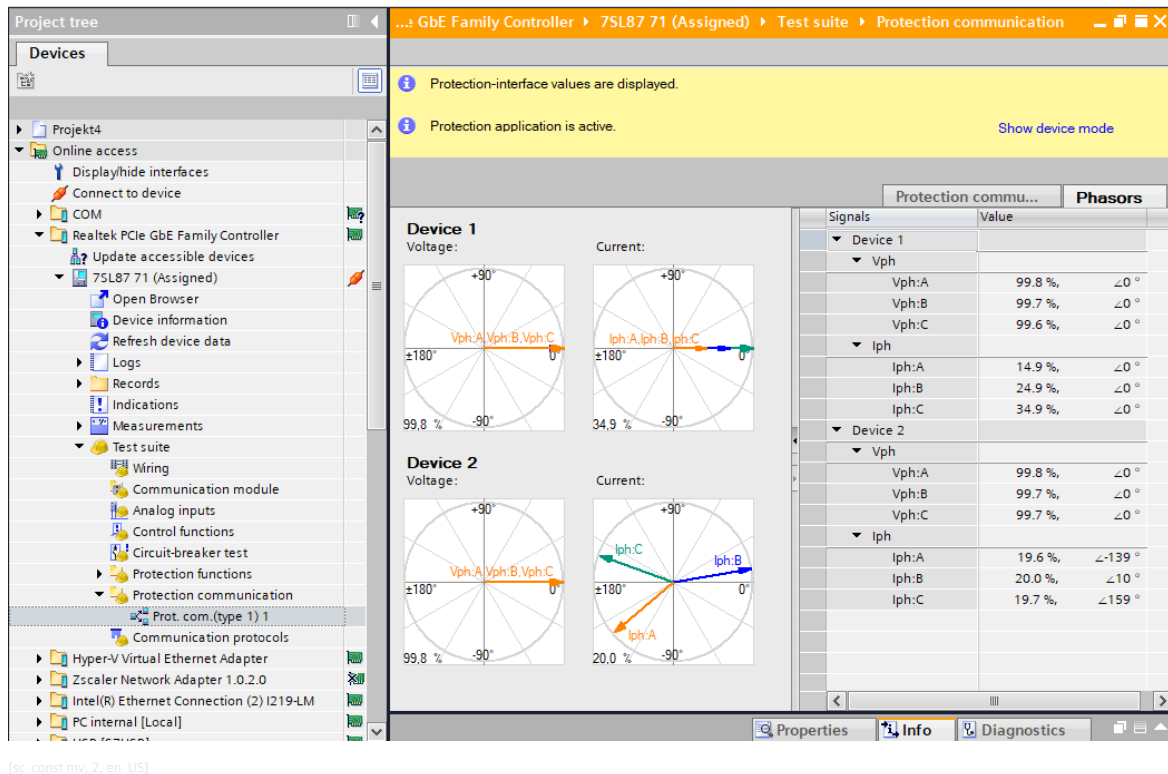
When displaying the constellation measured values the local device is prioritized. The device connected directly with DIGSI 5 is the local device.

The reference of the angle information depends on whether a line differential protection has been instantiated in the FG **Line**. If a line differential protection is instantiated, the protection communication is type 1, otherwise type 2.

- Protection communication **Type 1**:
 - The angle values of the voltages show the angle difference between the local and the remote voltage. The local voltage serves as the reference with an angle of 0°.
 - The angle values of the currents show the angle difference between the local and the remote current. The local current serves as the reference with an angle of 0°.
- Protection communication **Type 2**:

The angles of the phase-to-ground voltages and the phase currents relate to the voltage V_A of the relevant device.

You can find these measured values in the device under the following DIGSI mask:



[sc_const mv, 2, en_US]

Figure 3-86 Example of Constellation Measured Values with Phases

3.4.6.9 Setting Notes for External Synchronization

With the FB **External synchronization**, you can synchronize the measured values of the devices connected via protection connections with microsecond accuracy using external synchronization sources ($1 \cdot 10^{-6}$ s).

The measured values transmitted via protection communication for the line differential protection must be time-synchronized. The synchronization is possible as follows:

- Internally via telegram measurement
- Externally via the IEEE 1588 protocol
- Externally via a synchronous pulse from a satellite receiver

If you use Ethernet-BD communication modules for the protection communication of the line differential protection, the external synchronization of the measured values transmitted via the protection interface is mandatory.

If you use USART communication modules, you can synchronize the transmitted measured values either internally via telegram measurement or via external synchronization. If you do not use the external synchronization, the device automatically uses the internal synchronization.

If you want to use the external synchronization of the measured values, you must instantiate the FB **External synchronization** from the Global DIGSI 5 library into the FG **Protection comm..** You can find the **External synchronization** in the Global DIGSI 5 library under **Advanced protection communication > Synchronization**.

The external synchronization is possible for line differential protection applications or synchrophasor measuring devices as follows:

- Via a high-precision electrical synchronous pulse (**PPS electrical (Port G)**, 1-second pulse) from a satellite receiver at the time-synchronization interface (Port G)
- Via a high-precision optical synchronous pulse (**PPS optical (USART)**, 1-second pulse) from a satellite receiver at a USART communication module
- Via the **IEEE 1588** time-synchronization protocol

With external synchronization, you can measure and display the signal-transit time of the transmission and receive path separately. This allows you to achieve maximum sensitivity even with unequal (unbalanced) signal-transit times in communication networks with the line differential protection. For the transmission of protection data in the **type 2** protection communication, different signal-transit times do not play a role.

If an **FB External synchronization** is instantiated, the parameter **Synchronization** is visible in the **FB Protection interf.**. With this parameter, you establish the connection between the protection interface and the type of external synchronization. See [3.4.6.5 Setting Notes for the Protection Interface](#).

If you use 2 protection interfaces in the **FG Protection comm.**, you can set a different synchronization source for each protection interface if required. For this use case, you must instantiate 2 **FBs External synchronization** into the **FG Protection comm.** and set the desired synchronization source separately.

Parameter: Name of synchron. block

- Default setting (**_:101**) **Name of synchron. block** = *Ext. synchronization 1*

The parameter **FB External synchron.** shows the name of the **FB External synchronization**.

If you have instantiated 2 **FBs External synchronization** into the **FG Protection comm.**, you can use this parameter to switch between the **FB Ext. synchronization 1** and the **FB Ext. synchronization 2**.

Parameter: Synchronization source

- Default setting (**_:117**) **Synchronization source** = *nothing*

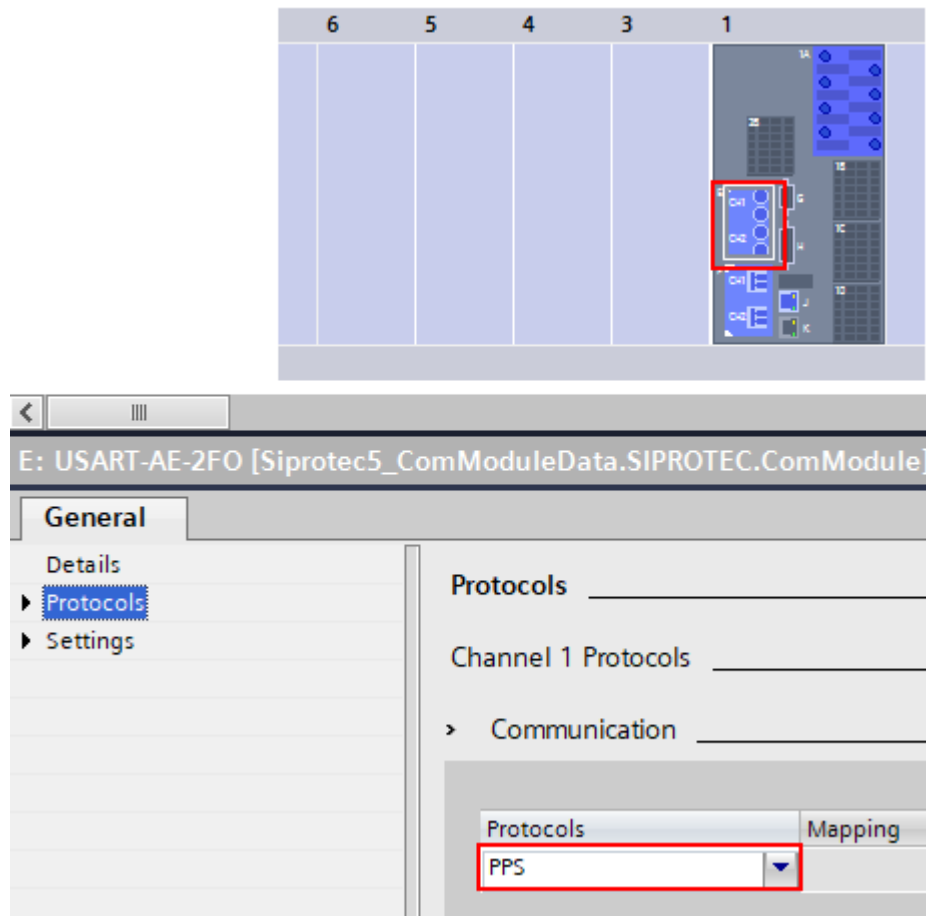
With the parameter **Synchronization source**, you select the desired synchronization source for the external synchronization of the measured values.



NOTE

The possible setting options of the parameter **Synchronization source** depend on the configuration of the protocol for the respective channel of the communication module.

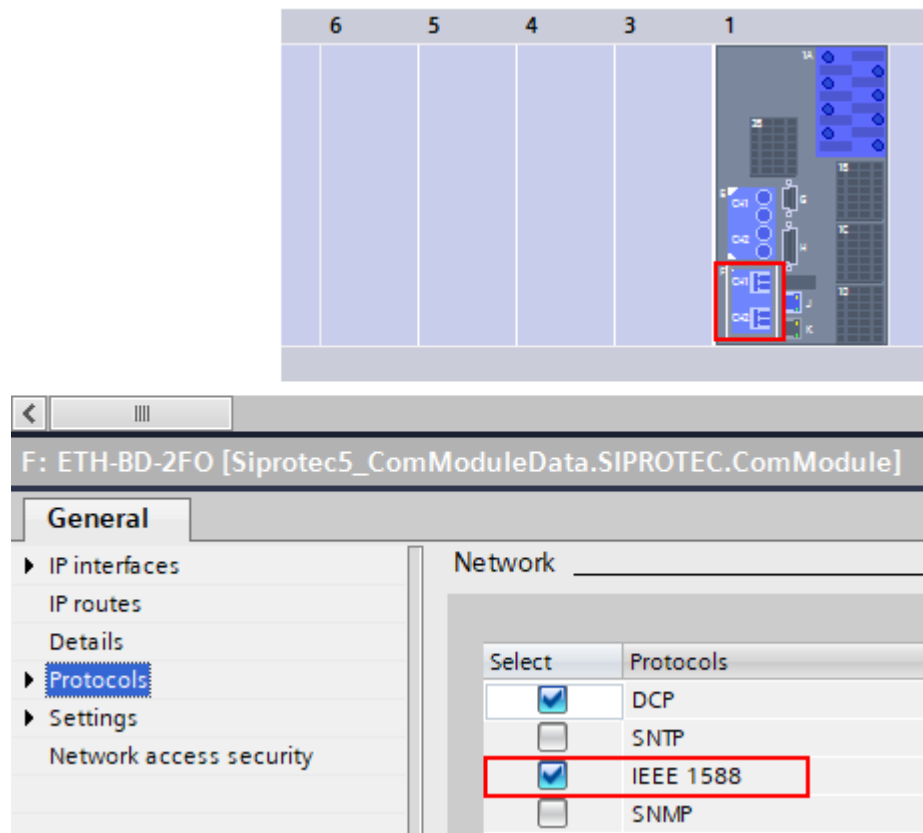
To display the selection text for the selection of an optical synchronous pulse, you must configure the protocol **PPS** on a USART communication module as follows:



[sc_PPS, 1, en_US]

Figure 3-87 Configuration of the Optical Synchronous Pulse (PPS) on a Channel of a USART Communication Module

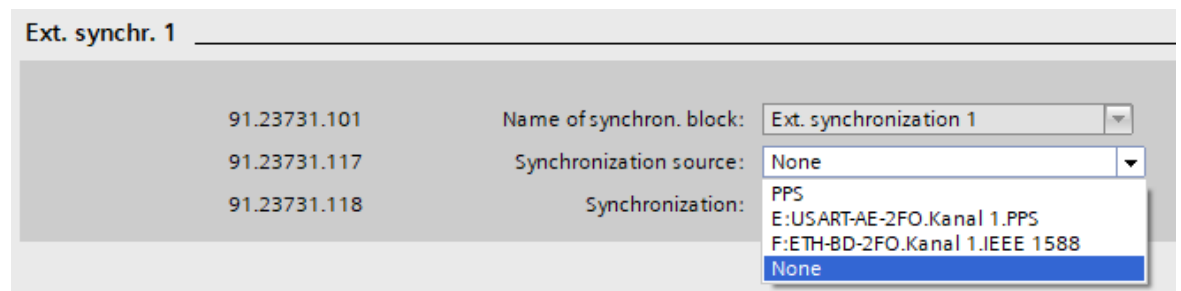
To display the selection text for the selection of the protocol IEEE 1588, you must configure the protocol **IEEE 1588** on an Ethernet-BD communication module as follows:



[sc_1588, 1, en_US]

Figure 3-88 Configuration of the Protocol IEEE 1588 on an Ethernet-BD Communication Module

The setting options for the parameter **Synchronization source** then look as follows, for example:



[sc_syncopt, 1, en_US]

Figure 3-89 Possible Setting Options for the Synchronization Source

Depending on the configuration, the following synchronization sources are displayed:

Parameter Value	Description
G:Timesynchron...PPS	The electrical synchronization pulse of a satellite receiver (PPS: 1 Pulse Per Second) at the time-synchronization interface Port G is the synchronization source.
[Port]:USART-AD-1FO.Channel 1.PPS	The optical synchronization pulse of a satellite receiver (PPS: 1 Pulse Per Second) on channel 1 of a USART communication module is the synchronization source.

Parameter Value	Description
[Port]:USART-AE-2FO.Channel 2.PPS	The optical synchronization pulse of a satellite receiver (PPS: 1 Pulse Per Second) on channel 2 of a USART communication module is the synchronization source.
[Port]:ETH-BD-2FO.Channel 1.IEEE 1588	The time-synchronization standard IEEE 1588 on an Ethernet-BD communication module is the synchronization source.



NOTE

You can select different synchronization sources for the same protection connection in the devices involved, for example, the synchronization via the **IEEE 1588** protocol in device **1** and via the protocol **PPS** electrical in device **2**.

Siemens recommends using the same synchronization source for the same protection connection. If it is not possible to use the same synchronization source, check the differential current in the line differential protection in the mode **Test on all devices**. If the differential current is not in the expected range, the set synchronization sources are not synchronous to each other and therefore not usable.



NOTE

For detailed information on the communication protocols, refer to the SIPROTEC 5 manual Communication Protocols.

Parameter: Synchronization using

- Default setting (`_:118`) **Synchronization using** = *nothing*

This parameter **Synchronization using** cannot be adjusted. The parameter shows further information for the selected synchronization source:

Parameter Value	Description
nothing	You have not selected any external synchronization source.
PPS electrical (Port G)	The electrical synchronization pulse of a satellite receiver (PPS: 1 Pulse Per Second) at the time-synchronization interface Port G is the synchronization source.
PPS optical (USART)	The optical synchronization pulse of a satellite receiver (PPS: 1 Pulse Per Second) on channel 1 of a USART communication module is the synchronization source.
IEEE 1588	The time-synchronization standard IEEE 1588 on a BD communication module is the synchronization source.

Parameter: Max. inaccuracy

- Default setting (`_:119`) **Max. inaccuracy** = *0.500 ms*

With the **Max. inaccuracy** parameter, you set the maximum expected inaccuracy of the synchronization sourced used. The set value is only effective if the synchronization source used does not supply any information on the current inaccuracy in the synchronization signals. If you no information on the inaccuracy of the synchronization source used, use the default setting.



NOTE

The inaccuracy of the synchronization source enters the stabilization of the **Line differential protection** as an error signal.

This means that greater inaccuracy increases the calculated stabilization quantity and makes the **Line differential protection** less sensitive.

If **IEEE 1588** is used as the synchronization source in the synchronization status **SmpSynch** = *global*, accuracy values are supplied with the synchronization signals and the parameter **Max. inaccuracy** is not

used. If the supplied accuracy values become invalid, the value set in the parameter **Max. inaccuracy** is used.

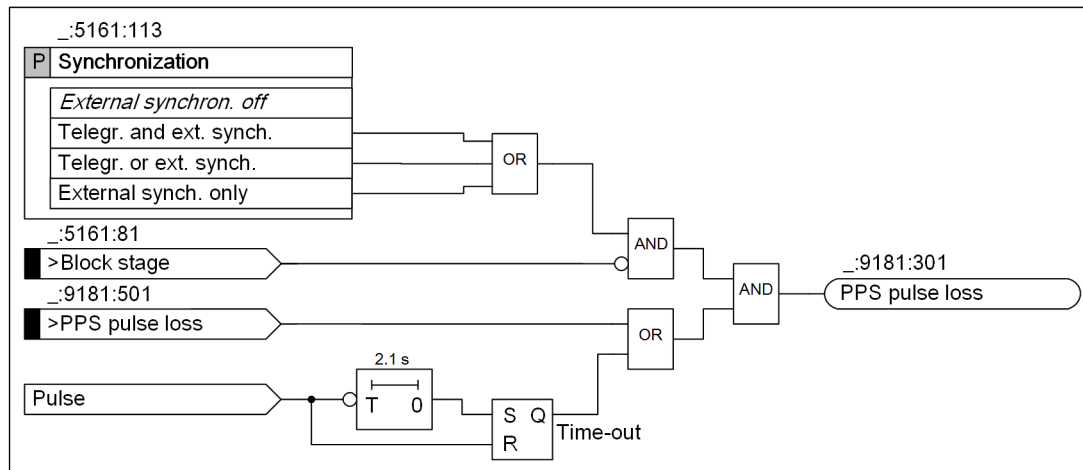
If the synchronization source **IEEE 1588** works in the synchronization status **SmpSynch = local**, then the value set in the parameter **Max. inaccuracy** is used as permanently available inaccuracy.

If **PPS electrical (Port G)** or **PPS optical (USART)** are used as synchronization source, then the value set in the parameter **Max. inaccuracy** is used as permanently available inaccuracy.

If a USART communication module with the **PPS** protocol and the **PPS generator** operating mode is also used as a synchronization source at the same time, the value set in the parameter **Max. inaccuracy** is used as permanently available inaccuracy.

3.4.6.10 Indications and Measured Values of the External Synchronization

Indication	Description
<i>(_:501) >PPS pulse loss</i>	The indication <i>(_:501) >PPS pulse loss</i> is only visible with the following setting options of the parameter <i>(_:117) Synchronization source</i>: • G:Timesynchron.PPS • [Port]:USART-AD-1FO.Channel x.PPS • [Port]:USART-AE-2FO.Channel x.PPS The binary input <i>(_:501) >PPS pulse loss</i> can be used to signal an externally detected failure in the PPS synchronous pulse, for example, an error message from the satellite receiver. If the binary input <i>(_:501) >PPS pulse loss</i> is set, this leads to the indication <i>(_:304) Synchronization loss</i>. The external synchronization detects immediately that there is a problem with the connected synchronization pulse. Otherwise, the problem will only be noticed after approx. 2.1 s – after the test for synchronous-pulse failure.
<i>(_:304) Synchronization loss</i>	The synchronization has failed. This can be due to a problem with the synchronization source. The indication <i>(_:304) Synchronization loss</i> shows that the synchronization has failed. This can be due to the following reasons: • The input indication <i>(_:501) >PPS pulse loss</i> has occurred. • The synchronous pulse has failed. • The quality of the synchronous pulse is inadequate. • There is another problem with the synchronization source.
<i>(_:305) Synchronization OK</i>	The synchronization is operating correctly.
<i>(_:306) Synchronization pulse</i>	You can use this indication to make the synchronous pulse visible. As a rule, one pulse is generated per second.
<i>(_:307) Synchron. imprecise</i>	If the set synchronization source operates in the global synchronization status and the time of the synchronization source deviates from the global time by more than 0.5 ms, the indication Synchron. imprecise is generated and the line differential protection becomes ineffective. The indication Synchron. imprecise is visible if you select ETH-BD-2FO.Channe11.IEEE1588 in the parameter <i>_:103 Synchronization source</i>. The read-only parameter <i>(_:118) Synchronization using</i> then displays IEEE 1588.



[io_pps_syn, 2, en_US]

Figure 3-90 Logic for the Generation of the Indication *>PPS pulse loss*

3.4.6.11 Setting Notes for the Remote Data

Parameter: Dropout Time Prio. x

- Default setting (`_:22741:111`) **Dropout time prio. 1 = 2.00 s**
- Default setting (`_:22741:112`) **Dropout time prio. 2 = 2.00 s**
- Default setting (`_:22741:113`) **Dropout time prio. 3 = 2.00 s**

If you use user-specific remote data, you can set how long the last received state of your remote data is held in case of a communication failure. This allows you to bridge short-term communication failures. The time can be set separately for each priority of the remote data.

3.4.6.12 Description Phase Swapping

Phase Swap

If you want to exchange information via the protection communication with a device showing phases with a different sequence but with the same rotating field as your device, the SIPROTEC 5 device can swap the phase information when sending and receiving. It is no longer necessary to swap phases when connecting the current transformers.

This use case exists on some tie lines of different power-system operators.

[Figure 3-91](#) shows an example of the different designation of the same phases at the line ends. For example, phase **A** on the left side of the line becomes phase **C** on the right side. If a SIPROTEC 5 device is used on the right side, you can instantiate the **FB Phase swap** in the **FG Advanced protection communication**. Use the **FB Phase swap** to set how the phases are swapped when sending and receiving phase-selective information via the protection interface.

This results in the following SIPROTEC 5 device behavior:

- Connect the current and voltage transformers to the terminals **A**, **B**, and **C** of the protection device as usual.
- Connect the circuit breaker without swapping phases.
- The protection functions in both devices, such as **Line differential protection** or **Teleprotection with distance protection** cooperate without any problems.
- The phase-selective messages and measured values are displayed correctly from the point of view of the respective device.

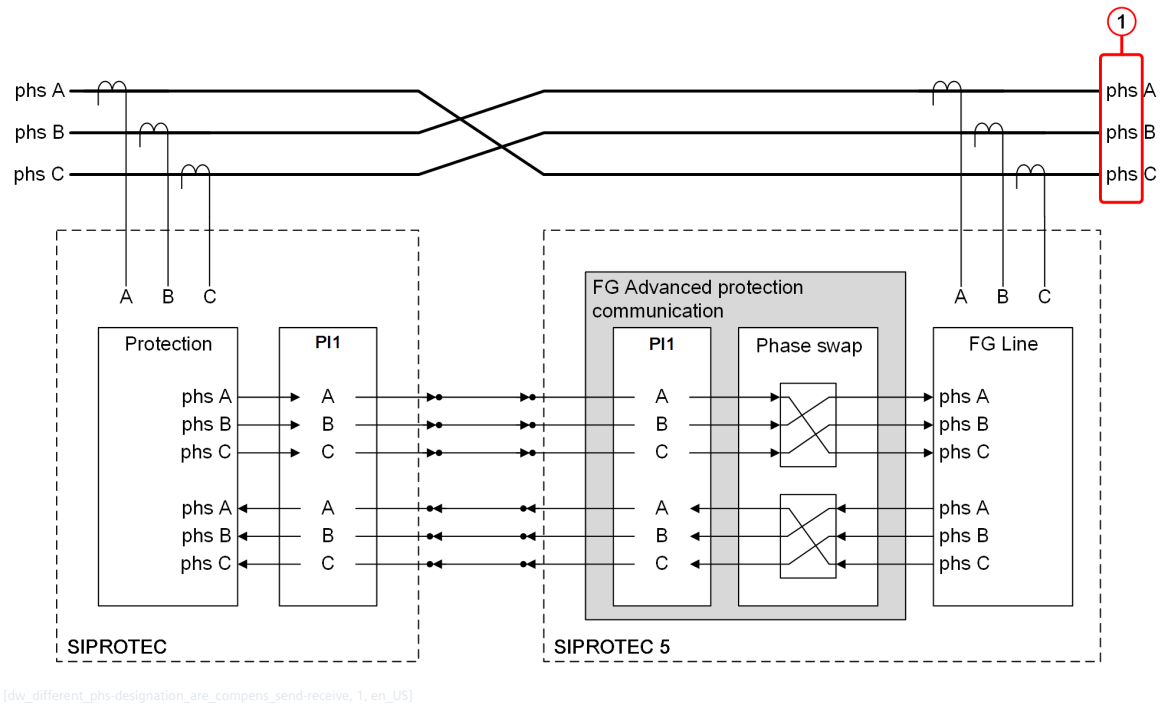


Figure 3-91 Differing Phase Designations Are Compensated for while Sending and Receiving

(1) Other phase designations than at the opposite end for the same physical phase



NOTE

Phase swapping does not support the **I2-DIFF** stage of the function **Line differential protection**. Swapping of user-specific phase-selective information sent and received using the function **Remote data** is not supported.

3.4.6.13 Setting Notes for Phase Swapping

Swap in Send Direction

- Default setting (`_:101`) **Swap in send direction** = **No phase swap**

With the parameter **Swap in send direction**, you select phase swapping. The phases are swapped from the send direction view. The following options are possible:

Parameter Value	Description
No phase swap	When sending phase-selective information, there is no phase swap.
A → B, B → C, C → A	The local data such as measured values and status information of the phases are swapped and sent to the neighboring device as follows: • The local data of phase A as data of phase B • The local data of phase B as data of phase C • The local data of phase C as data of phase A
A → C, B → A, C → B	The local data such as measured values and status information of the phases are swapped and sent to the neighboring device as follows: • The local data of phase A as data of phase C • The local data of phase B as data of phase A • The local data of phase C as data of phase B

Swap in Receive Direction

Depending on the setting value of the parameter **Swap in send direction**, the reverse swap direction results from the receive direction view. The read-only parameter (**_:102**) **Swap in receive direction** then indicates the resulting phase swap.

Parameter Value	Description
No phase swap	When receiving phase-selective information, there is no phase swap.
A → C, B → A, C → B	The data received from the neighboring device such as measured values and status information of the phases are used as follows: • The received data of phase A as local data of phase C • The received data of phase B as local data of phase A • The received data of phase C as local data of phase B
A → B, B → C, C → A	The data received from the neighboring device such as measured values and status information of the phases are used as follows: • The received data of phase A as local data of phase B • The received data of phase B as local data of phase C • The received data of phase C as local data of phase A

Examples of a Device Combination with 3 Devices:

For a device combination with more than 2 devices, you need to mentally divide the device combination into a section using the phase swap and a section not using the phase swap. In the section using the phase swap, you need to instantiate the **FB Phase swap** in the SIPROTEC 5 devices. When using SIPROTEC 4 devices, you need to swap phases when connecting the transformers and the circuit breaker.

The following figure shows a device combination with 3 devices. The device on the left can be a SIPROTEC 4 or SIPROTEC 5 device. There is a SIPROTEC 5 device in the middle and a SIPROTEC 4 device on the right side. The device in the middle swaps phases by using the **FB Phase swap**. The **FB Phase swap** is used for both protection interfaces, but it is instantiated only once for each **FG Advanced protection communication**. In the SIPROTEC 4 device on the right, you can implement the phase swap only by changing the wiring of the current and voltage transformers and of the circuit breaker. You must reinterpret the phase-selective indications accordingly.

Figure 3-92 Device Combination with 3 Devices

3.4.6.14 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Remote data				
_:22741:111	Remote data:Dropout time prio. 1		0.00 s to 300.00 s	2.00 s
_:22741:112	Remote data:Dropout time prio. 2		0.00 s to 300.00 s	2.00 s
_:22741:113	Remote data:Dropout time prio. 3		0.00 s to 300.00 s	2.00 s
Prot. interf.1				
_:5161:1	Prot. interf.1:Mode		- off - on	on
_:5161:105	Prot. interf.1:Max. error rate per hour		0.000 % to 100.000 %	1.000 %
_:5161:106	Prot. interf.1:Max. error rate per min		0.000 % to 100.000 %	1.000 %
_:5161:107	Prot. interf.1:Distur- bance alarm after		0.05 s to 2.00 s	0.10 s
_:5161:108	Prot. interf.1:Transm. fail. alarm after		0.0 s to 6.0 s	6.0 s
_:5161:109	Prot. interf.1:Delay time threshold		0.1 ms to 30.0 ms	30.0 ms
_:5161:110	Prot. interf.1:Difference Tx and Rx time		0.000 ms to 3.000 ms	0.100 ms
_:5161:113	Prot. interf.1:Synchroni- zation		- External synchron. off - Telegr. and ext. synchron. - Telegr. or ext. synchron. - External synchron. only	External synchron. off

Addr.	Parameter	C	Setting Options	Default Setting
_:5161:117	Prot. interf.1:FB External synchron.		- Ext. synchronization 1 - Ext. synchronization 2	Ext. synchroni- zation 1
_:5161:120	Prot. interf.1:Check synchron.-source		- no - yes	yes
_:5161:120	Prot. interf.1:PI assign- ment		Setting options depend on configuration	

3.4.6.15 Information List

No.	Information	Data Class (Type)	Type
<i>Prot. interf.1</i>			
_:5161:81	Prot. interf.1:>Block stage	SPS	I
_:5161:500	Prot. interf.1:>Sync reset	SPS	I
_:5161:341	Prot. interf.1:Reset synchronization	SPC	C
_:5161:342	Prot. interf.1:Reset measurements	SPC	C
_:5161:52	Prot. interf.1:Behavior	ENS	O
_:5161:53	Prot. interf.1:Health	ENS	O
_:5161:301	Prot. interf.1:Status of lay. 1 and 2	ENS	O
_:5161:302	Prot. interf.1:Status of lay. 3 and 4	ENS	O
_:5161:303	Prot. interf.1:Connection broken	SPS	O
_:5161:316	Prot. interf.1>Error rate / min exc.	SPS	O
_:5161:317	Prot. interf.1>Error rate / hour exc.	SPS	O
_:5161:318	Prot. interf.1:Time delay exceeded	SPS	O
_:5161:319	Prot. interf.1:Time delay different	SPS	O
_:5161:320	Prot. interf.1:Time delay jump	SPS	O
_:5161:321	Prot. interf.1:PI synchronized	SPS	O
_:5161:340	Prot. interf.1:Telegram lost	SPS	O
_:5161:323	Prot. interf.1:PPS: time del. unsym.	SPS	O
_:5161:324	Prot. interf.1:PI with PPS synchron.	SPS	O
_:5161:343	Prot. interf.1:Partner	INS	O
_:5161:308	Prot. interf.1:Tx tel/h	MV	O
_:5161:309	Prot. interf.1:Rx tel/h	MV	O
_:5161:310	Prot. interf.1:Tx tel/min	MV	O
_:5161:311	Prot. interf.1:Rx tel/min	MV	O
_:5161:312	Prot. interf.1:Tx err/h	MV	O
_:5161:313	Prot. interf.1:Rx err/h	MV	O
_:5161:314	Prot. interf.1:Tx err/min	MV	O
_:5161:315	Prot. interf.1:Rx err/min	MV	O
_:5161:334	Prot. interf.1:Miss.tel/min	MV	O
_:5161:335	Prot. interf.1:Miss.tel/h	MV	O
_:5161:336	Prot. interf.1:Miss.tel/d	MV	O
_:5161:337	Prot. interf.1:Miss.tel/w	MV	O
_:5161:338	Prot. interf.1:M. loss/d	MV	O
_:5161:339	Prot. interf.1:M. loss/w	MV	O
_:5161:331	Prot. interf.1:Recept.	MV	O
_:5161:325	Prot. interf.1:Aver.Δt	MV	O
_:5161:326	Prot. interf.1:Rec. Δt	MV	O

No.	Information	Data Class (Type)	Type
_:5161:327	Prot. interf.1:Sen. Δt	MV	O
Prot. interf. 1B			
_:23461:81	Prot.interf.1B:>Block stage	SPS	I
_:23461:500	Prot.interf.1B:>Sync reset	SPS	I
_:23461:341	Prot.interf.1B:Reset synchronization	SPC	C
_:23461:342	Prot.interf.1B:Reset measurements	SPC	C
_:23461:52	Prot.interf.1B:Behavior	ENS	O
_:23461:53	Prot.interf.1B:Health	ENS	O
_:23461:301	Prot.interf.1B:Status of lay. 1 and 2	ENS	O
_:23461:302	Prot.interf.1B:Status of lay. 3 and 4	ENS	O
_:23461:303	Prot.interf.1B:Connection broken	SPS	O
_:23461:316	Prot.interf.1B>Error rate / min exc.	SPS	O
_:23461:317	Prot.interf.1B>Error rate / hour exc.	SPS	O
_:23461:318	Prot.interf.1B:Time delay exceeded	SPS	O
_:23461:340	Prot.interf.1B:Telegram lost	SPS	O
_:23461:323	Prot.interf.1B:PPS: time del. unsym.	SPS	O
_:23461:324	Prot.interf.1B:PI with PPS synchron.	SPS	O
_:23461:343	Prot.interf.1B:Partner	INS	O
_:23461:308	Prot.interf.1B:Tx tel/h	MV	O
_:23461:309	Prot.interf.1B:Rx tel/h	MV	O
_:23461:310	Prot.interf.1B:Tx tel/min	MV	O
_:23461:311	Prot.interf.1B:Rx tel/min	MV	O
_:23461:312	Prot.interf.1B:Tx err/h	MV	O
_:23461:313	Prot.interf.1B:Rx err/h	MV	O
_:23461:314	Prot.interf.1B:Tx err/min	MV	O
_:23461:315	Prot.interf.1B:Rx err/min	MV	O
_:23461:334	Prot.interf.1B:Miss.tel/min	MV	O
_:23461:335	Prot.interf.1B:Miss.tel/h	MV	O
_:23461:336	Prot.interf.1B:Miss.tel/d	MV	O
_:23461:337	Prot.interf.1B:Miss.tel/w	MV	O
_:23461:338	Prot.interf.1B:M. loss/d	MV	O
_:23461:339	Prot.interf.1B:M. loss/w	MV	O
_:23461:331	Prot.interf.1B:Recept.	MV	O
_:23461:325	Prot.interf.1B:Aver.Δt	MV	O
_:23461:326	Prot.interf.1B:Rec. Δt	MV	O
_:23461:327	Prot.interf.1B:Sen. Δt	MV	O

3.4.7 Assignment of the Protection Function Group to the FG Protection Communication

If protection functions want to use the protection interfaces in a protection function group, you must route the connection of the protection function group, for example, the FG **Line 1**, with a function group **Protection communication** in DIGSI 5. Then, each protection function in the FG **Line 1** can use the protection communication.

Route the connection between the FG **Line** and the FG **Protection communication** in DIGSI 5 as follows:

Project tree > **Function-group connections** > Tab **Protection FG** ↔ **Protection FG**. Right-click to route the connection in the desired line/column.

Measuring points <=> Function g...		Function group <=> Circuit-break...		Protection-FG <=> Protection-FG
▼ Connect protection-function group to protection-function group				
Prot. com.(type 1) 1		Prot. com.(type 1) 2		
Protection group	protection data	protection data		
(All) ▼	(All) ▼	(All) ▼		
Line 1	X			
Line 2		X		

[sc_PDC_rout1, 1, en_US]

Figure 3-93 Routing of the Connection between the Protection FG and the FG Protection Communication in DIGSI 5



NOTE

If only one protection function group and one FG **Protection communication** are instantiated in the device, DIGSI 5 connects both function groups automatically.

3.4.8 Application Examples and Setting Notes for IP Communication

3.4.8.1 Overview

The advanced protection communication supports the IP communication via MPLS¹³ communication networks.

- If existing systems are to be upgraded for protection-interface communication via IP, you must retrofit an Ethernet-BD communication module in the respective SIPROTEC 5 devices.
- The protection-interface communication via IP requires an Ethernet-BD communication module per device in the device combination.
- In a device, only one Ethernet-BD communication module can be used per device combination.
- However, another device combination can use the same Ethernet-BD communication module of the device.

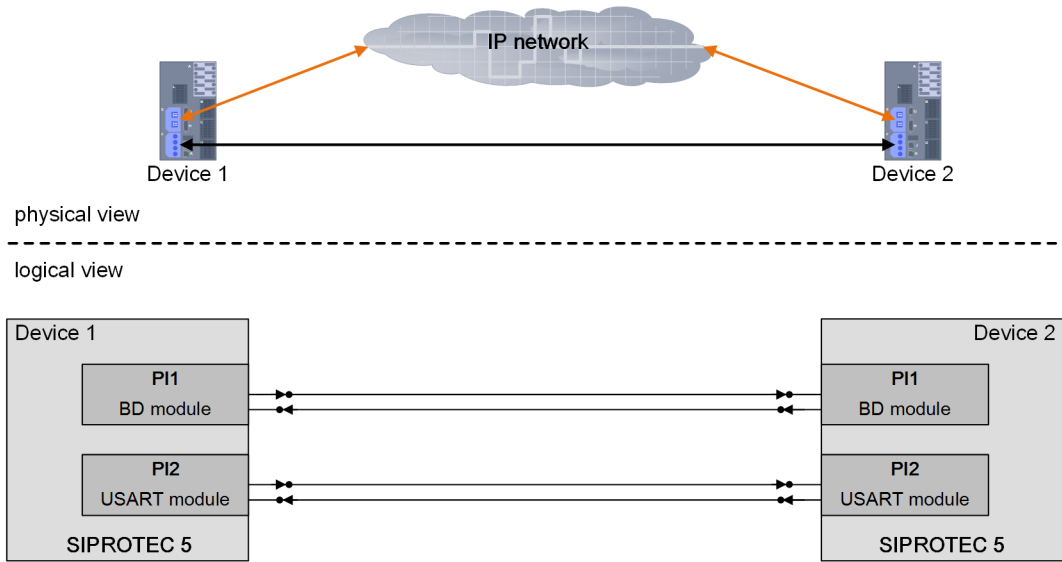
The following application examples show what you must consider when using the IP communication via MPLS communication networks.

3.4.8.2 Device Combination of 2 Devices and Redundant Communication Connection

If redundancy of the communication connection is required for a device combination consisting of 2 devices, 2 different procedures are possible:

- You can use the redundancy mechanisms of the LAN and the Ethernet-BD communication module (PRP, HSR, RSTP). In this case, the redundant communication route runs through the same Ethernet-BD communication module.
- You can set up a 2nd communication connection via a physically separate path. It is best to use a different medium for this, for example, a fiber-optic direct connection, a direct cable connection (pilot wire), or a connection based on C37.94. That is, for the 2nd communication connection, you must use another communication module in each device. The following figure shows this case from a physical and logical view:

¹³ MPLS = Multi-Protocol Label Switching



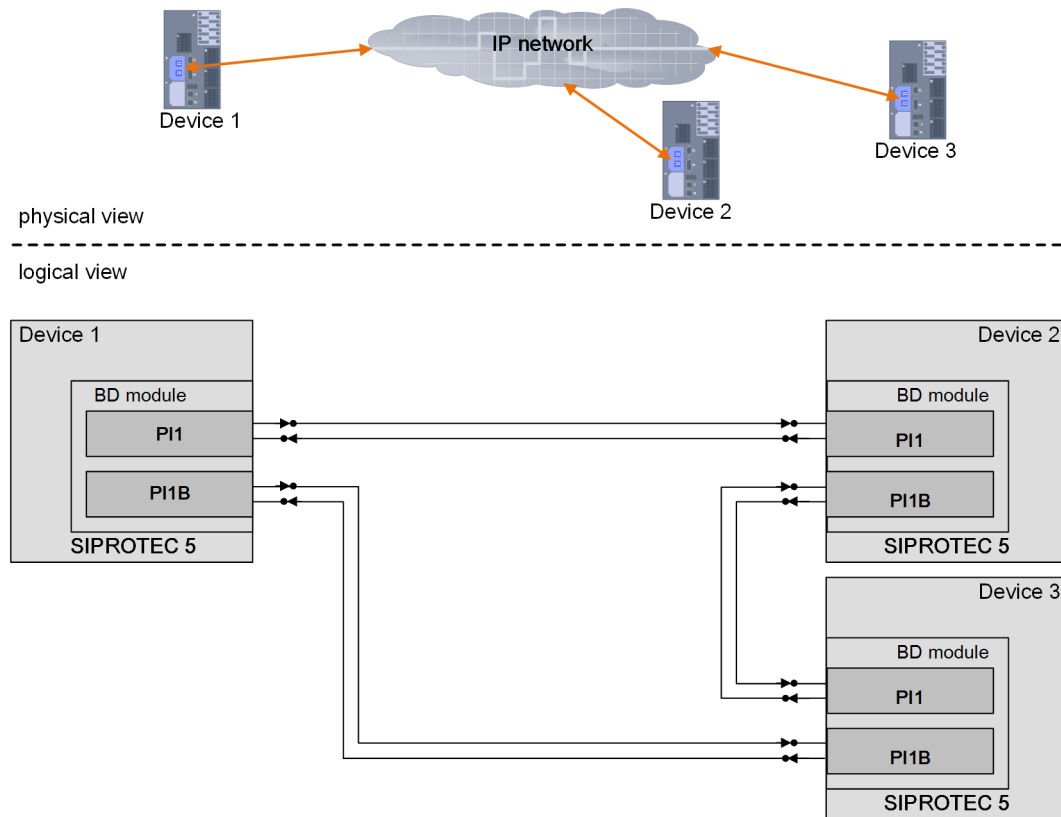
[dw_network_with_2-device_redundant-comm, 1, en_US]

Figure 3-94 Device Combination with 2 Devices and Redundant Communication Connection

3.4.8.3 Device Combination of 3 Devices and Only IP Communication

If you configure a device combination with 3 devices and all devices are using the IP communication, then, from the view of a device, the 2 other devices in the network are visible and reachable. For this, you configure in each device the protocol **Advanced protection interface** on the Ethernet-BD communication module and the **Protection interface 1**. The Ethernet-BD communication module is assigned to the **Protection interface 1**.

The special feature of this configuration is that the topology detection automatically generates a 3-device ring topology (logical view). That is, 3 point-to-point communication connections are established between the devices. In addition, another **Protection interface 1B** is automatically visible in each device, which provides the necessary 2nd communication channel for the ring topology, see the following figure:



[dw_network_with_3-device_redundant-comm, 1, en_US]

Figure 3-95 Device Combination with 3 Devices in the IP Communication Network

The **Protection interface 1B** takes over the settings of **Protection interface 1**, that is **Protection interface 1B** does not have its own settings view. The **Protection interface 1B** has its own indications and measured values, which you can see in the information routing.



NOTE

If you use 3 devices in the device combination with IP communication, the aim of the topology detection is to form a ring topology, as in addition to a redundant connection, shorter transmission times are also possible.

If you have instantiated a 2nd protection interface, for example to establish a communication connection via another medium, the device hides the **Protection interface 1B**.



NOTE

In the following cases, the **Protection interface 1B** becomes inactive and does not have any messages or measured values:

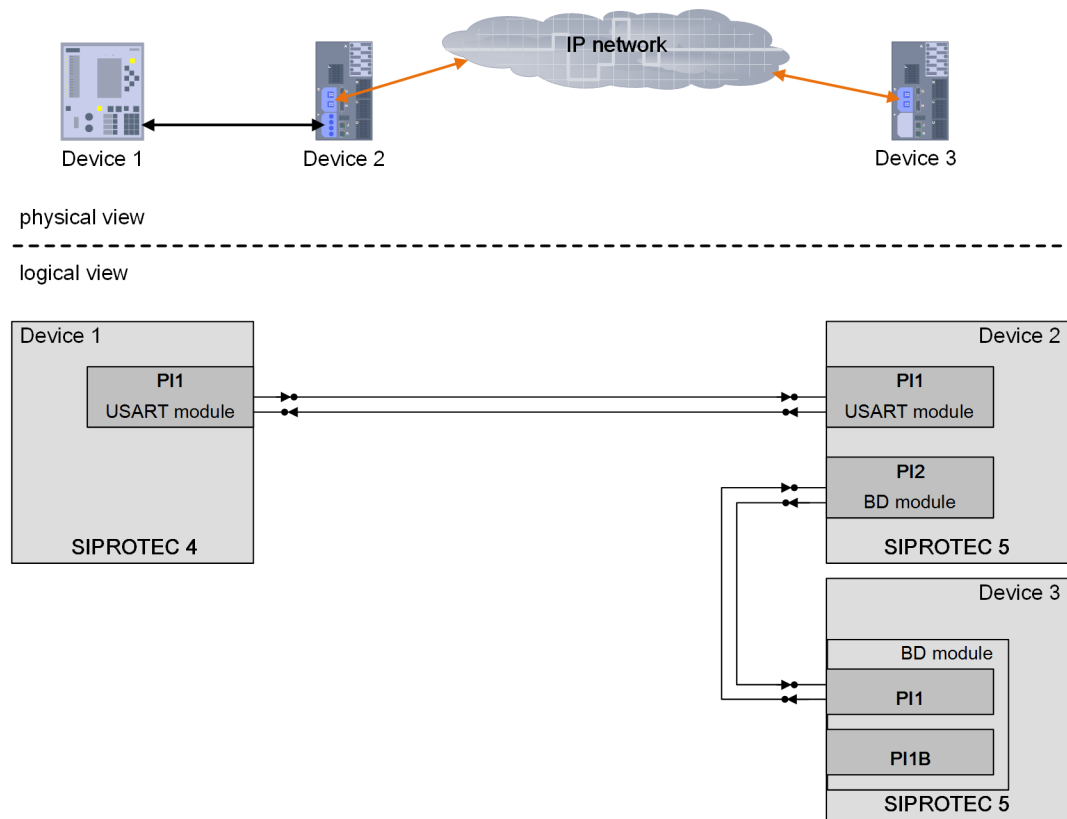
- A 2nd protection interface is instantiated.
- Only 2 devices are present in the device combination.
- No protection interface is assigned to an Ethernet-BD communication module.

3.4.8.4 Device Combination of 3 Devices and Hybrid Communication Media

If you extend a system, it can be necessary to extend a device combination consisting of 2 existing devices by 1 device, see the following figure.

The previous 2 devices are connected to each other, for example, via a fiber-optic direct connection or via other communication media. The left device, for example, a SIPROTEC 4 device, and the middle SIPROTEC 5

device are the 2 devices previously present in the system. This device combination is to be extended by adding the right SIPROTEC 5 device. The communication between the middle and the right device is to take place via an IP communication network.



[dw_network_with_3-device_mixed-comm, 1, en_US]

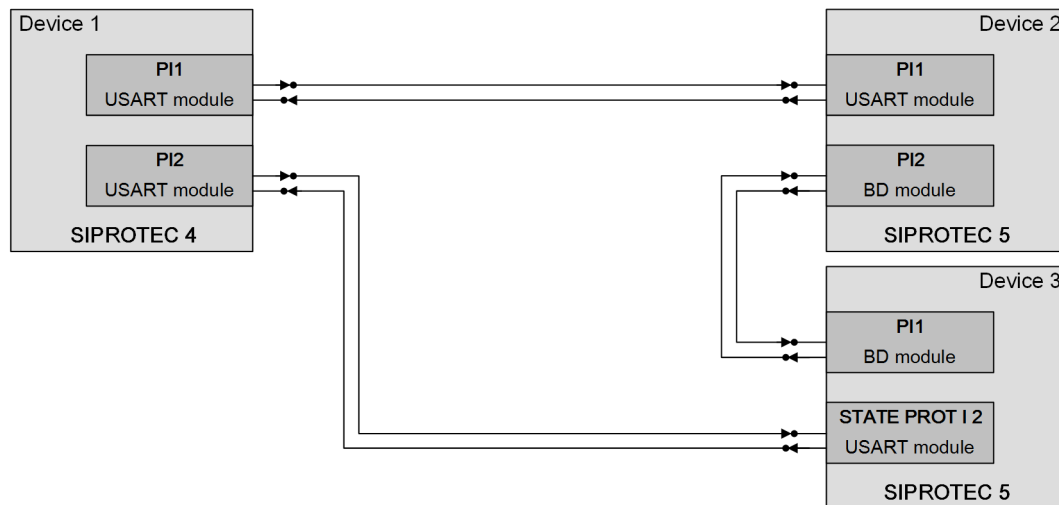
Figure 3-96 Device Combination with 3 Devices and Hybrid Communication Media

For this configuration of a 3-device chain topology, you must configure a **device combination with 3 devices** in all devices.

In the middle device, an Ethernet-BD communication module is additionally required. Configure the protocol **Advanced protection interface** in the properties of the Ethernet-BD communication module. Instantiate the function block **Protection interface 2** in the FG **Protection communication**. Assign the Ethernet-BD communication module to the **Protection interface 2**.

The device on the right must also have an Ethernet-BD communication module. Also configure here the protocol **Advanced protection interface** in the properties of the Ethernet-BD communication module and assign the Ethernet-BD communication module to the **Protection interface 1**. **Protection interface 1B** is created here as a special feature, but it is not used.

If a redundant communication connection is required for this configuration, Siemens recommends establishing a 3-device ring topology. For this purpose, you must connect the left and right devices via another communication channel. This creates the 3-device ring topology. The following figure shows this configuration:



[dw_3-device_and_mixed-comm, 1, en_US]

Figure 3-97 Device Combination with 3 Devices and Hybrid Communication Media and Redundant Communication Connection

The SIPROTEC 4 device (left device) does not support any IP communication. In this case, you must switch to another communication medium and retrofit a corresponding SIPROTEC 4 communication module. In any case, the communication medium used is also supported by the SIPROTEC 5 device on the right side, by retrofitting a corresponding equivalent communication module there. Configure this communication module with the protocol **Advanced protection interface**, add an additional **Protection interface 2** to the FG **Protection communication**. Assign the **Protection interface 2** to the communication module.

3.4.8.5 Device Combination of 6 Devices and Hybrid Communication Media

IP Addresses in Hybrid Topologies

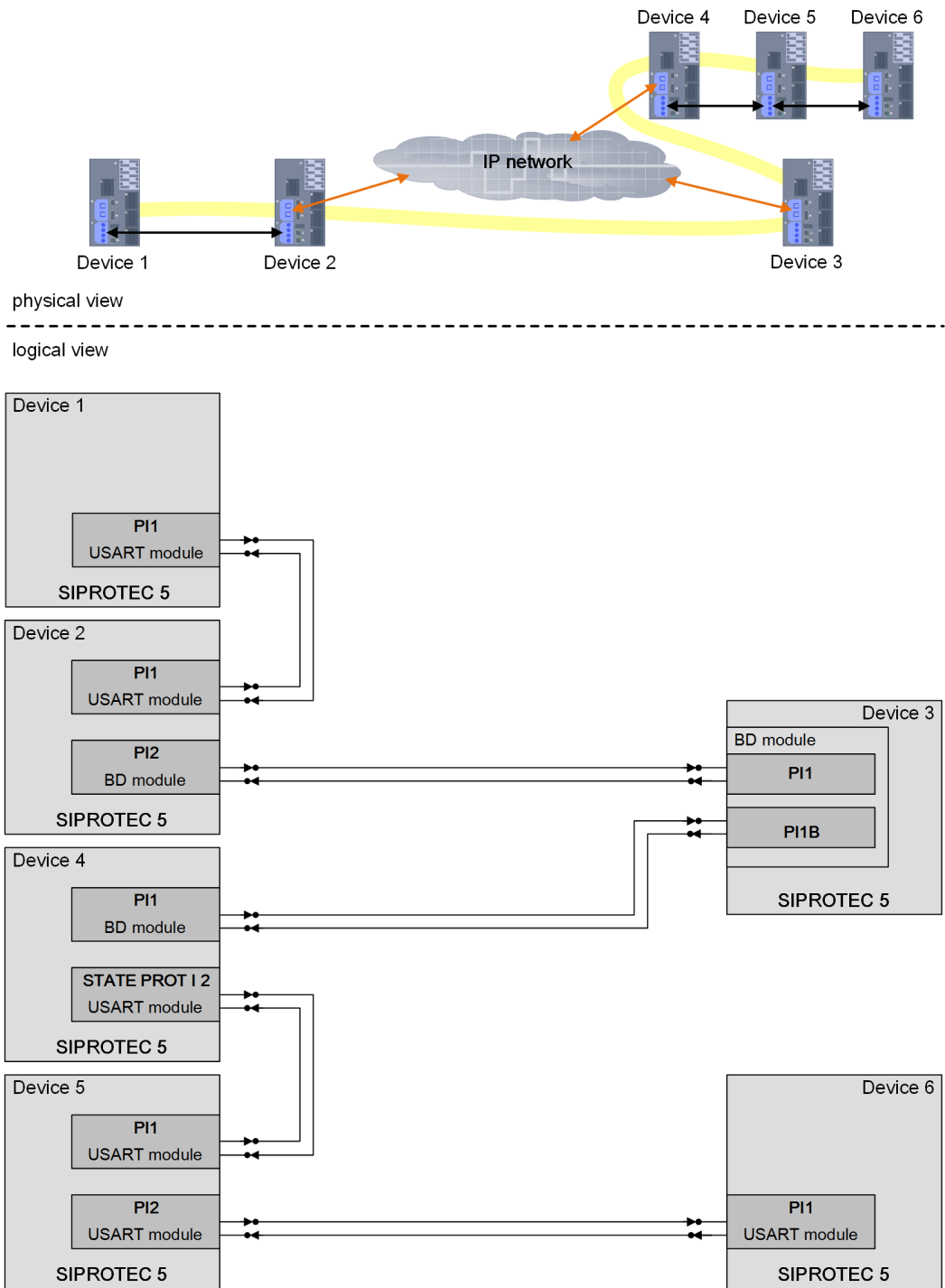
To ensure redundancy or downward compatibility, the devices also allow a mix of classic and IP-based communication media.

In such applications, special consideration must be given to the configuration of the IP addresses. When parametrizing the devices, you must first clarify which path the communication is to take through the network. That is, it must be clear which devices communicate with each other. To define a route, you may only configure its planned communication partners in a device. The following examples illustrate the correct IP configuration.

For device combinations with more than 3 devices and hybrid communication media, different configurations are possible. If you want to use the IP communication, consider that only one Ethernet-BD communication module per device combination is supported for the protection-interface communication.

The following figure shows a device combination with 6 devices. In the example, several devices are connected by other communication media, which form 3 device groups. The device groups are connected by an IP network. The result is a 6-device chain topology. The yellow line illustrates the communication route. To establish this communication route, you may only parameterize the IP addresses of their direct communication partners in the devices. The following example applies:

- The devices **2** and **4** only know the IP address of device **3**.
- Device **3** only knows the IP addresses of the devices **2** and **4**.
- Leave all other IP addresses at **0.0.0.0**.



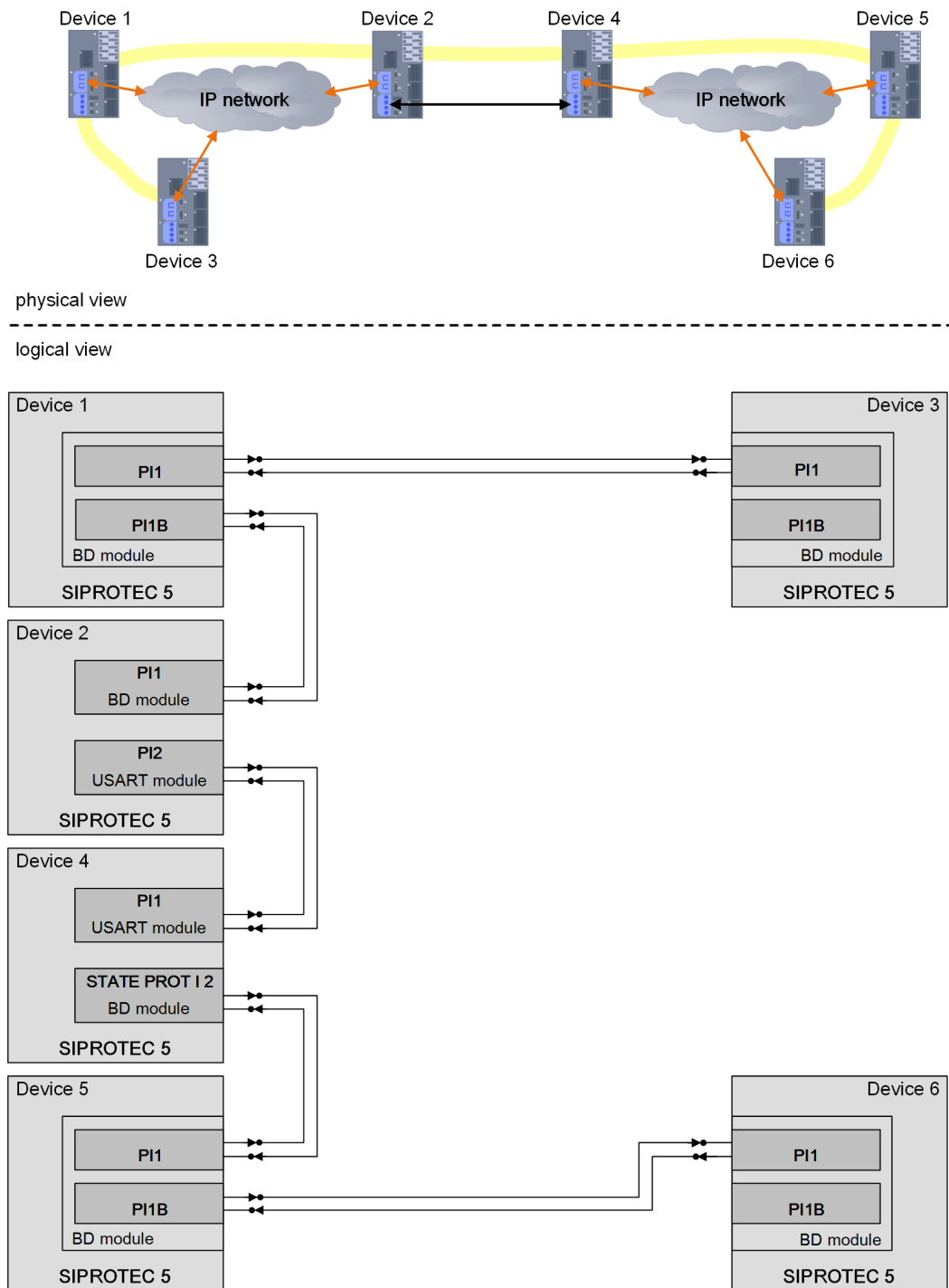
[dw_network_with_6-device_redundant-comm, 1, en_US]

Figure 3-98 Example 1 of a Device Combination with 6 Devices

Another example shows 2 device groups whose devices are connected to each other via IP networks. The 2 device groups are connected to each other by a different communication medium. The topology detection in turn forms a 6-device chain topology.

To establish this communication route, you may only parameterize the IP addresses of their direct communication partners in the devices. The following example applies:

- Device **1** only knows the IP addresses of the devices **2** and **3**.
- The devices **2** and **3** only know the IP address of device **1**.
- Device **5** only knows the IP addresses of the devices **4** and **6**.
- The devices **4** and **6** only know the IP address of device **5**.
- Leave all other IP addresses at **0 . 0 . 0 . 0**.



[dw_network_with_6-device, 1, en_US]

Figure 3-99 Example 2 of a Device Combination with 6 Devices

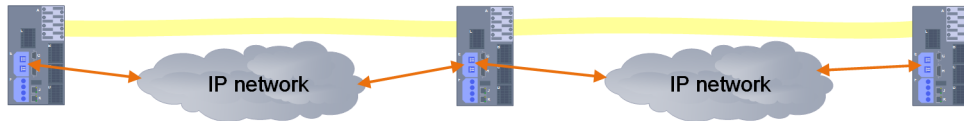
3.4.8.6 Unsupported Configurations

The following figure shows an example of a device combination with 3 devices. In the example, all devices use the IP communication. The middle device contains 2 Ethernet-BD communication modules, which are both configured with the **Advanced protection interface** protocol.



NOTE

You can only use 1 Ethernet-BD communication module in one device!
2 Ethernet-BD communication modules with the **Advanced protection interface** protocol are not supported.



[dw_non-supported-config_network_with_3-device, 1, en_US]

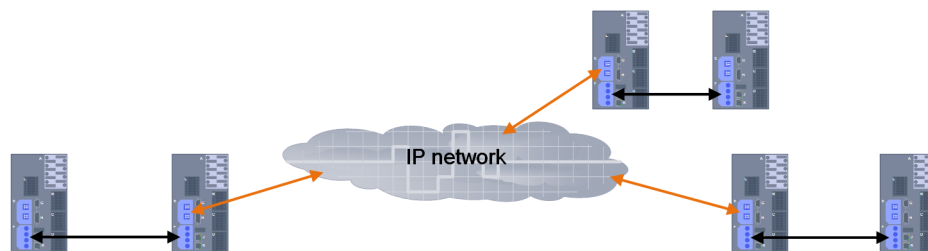
Figure 3-100 Unsupported Configuration of a Device Combination with 3 Devices



NOTE

If you use the IP communication, the aim of the topology detection is to form a chain topology if there are 4 or more devices. For certain configurations, the topology detection cannot form a working chain topology.

The following figure shows an example of a device combination with 6 devices and hybrid communication media. In this case, the topology detection cannot form a functioning 6-device chain topology.



[dw_non-supported-config_network_with_6-device, 1, en_US]

Figure 3-101 Unsupported Configuration of a Device Combination with 6 Devices

3.5 Date and Time Synchronization

3.5.1 Overview of Functions

Timely recording of process data requires precise time synchronization of the devices. The integrated date/time synchronization allows the exact chronological assignment of events to an internally managed device time that is used to time stamp events in logs, which are then transmitted to a substation automation technology or transferred via the protection interface. A clock module internal to the device and having battery backup is synchronized cyclically with the current device time so that the right device time is available and used even in case of auxiliary-voltage failure. At the same time, this permits hardware-supported monitoring of the device time.

3.5.2 Structure of the Function

The integrated date/time synchronization is a supervisory device function. Setting parameters and indications can be found in the following menus for the DIGSI and the device:

Set date and time:

- DIGSI: Online access -> Interface -> Device -> Device Information -> **Time Information**
- Device: Main menu → Device functions → **Date & Time**

Parameter:

- DIGSI: Project -> Device -> Parameter -> **Time Settings**

Indications:

- DIGSI: Project -> Device -> Information routing -> **Time keeping** or **Time Sync.**

3.5.3 Function Description

Every SIPROTEC 5 device maintains an internal device time with date. The date and time can also be set on the device via the on-site operation panel or via DIGSI 5. Within a system, or even beyond, it is usually necessary to record the time of process data accurately and to have exact time synchronization of all devices. For SIPROTEC 5 devices, the sources of time and synchronization options can be configured.

Configurable Synchronization Options:

- **None** (default setting)
The device functions without any external time synchronization. The internal time synchronization continues to work with the help of the back-up battery even when the auxiliary voltage is shut down temporarily. The time can be adjusted manually.
- **Telegram**
The time is synchronized via a telegram with an appropriately configured communication interface in accordance with the IEC 60870-5-103 or DNP3 protocol.
- **Connection to a radio clock**
The time synchronization takes place with the set time telegram from an external IRIG B or DCF77 receiver via the time synchronization interface of the device.
- **Ethernet**
The time synchronization is done via Ethernet-based SNTP protocol (Simple Network Time Protocol), for example with IEC 61850 stations or via IEEE 1588. If you enable both services during configuration of Ethernet interfaces, these protocols are available as an option for the time synchronization.

- **Protection interface**

The time synchronization takes place via the protection interfaces configured for your SIPROTEC 5 device. Here, the timing master takes over the time management.

Configurable Time Sources:

- 2 time sources can be taken into consideration with the SIPROTEC 5 devices. For each time source, the synchronization type may be selected based on the options provided.
- **Time source 1** takes precedence over **Time source 2**, that is, **Time source 2** will be effective for the synchronization of the device time only if **Time source 1** fails. If only one time source is available and it fails, then only the internal clock continues unsynchronized. The status of the time sources is indicated.
- For every time source, it is possible to define via the **Time zone time source 1** parameter (or **Time zone time source 2**) if this source transmits its time by UTC (universal time) or if the settings correspond to the local time zone of the device.



NOTE

Make sure that the settings for the time sources coincide with the actual hardware configuration of your SIPROTEC 5 device. In any event, incorrect settings cause the status indications of time sources to pick up.

Configurable Date Format

Regardless of a feed time-synchronization source, a uniform format is maintained internally within the device. The following options are available for the customary local representation of the date format:

- Day.Month.Year: 24.12.2009
- Month/Day/Year: 12/24/2009
- Year-Month-Day: 2009-12-24

Taking Local Time Zones into Account

The internal device time is maintained in universal time (UTC). To display time stamps in DIGSI and on the device display, you can define the local time zone of the device (parameter Offset time zone for GMT), including the applicable daylight saving times (start, end, and offset of daylight saving time) using parameters. This allows the display of the local time.



NOTE

- For time sources that transmit the status of the switch to daylight saving time, this will be taken into account automatically when creating the internal device time in the UTC format. The differential time of the daylight saving time set in the device (parameter Offset daylight saving time) is taken into consideration. However, in contrast, the settings of the start of daylight saving time and end of the daylight saving times are ignored when converting into the device internal UTC format.
 - For active time sources, it is not possible to set the time via the device display or DIGSI 5. An exception is setting the calendar year for active time protocol IRIG B.
-

Status, Supervision, and Indications of Time Management

Your SIPROTEC 5 device generates status and monitoring indications that provide important information regarding the correct configuration of the time source and the status of the internal time management during startup and device operation.

Internal time synchronization is monitored cyclically. Important synchronization processes, the status of the time sources and errors detected are reported. A device time that has become invalid will be marked accordingly so that affected functions can go to a safe state.

Indication	Description
Device: <i>clock fail</i>	This indication signals a high difference between the internally managed time and the time of the clock module that is not permissible. The pickup of the indication can point to a defect in the clock module or to an unacceptable high drift of the system quartz crystal. The time maintained internally is marked as invalid.
Time management: <i>Daylight saving time</i>	This indication signals whether daylight saving time has been enabled.
Time management: <i>clock set manually</i>	This indication signals that the device time has been set manually via the on-site operation panel or via DIGSI 5.
Time synchronization: <i>Status time source 1</i> <i>Status time source 2</i>	These 2 indications signal whether the active time sources are recognized as valid and active from the device point of view. When the indications pick up, it can also be an indication that an incorrect configuration of the port or channel numbers was done at the on-site operation panel.
Time synchronization: <i>Time sync. error</i>	This indication signals after the parameterized time Fault indication after that synchronization using an external time source has failed.
Time synchronization: <i>Leap second</i>	This indication signals that a Leap second has occurred during time synchronization using an external GPS receiver (protocol variant IRIG B 005(004) with extension according to IEEE C37.118-2005).
Time synchronization: <i>High accuracy</i>	This indication signals that the device is synchronized with an accuracy better than 1 µs. The indication is only of significance when the PMU function is used.



NOTE

In case of a missing or discharged battery, the device starts without active external time synchronization with the device time 2011-01-01 00:00:00 (UTC).

For the device, DIGSI 5 provides a compact overview of the status of the time synchronization of your SIPROTEC 5 device in online mode. All displays are updated continuously. You can access the overview in the project-tree window via Online access.

DIGSI: Online access -> Interface -> Device -> Device Information -> **Time Information**

Time information

Time source 1

Source time: 01.01.1970 01:00:00 Received at device time: 01.01.1970 01:00:00

Clock failed: Yes Type: HMI

Clock synchronized: No

Time source 2

Source time: 01.01.1970 01:00:00 Received at device time: 01.01.1970 01:00:00

Clock failed: Yes Type: HMI

Clock synchronized: No

Device time

April 22, 2015 11:25:01 AM Edit time Set time

[sc_time_dg, 1, en_US]

Figure 3-102 Time Information in DIGSI

For every time source, you see the following:

- Last received time (with date)
- Receipt time of the last received time telegram
- Configured type of timer
- Indication of timer outage or failure
- Whether the device time is currently synchronized from the time source

The lower section displays the device time, which is continuously updated. If the internal device time and the infed time source were synchronous at the time of telegram receipt, both displayed times are identical.

**NOTE**

All times displayed (also the time source) take into consideration the local time settings (zone and daylight saving time of the device) in the form of a numerical offset for UTC (universal time).

3.5.4 Application and Setting Notes

Parameter: Date Format

- Default setting **Date format** = **YYYY-MM-DD**

With the parameter **Date format**, you define the local customary format of the date display.

Parameter Value	Description
DD.MM.YYYY	Day.Month.Year: Typical European display Example: 24.12.2010
MM/DD/YYYY	Month/Day/Year: Typical US representation Example: 12/24/2010
YYYY-MM-DD	Year-Month-Day: Typical Chinese display Example: 2010-12-24

Parameter: Time zone time source 1, Time zone time source 2

- Default setting **Time zone time source 1** = **local**, **Time zone time source 2** = **local**

With the parameters **Time zone time source 1** and **Time zone time source 2**, you define the handling of time zones of the external timer.

Parameter Value	Description
<i>local</i>	Local time zone and daylight saving time are considered as time zone offsets to GMT.
<i>UTC</i>	Time format according to UTC (universal time)

Parameter: Time source 1, Time source 2

- Default setting **Time source 1 = none, Time source 2 = none**

With the parameters **Time source 1** and **Time source 2**, you can configure an external timer. The prerequisite is to have the corresponding hardware configuration of the communication interfaces of your SIPROTEC 5 device. This is listed as a prefix when making a selection in DIGSI 5.

Parameter Value	Description
<i>none</i>	The time source is not configured.
<i>IRIG-B</i>	Time synchronization by an external GPS receiver: SIPROTEC 5 devices support several protocol variants of the IRIG-B standard: • IRIG-B 002(003) The control function bits of the signal are not occupied. The missing year is formed from the current device time. In this case, it is possible to set the year via the online access in DIGSI 5. • IRIG-B 006(007) The bits for the calendar year are not equal to 00. The calendar year is set automatically by the time protocol. • IRIG-B 005(004) with extension according to IEEE C37.118-2005 If, in the time signal, other control function bits are occupied in addition to the calendar year, then the device takes the additional information into consideration for leap seconds, daylight saving time, time offset (zone, daylight saving time), and time accuracy. Time zone time source 1 or Time zone time source 2: The value of this setting is not evaluated by the device, since this protocol either transmits in UTC or in the case of local time, specifies the appropriate offset to UTC in each set time telegram.
<i>DCF77</i>	Time synchronization by an external DCF77 receiver Time zone time source 1 or Time zone time source 2 = local Note: There are also clocks that generate a DCF77 signal representing UTC. In this case, UTC must be set.
<i>PI</i>	The time synchronization takes place via the protection interfaces configured for your SIPROTEC 5 device. Here, the timing master takes over the time management. Signal-transit times of the protection interface communication are calculated automatically. Time zone time source 1 or Time zone time source 2 = UTC A slave that receives a time or a SIPROTEC 5 master, receives its system time kept in UTC.

Parameter Value	Description
<i>SNTP</i>	The time synchronization is done via the Ethernet service SNTP (SNTP server or via IEC 61850). SIPROTEC 5 devices support both Edition1 and Edition2 in accordance with IEC 61850-7-2. In Edition2, the logical attributes LeapSecondsKnown, Clock-Failure, ClockNotSynchronized, and the value TimeAccuracy are maintained in each time stamp. For Edition1, these signals contain default settings. Thus, the interoperability for substation automation technology is ensured for both editions! The SNTP service must be enabled during configuration of Ethernet interfaces so that it is available as an option for the time synchronization. Time zone time source 1 or Time zone time source 2 = UTC
<i>IEC 60870-5-103</i>	The time is synchronized via telegram with an appropriately configured communication interface in accordance with the IEC 60870-5-103 protocol. Time zone time source 1 or Time zone time source 2 = local However, there are also T103 systems that send the UTC.
<i>DNP3</i>	The time is synchronized via telegram with the appropriately configured communication interface in accordance with the DNP3 protocol. 2 characteristics are supported in the process: • Time synchronization via UTC • Time synchronization with local time The daylight saving time status is not transmitted. The device assumes that the DNP3 master follows the same rules for the start and end of the daylight saving time as those that were set for the device. Time zone time source 1 or Time zone time source 2 = UTC is the current implementation, local concerns older implementations.
<i>IEEE 1588</i>	Time is synchronized via an IEEE 1588 timing master. In this case, SIPROTEC 5 devices operate as slave-only clocks. IEEE 1588 v2 is supported with P2P and Ethernet Transport. The IEEE 1588 service must be enabled during configuration of Ethernet interfaces so that it is available as an option for the time synchronization. Time zone time source 1 or Time zone time source 2 = UTC.

Parameter: Fault indication after

- Default setting **Fault indication after = 600 s**

With the parameter **Fault indication after**, you set the time delay after which the unsuccessful attempts of time synchronization with external time sources configured are indicated.

Parameter: Time Zone and Daylight Saving Time

This parameter block contains all the settings for the local time zone and daylight saving time of your SIPROTEC 5 device. In addition to the individual parameters, configure the basic settings by preselecting via the option buttons or check box.

The screenshot shows a configuration window titled "Time zone and daylight saving time". It contains several input fields and dropdown menus. The "Time zone offset to UTC" is set to 60 min. The "Switch daylight sav. time" checkbox is checked. The "Start of daylight sav. time" is configured with "Last" as the day, "Sunday" as the month, "March" as the day of the month, and "02:00 AM" as the time. The "End of daylight sav. time" is configured with "Last" as the day, "Sunday" as the month, "October" as the day of the month, and "03:00 AM" as the time. The "Offset daylight sav. time" is set to 60 min.

[sc_time_zo, 1, en_US]

Figure 3-103 Settings for Time Zone and Daylight Saving Time in DIGSI

Selection Button	Description
Manual settings (local time zone and daylight saving time regulation)	This setting must be selected if you want to select the local time zone and daylight saving time zone regulations of your SIPROTEC 5 device regardless of the PC settings. Input: Offset time zone for GMT [min] Selection: Switchover to daylight saving time [yes/no] via check box ☒ Switch daylight sav. time • Input: Start of daylight saving time [Day and time] • Input: End of daylight saving time [Day and time] • Input: Offset daylight saving time [min] • Default settings as in the picture above

3.5.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
<i>Time sync.</i>				
_:102	Time sync.:Time source 1		• none • IRIG-B • DCF77 • PI • SNTP • IEC 60870-5-103 • PROFIBUS DP • Modbus • DNP3 • IEEE 1588 • IEC 60870-5-104	none
_:103	Time sync.:Time source 1 port		• port J • port F • port E • port P • port N • port G	
_:104	Time sync.:Time source 1 channel		• Ch1 • Ch2	

Addr.	Parameter	C	Setting Options	Default Setting
_:105	Time sync.:Time source 2		• none • IRIG-B • DCF77 • PI • SNTP • IEC 60870-5-103 • PROFIBUS DP • Modbus • DNP3 • IEEE 1588 • IEC 60870-5-104	none
_:106	Time sync.:Time source 2 port		• port J • port F • port E • port P • port N • port G	
_:107	Time sync.:Time source 2 channel		• Ch1 • Ch2	
_:108	Time sync.:Time zone time source 1		• UTC • local	local
_:109	Time sync.:Time zone time source 2		• UTC • local	local
_:101	Time sync.:Fault indication after		0 s to 3600 s	600 s

3.5.6 Information List

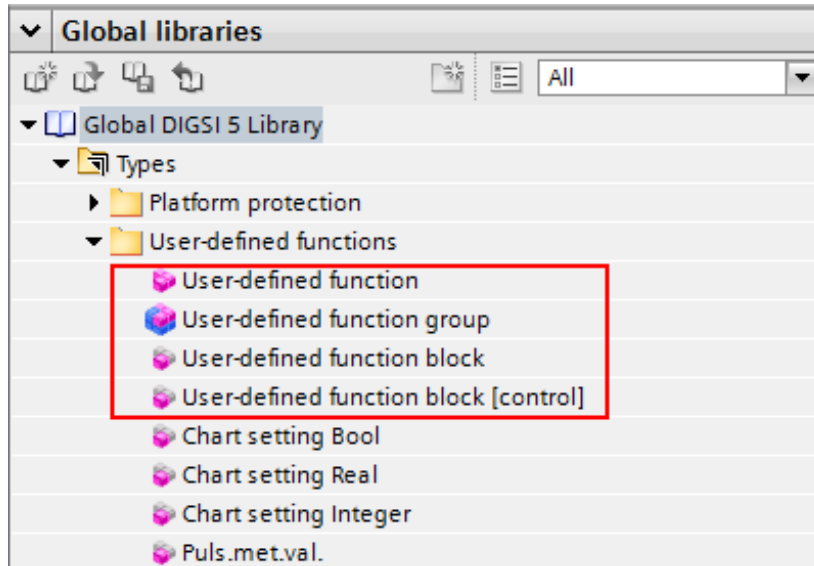
No.	Information	Data Class (Type)	Type
Time managem.			
_:300	Time managem.:Daylight saving time	SPS	O
_:301	Time managem.:Clock set manually	SPS	O

No.	Information	Data Class (Type)	Type
Time sync.			
_:303	Time sync.:Status time source 1	SPS	O
_:304	Time sync.:Status time source 2	SPS	O
_:305	Time sync.:Time sync. error	SPS	O
_:306	Time sync.:Leap second	SPS	O
_:307	Time sync.:High accuracy	SPS	O

3.6 User-Defined Objects

3.6.1 Overview

With help from user-defined function groups and user-defined functions you can group user-defined objects, for example user-defined function blocks. 2 user-defined function blocks are available (see following figure).



[sc_undef_lib, 1, en_US]

Figure 3-104 User-Defined Objects in the DIGSI 5 Library

The **user-defined function block** allows you to add (see following figure) single-point indications, pickup indications, operate indications (ADC, ACT), single and double commands, commands with a controllable whole number as well as measured values. You can assign the group a superordinate name (for example **process indications** for a group of single-point indications which are read via binary inputs). This function can be deactivated using the mode. The standby mode is also analyzed or displayed.

The user-defined function blocks can be instantiated at the highest level (alongside other function groups) as well as within function groups and functions.

In addition, there is a **user-defined function block [control]**. Alongside the aforementioned possibilities presented by **user-defined function blocks**, this block offers additional tests for user-defined control signals, for example SPC or DPC.

These are described in chapter [6.6.1 Overview of Functions](#).

Information			Source									
			Binary input									
			Base module									
Signals	Number	Type	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.1	
(All...)	(All...)											
Process indic	851.6361								*	*	*	
Mode (controllable)	851.6361.51	ENIC										
Behavior	851.6361.52	ENIS										
Health	851.6361.53	ENIS										
SF6 Alarm L1		SPS							H			
SF6 Alarm L2		SPS								H		
SF6 Alarm L3		SPS									H	

[sc_user, 1, en_US]

Figure 3-105 Information Routing with Incorporated User-Defined Function Block: Process Indications and some Single-Point Indications

3.6.2 Basic Data Types

The following data types are available for user-defined objects in the DIGSI 5 library under the heading **User-defined signals**. Additionally, a folder for external signals is available (see chapter [3.6.5 External Signals](#)).

User-Defined Signals

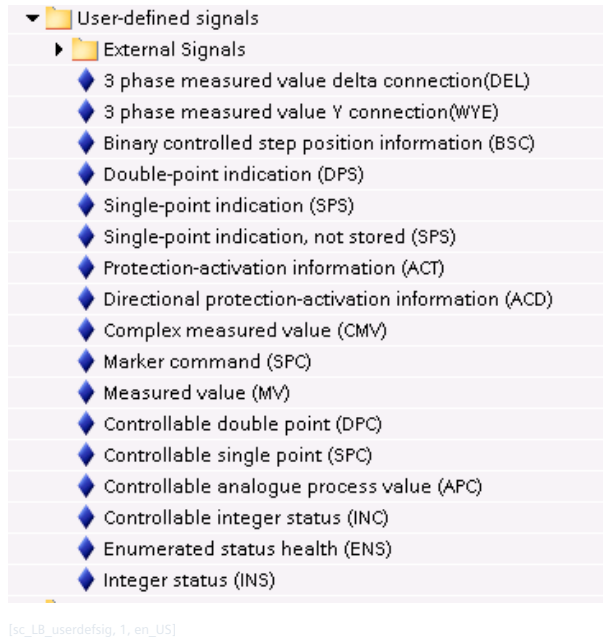


Figure 3-106 User-Defined Signals

Single-Point Indication (Type SPS: Single-Point Status)

The status of a binary input can be registered in the form of a single-point indication or forwarded as the binary result from a CFC chart.

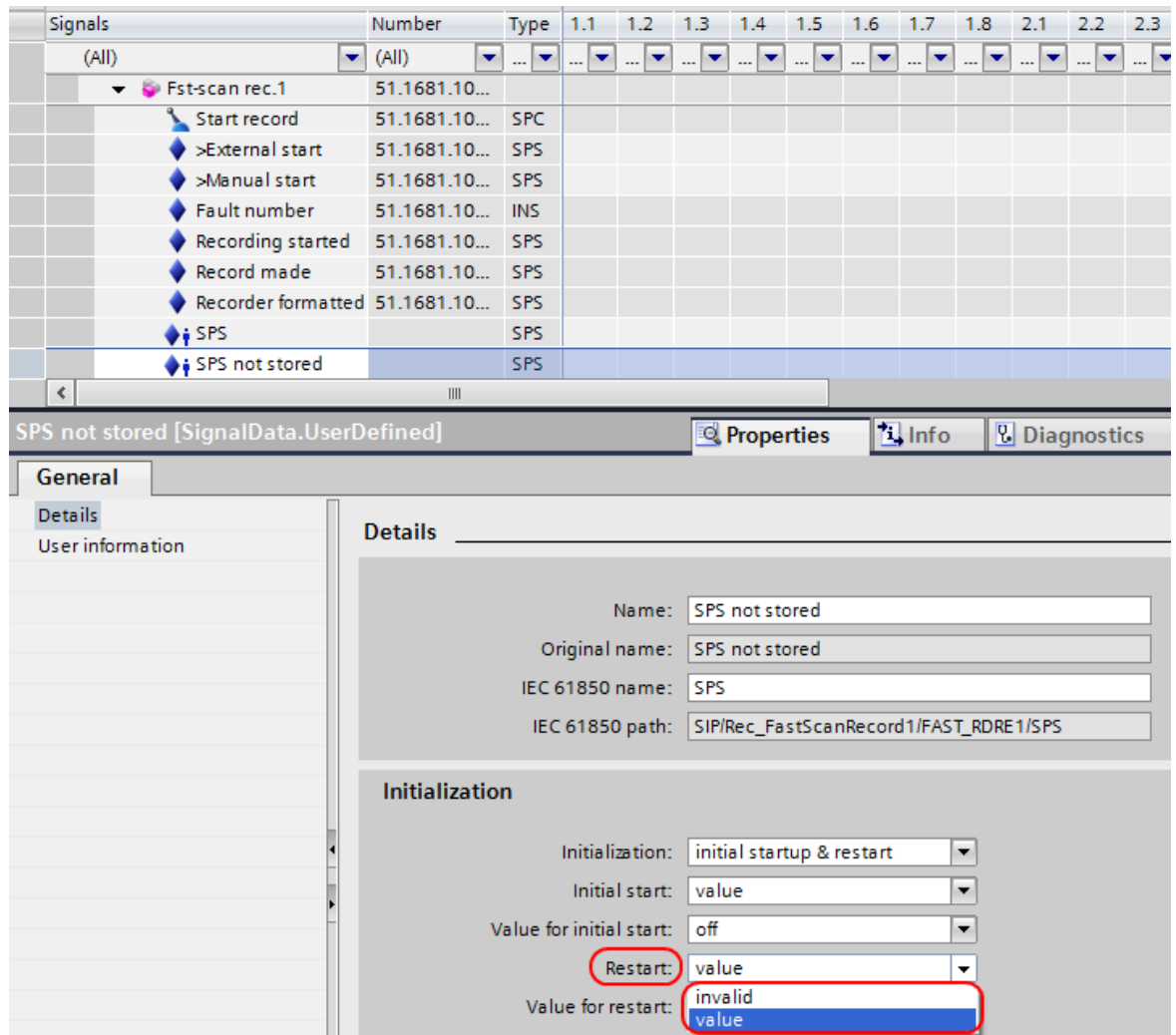
EXAMPLE

Acquisition using binary input, further processing in a CFC and/or signaling using an LED.

Single-Point Indication (Type SPS unsaved: Single-Point Status Unsaved)

In contrast to **SPS** single-point indications, the state of the **SPS unsaved** indication is not maintained after the device restarts.

For this purpose, go to **Properties > Details > Initialization > Restart** and set the **value**.



[sc_spsfas, 1, en_US]

Figure 3-107 Single-Point Indication SPS Unsaved (Example: 7KE85 Fault Recorder)

Double-Point Indication (Type DPS: Double-Point Status)

When using a double-point indication, the status of 2 binary inputs can be captured simultaneously and mapped in an indication with 4 possible conditions (**ON**, **Intermediate position**, **OFF**, **Disturbed position**).

EXAMPLE

Acquisition of a disconnector or circuit-breaker switch position.

Marker Command (Type SPC, Single-Point Controllable)

This data type can be used as a command without feedback for simple signaling or as an internal variable (marker).

Integer Status Value (Type INS)

The data type **INS** is used to create a whole number that represents a CFC result.

EXAMPLE

The output of the CFC block **ADD_D** can, for example, be connected with the data type **INS**. The result can be shown on the display of the device.

State of an Enumeration Value (Type ENS)

The data type **ENS** is used to create an enumerated value that represents a CFC result.

Controllable Single-Point Indication (SPC, Single-Point Controllable)

This can be used to issue a command (to one or several relays, selectable under information routing) that is monitored via a single feedback.

Command with Double-Point Feedback (DPC, Double-Point Controllable)

This can be used to issue a command (to one or several relays, selectable under information routing) that is monitored via double-point indication as feedback.

Command with a Whole Number (INC, Controllable Integer Status)

This can be used to issue a command (to one or more relays, selectable under information routing) that is monitored via a whole number as feedback.

Complex Measured Values (CMV)

This data type provides a complex measured value that can be used as a CFC result, for example.

Measured Values (MV)

This data type provides a measured value that can be used as a CFC result, for example.



NOTE

Additional data types can be found under other headings in the DIGSI 5 library as well as in the corresponding function blocks. This applies to the following data types:

- Pulse-metered values (see **User-defined functions** in the DIGSI 5 library)
- Transformer taps
- Metered values

Phase-to-Ground Measured Values (WYE)

This data type represents the phase-to-ground measured values of a 3-phase system.

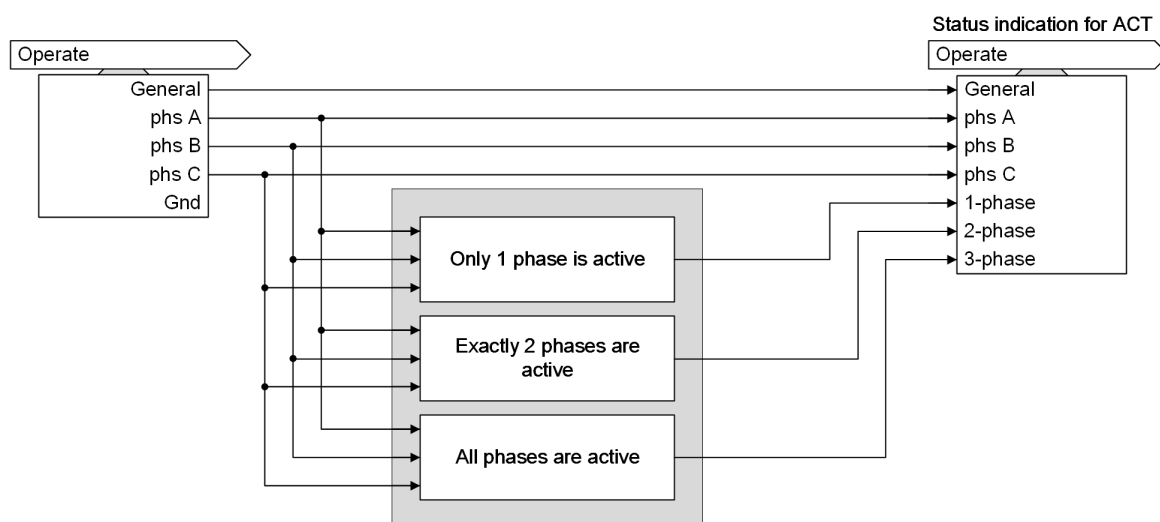
Phase-to-Phase Measured Values (DEL, Delta)

This data type represents the phase-to-phase measured values of a 3-phase system.

Protection Activation Information (ACT)

This object type is used by the protection functions for **Tripping**. It is available in the library for receiving protection information via the protection interface, which could also indicate **Tripping**.

The status indications for the **ACT** data type are built as follows:



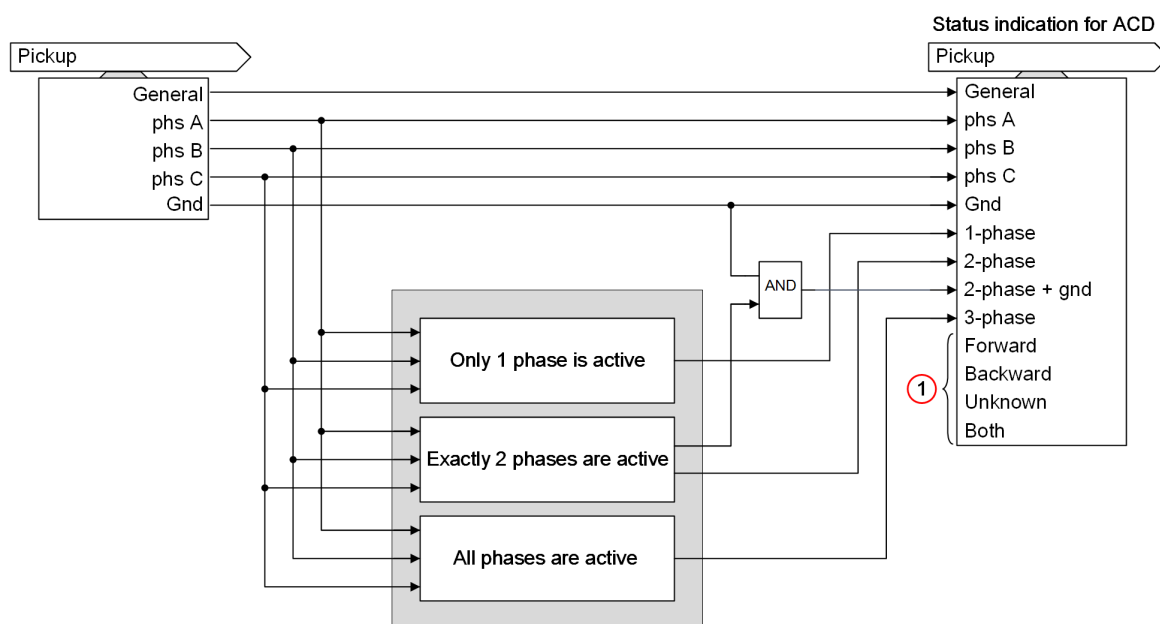
[lo_ACT-information, 1, en_US]

Figure 3-108 Building of the Status Indications ACT

Protection Activation Information with Direction (ACD)

This object type is used by the protection functions for **Pickup**. It is available in the library for receiving protection information via the protection interface, which could also indicate **Pickup**. In addition, both ACD and ACT, can be generated and processed by CFC charts.

The status indications for the **ACD** data type are built as follows:



[lo_ACD-information, 1, en_US]

Figure 3-109 Building of the Status Indications ACD

(1) Further information, see [Table 3-19](#)

Table 3-19 Building of the Direction Information for the Data Type **ACD**

Direction Information	Description
<i>forward</i>	All picked up phases have picked up in forward direction.
<i>backward</i>	All picked up phases have picked up in backward direction.
<i>unknown</i>	The direction could not be determined for the pickup.
<i>both</i>	At least 1 phase has picked up in forward direction and at least 1 phase has picked up in backward direction.

3.6.3 Pulse and Energy Metered Values

Pulse-Metered Values

Pulse-metered values are available as data types **BCR** (Binary Counter Reading) in the DIGSI library under **User-defined Functions**.

You can find the functionality and the settings of the pulse-metered values in [8.2.1 Function Description of Pulse-Metered Values](#).

3.6.4 Additional Data Types

The following data types are also used in the system but are not available for general use as user-defined signals in the library:

- **ENC** (Enumerated Setting Controllable)
The data type **ENC** models a command with which the user can set predefined values.
- **SEQ** (Sequence)
- **BSC** (Binary Controlled Step Position)
The data type **BSC** can, for example, be used to control a transformer tap changer. The commands **up**, **down** can be given.

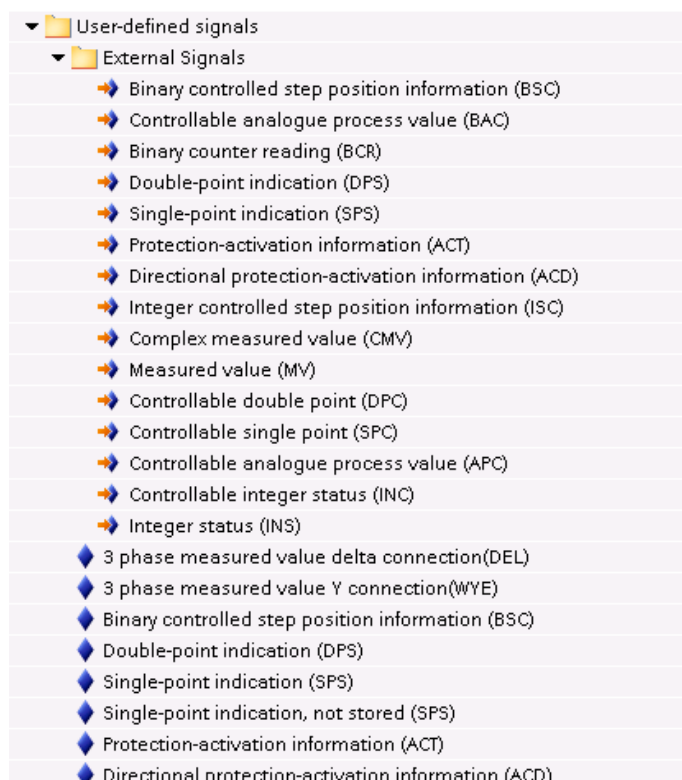


NOTE

Transformer taps are included in the **Transformer tap changer** switching element. If this switching element is created in the device, the transformer tap position is available as a data object of type **BSC** (binary controlled step position information).

3.6.5 External Signals

User-defined signals of different types (see [Figure 3-110](#)) are available for GOOSE Later Binding. After instantiation in a logical node, an external reference is generated during IID export and provided to a IEC 61850 system tool (for example, System Configurator) for GOOSE Later Binding (according to the Later-Binding procedure specified in IEC 61850-6).



[sc_lb_extsign, 1, en_US]

Figure 3-110 External Signals



NOTE

Consider the chapter on GOOSE Later Binding in the DIGSI Online Help. User-defined signals exist as external signals and as preconfigured inputs that have been activated via the GOOSE column.

3.7 Other Functions

3.7.1 Signal Filtering and Chatter Blocking for Input Signals

Input signals can be filtered to suppress brief changes at the binary input. Chatter blocking can be used to prevent continuously changing indications from clogging the event list. After an adjustable number of changes, the indication is blocked for a certain period.

The settings for indication filtering can be found at the individual signals. The next figure shows the settings using the example of a controllable (circuit-breaker switch position).



NOTE

The software filtering time is available only for the circuit breaker and disconnector in the controllable **Cmd. with feedback (control function block)**, as this is used for logging purposes. The controllable **position (circuit breaker or disconnector function block)** is used for interlocking conditions and must always show the unfiltered position of the switching object.

The screenshot shows the configuration window for 'Cmd. with feedback [SignalDataV2]'. The 'Details' tab is selected, displaying the following settings:

- Name: Cmd. with feedback
- Original name: Cmd. with feedback
- IEC 61850 name: Pos
- IEC 61850 path: SIP1/QA1/CSW11/Pos

The 'Software filter' section contains the following options:

- Software filter time: 0 ms (input field)
- Retrigger filter: ☐
- Indication timestamp before filtering: ☐
- Suppress intermediate position: ☐
- Spontaneous position changes filtered by: Spont. software filt. (dropdown menu)
- Spontaneous software filter time: 0 ms (input field)
- Spontaneous retrigger filter: ☐
- Spontaneous indication timestamp before filtering: ☐
- Spontaneous suppress intermediate position: ☐

[sc_iposi, 1, en_US]

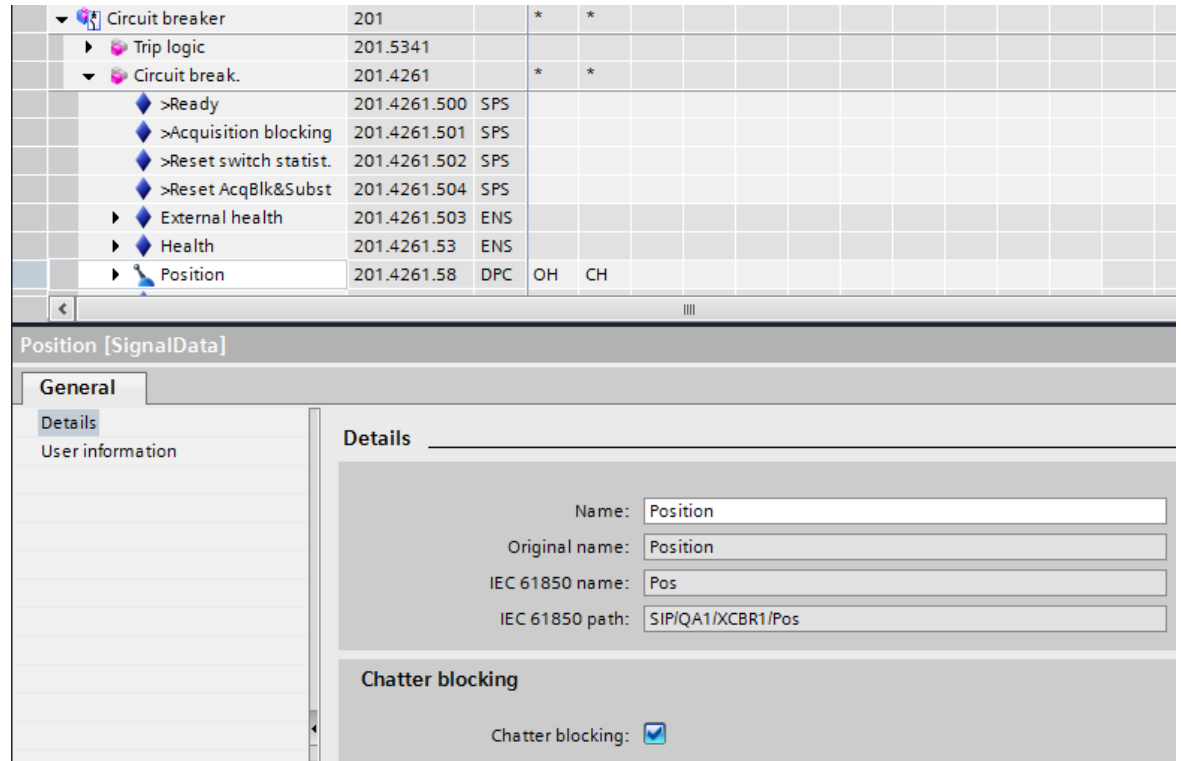
Figure 3-111 Settings for Circuit-Breaker Switch Position

The setting range for the **Software filter time** parameter ranges from 0 ms to 100 000 ms in ms increments. The **Retrigger filter** check box can be used to select whether to restart the filtering time whenever a status change is performed within the software filtering time. When activated, the **Indication timestamp before filtering** check box backdates the time stamp by the set software filtering time. In this case, the time stamp corresponds to the actual status change of the signal. If you activate the **Suppress intermediate position** check box, the intermediate position is suppressed for the duration of this software filtering time.

If you leave the software filtering time at 0 ms, the time for the suppression of the intermediate position is also 0 ms. The activated **Suppress intermediate position** check box then remains ineffective.

If you do not activate the **Suppress intermediate position** check box, the software filtering time affects the **on**, **off**, **intermediate**, and **disturbed** positions of the circuit breaker or disconnector switch. With the parameter **Spontaneous position changes filtered by:**, you set how such position changes are to be filtered. Spontaneous position changes are caused by external switching commands, for example. If you select the **General software filter** setting, the general settings for software filtering of spontaneous position changes and for position changes caused by a switching command apply. The settings for spontaneous position changes then cannot be edited. A separate filtering for spontaneous position changes is activated with the **Spontaneous software filter** setting and you can edit the settings for this.

Chatter blocking can be activated or deactivated as an input parameter, for example as a parameter of the position in the **Circuit breaker** or **Disconnector** function block.



[sc_flatte, 1, en_US]

Figure 3-112 Setting Chatter Blocking

The settings for the chatter blocking function are set centrally for the entire device in DIGSI. They are accessible as settings in the **General** function group (see the following figure).

The chatter-blocking settings have the following meaning (see also [Figure 3-113](#) and [Figure 3-114](#) in the examples shown in the following):

- **No. permis.state changes**

This number specifies how often the state of a signal may toggle within the chatter-test time and the chatter-checking time. If this number is exceeded, the signal will be or remains blocked.

Enter a number from 0 to 65535 in this field. If the entry is 0, chatter blocking is essentially inactive.

- **Initial test time**

During this time, the number of times a signal changes its status is checked. This time is started if chatter blocking is configured for at least one signal and this signal changes its status. If the configured number of permissible status changes is exceeded during the initial test time, the signal is temporarily blocked and the indication *Chatter blocking* is set.

Enter a number from 1 to 65535 in this field. The number entered corresponds to the time in seconds. When the set time has expired, the timer restarts automatically (cycle time).

- **No. of chatter tests**

This number specifies the maximum number of test cycles to be run. If the number of permissible status changes of the signal stays exceeded during the initial test time of the last test cycle, the signal is finally blocked. In this case, the indication *Group warning* (**Alarm handling** group and **Device** group) is set additionally to the *Chatter blocking* indication after expiry of the set number. Restarting the devices removes this block again.

Enter a number from 0 to 32767 in this field. The value Infinite (∞) is also permissible here.

Enter this value as character string oo.

- **Chatter idle time**

If the number of permissible status changes for a signal is exceeded during the initial test time or the subsequent test time, the **Chatter idle time** starts. Within this time, this signal is blocked temporarily and the *Chatter blocking* indication is set. The blocked input signal is assigned the **oscillatory** quality.

Enter a number from 1 to 65535 in this field. The number entered corresponds to the time in minutes. An entry here is only considered if the number of chatter tests does not equal to 0.

- **Subsequent test time**

During this second test time, the number of times a signal changes its status is checked once again. The time begins when the **Chatter idle time** expires. If the number of status changes is within the permissible limits, the signal is released. Otherwise, an additional dead time begins, unless the maximum number of chatter tests has been reached.

Enter a number from 2 to 65535 in this field. The number entered corresponds to the time in seconds. An entry here is only considered if the number of chatter tests does not equal 0.

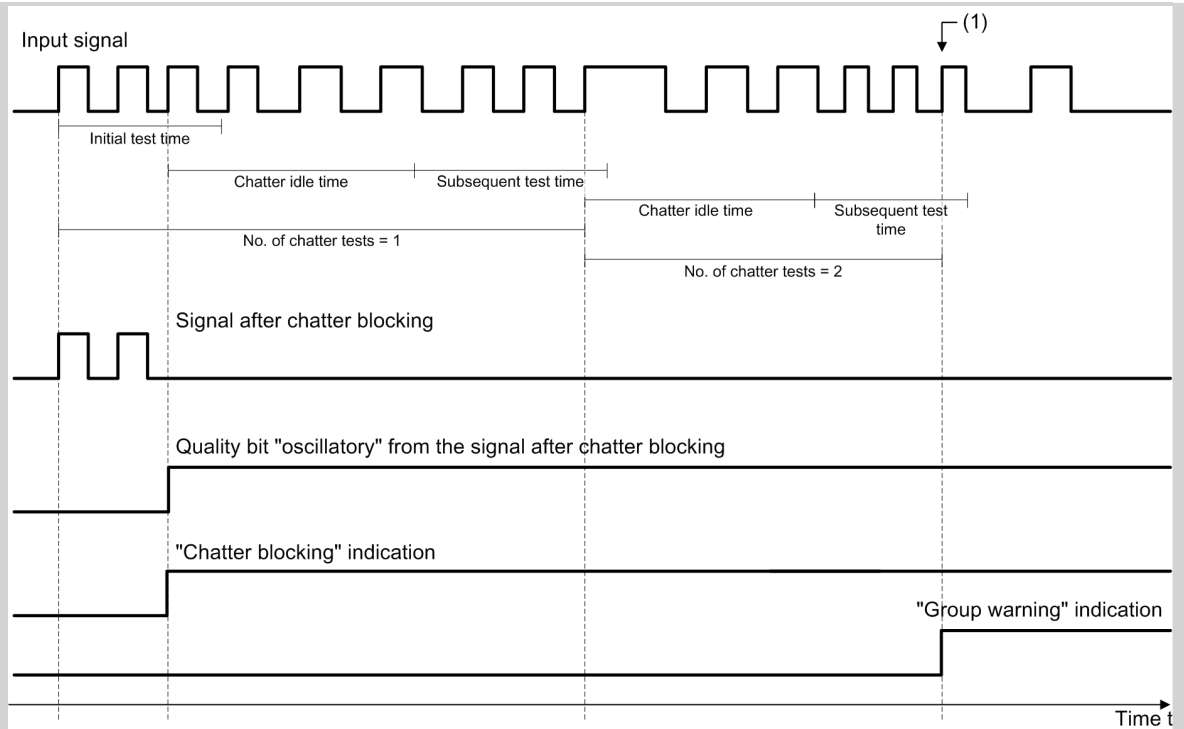
Example 1: Permanent Blocking

The chatter-blocking settings are set as follows:

- **No. permis.state changes** = 4
- **No. of chatter tests** = 2

After more than 4 state changes within the **Initial test time**, the input signal is set to the original state by the chatter blocking and the **oscillatory** quality is assigned. Additionally, a corresponding indication is added to the operational log. At the same time, the *Chatter blocking* indication is set. After expiry of the settable **Chatter idle time**, during the following **Subsequent test time**, it is checked whether the input signal is still chattering. This check is repeated, as the **No. of chatter tests** is set to 2 in this example.

If, during the 2nd **Subsequent test time**, it has been detected that the number of status changes of the input signal exceeds the set **No. permis.state changes**, the chatter blocking detects a persistent violation of the signal stability and sets the *Group warning* indication. The original state of the signal is permanently frozen. Only a device restart removes the chatter blocking again.



[dw_chatter-block-01_1_en_US]

Figure 3-113 Signal Change during Chatter Blocking with too Important Number of Signal State Changes During 2nd Subsequent Test Time

(1) The input signal is permanently blocked starting from this point in time.

Example 2: Temporary Blocking

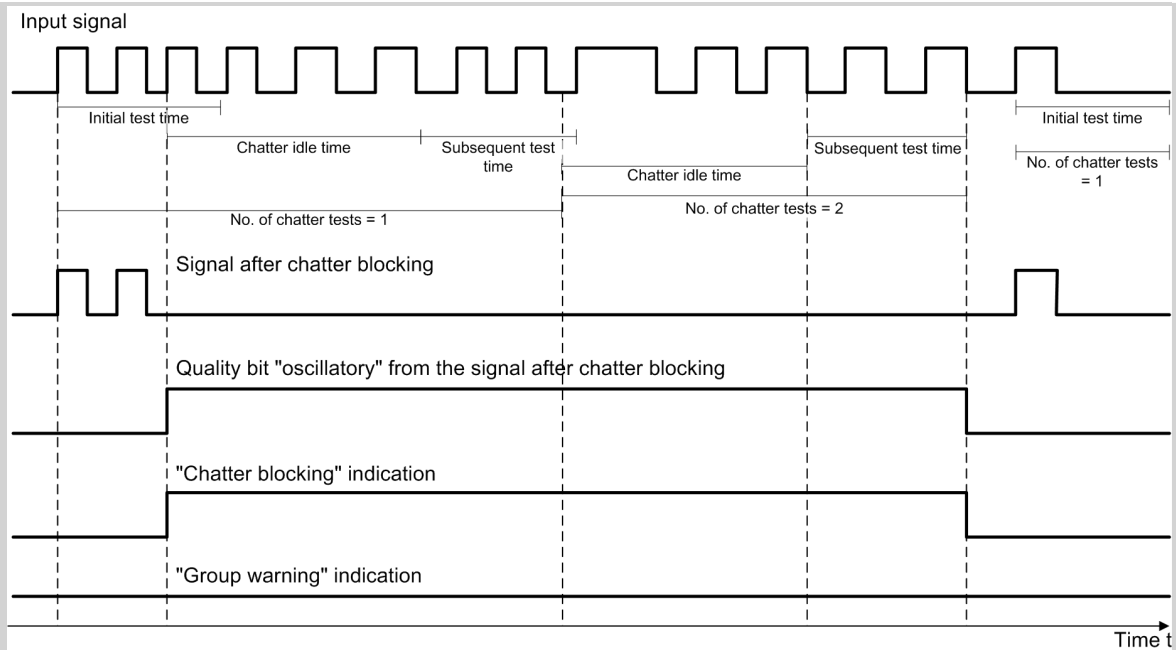
The chatter-blocking settings are set as follows:

- **No. permis.state changes = 4**
- **No. of chatter tests = 2**

After more than 4 state changes within the **Initial test time**, the input signal is set to the original state by the chatter blocking and the **oscillatory** quality is assigned. Additionally, a corresponding indication is added to the operational log. At the same time, the **Chatter blocking** indication is set. After expiry of the settable **Chatter idle time**, during the following **Subsequent test time**, it is checked whether the input signal is still chattering. This check is repeated, as the **No. of chatter tests** is set to 2 in this example.

If, during the 2nd **Subsequent test time**, it has been detected that the number of state changes of the input signal is within the set **No. permis.state changes**, the temporary blocking of state changes of the signal is removed and the actual signal state is released.

The quality bit **oscillatory** is removed and the **Chatter blocking** indication is reset. As the temporary blocking of the signal is removed, the **Group warning** indication is not set. The chatter test starts again.



[dw_chatter_block-02, 1, en-US]

Figure 3-114 Signal Change during Chatter Blocking with Permissible Number of Signal State Changes During 2nd Subsequent Test Time

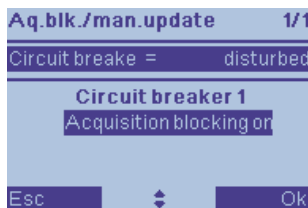
3.7.2 Acquisition Blocking and Manual Updating

During commissioning, maintenance, or testing, a brief interruption of the connection between the logical signals and binary inputs may be useful. It allows you to manually update the status of a switching device that is not providing feedback correctly. Before this can take place, you must first set acquisition blocking.

To set the acquisition blocking, proceed as follows:

- Using the navigation keys, move in the **main menu** of the device display to **Commands→Equipment→Aq.blkman. update**.
- Select the appropriate device (for example, a circuit breaker) from among the several switching devices using the navigation keys.
- Press the **Change** softkey.
- Enter the confirmation ID (not relevant for active role-based access control (RBAC) in the device).
- Confirm the process with the softkey marked **OK** in the display.

After entering the confirmation ID (only with the RBAC inactive), acquisition blocking is switched on.

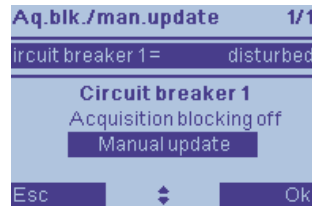


[sc_detection, 1, en-US]

Figure 3-115 Activating the Acquisition Blocking

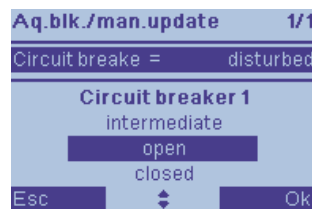
Manual updating of the switching device is possible from within the same menu.

- Select **Manual update** (Figure 3-116) using the navigation keys.
- Select the switching device setting to be manually updated using the navigation keys (for example, **off**, Figure 3-117).
- Confirm the process with the softkey marked **Ok** in the display.



[sc_status, 1, en_US]

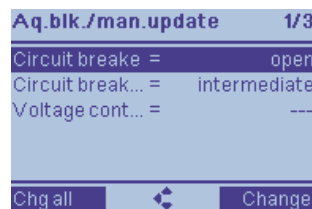
Figure 3-116 Activating Manual Update



[sc_statu2, 1, en_US]

Figure 3-117 Selecting Position

The manually updated position of the switching device will be displayed.



[sc_statu3, 1, en_US]

Figure 3-118 Position of the Switching Device



NOTE

For security reasons, manual updating is possible only directly through the on-site operation panel of the device and not through DIGSI 5.



NOTE

Setting acquisition blocking and the subsequent manual updating are also possible via the IEC 61850 system interface.

You can set acquisition blocking also via a binary input. If you want to put in the feeder or the switching device in revision, you can set the acquisition blocking with an external toggle switch for one or more switching devices. For this purpose, every switching device in the **Switch** function block (circuit breaker or disconnector switch) has the input signal **>Acquisition blocking**. This signal can also be set from the CFC.

Information			Source												Destination		
			Binary input												CFC		
			Base module												Binary output		
			Base module												Base module		
Signals	Number	Type	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.1	2.2	2.3		1.1	1.2	1.3
(All)	(All)	...	...	...	...	...	...	...	...	...	...	...	...	(All)	...	...	...
▶ Trip logic	201.5341																
▼ Circuit break.	201.4261		*	*											*	*	
▶ >Ready	201.4261.500	SPS															
▶ >Acquisition blocking	201.4261.501	SPS															
▶ >Reset switch statist.	201.4261.502	SPS															
▶ >Reset AcqBlk&Subst	201.4261.504	SPS															
▶ External health	201.4261.503	ENS															

[sc_beerfa, 1, en_US]

Figure 3-119 Input Signals >Acquisition Block and >Release Acquisition Block & Manual Updating on the Switching Device



NOTE

Interlockings are carried out with the status changes of the switching device. Remove acquisition blocking again manually. Otherwise, position changes of the switching device are not detected and interlockings are ineffective.

If the acquisition blocking and the manually updated position are set using the operation panel of the device or the system interface IEC 61850, these are retained until the acquisition blocking is manually deactivated. When you initially start the device, the acquisition blocking is deactivated.

Except for a restart, the acquisition blocking and the manually updated position are retained.

If the acquisition blocking is activated via the input signal **>Acquisition blocking**, it is retained as long as the binary input is active.

To set the acquisition blocking of a switching device, the following sources are possible:

- Operation panel of the device
- System interface IEC 61850
- Input signal **>Acquisition blocking**

All sources undergo OR operations, that is, the acquisition blocking remains set until all the sources are deactivated.

After deactivation of the acquisition blocking, the actual position of the switching device is adopted and displayed in the operation panel of the device.



NOTE

When the acquisition blocking is activated or the switching device updated manually while the entire device or the switching device is in application mode, these states are not saved. The acquisition blocking and the manual updating are not retained after a restart.

The acquisition blocking and the manual update for the circuit breaker, the disconnector, and the tap changer are reset by way of the **>Reset AcqBlk&Subst** binary input. Setting acquisition blocking and manual update is blocked with the input activated.

3.7.3 Persistent Commands

In addition to the switching commands, which are issued as pulse commands, and stored for the standard switching devices (circuit breaker, disconnector switch), persistent commands are also possible. In this case, a distinction must be drawn between controllables with the **Continuous output** operating mode and a stored signal output that is immune to reset.

You can change a controllable from pulse to persistent command with the **Command output** parameter.

The screenshot displays the DIGSI 5 configuration window for a protection function (SPC). The top section shows a list of signals with columns for Number and Type. Below this, the 'Details' tab is active, showing fields for Name, Original name, IEC 61850 name, and IEC 61850 path. The 'General' section contains settings for Command output, Pulse duration, Pulse-pause duration, Number of pulse, Control model, SBO time-out, Feedback monitoring time, and Seal-in time.

[sc_command, 1, en_US]

Figure 3-120 Setting the Command Type in DIGSI 5

Select **Pulse output** or **Continuous output** for the command output type. If a persistent command is selected, the Pulse parameter is irrelevant.

3.7.4 Device Logout

3.7.4.1 Overview

In the case of multibay functions, a device uses information from one or more other devices. For some applications, it may be necessary for you to remove a device with all effective functions temporarily from the plant and even to switch it off. These applications are, for example:

- Maintenance work
- System upgrades
- Testing the local protection functions, for example, the local line differential protection

The **Device Logout** functionality informs the receiver devices about the imminent disconnection of the transmitter devices. To do this, the last valid received information is stored in the receiver devices and used for the multibay functions.



NOTE

If you need to remove a device temporarily from the plant, you must log off the device. Protection functions distributed to several devices operate in a healthy manner with the remaining devices only if you have logged off the device.

You can log off the device as follows:

- Via the on-site operation panel
- Via a communication interface using the *Device logout* (`_:319`) controllable
- Via the binary inputs, general: *>Dev. funct. logout on* (`_:507`) or *>Dev. funct. logout off* (`_:508`)

You can find the controllable and the binary inputs in the DIGSI 5 project tree under **Name of the device** → **Information routing** in the working area in the **General** block.

During the log-off process, the device checks whether all conditions for a logout have been met. If the conditions for the log off have not been met, the logout is rejected.

The logout is rejected under the following conditions:

- The devices are communicating via the protection interface and switching off the device leads to an interruption in protection-interface communication.
- The **Line differential protection** function is operating in the device and the local circuit breaker is still switched on.

In this case, you must switch off the local circuit breaker and repeat the log-off process for the device. After the logout, the local **Line differential protection** function is removed from the summation of the currents for the **Line differential protection** of the other devices. The **Line differential protection** function remains active in the other devices.



NOTE

The path used to log the device off is stored in the operational log.
Even if you switch off the device after logout, the *Device logged off* (`_:315`) state is stored.

If you want to establish the initial state again after logging off the device, you must log on the device again. To log on the device, you must use the same option used for logout. For example, if you have logged off the device via binary inputs, you must log it on again via the binary inputs. This applies in similar manner if you have logged off the device via DIGSI or via on-site operation.

3.7.4.2 Application and Setting Notes

Logoff Options for a Device

You can log a device off as follows:

- Via the on-site operation panel
- Via communication through the controllable *Device logout* (`_:319`)
- Via the binary inputs, general: *>Dev. funct. logout on* (`_:507`) or *>Dev. funct. logout off* (`_:508`)

Conditions for Logging off the Device

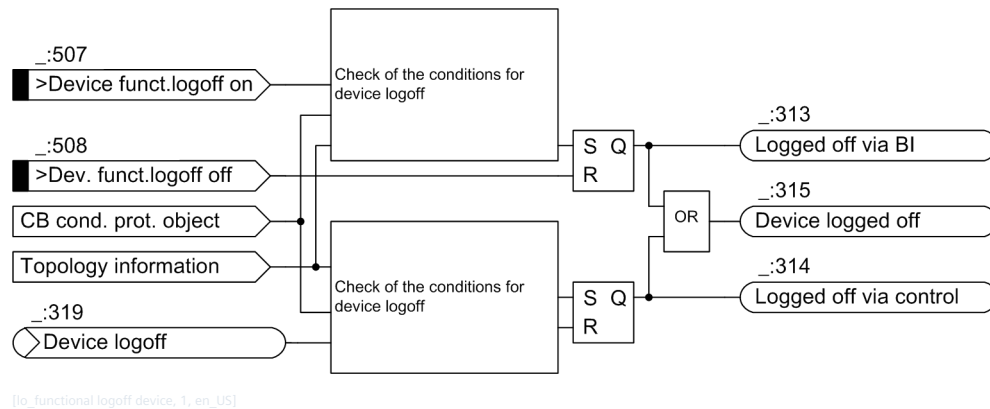


Figure 3-121 Logic for Logging off the Device

The conditions for a successful logout of the device result from the conditions for every activated protection function.

Logoff of a Device from a Device Combination with Communication via the IEC 61850-8-1 (GOOSE) Protocol

If devices are exchanging data using the IEC 61850-8-1 (GOOSE) protocol – for example in the case of substation interlocking – for each received data point the value of this data point can be set in the receiver device when the transmitter device logs off. This value remains effective in the receiver device until the logout is canceled by the transmitter device, even if the transmitter and/or the receiver are switched off in the meantime.

Logoff of a Device from a Device Combination Using Protection Communication

If devices in a device combination communicate via the protection interface, you can only log off a device under the following conditions:

- Logging off and switching off a device in a device combination must not result in an interruption in the protection communication.
- For series-connected topologies, the device must be located at one end of the communication chain as otherwise the protection communication is interrupted when the device is logged off and switched off. For this reason, devices not at one of the ends in series-connected topologies cannot be logged off.

Logout via Binary Inputs

The following diagrams show potential variants on how to control binary inputs. If you want to use push-buttons, switch on this function as shown in the following figure. Log off the device using the push-button **Key2**; log on the device again with the push-button **Key1**.

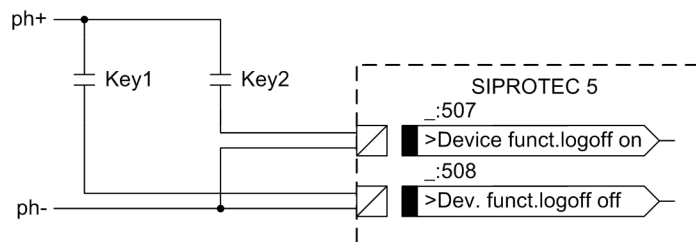


Figure 3-122 External Push-Button Wiring for Logging off the Device

If a switch is being used for control, route the binary input *>Dev. funct.logout on* as **H (active with voltage)** and the binary input *>Dev. funct.logout off* as **L (active without voltage)**. If the switch **S** is closed, the device is logged off.

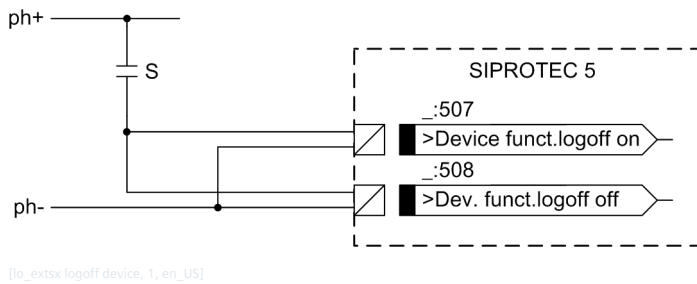


Figure 3-123 External Switch Wiring for Logging off the Device

Indications

The logged-off device reports the status (*._:315 Device Logged off*) and cause of the logout.
 If you have logged off the device using binary inputs, the indication (*._:313 Logged off via BI*) results.
 If you have logged off the device using on-site operation, via DIGSI 5 or via the protection interface, the indication (*._:314 Logged off via control*) is issued.
 The indications are stored in the operational log.

3.7.4.3 Information List

No.	Information	Data Class (Type)	Type
General			
._:507	General:>Dev. funct.logout on	SPS	I
._:508	General:>Dev. funct.logout off	SPS	I
._:319	General:Device logout	SPC	C
._:313	General:Logged off via BI	SPS	O
._:314	General:Logged off via control	SPS	O
._:315	General:Device logged off	SPS	O

3.8 Device Settings

3.8.1 Settings-Group Switching

3.8.1.1 Overview of Functions

For different applications you can save the respective function settings in so-called **Settings groups**, and if necessary enable them quickly.

You can save up to 8 different settings groups in the device. In the process, only one settings group is active at any given time. During operation, you can switch between settings groups. The source of the switchover can be selected via a parameter.

You can switchover the settings groups via the following alternatives:

- Via the on-site operation panel directly on the device
- Via an online DIGSI connection to the device
- Via binary inputs
- Via a communication connection to the substation automation technology.
The communication protocols IEC 60870-5-103, IEC 60870-5-104, IEC 61850, DNP, or Modbus TCP can be used for switching the settings groups.

A settings group includes all switchable settings of the device. Except for a few exceptions (for example, general device settings such as rated frequency), all device settings can be switched.

For detailed information about the settings groups, refer to the *Operating Manual* and to the *DIGSI 5 Online Help*.

3.8.1.2 Structure of the Function

The function of the **Settings group switching** is a supervisory device function. Accordingly, the settings and indications of the settings group switching can be found in DIGSI 5 and at the on-site operation panel of the device, below the general device settings respectively.

If you want to switchover a settings group, navigate to DIGSI 5 or proceed on the on-site operation panel of the device, as follows:

- Via the project tree in DIGSI 5:
Project -> Device -> Settings -> Device settings
- Via the on-site operation panel of the device:
Main menu → Settings → General → Group switchover

The indications for the settings group switching can be found in the DIGSI 5 project tree under:
Project → Device → Information routing → General

3.8.1.3 Function Description

Activation

If you want to use the **Settings group switching** function, you must first set at least 2 settings groups in DIGSI 5 (parameter **Number of settings groups** > 1). You can set up a maximum of 8 settings groups. The settings groups set in DIGSI 5 are subsequently loaded into the device.

Mechanism of the Switchover

When switching over from one settings group to another, the device operation is not interrupted. With the 2dfcbba843c4f68d9da3529601704025 parameter, you are either specifying a certain settings group or you allow switching **via control** (IEC 60870-5-103, IEC 61850) or **via binary input**.

Switching via Control

When using the **Contro1** function for switching, the settings groups can be switched via a communication connection from the substation automation technology or via a CFC chart.

The communication protocols IEC 60870-5-103, IEC 60870-5-104, IEC 61850, DNP, or Modbus TCP can be used for switching the settings groups via a communication connection.

In order to use a CFC chart for switching, you must create a new CFC chart in DIGSI 5. Create the CFC chart in the DIGSI 5 project tree under **Name of the device** → **Charts** → **Add new chart**. Link the signals that control settings group switching in the CFC chart.

Switching via Binary Input

There are 3 appropriate input signals available for switching via binary inputs. These input signals allow selection of the settings group via a binary code. If one of the 3 signals changes, the signal image present will, after 100 ms (stabilization time), result in switching over to the appropriate settings group. If only 2 settings groups must be switched over, only 1 binary input is required. The following table shows the possible binary codes (BCD) and applicable settings groups (PG).

Table 3-20 Binary Codes of the Input Signals and Applicable Settings Groups

BCD Code via Binary Inputs	PG 1	PG 2	PG 3	PG 4	PG 5	PG 6	PG 7	PG 8
>PG selection bit 3	0	0	0	0	1	1	1	1
>PG selection bit 2	0	0	1	1	0	0	1	1
>PG selection bit 1	0	1	0	1	0	1	0	1

Copying and Comparing Settings Groups

In DIGSI 5, you can copy or compare settings groups with each other.

If you want to copy settings groups, select a source and target parameter group in DIGSI 5 in the device settings, and then start the copy process. The device settings can be found in the DIGSI 5 project tree under Project → Device → Settings → Device settings.

If you want to compare settings groups, it is possible to do so in all setting sheets for settings. You will then select in addition to the active settings group, a 2nd settings group for comparison. Active setting values and the comparable values are displayed next to each other. For settings that cannot be switched over, no comparable values are displayed.

Indication of Settings Group Switchings

Every settings group shows an applicable binary indication as well as its activation and deactivation. The process of settings group switching is also logged in the log for settings changes.

3.8.1.4 Application and Setting Notes

Parameter: Number settings groups

- Default setting (**_:113**) **Number settings groups = 1**

With the parameter **Number settings groups**, you can set the number of available settings groups; you can switch between these.

Parameter: Activat. of settings group

- Default setting (**_:114**) **Activat. of settings group = settings group 1**

With the parameter **Activat. of settings group**, you specify the settings groups that you want to activate, or the mechanisms via which the switchover is allowed. You can switchover only between the settings groups specified with the parameter **Number settings groups**.

Parameter Value	Description
<i>via control</i>	The switchover between the settings groups can only be initiated via a communication connection from a substation automation technology or via a CFC chart. The communication protocols IEC 60870-5-103, IEC 60870-5-104, IEC 61850, DNP, or Modbus TCP can be used for switching the settings groups via a communication connection.
<i>via binary input</i>	The switchover between the settings groups functions exclusively via the binary input signals routed to the settings group switching.
<i>settings group 1</i> ... <i>settings group 8</i>	They define the active settings groups. You can define the active settings groups in DIGSI 5, or directly on the device via the on-site operation.

3.8.1.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Change group				
_:113	General: Number settings groups		1 to 8	1
_:114	General: Activat. of settings group		- via control - via binary input - settings group 1 - settings group 2 - settings group 3 - settings group 4 - settings group 5 - settings group 6 - settings group 7 - settings group 8	settings group 1

3.8.1.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:500	General:>SG choice bit 1	SPS	I
_:501	General:>SG choice bit 2	SPS	I
_:502	General:>SG choice bit 3	SPS	I
_:300	General: Act. settings group 1	SPC	C
_:301	General: Act. settings group 2	SPC	C
_:302	General: Act. settings group 3	SPC	C
_:303	General: Act. settings group 4	SPC	C
_:304	General: Act. settings group 5	SPC	C
_:305	General: Act. settings group 6	SPC	C
_:306	General: Act. settings group 7	SPC	C
_:307	General: Act. settings group 8	SPC	C

3.8.2 General Device Settings

3.8.2.1 Overview

In **Device settings** in DIGSI 5, you find the following general settings.

General			
Device			
91.102	Minimum operate time:	0.00	s
91.115	Set. format residu. comp.:	Kr, Kx	
91.138	Block monitoring dir.:	off	
Chatter blocking			
91.123	No. permis.state changes:	0	
91.127	Initial test time:	1	s
91.124	No. of chatter tests:	0	
91.125	Chatter idle time:	1	min
91.137	Subsequent test time:	2	s
Control			
91.118	Enable sw.auth. station:	☐	
91.119	Multiple sw.auth. levels:	☐	
91.152	Specific sw. authorities:	☐	
91.166	Shows interlock.cond. HMI:	☐	
CFC			
91.161	CFC chart quality handling:	manual	
Test support			
91.150	Activate device test mode:	☐	
91.151	Oper.bin.outp. under test:	☐	

[sc_6MD84_general_device_set, 1, en_US]

Figure 3-124 General Device Settings

The following list shows you the chapters containing the desired information.

You can find more about:

- **Chatter blocking** in [3.7.1 Signal Filtering and Chatter Blocking for Input Signals](#).
- **Control** in [6.3 Control Functionality](#).
- **Continuous Function Chart Quality Treatment** in [3.2.3 Quality Processing/Affected by the User in CFC Charts](#).

Under **Device**, you set the parameters for the device that are valid across functions.

With **Test support**, indications issued via communication interfaces are labeled with an additional test bit, if this is supported by the protocol. With this test bit you can determine whether an indication is generated in a test and all or individual functions of the device are in the test mode. In this manner the reactions that are necessary in normal operation due to an indication can be suppressed in other devices that receive these indications. You can also permit, for example, a trip command to close an energized binary output for test purposes. Siemens recommends deactivating the **Test support** again after the test phase.

3.8.2.2 Application and Setting Notes

The major portion of the settings is described in the chapters cited above. Then, the parameters on the section **Device**, **Spontaneous indication**, and **Test support** are described.

Parameter: Rated frequency

- Default setting (`_:101`) **Rated frequency** = *50 Hz*

With the parameter **Rated frequency**, you set the rated frequency of the electrical power system.

Parameter: Minimum operate time

- Default setting (`_:102`) **Minimum operate time** = *0.00 s*

With the parameter **Minimum operate time**, you set the minimum duration for the trip command of the functions. The trip command is maintained for the set duration.

Parameter: Block monitoring dir.

- Default setting (`_:138`) **Block monitoring dir.** = *off*

With the parameter **Block monitoring dir.**, you set whether indications are output via the system interface(s) of the SIPROTEC 5 device or not.

If transmission blocking is switched on, no indications are output via the system interface(s) of a SIPROTEC 5 device, except via the IEC 61850 interface(s).

To avoid receiving IEC 61850 data, the corresponding IEC 61850 Client must stop the reporting or freeze the data. You can find more information in the Communication Protocols Manual (C53000-L1840-C055-3).

Parameter: Fault-display

- Default setting (`_:139`) **Fault-display** = *with pickup*

With the parameter **Fault-display**, you set whether spontaneous fault indications which are signed as **NT** (*conditioned latching*) in the matrix, get stored with every pickup or only for one tripping.

Keep the DIGSI 5 routing options in chapters [3.1.7 Spontaneous Indication Display in DIGSI 5](#) and [3.1.9 Stored Indications in the SIPROTEC 5 Device](#) in mind.

Parameter: Activate device test mode

- Default setting (`_:150`) **Activate device test mode** = *inactive*

With the parameter **Activate device test mode**, you can activate the test mode for the complete device. This means that all indications generated in the device are given a test bit.

For further information, refer to [3.8.3 Enabling/Disabling the Application/Test Mode for the Entire Device](#).

Apart from activating the test mode via this parameter, you can also activate the test mode using the IEC 61850-8-1 protocol. For more information, refer to the *SIPROTEC 5 Communication protocol* manual.

When the test mode is activated for the complete device, but the parameter **Oper.bin.outp. under test** is not, the routed relay outputs of the device are not activated by the generated the indications.



NOTE

The device remains in test mode during every restart until you intentionally set the device back into the process mode or you have carried out an initial start.

You can set the process mode by switching the parameter **Activate device test mode** to inactive again (removing the check mark) or by deactivating the test mode again via the IEC 61850-8-1 protocol.



NOTE

Besides the cross device test mode, you also have the option to place an individual function or stage into test mode depending on the supported operating modes of a function or stage. To do this, see the description of the relevant function or stage.

When you place an individual function or stage into the test mode, all indications issued by this function or stage are given a test bit.

When you activate the test mode for an individual function or stage, but not the parameter **Oper.bin.outp. under test**, the routed relay outputs of the function or stage are not activated by the generated indications.

An individual function or stage remains in the test mode during every restart until you have intentionally deactivated the test mode for this function or stage again or carried out an initial start.

Parameter: Oper.bin.outp. under test

- Default setting (**_:151**) **Oper.bin.outp. under test** = inactive

If you activate the parameter **Oper.bin.outp. under test**, the indications generated in the device and marked with a test bit can be issued to a routed relay output of the device, that is, you enable the relay outputs of the device to be opened and closed.

If only one individual function or stage of the device is in test mode, that is, the cross device tested mode has not been activated, only the indications of this function or stage are marked with a test bit and the routed relay outputs of the device are activated.



NOTE

If the parameter **Oper.bin.outp. under test** is inactive (default setting), the **Test** state of a function or stage is changed to **Test/Relays blocked**.

Output Signal: Functions in Test mode

Normally, the output signal *Functions in Test mode* is prerouted to the last LED of the device base module. If one or more protection or control functions are in test mode, the output signal *Functions in Test mode* is generated and the corresponding LED of the device lights up red.

3.8.2.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Device				
_:101	General:Rated frequency		• 50 Hz • 60 Hz	50 Hz
_:102	General:Minimum operate time		0.00 s to 60.00 s	0.00 s
_:138	General:Block monitoring dir.		• off • on	off
Setting change				
_:163	General:Reserv.time for com.prot.		0 s to 65535 s	120 s
Spontan.indic.				
_:139	General:Fault-display		• with pickup • with trip	with pickup
Control				
_:166	General:Shows interlock.cond. HMI		• 0 • 1	false

Addr.	Parameter	C	Setting Options	Default Setting
Test support				
_:150	General:Activate device test mode		0 1	false
_:151	General:Oper.bin.outp. under test		0 1	false

3.8.2.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:500	General:>SG choice bit 1	SPS	I
_:501	General:>SG choice bit 2	SPS	I
_:502	General:>SG choice bit 3	SPS	I
_:503	General:>Sw. authority local	SPS	I
_:504	General:>Sw. authority remote	SPS	I
_:505	General:>Sw. mode interlocked	SPS	I
_:506	General:>Sw. mode non-interl.	SPS	I
_:510	General:>Test mode on	SPS	I
_:511	General:>Test mode off	SPS	I
_:507	General:>Dev. funct.logout on	SPS	I
_:508	General:>Dev. funct.logout off	SPS	I
_:512	General:>LED reset	SPS	I
_:513	General:>Light on	SPS	I
_:300	General:Act. settings group 1	SPC	C
_:301	General:Act. settings group 2	SPC	C
_:302	General:Act. settings group 3	SPC	C
_:303	General:Act. settings group 4	SPC	C
_:304	General:Act. settings group 5	SPC	C
_:305	General:Act. settings group 6	SPC	C
_:306	General:Act. settings group 7	SPC	C
_:307	General:Act. settings group 8	SPC	C
_:318	General:Active settings group	INS	O
_:308	General:Switching auth. station	SPC	C
_:324	General:Enable sw. auth. 1	SPC	C
_:325	General:Enable sw. auth. 2	SPC	C
_:326	General:Enable sw. auth. 3	SPC	C
_:327	General:Enable sw. auth. 4	SPC	C
_:328	General:Enable sw. auth. 5	SPC	C
_:311	General:Switching authority	ENS	O
_:312	General:Switching mode	ENS	O
_:309	General:Sw.authority key/set	ENS	O
_:310	General:Sw.mode key/set	ENS	O
_:52	General:Behavior	ENS	O
_:53	General:Health	ENS	O
_:51	General:Test mode	ENC	C
_:321	General:Protection on	SPC	C
_:54	General:Protection inactive	SPS	O

No.	Information	Data Class (Type)	Type
_:319	General:Device logout	SPC	C
_:313	General:Logged off via BI	SPS	O
_:314	General:Logged off via control	SPS	O
_:315	General:Device logged off	SPS	O
_:323	General:LED reset	SPC	C
_:320	General:LED have been reset	SPS	O
_:509	General:>Block monitoring dir.	SPS	I
_:317	General:Block monitoring dir.	SPS	O
_:329	General:Functions in Test mode	SPS	O

3.8.3 Enabling/Disabling the Application/Test Mode for the Entire Device

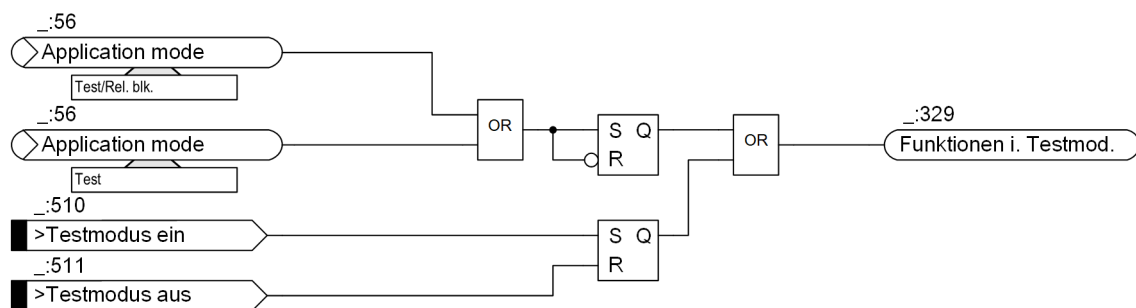
Siemens recommends to enable the test mode for the entire device before you start testing protection functions.

You can enable or disable the test mode for the entire device as follows:

- Via the on-site operation panel under **Device functions > Operating states > Application mode = Test** or **Test/Relay blk.**
- Via the binary inputs (_:91:510) *General:>Test mode on* and (_:91:511) *General:>Test mode off*
You can find the binary inputs in the DIGSI information routing under **General**.
- Via communication (IEC 61850) with the controllable (_:91:56) *General:Application mode*
You can find the controllable in the DIGSI information routing under **General**.

When the test mode for the entire device is enabled, the indication (_:91:329) *Functions in Test mode* is generated.

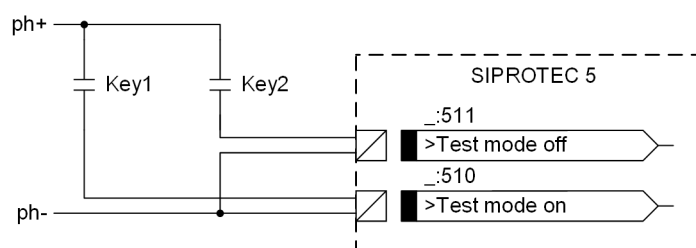
In the test mode of the device all device indications are marked with a test bit. This prevents the circuit breaker from switching unintentionally or protection functions from starting unintended actions. If you enable or disable the test mode for the entire device using the controllable (_:91:56) *General:Application mode*, the device stores the state of the controllable in a voltage-fail-safe memory.



[io_application_mode_device, 1, en_US]

Figure 3-125 Logic Diagram: Enabling/Disabling the Test Mode for the Entire Device

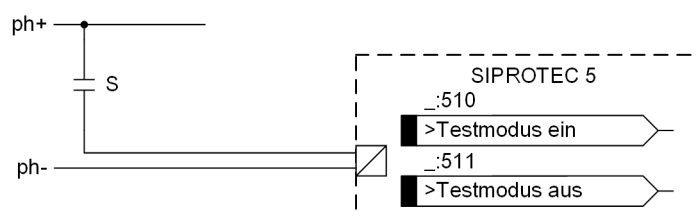
The following figures show possible variants for enabling and disabling the test mode for the entire device using binary inputs. The following figure shows the use of push-buttons **Ta1** and **Ta2**:



[io_application_mode_device_taster, 1, en_US]

Figure 3-126 External Wiring of Push-Buttons for Enabling/Disabling the Test Mode for the Entire Device

The following figure shows the use of a switch **S**. Route the logical binary input (`<:91:510`) *General:>Test mode on* as **H** (high-active) and the logical binary input (`<:91:511`) *General:>Test mode off* as **L** (low-active) to a physical binary input.



[io_application_mode_device_switch, 1, en_US]

Figure 3-127 External Wiring of Switches for Enabling/Disabling the Test Mode for the Entire Device

3.8.4 Device Logout

3.8.4.1 Overview

In the case of multibay functions, a device uses information from one or more other devices. For some applications, it may be necessary for you to remove a device with all effective functions temporarily from the plant and even to switch it off. These applications are, for example:

- Maintenance work
- System upgrades
- Testing the local protection functions, for example, the local line differential protection

The *Device Logout* functionality informs the receiver devices about the imminent disconnection of the transmitter devices. To do this, the last valid received information is stored in the receiver devices and used for the multibay functions.



NOTE

If you need to remove a device temporarily from the plant, you must log off the device. Protection functions distributed to several devices operate in a healthy manner with the remaining devices only if you have logged off the device.

You can log off the device as follows:

- Via the on-site operation panel
- Via a communication interface using the *Device Logout* (`<:319`) controllable
- Via the binary inputs, general: `>Dev. funct. logout on(<:507)` or `>Dev. funct. logout off(<:508)`

You can find the controllable and the binary inputs in the DIGSI 5 project tree under **Name of the device** → **Information routing** in the working area in the **General** block.

During the log-off process, the device checks whether all conditions for a logout have been met. If the conditions for the log off have not been met, the logout is rejected.

The logout is rejected under the following conditions:

- The devices are communicating via the protection interface and switching off the device leads to an interruption in protection-interface communication.
- The **Line differential protection** function is operating in the device and the local circuit breaker is still switched on.

In this case, you must switch off the local circuit breaker and repeat the log-off process for the device. After the logout, the local **Line differential protection** function is removed from the summation of the currents for the **Line differential protection** of the other devices. The **Line differential protection** function remains active in the other devices.



NOTE

The path used to log the device off is stored in the operational log.
Even if you switch off the device after logout, the *Device logged off*(_:315) state is stored.

If you want to establish the initial state again after logging off the device, you must log on the device again. To log on the device, you must use the same option used for logout. For example, if you have logged off the device via binary inputs, you must log it on again via the binary inputs. This applies in similar manner if you have logged off the device via DIGSI or via on-site operation.

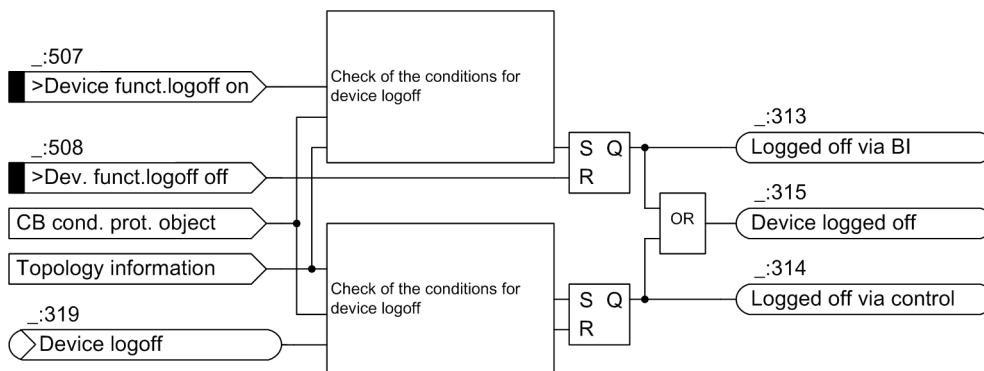
3.8.4.2 Application and Setting Notes

Logoff Options for a Device

You can log a device off as follows:

- Via the on-site operation panel
- Via communication through the controllable *Device logout*(_:319)
- Via the binary inputs, general: *>Dev. funct.logout on*(_:507) or *>Dev. funct.logout off*(_:508)

Conditions for Logging off the Device



[io_functional logoff device, 1, en_US]

Figure 3-128 Logic for Logging off the Device

The conditions for a successful logout of the device result from the conditions for every activated protection function.

Logoff of a Device from a Device Combination with Communication via the IEC 61850-8-1 (GOOSE) Protocol

If devices are exchanging data using the IEC 61850-8-1 (GOOSE) protocol – for example in the case of substation interlocking – for each received data point the value of this data point can be set in the receiver

device when the transmitter device logs off. This value remains effective in the receiver device until the logout is canceled by the transmitter device, even if the transmitter and/or the receiver are switched off in the meantime.

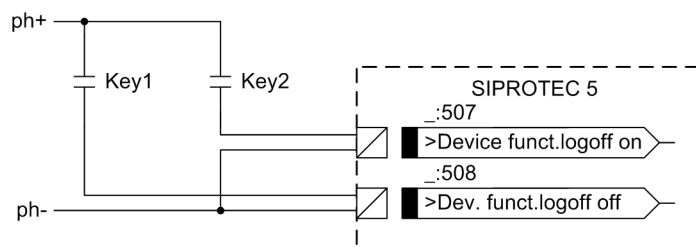
Logoff of a Device from a Device Combination Using Protection Communication

If devices in a device combination communicate via the protection interface, you can only log off a device under the following conditions:

- Logging off and switching off a device in a device combination must not result in an interruption in the protection communication.
- For series-connected topologies, the device must be located at one end of the communication chain as otherwise the protection communication is interrupted when the device is logged off and switched off. For this reason, devices not at one of the ends in series-connected topologies cannot be logged off.

Logout via Binary Inputs

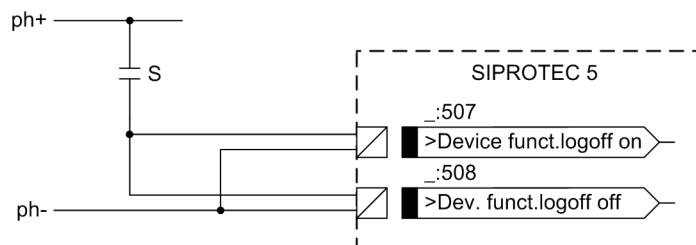
The following diagrams show potential variants on how to control binary inputs. If you want to use push-buttons, switch on this function as shown in the following figure. Log off the device using the push-button **Key2**; log on the device again with the push-button **Key1**.



[io_extta logoff device, 1, en_US]

Figure 3-129 External Push-Button Wiring for Logging off the Device

If a switch is being used for control, route the binary input *>Dev. funct.logout on as H (active with voltage)* and the binary input *>Dev. funct.logout off as L (active without voltage)*. If the switch **S** is closed, the device is logged off.



[io_extsx logoff device, 1, en_US]

Figure 3-130 External Switch Wiring for Logging off the Device

Indications

The logged-off device reports the status (*_:315 Device logged off*) and cause of the logout.

If you have logged off the device using binary inputs, the indication (*_:313 Logged off via BI*) results.

If you have logged off the device using on-site operation, via DIGSI 5 or via the protection interface, the indication (*_:314 Logged off via control*) is issued.

The indications are stored in the operational log.

3.8.4.3 Information List

No.	Information	Data Class (Type)	Type
General			
_:507	General:>Dev. funct.logout on	SPS	I
_:508	General:>Dev. funct.logout off	SPS	I
_:319	General:Device logout	SPC	C
_:313	General:Logged off via BI	SPS	O
_:314	General:Logged off via control	SPS	O
_:315	General:Device logged off	SPS	O

3.9 Display Pages

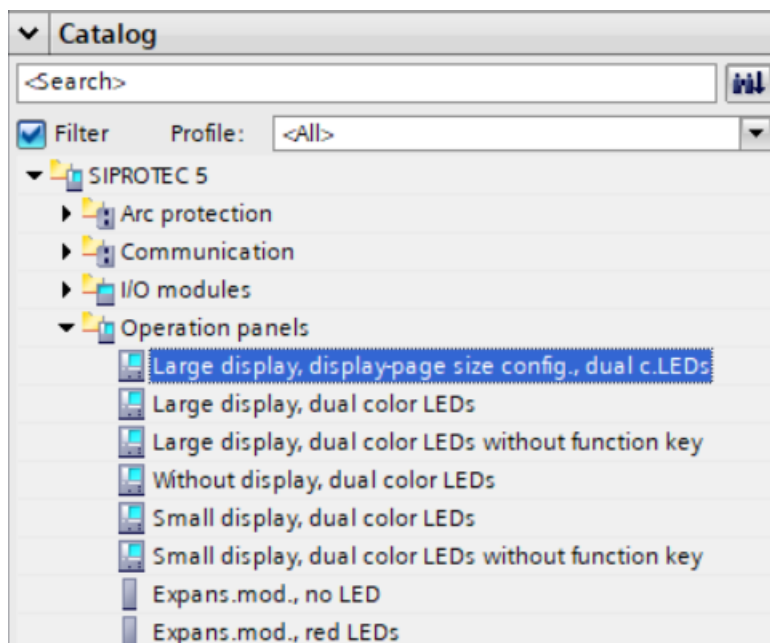
3.9.1 Display-Page Setting

3.9.1.1 Overview

Specific SIPROTEC 5 devices can be ordered with the operation-panel option **Large display, display-page size config., dual c.LEDs**. In this case, the size of the configurable display pages is settable by the user, and is function-points dependent:

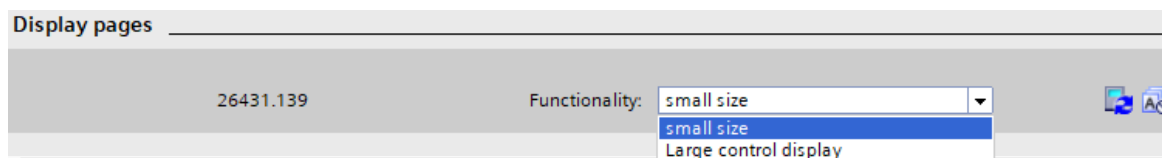
- Small display pages can be configured without extra function points.
- Large display pages for large control displays require extra function points.

For devices with the operation panel **Large display, display-page size config., dual c.LEDs**, you can find the block **Display pages** in **Device settings** in DIGSI 5.



[sc_Display_page_Operation Panels, 1, en_US]

Figure 3-131 Operation Panel **Large display, display-page size config., dual c.LEDs** in DIGSI 5



[sc_Functionality_block1, 2, en_US]

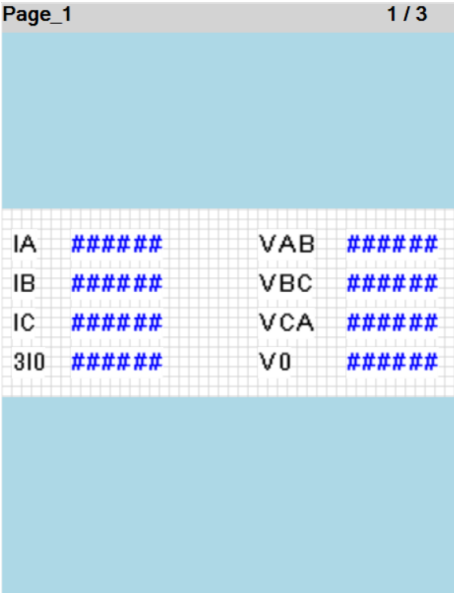
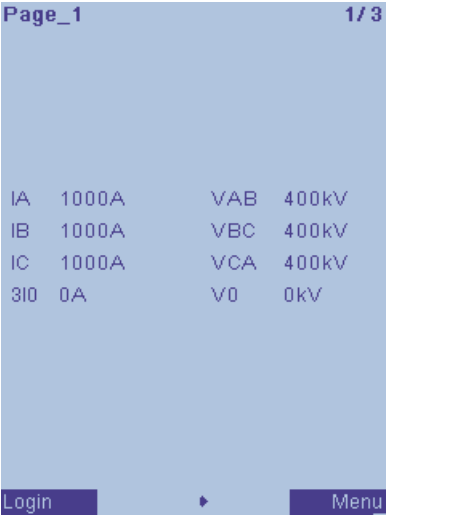
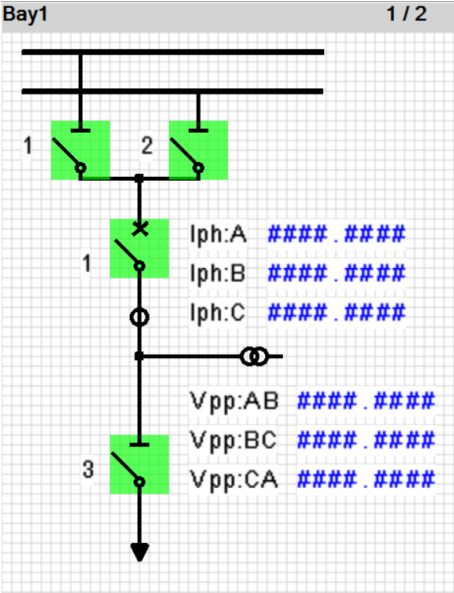
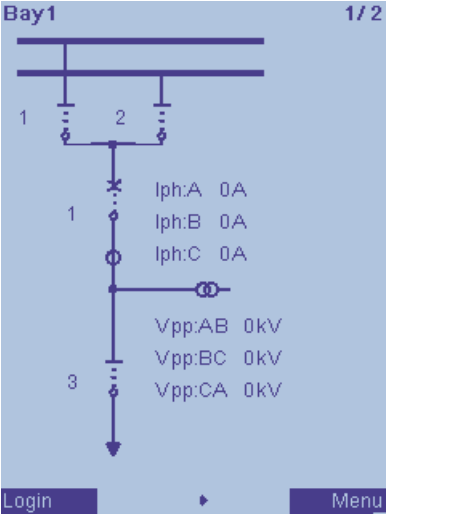
Figure 3-132 Block **Display pages** in DIGSI 5

3.9.1.2 Application and Setting Notes

Parameter: Functionality

- Default setting (`_:139`) **Functionality** = *small size*

With the parameter **Functionality**, you set the size of the display pages that are shown in DIGSI 5 and in the HMI.

Parameter Value	Description
small size	The size of the display page is 240 x 128 pixels. With this size, usually up to 8 operational values or very small control displays with, for example, up to 3 switches can be configured. Page_1 1/3  Page_1 1/3  Figure 3-134 Example of Display Page in the HMI (Small Size) Figure 3-133 Example of Display Page in DIGSI 5 (Small Size)
Large control display	The size of the display page is 240 x 320 pixels. With this size, large control displays or a large number of operational values, or a combination of both can be configured. Bay1 1/2  Bay1 1/2  Figure 3-136 Example of Display Page in the HMI (Large Control Display) Figure 3-135 Example of Display Page in DIGSI 5 (Large Control Display)

3.9.1.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Display pages				
_:139	Display pages:Functionality		• small size • Large control display	small size

3.9.2 Display-Page Editor

If you order a SIPROTEC 5 device with display, you can preconfigure one or more display pages with the DIGSI 5 Editor **Display page**.

Via a display page, you can quickly obtain an overview of the following information:

- Text
- Signals
- Static and dynamic graphics

In DIGSI 5 Editor **Display page**, default names that are numbered in a consecutive order are assigned to the newly added display pages. When a display page is added or deleted, a binary signal (SPS) that has the same name is created or deleted automatically in **Information routing > Display pages**. With the activation of this binary signal, the device display switches to the corresponding display page automatically. The display page is maintained until another display-page signal is activated or the HMI is used.

From firmware version V9.50, you can create up to 30 different display pages for each SIPROTEC 5 device. By pressing the left and right navigation keys, you can toggle between the display pages in the device.

For more information, refer to *DIGSI 5 Online Help*.

4 Applications

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4.1 Overview

The function library in DIGSI 5 provides application templates for the standard applications of the devices. The application template

- Supports the fast realization of complete protection solutions for standard applications
- Contains the basic configuration for the use case
- Contain functions and default settings for the use case

When using an application template, note the following:

- Adapt the application template to your specific application (check/adapt default settings, delete/add functions).

You can find more detailed information on this in [2.1 Embedding of Functions in the Device](#).

- Check the routing of binary outputs with respect to fast and normal relay.
- Check the logic block chart for the group warning indication

The following describes the application templates of the 6MD84 I/O box.



NOTE

The availability of certain settings and setting options depends on the device type and the functions available on the device!

4.2 Application Template and Functional Scope for the 6MD84 Device

The following application template is available for the device **6MD84** in the **DIGSI 5** function library:

- Not pre-configured

Application Template: 6MD84 not configured

An unconfigured application template is available for the IO box 6MD84, from which you do not have to delete anything. You can set up your own configuration on it.

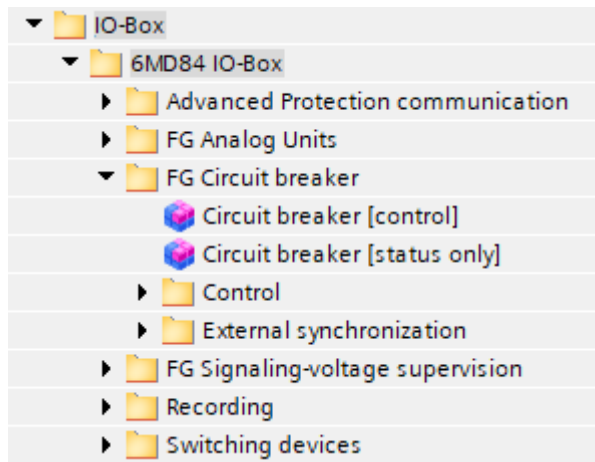
5 Function-Group Types

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5.1 Function-Group Type Circuit Breaker

5.1.1 Overview

The **Circuit-breaker** function group combines all the user functions that relate to a circuit breaker. You will find the **Circuit-breaker** function group under each device type in the function library in DIGSI 5. The **Circuit-breaker** function group contains all of the control and supervision functions that you can use for this device type. The following figure shows, for example, the functional scope of the **Circuit-breaker** function group.



[sc_lib_6MD84_1_en_US]

Figure 5-1 Circuit-Breaker Function Group – Functional Scope

The Circuit-breaker function group includes 2 different types of circuit breakers:

- Circuit breaker [control]
- Circuit breaker [status only]

The type circuit breaker [status only] is used only for acquiring the circuit-breaker switch position. This type can be used to model switches that can only be read but not controlled by the SIPROTEC 5 device.

5.1.2 Circuit Breaker

5.1.2.1 Overview

The function block **Circuit breaker** represents the physical switch in the SIPROTEC 5 device.

The basic tasks of this function block are:

- Operation of the circuit breaker (CB)
- Acquisition of the circuit-breaker auxiliary contacts
- Acquisition of other circuit-breaker information

The function block **Circuit breaker** provides the following information:

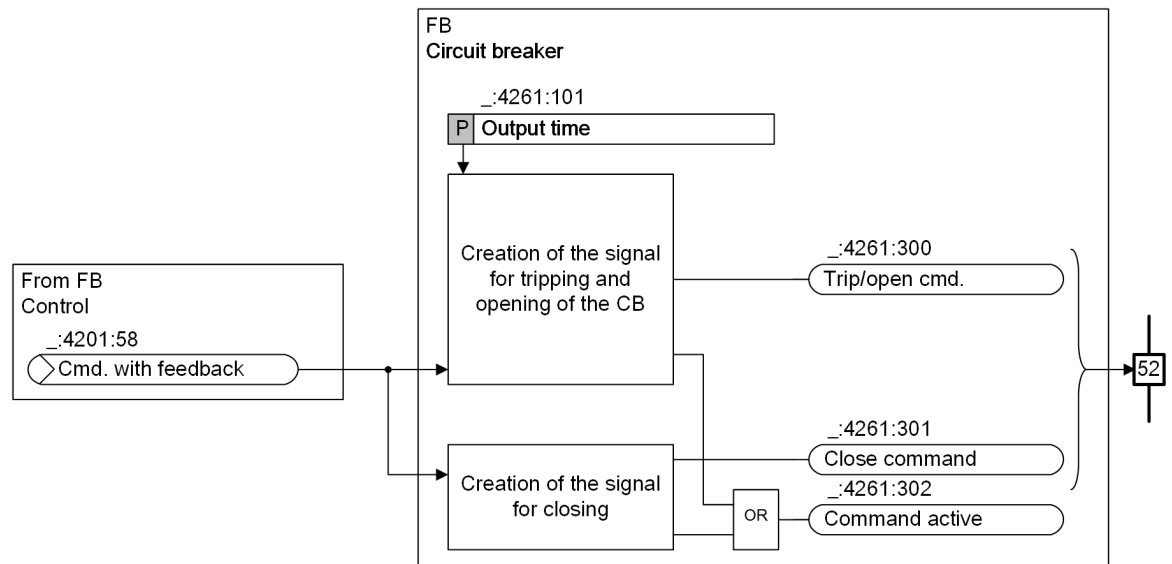
- Number of switching cycles

5.1.2.2 Opening, and Closing the Circuit Breaker

The circuit breaker is operated in the following situations:

- Opening of the circuit breaker as a result of control operations
- Closing of the circuit breaker as a result of control operations

For the operational handling of the circuit breaker, the function block **Circuit breaker** provides the output signals that must be routed to the corresponding binary outputs of the device (see [Table 5-1](#)).



[io_ausssc_6md84, 1, en_US]

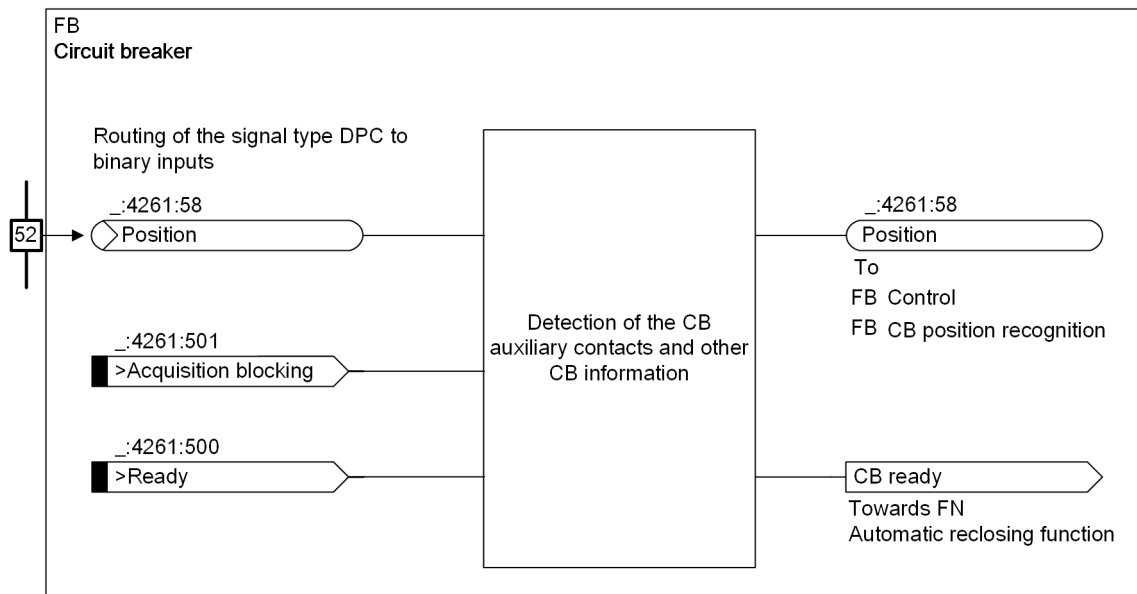
Figure 5-2 Opening and Closing the Circuit Breaker

Table 5-1 Description of the Output Signals

Signal	Description	Routing Options
Open command	This signal executes all opening operations. The Output time parameter affects the signal. The signal is pending for the duration of the output time, with the following exceptions: Only when switched off by the control: The signal is reset before expiration of the period if the auxiliary contacts report that the circuit breaker is open before expiration of the period.	Unlatched
Close command	This signal executes all closing operations. The Output time parameter affects the signal. The signal is pending for the duration of the output time, with the following exception: The signal is canceled before expiration of the period if the auxiliary contacts report that the circuit breaker is closed before expiration of the period.	Normal routing
Command active	This signal is active if one of the following binary outputs is active: Open command Close command The binary outputs are active as long as a switching command is being executed by the control.	Normal routing

5.1.2.3 Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information

To determine the circuit-breaker position, the function block **Circuit breaker** provides position signals. These signals are of the **Double-point indication** (DPC) type. A double-point indication can be routed to 2 binary inputs so that the open and closed circuit-breaker switch positions can be reliably acquired.



[lo_erfass_2_en_US]

Figure 5-3 Acquisition of the Circuit-Breaker Information

Signal	Type	Description
Position	DPC	Acquisition of the circuit-breaker switch position The switch position CB 3-pole open and/or the position CB 3-pole closed can be detected by routing to 1 or 2 binary inputs.

The signals must be routed to the binary input that is with the CB auxiliary contacts. The **open** and **closed** signals do not necessarily have to be routed in parallel. The advantage of parallel routing is that it can be used to determine an intermediate or disturbed position. If you route only one signal (**open** or **closed**), you cannot determine an intermediate position or a disturbed position.

In the monitoring direction, the position signals generate the following information when the **open** and **closed** positions are detected (see following table). This information is further processed by the **Circuit-breaker position recognition** and **Control** function blocks.

Information	Type	Description
Open	SPS	The circuit-breaker switch position is opened .
Closed	SPS	The circuit-breaker switch position is closed .
Intermediate position	SPS	The circuit-breaker switch position is in the intermediate position . The signal open and the signal closed have not been set.
Disturbed position	SPS	The circuit-breaker switch position is in the disturbed position . The signal open and the signal closed have been set simultaneously.
Not selected	SPS	The circuit breaker is not selected for a control operation.

The following table shows the additional input signals:

Signal	Type	Description
>Acquisition blocking	SPS	This is used to activate acquisition blocking of the circuit-breaker auxiliary contacts (see <i>Other Functions 3.7.3 Persistent Commands</i> for a description of acquisition blocking).
>Reset AcqBlk&Subst	SPS	This is used to reset acquisition blocking and manual update of the circuit breaker. If the signal is active, acquisition blocking and manual update are reset.
>Ready	SPS	The active signal indicates that the circuit breaker is ready for an Open-Closed-Open cycle. The signal remains active as long as the circuit breaker is unable to trip. The signal is used in the Automatic reclosing and Circuit-breaker test functions.

The following table shows one additional output signal:

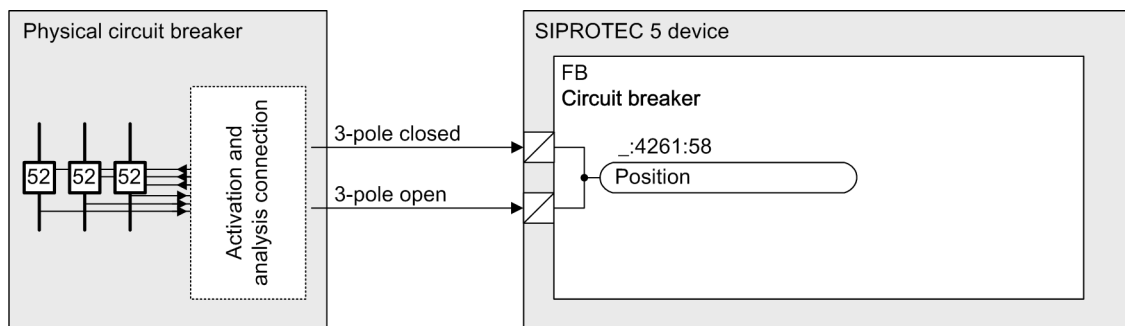
Signal	Type	Description
External health	ENS	This can be used to indicate the health of the physical circuit breaker. For this, all failure information of the circuit breaker must be detected via a binary input. This failure information can set the appropriate state of the External health signal with a CFC chart (using the BUILD_ENS block). The signal has no effect on the health of the function block.

5.1.2.4 Application and Setting Notes

Routing to Evaluate the Circuit-Breaker Switch Position

The operating principle of the auxiliary contacts is described in the individual functions.

Siemens recommends capturing the information *Circuit breaker is open in 3 poles* and *Circuit breaker is closed in 3 poles* via auxiliary contacts. This is the optimal configuration for the control functionality. For purely protection applications, it is also sufficient to acquire just one of the 2 circuit-breaker switch positions. When used as a protection and control device, Siemens recommends the following evaluation of the circuit-breaker switch position:



[Io_evaluation2, 1, en_US]

Figure 5-4 Recommended Evaluation of the Circuit-Breaker Switch Position

The following diagram shows the recommended routing, in which **OH** stands for **active with voltage**.

Information					Source							
					Binary input							
					Base module							
Signals	Fav	Number	Type		1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8
(All)	...	(All)	...	...	...	...	...	...	...	...	...	...
Position	☆	201.4261.58	DPC	CH	OH							

[sc_polg3p, 1, en_US]

Figure 5-5 Routing for Acquisition of the Circuit-Breaker Switch Position via 2 Auxiliary Contacts

The device can also function without the analysis from the circuit-breaker auxiliary contacts, that is, routing of the auxiliary contacts is not absolutely necessary. However, this is a requirement for control functions.

Parameter: Output Time

- Default setting (`_:101`) **Output time** = *0.10 s*

The **Output time** parameter acts on the signals for tripping, opening, and closing of the circuit breaker.

**CAUTION**

Do not set a time that is too short.

If you set a time that is too short, there is a danger that the device contacts will interrupt the control circuit. If this happens, the device contacts will burn out.

- ✧ Set a time that is long enough to ensure that the circuit breaker reliably reaches its final position (**open** or **closed**) after a control operation.

5.1.2.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Circuit break.				
<code>_:101</code>	Circuit break.:Output time		0.02 s to 1800.00 s	0.10 s

5.1.2.6 Information List

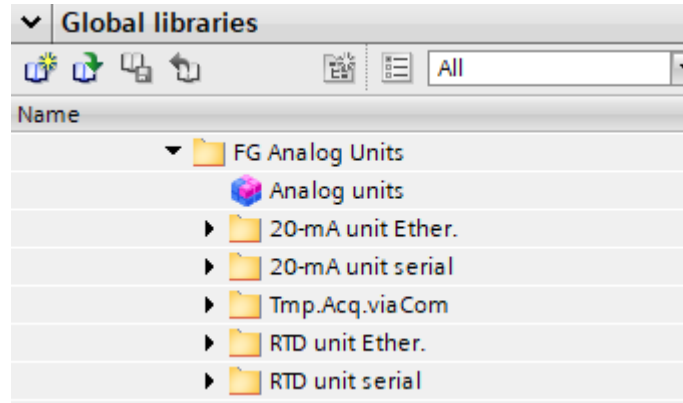
No.	Information	Data Class (Type)	Type
Circuit break.			
<code>_:500</code>	Circuit break.:>Ready	SPS	I
<code>_:501</code>	Circuit break.:>Acquisition blocking	SPS	I
<code>_:502</code>	Circuit break.:>Reset switch statist.	SPS	I
<code>_:504</code>	Circuit break.:>Reset AcqBlk&Subst	SPS	I
<code>_:503</code>	Circuit break.:External health	ENS	I
<code>_:53</code>	Circuit break.:Health	ENS	O
<code>_:58</code>	Circuit break.:Position	DPC	C
<code>_:300</code>	Circuit break.:Trip/open cmd.	SPS	O
<code>_:301</code>	Circuit break.:Close command	SPS	O
<code>_:302</code>	Circuit break.:Command active	SPS	O
<code>_:306</code>	Circuit break.:Op.ct.	INS	O

5.2 Function-Group Type Analog Units

5.2.1 Overview

The function group **Analog units** is used to map analog units and communicate with them. Analog units are external devices, such as RTD units, or analog plug-in modules or measuring-transducer modules.

You can find the function group **Analog units** for many device types in the Global DIGSI 5 library.



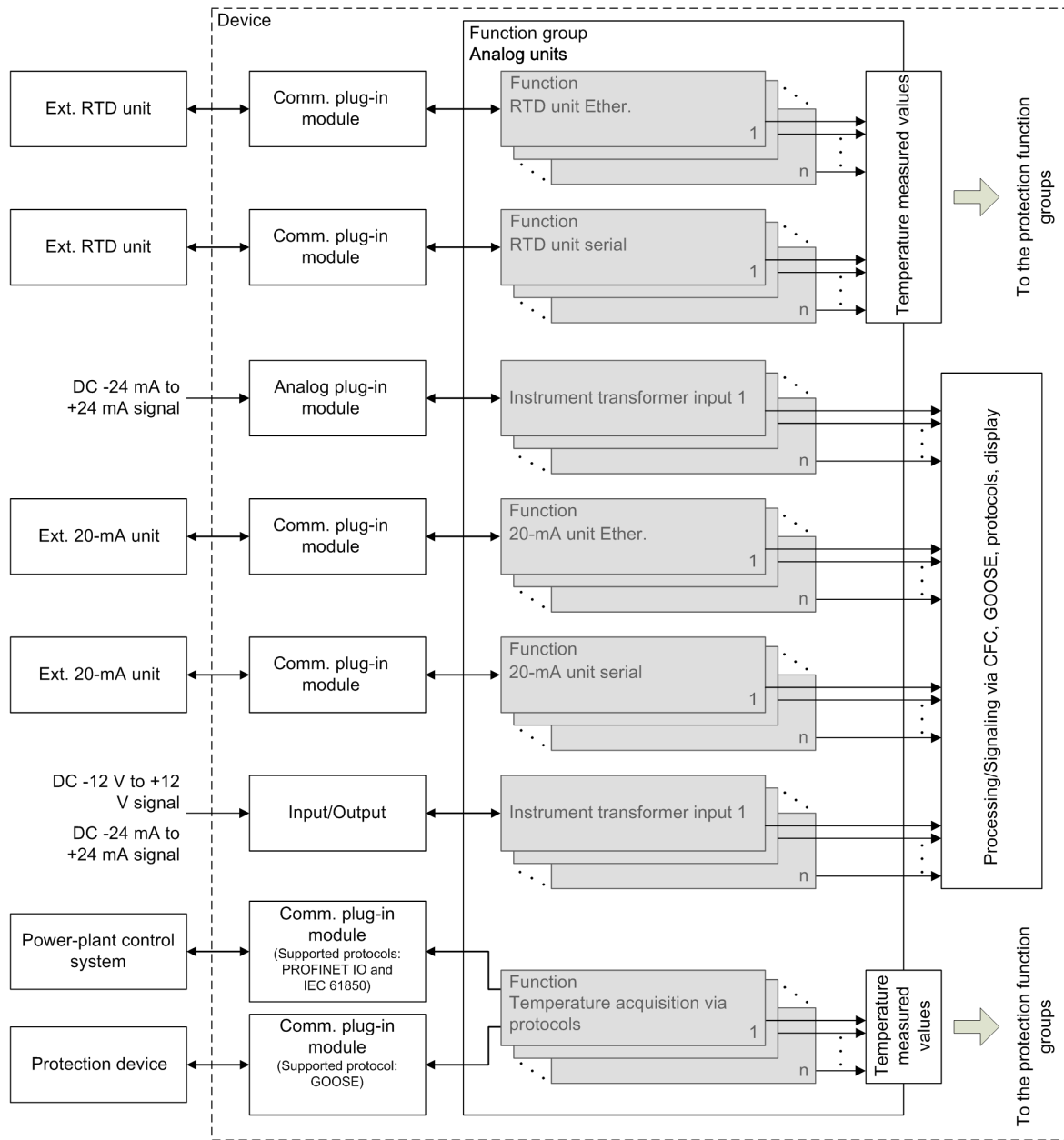
[sc_20_maae, 3, en_US]

Figure 5-6 Analog Unit Function Group in DIGSI

5.2.2 Structure of the Function Group

If the device has a measuring transducer, it is automatically mapped in the function group **Analog units**. If one or more RTD units are connected to the device, you have to load one or more **RTD unit Ether.** or **RTD unit serial** functions from the Global DIGSI 5 library in order to map the RTD units.

If the device is connected to a power-plant control system or another protection device, you must load one or more **Temperature acquisition via protocols** functions from the Global DIGSI 5 library to form the protocols. The following figure shows the structure of the function group.



[dw_str_the_3_en_US]

Figure 5-7 Structure of the Function Group Analog Unit

Gray: Optionally wired, optionally available

White: Always wired, always available

The function group **Analog units** has interfaces to protection function groups. The function group **Analog units** provides, for example, measured temperature values that come from an external RTD unit, a measuring transducer or via protocols. These measured temperature values are available for all protection function groups in which a temperature monitoring function works.

The function **RTD unit Ether.** is not preconfigured by the manufacturer. A maximum of 20 function instances can operate simultaneously.

The structure of the function **RTD unit serial** is identical to the structure of the function **RTD unit Ether.**

The function **20-mA unit Ether.** is not preconfigured by the manufacturer. A maximum of 4 function instances can operate simultaneously. The structure of the function **20 mA serial unit** is identical to the structure of the function **20-mA unit Ether.**

The function **Temperature acquisition via protocols** has 2 stage types: The **Temperature acquisition via PROFINET IO or IEC 61850** and the **Temperature acquisition via GOOSE**. One instance of the **Temperature acquisition via PROFINET IO or IEC 61850** is preconfigured by the manufacturer. A maximum of 12 instances can operate simultaneously for both stage types.

5.2.3 20-mA Unit Ethernet

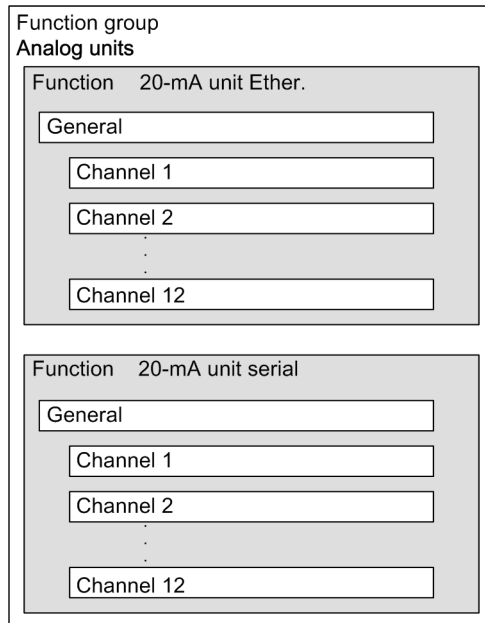
5.2.3.1 Overview

The function **20-mA unit Ether.**:

- Communicates in series with a 20-mA unit via the Slave Unit Protocol (SUP) and records the values measured by the 20-mA unit
- Transforms the measured 20-mA values into slowly changing process tags such as temperature or gas pressure
- Makes the recorded process tags available to CFC, GOOSE, protocols and the device display
- Monitors communication with the 20-mA unit

5.2.3.2 Structure of the Function

The function **20-mA unit Ether.** can only work in the function group **Analog units**. A maximum of 4 function instances can work simultaneously. Each instance contains 12 preconfigured channel function blocks. The function **20-mA unit Ether.** contains input and output channels which can be configured independently of one another.



[dw_str_fn2, 2, en_US]

Figure 5-8 Structure/Embedding of the Function

5.2.3.3 Communication with 20-mA Unit Ethernet

Logic

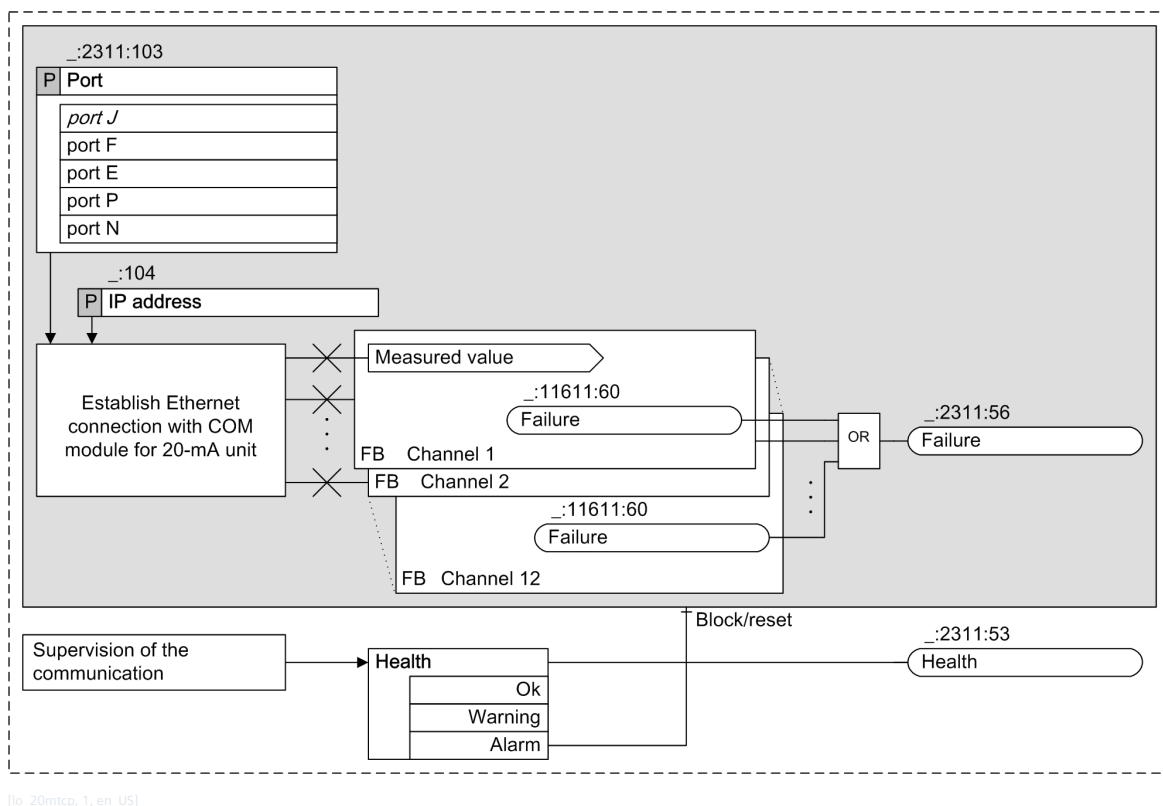


Figure 5-9 Logic of the Function 20-mA Unit Ethernet

Communication with 20-mA Unit

The function is used to communicate with a 20-mA unit connected via an Ethernet connection. When a connection of the function to an external 20-mA unit via an Ethernet interface has successfully been established, the 20-mA unit sends the measured values of all connected channels to the function **20-mA unit Ether..** For the connection to be established successfully, specific communication settings must be specified. You can find more detailed information in [5.2.3.4 Application and Setting Notes](#). The 20-mA measuring unit **7XV5674** is supported.

Error Responses

The following table lists the conditions under which the status *Health* transitions to the Alarm or Warning state.

Table 5-2 Error Responses

Error Description	Status Health
The function 20-mA unit Ether. cannot establish a connection with a communication module.	Alarm
The function 20-mA unit Ether. sends TCP settings to the communication module, which evidently would like to connect to the 20-mA unit via a serial protocol. This communication module does not establish a connection to the 20-mA unit.	Alarm

Error Description	Status Health
The connection between the communication module and the 20-mA unit causes a time-out indication.	Warning
A communication module has not received any more data from the 20-mA unit for 9 sec.	Warning

The signal *Failure* is issued as soon as one of the channel function blocks reports a failure.

5.2.3.4 Application and Setting Notes

Parameter: Port

- Default setting (`_:2311:103`) **Port** = *port J*

With the parameter **Port**, you define the port connecting the 20-mA unit to the SIPROTEC 5 device.

Parameter: IP address

- Default setting (`_:2311:104`) **IP address** = *10.16.60.1*

With the parameter **IP address**, you set the IP address of the 20-mA unit connected to the communication module via the TCP protocol. You must assign each 20-mA unit an unambiguous IP address. The IP address to be set depends on your network configuration. You can set any valid IPv4 address that does not cause conflicts with other IP addresses in the network. First set an IP address for the **7XV5674 20-mA unit**. Then specify the parameter **IP address** for the communication module to the same address.

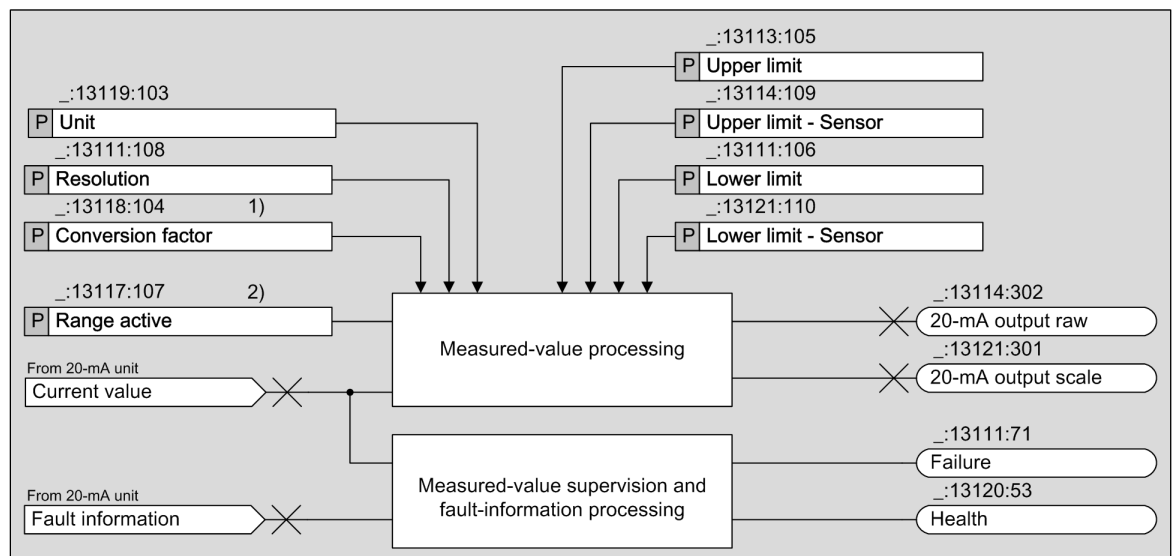
Settings on the 20-mA Unit

Set the **7XV5674 20-mA unit** with a Web browser on the laptop computer via the latter's Ethernet interface. Set **Modbus TCP** as a bus protocol/operating mode.

You can find detailed notes on the settings in the 7XV5674 manual that accompanies the 20-mA unit. The documents are also available in the SIPROTEC download area (www.support.industry.siemens.com).

5.2.3.5 20-mA Channel

Logic



[to_20mcha, 1, en_US]

Figure 5-10 Logic Diagram of the Function 20-mA Channel

- (1) If the setting **Range active** is set to **test**, the setting **Transformation ratio** is not displayed.
- (2) If the setting **Range active** is set to **false**, the settings **Upper limit**, **Transformation ratio upper limit**, **Lower limit** and **Transformation ratio** are not displayed.

Measured-Value Calculation

The function **20-mA channel** processes a single 20-mA current signal supplied by the 20-mA unit of the corresponding channel. The 20-mA current measured value is converted into the correct physical quantities such as temperature or pressure. In each 20-mA functional unit (Ether. and serial) there are always 12 of the 20-mA channel function blocks, even if fewer channels are connected with the 20-mA unit. The calculated values are available for further processing via CFC, GOOSE, protocols, and the display image.

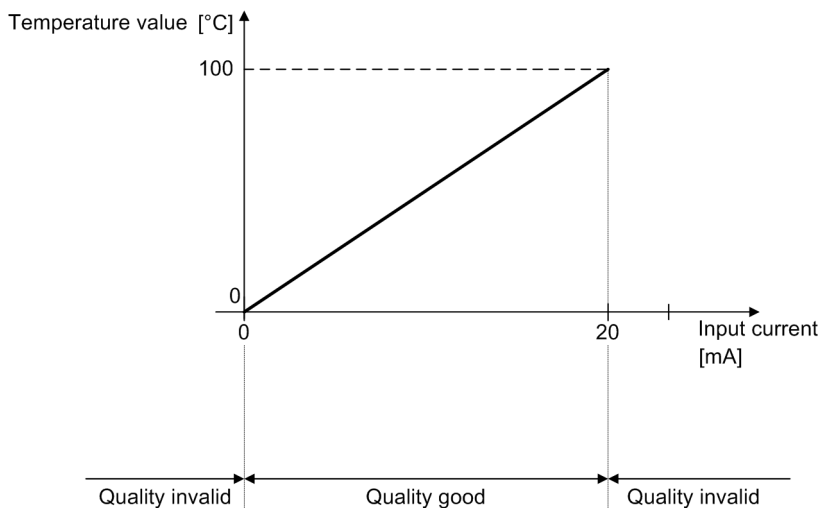
Measured-Value Processing

The 20-mA unit typically transmits a value which represents a physical quantity, such as a temperature or a pressure. Therefore, the device must contain a characteristic curve that maps the physical quantity to the 20-mA value. If you do not activate the **Range active** setting (no x in the check box), the function operates over the range 0 mA to 20 mA. If a value smaller than 0 mA or greater than 20 mA is active at the input of the 20-mA unit, the measured value is identified as invalid. The setting of the range for the scaled value goes from a usable range of 0 mA to 20 mA. The following figure shows an example.

[sckanumw-190214-01, 1, en_US]

Figure 5-11 Settings for Example 1

In this example, the measured value 0 mA means a temperature of 0 °C and the measured value 20 mA means a temperature of 100 °C. So enter as **Unit = °C** and **Conversion factor = 100**. The resolution (decimal place) of the temperature value can be chosen; for a decimal place, select **Resolution = 0.1**.



[dw_knges3, 1, en_US]

Figure 5-12 Characteristic Curve of a 20-mA Input (Example 1)

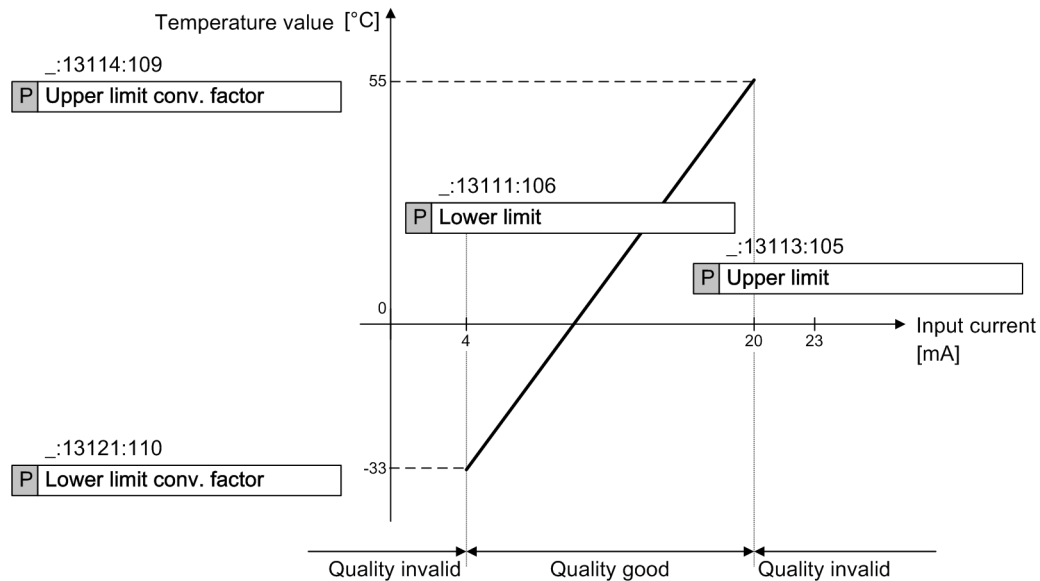
If you activate the **Range active** setting, then 4 additional parameters **Upper limit**, **Lower limit**, **Upper limit - Sensor**, and **Lower limit - Sensor** appear. The parameters **Upper limit** and **Lower limit** indicate the range of the input current in mA. The setting **Upper limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Upper limit** setting. The setting **Lower limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Lower limit** setting. The setting of the range for the scaled value corresponds to the useable range between **Lower limit** and **Upper limit** (see following figure).

Channel 1

826.1931.13111.103	Unit:	°C
826.1931.13111.108	Resolution:	0.1
826.1931.13111.107	Range active:	☒
826.1931.13111.105	Upper limit:	20.000 mA
826.1931.13111.109	Upper limit conv. factor:	55
826.1931.13111.106	Lower limit:	4.000 mA
826.1931.13111.110	Lower limit conv. factor:	-33

[sckanumf-190214-01, 1, en_US]

Figure 5-13 Settings for Example 2



[dw_knges2, 1, en_US]

Figure 5-14 Characteristic Curve of a 20-mA Unit (Example 2)

In this example, the **Range active** setting is selected. The setting **Upper limit** is at 20 mA, the setting **Lower limit** is at 4 mA. The setting **Upper limit - Sensor** is at 55 and the setting **Lower limit - Sensor** is at -33. If the input current is smaller than 4 mA or greater than 20 mA, the quality of the scaled measured value in this example is invalid.

Each 20-mA channel makes available the scaled measured value in the information routing (these are the temperature values in the examples) and the original current measured value in mA for further processing. The 20-mA values can be displayed in the display page and processed with CFC charts.

Error Responses

If the current input value is determined to be incorrect, the quality attribute of the output value is set to *invalid*. That status for *Health* and the defect status assume the states displayed in the table.

Table 5-3 Error Responses

Error Description	Status <i>Health</i>	Error Status
The input value lies outside the given limits	OK	Yes
Channel not connected	OK	No

5.2.3.6 Application and Setting Notes

Parameter: Unit

- Default setting (`_:13111:103`) **Unit** = °C

With the **Unit** parameter, you set the physical unit of measurement the measured values. The possible setting values are listed in the settings table.

Parameter: Conversion factor

- Default setting (`_:13111:104`) **Conversion factor** = 100

With the **Conversion factor** parameter, you set the conversion factor for the measuring transducer.

Parameter: Resolution

- Default setting (`_:13111:108`) **Resolution** = 0.1

With the **Resolution** parameter, you set the resolution of the scaled values.

Parameter: Range active

- Default setting (`_:13111:107`) **Range active** = false

If you do not activate the parameter **Range active** (no x in the check box), the function operates over the range 0 mA to 20 mA. The setting of the range for the scaled value goes from a usable range of 0 mA to 20 mA.

If you activate the parameter **Range active**, the 4 additional parameters **Upper limit**, **Upper limit - Sensor**, **Lower limit**, and **Lower limit - Sensor** appear.

Parameter: Upper limitLower limitUpper limit - Sensor and Lower limit - Sensor

- Default setting (`_:13111:105`) **Upper limit** = 20.000 mA
- Default setting (`_:13111:109`) **Upper limit - Sensor** = 100
- Default setting (`_:13111:106`) **Lower limit** = 4.000 mA
- Default setting (`_:13111:110`) **Lower limit - Sensor** = 100

If you activate the parameter **Range active**, the 4 additional parameters **Upper limit**, **Lower limit**, **Upper limit - Sensor**, and **Lower limit - Sensor** appear. The parameter **Upper limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Upper limit** setting. The parameter **Lower limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Lower limit** setting.

The following settings and information table shows only 1 of the 12 channels, as the setting possibilities of the 12 channels do not differ.

5.2.3.7 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:103	General:Port		• port E • port F • port J • port N • port P	port J

Addr.	Parameter	C	Setting Options	Default Setting
Channel 1				
_:13111:103	Channel 1:Unit		• % • ° • °C • °F • Ω • Ω/km • Ω/mi • 1/s • A • As • cos φ • cycles • dB • F/km • F/mi • h • Hz • Hz/s • in • J • J/Wh • K • l/s • m • mi • min • p.u. • Pa • periods • rad • rad/s • s • V • V/Hz • VA • VAh • var • varh • Vs • W	m

Addr.	Parameter	C	Setting Options	Default Setting
			- W/s - Wh	
_:13111:108	Channel 1:Resolution		1 0.1 0.01 0.001	0.1
_:13111:107	Channel 1:Range active		0 1	false
_:13111:104	Channel 1:Conversion factor		1 to 1000000	100
_:13111:105	Channel 1:Upper limit		0.00 mA to 20.00 mA	20.00 mA
_:13111:109	Channel 1:Upper limit - Sensor		-1000000 to 1000000	100
_:13111:106	Channel 1:Lower limit		0.00 mA to 20.00 mA	4.00 mA
_:13111:110	Channel 1:Lower limit - Sensor		-1000000 to 1000000	100

5.2.3.8 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:53	General:Health	ENS	O
_:2311:56	General:Failure	SPS	O
Channel 1			
_:13111:53	Channel 1:Health	ENS	O
_:13111:71	Channel 1:Failure	SPS	O
_:13111:301	Channel 1:20-mA output scale	MV	O
_:13111:302	Channel 1:20-mA output raw	MV	O

5.2.4 20-mA Unit Serial

5.2.4.1 Overview

The function **20-mA unit Serial**:

- Provides serial communications with a 20-mA unit via the Modbus protocol and records the values measured by the 20-mA unit
- Transforms the measured 20-mA values into slowly changing process variables such as temperature or gas pressure
- Makes the recorded process tags available to CFC, GOOSE, protocols and the device display
- Monitors communication with the 20-mA unit

The function **20-mA unit Serial** is structured in the same way as the function **20-mA Unit Ether..** The mode of operation is also identical. The only difference is that the measured values are transferred to the communication module via a serial connection instead of an Ethernet connection.

You can find more information in Chapter [5.2.3.2 Structure of the Function](#).

5.2.4.2 Application and Setting Notes

Parameter: Port

- Default setting (`_:2311:103`) **Port** = *Port J*

With the parameter **Port**, you specify the slot for the communication module that will be used for the connection with an external 20-mA unit.

Parameter: Channel number

- Default setting (`_:2311:105`) **Channel number** = *1*

A serial communication module optionally uses 2 channels. With the parameter **Channel number**, you specify the channel number (1 or 2) used to connect the 20-mA unit to the device. The communication module inputs are labeled with the channel numbers.

Parameter: Slave address

- Default setting (`_:2311:106`) **Slave address** = *1*

With the parameter **Slave address**, you define the device address of the 20-mA unit. If only one 20-mA unit is connected to the serial bus, the default value *1* can be used. Set the same device address as used with the 20-mA unit. The device address is important for distinguishing several 20-mA units that are connected to a serial bus. Set an unambiguous device address on every 20-mA unit, for example, 1, 2 and 3 when connecting 3 of the 20-mA units. On every 20-mA unit, set for the parameter **Slave address** in the 3 functions **20-mA Unit Serial**.

Parameter: Unit

- Default setting (`_:13111:103`) **Unit** = *°C*

With the parameter **Unit**, you set the physical unit of measurement the measured values. The possible setting values are listed in the settings table.

Parameter: Conversion factor

- Default setting (`_:13111:104`) **Conversion factor** = *100*

With the parameter **Conversion factor**, you set the conversion factor for the measuring transducer.

Parameter: Resolution

- Default setting (`_:13111:108`) **Resolution** = *0.1*

With the parameter **Resolution**, you set the resolution of the scaled values.

Parameter: Range active

- Default setting (`_:13111:107`) **Range active** = *false*

If you do not activate the parameter **Range active** (no x in the check box), the function operates over the range 0 mA to 20 mA. The setting of the range for the scaled value goes from a usable range of 0 mA to 20 mA.

If you activate the parameter **Range active**, the 4 additional parameters **Upper limit**, **Upper limit - Sensor**, **Lower limit**, and **Lower limit - Sensor** appear.

Parameter: Upper limit, Lower limit, Upper limit - Sensor, and Lower limit - Sensor

- Default setting (`_:13111:105`) **Upper limit** = *20 mA*
- Default setting (`_:13111:109`) **Upper limit - Sensor** = *100*
- Default setting (`_:13111:106`) **Lower limit** = *4 mA*
- Default setting (`_:13111:110`) **Lower limit - Sensor** = *100*

If you activate the parameter **Range active**, the 4 additional parameters **Upper limit**, **Lower limit**, **Upper limit - Sensor**, and **Lower limit - Sensor** appear. The parameter **Upper limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Upper limit** setting. The parameter **Lower limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Lower limit** setting.

The following settings and information table shows only 1 of the 12 channels, as the setting possibilities of the 12 channels do not differ.

5.2.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:103	General:Port		- port F - port E - port J - port N - port P	port J
_:2311:105	General:Channel number		1 to 2	1
_:2311:106	General:Slave address		1 to 247	1

Addr.	Parameter	C	Setting Options	Default Setting
Channel 1				
_:13111:103	Channel 1:Unit		• % • ° • °C • °F • Ω • Ω/km • Ω/mi • 1/s • A • As • cos φ • cycles • dB • F/km • F/mi • h • Hz • Hz/s • in • J • J/Wh • K • l/s • m • mi • min • p.u. • Pa • periods • rad • rad/s • s • V • V/Hz • VA • VAh • var • varh • Vs • W	m

Addr.	Parameter	C	Setting Options	Default Setting
			- W/s - Wh	
_:13111:108	Channel 1:Resolution		1 0.1 0.01 0.001	0.1
_:13111:107	Channel 1:Range active		0 1	false
_:13111:104	Channel 1:Conversion factor		1 to 1000000	100
_:13111:105	Channel 1:Upper limit		0.00 mA to 20.00 mA	20.00 mA
_:13111:109	Channel 1:Upper limit - Sensor		-1000000 to 1000000	100
_:13111:106	Channel 1:Lower limit		0.00 mA to 20.00 mA	4.00 mA
_:13111:110	Channel 1:Lower limit - Sensor		-1000000 to 1000000	100

5.2.4.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:53	General:Health	ENS	O
_:2311:56	General:Failure	SPS	O
Channel 1			
_:13111:53	Channel 1:Health	ENS	O
_:13111:71	Channel 1:Failure	SPS	O
_:13111:301	Channel 1:20-mA output scale	MV	O
_:13111:302	Channel 1:20-mA output raw	MV	O

5.2.5 Communication with 20-mA Unit

5.2.5.1 Integration of a Serial 20-mA Unit

Connection of the Communication Lines

[Figure 5-15](#) shows how to connect the 20-mA unit to the SIPROTEC 5 device. Note that Pin 1 of the RJ45 plug is connected to RTD-B and Pin 2 is connected to RTD-A.

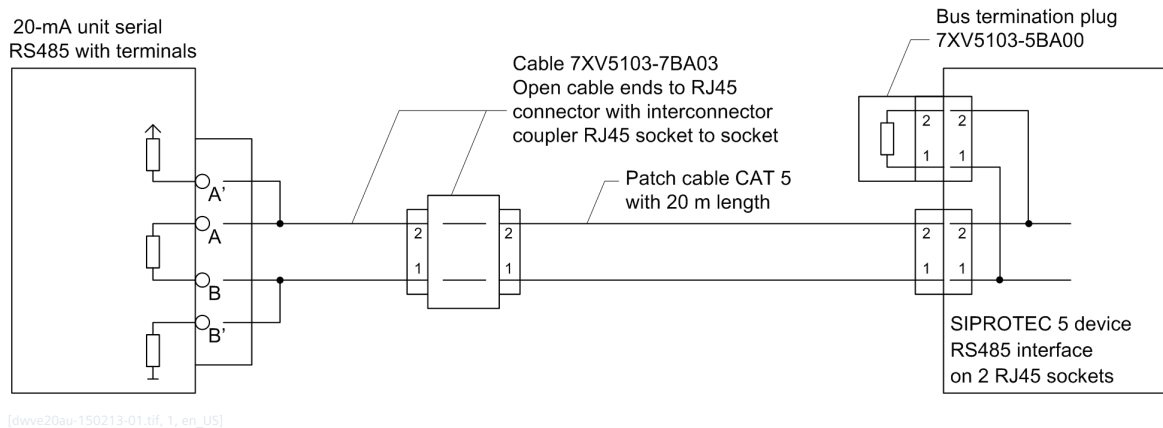
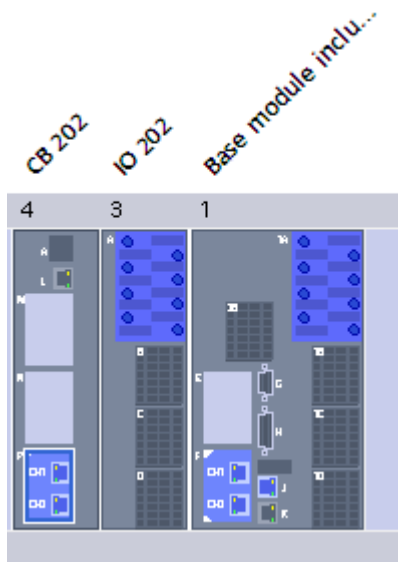


Figure 5-15 Connection of the 20-mA Unit to the SIPROTEC 5 Device

Adding a USART Module

Add a USART-AB-1EL or a USART-AC-2EL USART module in DIGSI to the device. The USART module must be inserted at one of the plug-in positions for communication modules in the base module or in the CB202 expansion module (refer to the following figure).

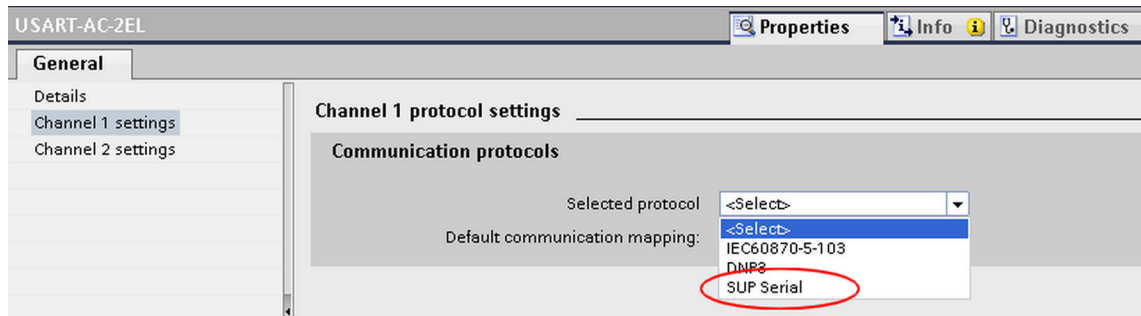


[sc20ser3-220114-01-DE, 1, en_US]

Figure 5-16 Insertion Position for a USART Module

Selecting the SUP Protocol

Select the Slave Unit Protocol (SUP). This protocol is responsible for the communication between the SIPROTEC 5 device and the 20-mA unit.



[scauser4-301012-01.tif, 1, en_US]

Figure 5-17 Selecting the SUP Protocol

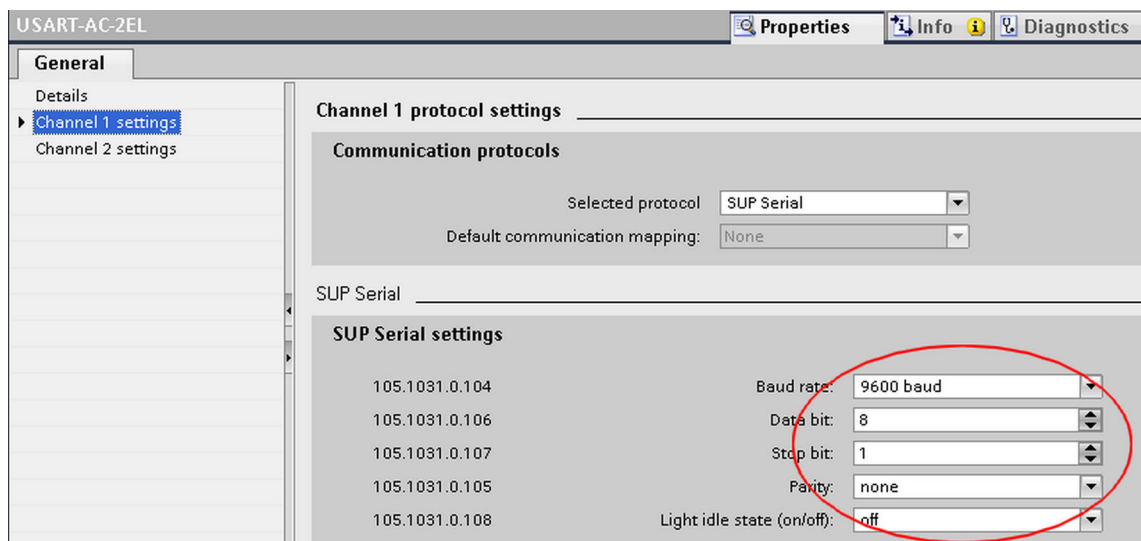
Communication Settings

Make the communications settings for the relevant serial channels. For this, use the default settings specified by the 20-mA unit. Normally, you must adapt only the parameterization of the SIPROTEC 5 device to the settings of the 20-mA unit. Make sure that the setting values in both devices are the same. The setting of the parameter **Non-flickering light (on/off)** : is not relevant for the RS485 interface.



NOTE

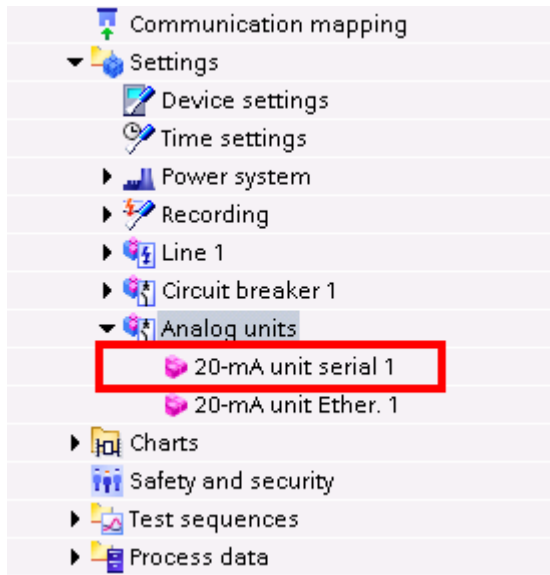
The driver for the USART module for the SUP protocol is not preinstalled as standard for the initial use of this interface (following the firmware update).



[scauser5-301012-01.tif, 1, en_US]

Figure 5-18 Making the Communication Settings

With the selection of the SUP protocol for the 20-mA unit DIGSI automatically adds the function group **Analog units** to your device configuration. You can now instantiate the function **20-mA unit serial 1** (see the following figure).

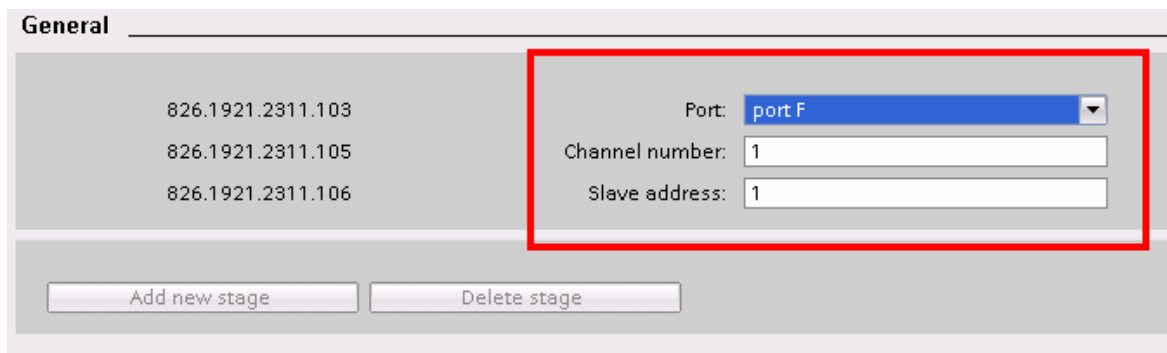


[sc20ser6-220114-01-DE, 1, en_US]

Figure 5-19 Insertion of the Function 20-mA Unit Serial 1

Now, set the channel number over which the SUP protocol runs. In addition, set the slave address of the 20-mA unit. This address must be set with the same value in the 20-mA unit (refer to the following figure). For the first use of the 20-mA unit, the following device configuration must be set on the 20-mA unit:

- Bus protocol: mod
- Device address: 1
- Baud rate: 9600
- Parity: no



[scauser7-220114-01-DE, 1, en_US]

Figure 5-20 Setting the Port, Channel Number, and Device Address

Finally, load the configuration in the device.

5.2.5.2 Integration of a 20-mA Unit Ethernet

Device Configuration

In DIGSI, insert an Ethernet module into the provided slot, thus adding the module to the device configuration. [Figure 5-21](#) displays the available slots in the base module or on the expansion module CB202. Alternatively, you can also use the integrated Ethernet interface Port J.

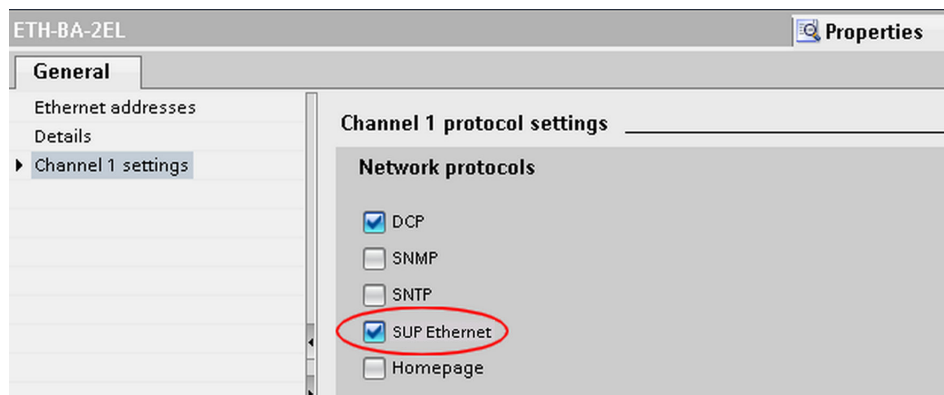


[sc_autcp1, 1, en_US]

Figure 5-21 Inserting an Ethernet Module

Communication Settings

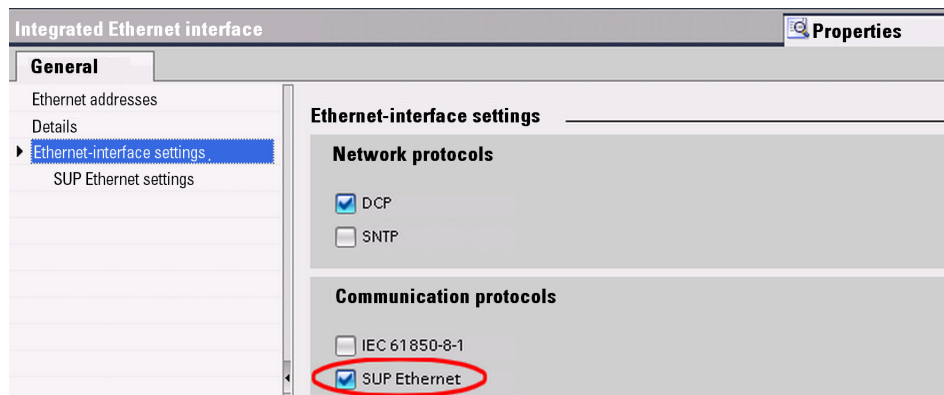
Activate the SUP Ethernet protocol for the Ethernet module.



[sc_autcp2, 1, en_US]

Figure 5-22 Activation of the Protocol

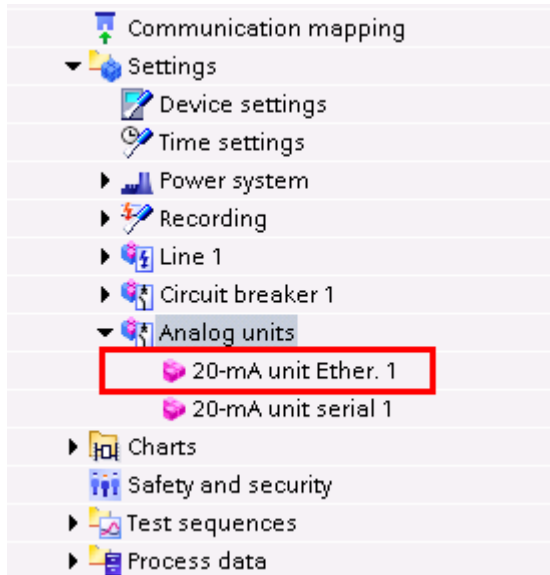
This protocol is also available for Port J of the integrated Ethernet interface of the base module (refer to following figure).



[sc_autcp3, 1, en_US]

Figure 5-23 Selection of the Protocol

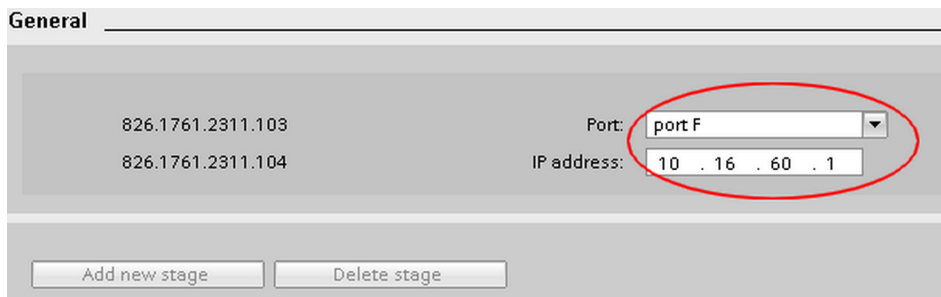
With the selection of the SUP protocol for the 20-mA unit, DIGSI automatically adds the **Analog units** function group and the **20-mA unit Ether. 1** function to your device configuration (refer to the following figure).



[sc_20tcp4, 1, en_US]

Figure 5-24 Insertion of the Function 20-mA Unit Ether. 1

Now, set the port over which the SUP protocol runs. In addition, set the IP address of the 20-mA unit (refer to the following figure). This address must be set with the same value in the 20-mA unit.



[sc_autcp5, 1, en_US]

Figure 5-25 Setting the Port and IP Address

Finally, load the configuration in the device.

5.2.6 V/I-Measuring-Transducer Unit with Fast Inputs

5.2.6.1 Overview

The fast analog measuring-transducer inputs process voltage values (DC -10 V to +10 V) as well as current values (DC -20 mA to 20 mA).

The function **MT fast input**:

- Provides sampled values for recording in the fault record (the maximum sampling frequency is 8 kHz for all other SIPROTEC 5 devices). The recorded sampling frequency results from the setting of the fault-recorder function.
- Calculated measured values from the sampled values. These measured values have been deduced from the arithmetic mean values. The measuring range for the mean-value calculation is adjustable in the interval from 10 ms to 100 ms.

- Converts the measured current or voltage values into process values, for example, temperature, gas pressure, etc.
- Provides the recorded process variables for further processing by the fault recorder, the CFC, and in GOOSE-applications for transmission via communication protocols, and for visualization

The fast measuring-transducer inputs are located on the IO212 module with 8 inputs (optionally current or voltage inputs), and the IO210 module with 4 inputs (optionally current or voltage inputs).

5.2.6.2 Structure of the Function

The function **MT fast input** works in the function group **Analog units** and contains the number of available measuring-transducer inputs, depending on the hardware configuration. You can configure these channels independently from one another either as current or voltage inputs.

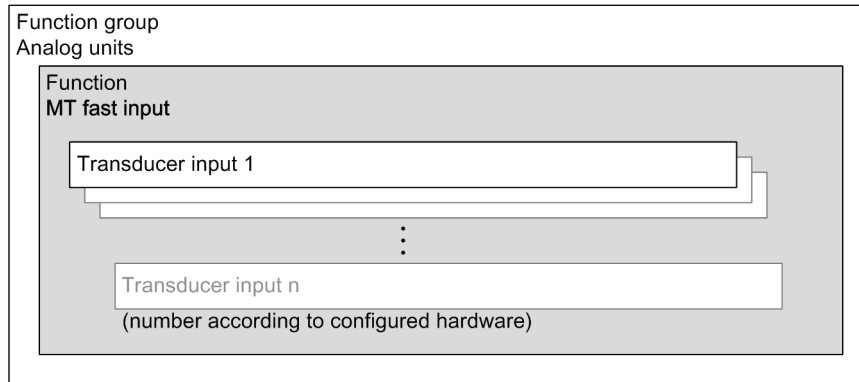


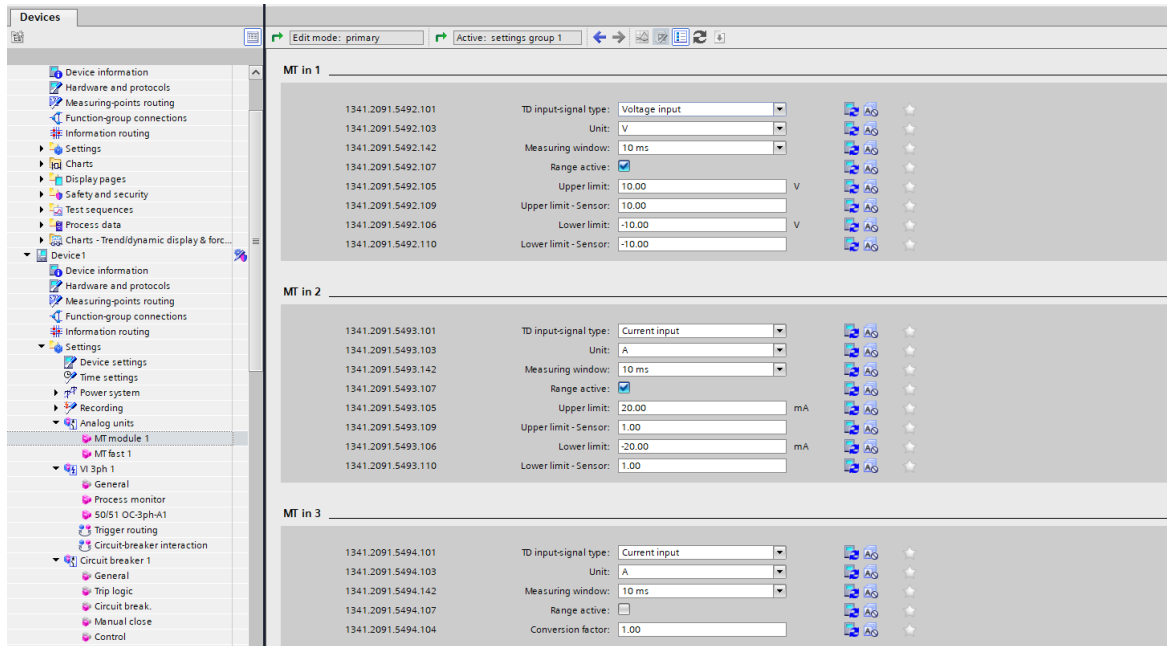
Figure 5-26 Structure/Embedding of the Function

5.2.6.3 Function Description

Once you have instantiated the **MT fast input** function, it will be visible in the project tree in the function group **Analog units**. You can find the function group **Analog units** in DIGSI in the **Settings** folder.

If you open the subdirectory **MT fast input**, you reach the setting sheet for the respective input (for more details, see [5.2.6.4 Application and Setting Notes](#)).

The hardware is designed in such a way that either a current or a voltage can be processed at each input. Use the corresponding terminals (see Hardware manual). Configure the input in accordance with the selected connection (Parameter **TD input-signal type**). With the parameter **Measuring window**, you set the measuring range with which the arithmetic mean value is determined. With the parameter **Measuring window**, you also determine measurement speed for the input. For example, a setting of 100 ms means that the measured value is updated every 100 ms.



[sclmuio212, 2, en_US]

Figure 5-27 Parameters of the Measuring-Transducer Channels.

The fast measuring-transducer channels can be configured either as current or as voltage inputs. Apart from this, their function corresponds to the basic function of the 20-mA channels (see chapter [5.2.3.5 20-mA Channel](#)).

5.2.6.4 Application and Setting Notes

Parameter: TD input-signal type

- Default setting (`_:101`) **TD input-signal type** = *Current input*

With the parameter **TD input-signal type**, you determine whether the measuring-transducer input channel works as a *Current input* or as a *Voltage input*.

Make sure that the selected channel has also been wired correctly (see *Hardware manual, Input and Output Module IO212*).

Parameter: Unit

- Default setting (`_:103`) **Unit** = *A*

With the parameter **Unit**, you set the physical unit of measurement of the measured values. The possible setting values are listed in the settings table.

Parameter: Measuring window

- Default setting (`_:142`) **Measuring window** = *10 ms*

With the parameter **Measuring window**, you set the measuring window that is used to determine the arithmetic mean value from the sampled values. In case of slowly varying signals, Siemens recommends setting the top value to 100 ms. With this value, a new, current measured value is provided every 100 ms for further processing.

Parameter: Range active

- Default setting (`_:107`) **Range active** = *false*

If you do not activate the **Range active** parameter, the function assumes a range of -20 mA to +20 mA or -10 V to +10 V. The setting of the range for the scaled value then assumes a usable range of -20 mA to +20 mA or -10 V to +10 V.

If you activate the parameter **Range active**, the 4 additional parameters **Upper limit**, **Upper limit - Sensor**, **Lower limit**, and **Lower limit - Sensor** appear.

Note that this setting is activated by either placing, or not placing the relevant check mark in DIGSI (see [Figure 5-27](#)).

Parameter: Conversion factor

- Default setting (**_:104**) **Conversion factor** = 1.00

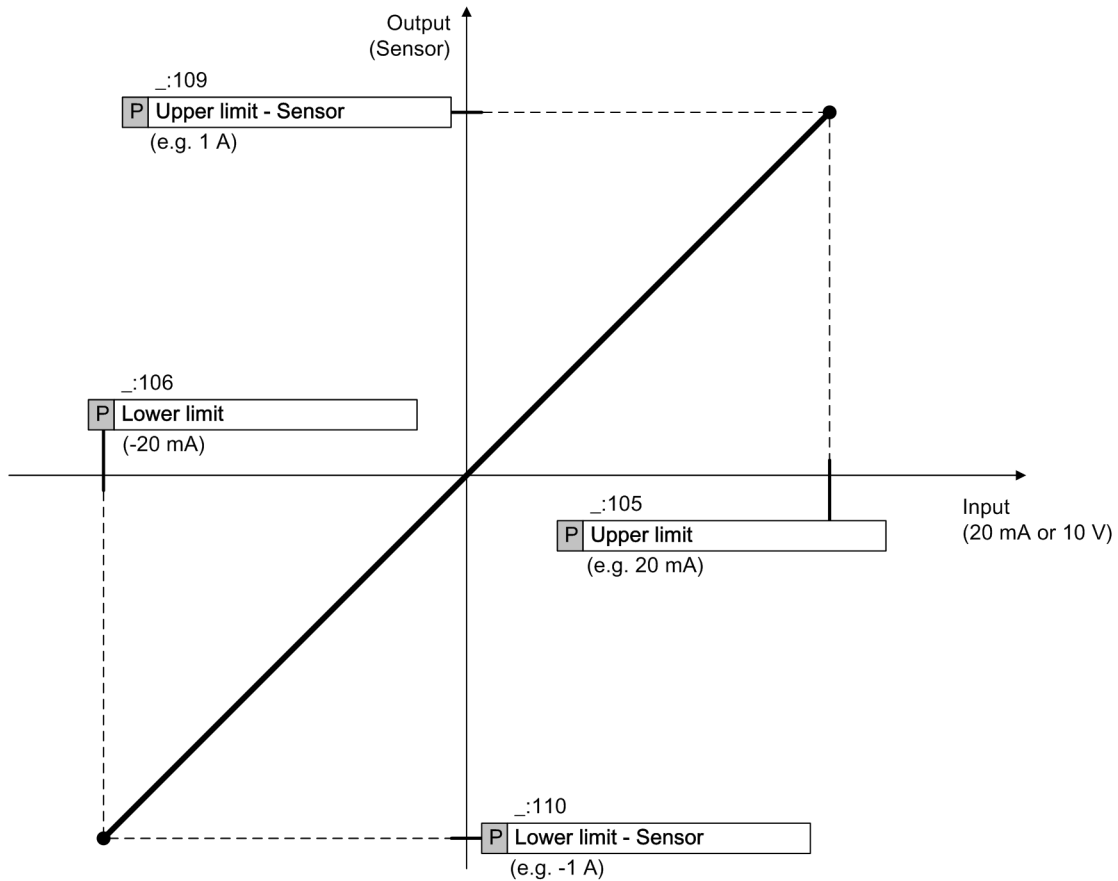
With the parameter **Conversion factor**, you set the conversion factor for the measuring transducer.

Parameter: Upper limit, Upper limit - Sensor, Lower limit, and Lower limit - Sensor

With the following parameters, you set the scaling of the measuring variables. By that, you can scale in an application-specific way:

- Default setting **Upper limit** = 20.00 mA
- Default setting **Upper limit - Sensor** = 1.00
- Default setting **Lower limit** = -20.00 mA
- Default setting **Lower limit - Sensor** = 1.00

With these setting parameters, you set the operating range of the measuring transducer as well as the conversion of the values transmitted to the sensor values. Harmonize the operating range of the measuring transducer with the transmitter of the sensor. Using the free scalability of the system, you can meet different requirements. The following figure shows the setting parameters in general terms.



[dw_measured-value-scaling, 1, en_US]

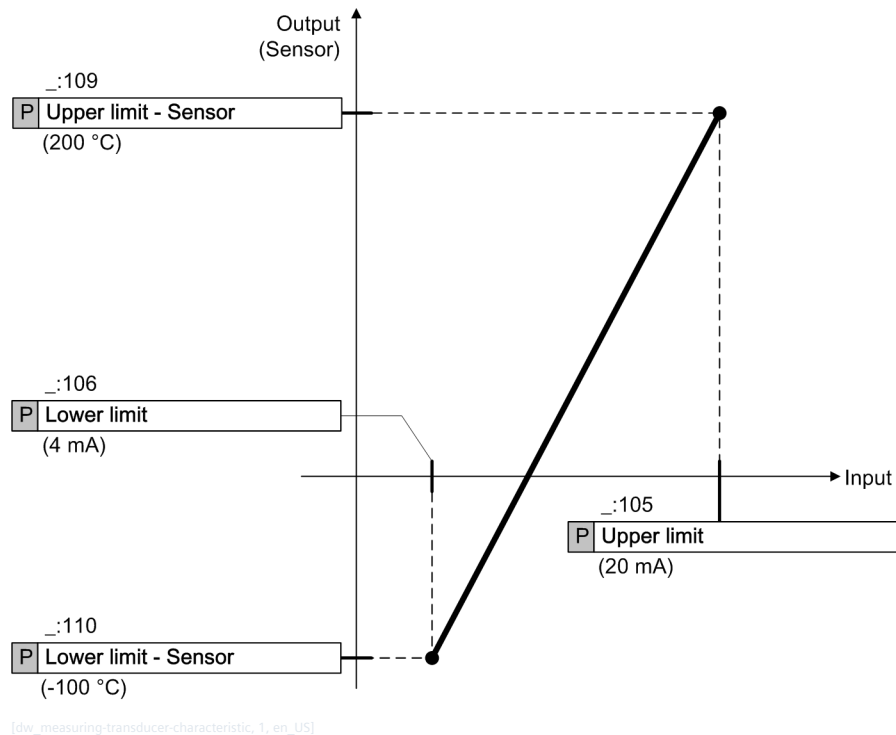
Figure 5-28 Scaling Principle

If you keep the preset limiting values, the following conditions are possible:

- If the input current is $< 2.000 \text{ mA}$
The function issues the indication *Broken wire* and the quality of the output value is invalid. The functions that use the output value as the measured value can be deactivated.
- If the input current is $> 2.500 \text{ mA}$
The indication *Broken wire* drops out.

Setting Example 1:

A measuring transducer transmitting a current signal of 4 mA to 20 mA is used as a transmitter. Currents well below -25.6 mA or above $+25.6 \text{ mA}$ indicate a transmitter failure. A sensor detecting a temperature is attached to the transmitter. The upper value corresponds to 200°C and the lower value to -100°C . This results in the following characteristic. In accordance with the set characteristic curve, the function calculates the sensor value from the measured current. The coefficients of the linear equation (gradient and foot point) are calculated from the set threshold and the sensor values are determined. A supplied current of 9.333 mA corresponds to a temperature of 0°C .



[dw_measuring-transducer-characteristic, 1, en_US]

Figure 5-29 Characteristic Curve of Setting Example 1



NOTE

The hardware of the measuring transducer has been designed in such a way that measured values are transmitted and analyzed using the setting range (**Upper limit** or **Lower limit**). Therefore, special applications are possible, if necessary. The limits are at approx. +20 mA and -20 mA or +10 V and -10 V.

Setting Example 2:

For special applications, the transmitter sends a maximum of ± 12 V. This voltage shall be issued accordingly as sensor voltage.

Set the parameters as follows:

- **Upper limit** = 10.00 V
- **Upper limit - Sensor** = 10.00 V
- **Lower limit** = -10.00 V
- **Lower limit - Sensor** = -10.00 V

With this setting, a signal of 12 V is issued as a 12-V measured value (see following figure).

Figure 5-30 Parameter Settings and Representation of an Input Signal Greater than 10 V

5.2.6.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
<i>MT fast #</i>				
_:101	MT in #:TD input-signal type		• Voltage input • Current input	Current input

Addr.	Parameter	C	Setting Options	Default Setting
_:103	MT in #:Unit		• % • ° • °C • °F • Ω • Ω/km • Ω/mi • 1/s • A • As • cos φ • cycles • dB • F/km • F/mi • h • Hz • Hz/s • in • J • J/Wh • K • l/s • m • mi • min • p.u. • Pa • periods • rad • rad/s • s • V • V/Hz • VA • VAh • var • varh • Vs • W • W/s • Wh	A

Addr.	Parameter	C	Setting Options	Default Setting
_:142	MT in #:Measuring window		10 ms 20 ms 40 ms 60 ms 80 ms 100 ms	10 ms
_:107	MT in #:Range active		0 1	false
_:104	MT in #:Conversion factor		-1000000.00 to 1000000.00	1.00
_:105	MT in #:Upper limit		-20.00 m A to 20.00 mA	5.00 mA
_:109	MT in #:Upper limit - Sensor		-1000000.00 to 1000000.00	1.00
_:106	MT in #:Lower limit		-20.00 m A to 20.00 mA	4.00 mA
_:110	MT in #:Lower limit - Sensor		-1000000.00 to 1000000.00	1.00

5.2.6.6 Information List

No.	Information	Data Class (Type)	Type
MT in #			
_:307	MT in #:Broken wire	SPS	O
_:302	MT in #:TD scale MV	MV	O
_:306	MT in #:TD scale SAV	SAV	O

5.2.7 RTD Unit Ethernet

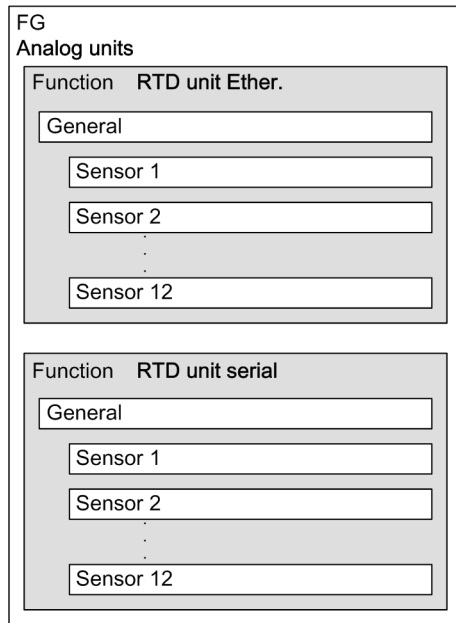
5.2.7.1 Overview

The **RTD unit Ether.** function:

- Communicates with an external RTD unit via the Slave Unit Protocol (SUP) and records the measured temperatures from the RTD unit
- Provides the captured temperatures to the temperature monitoring function
- Monitors communication with the RTD unit

5.2.7.2 Structure of the Function

The **RTD unit Ether.** function can only work in the **Analog units** function group. A maximum of 20 function instances can work simultaneously. Each instance contains 12 preconfigured sensor function blocks.

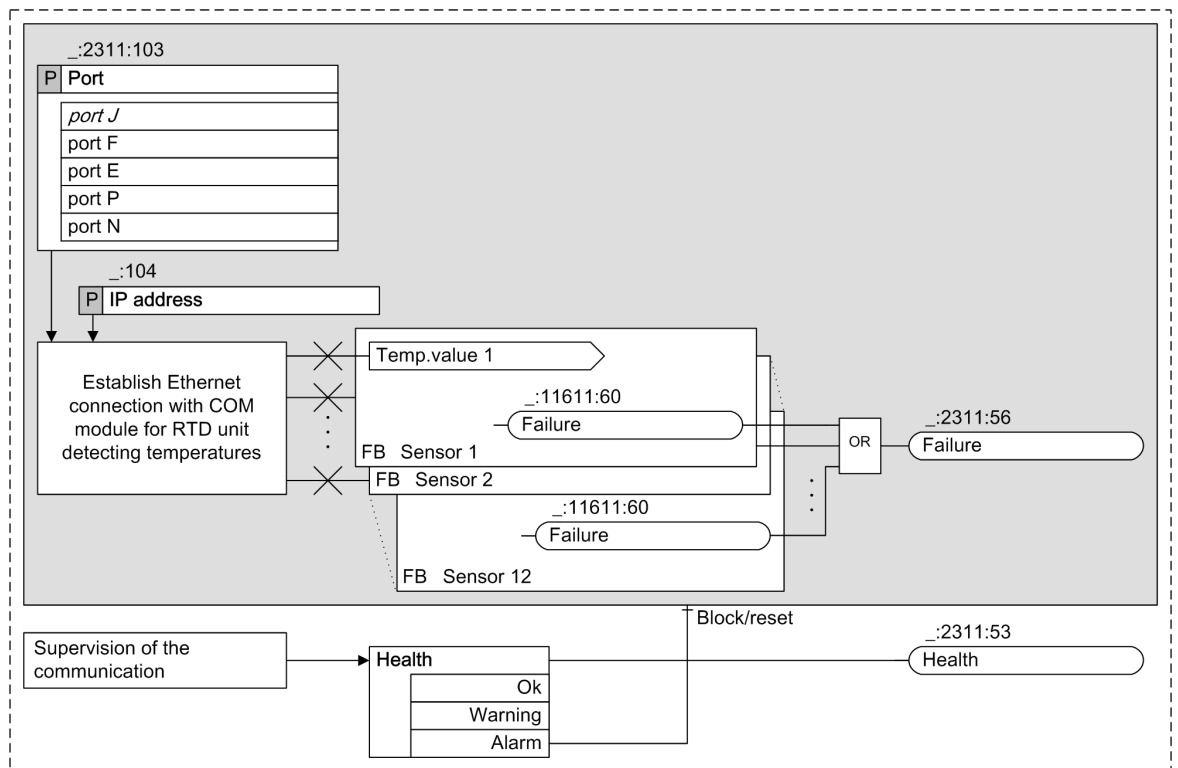


[dw_str_fnc, 2, en_US]

Figure 5-31 Structure/Embedding of the Function

5.2.7.3 Communication with an RTD Unit

Logic



[io_rtdtcp, 1, en_US]

Figure 5-32 Logic of the RTD Unit Ether. Function

Communication with an RTD Unit

The function is used to communicate with an RTD unit connected via an Ethernet connection. If the connection of the function is successfully established to the external RTD unit via the Ethernet interface, the RTD unit transmits the temperatures of all connected sensors to the **RTD unit Ether.** function. For the connection to be established successfully, specific communication settings must be set, see chapter [5.2.7.4 Application and Setting Notes](#).

The RTD unit **Ziehl TR1200 IP** supports only an Ethernet connection of 10 MBit/s. A direct connection to a 100-Mbit communication module is therefore not possible. For this reason, you must connect the RTD unit to the communication module via a 10/100 MBit/s autosensing switch which automatically recognizes the transmission rates and adapts them accordingly. Further information can be found in the Application and setting notes, see chapter [5.2.7.4 Application and Setting Notes](#).

Error Responses

The following table lists the conditions under which the *Health* status transitions to the Alarm or Warning state.

Table 5-4 Error Responses

Error Description	Status Health
The RTD unit Ether. function cannot establish a connection with a communication module.	Alarm
The connection between the communication module and the RTD unit causes a time-out.	Warning
A communication module has not received any more data from the RTD unit for 9 sec.	Warning

The *Failure* signal is issued as soon as one of the sensor function blocks reports a failure.

5.2.7.4 Application and Setting Notes

Parameter: Port

- Default setting (`_:2311:103`) **Port** = *port J*

Use the **Port** parameter to define over which port the external RTD unit is connected to the SIPROTEC 5 device.

If you want to connect the external RTD unit to the integrated Ethernet interface, set the parameter **Port** = *Port J*. If you want to connect the external RTD unit to an Ethernet plug-in module, set the parameter **Port** = *Port F*, *Port E*, *Port P*, or *Port N*.

You can connect directly the RTD unit to the device via the internal 10-Mbit Ethernet port J. If you operate the RTD unit on another port via a 100-Mbit communication module, you need an interconnected 10/100-Mbit autosensing switch, which adapts transmission rates accordingly.

Parameter: IP address

- Default setting (`_:2311:104`) **IP address** = *10.16.60.1*

With the parameter **IP address**, you set the IP address of the RTD unit connected to the communication module via the SUP protocol. Every RTD unit has to be assigned a unique IP address. The IP address to be set depends on your network configuration. You can set any valid IPv4 address that does not cause conflicts with other IP addresses in the network. Set an appropriate IP address first at the **Ziehl TR1200 IP** RTD unit. Then specify the parameter **IP address** for the communication module to the same address.

Settings on the RTD Unit

The **Ziehl TR1200 IP** RTD unit is set with the front keys or in a Web browser on a laptop computer via its Ethernet interface. Set the connection type of the sensors (3-wire connection or resistance value for 2-wire connection), the idle state of the fault-indication relay, as well as the IP interface setting.

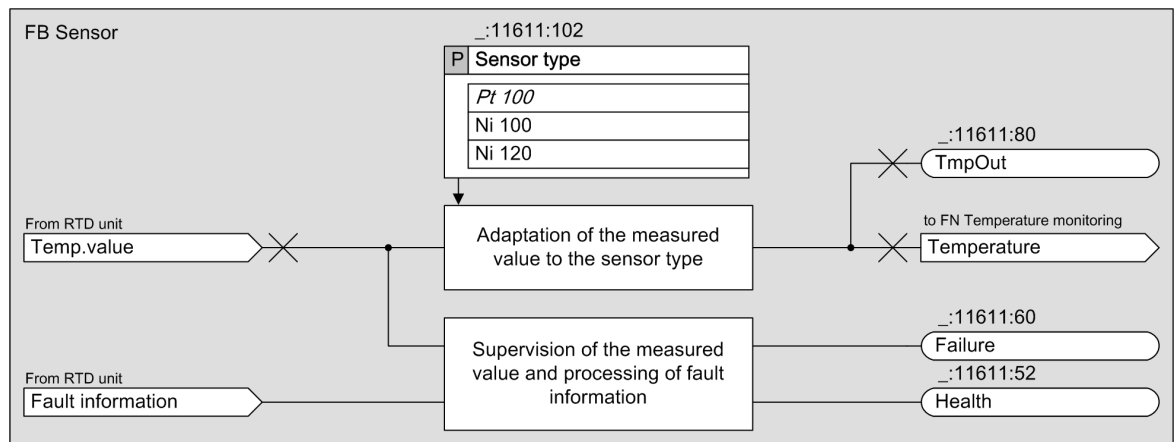
The code lock has to be switched off for parameterization. This is only possible using the front keys of the RTD unit. The code lock is **off** (switched off) in as-delivered condition and has pin **504**.

For detailed information on the settings, refer to the TR1200 IP manual that comes with the RTD unit. The documents are also available in the SIPROTEC download area (<http://www.siprotec.de>) under **Accessories -> 7XV5662-xAD**.

For an Ethernet connection to a SIPROTEC 5 device communicating with the RTD unit TR1200 IP via the **SUP** protocol (Slave Unit Protocol), the **Modbus TCP** setting must be activated in the RTD unit. You can activate the Modbus TCP protocol using the function keys under the **tcP**. → **Mod / on** menu item or with the Web browser in the **TCP/UDP Config** tab. The **RTD** (RTD protocol) and **UDP Port** settings have no effect here. The Modbus TCP port is permanently set to 502 and cannot be changed.

5.2.7.5 Temperature Sensor

Logic



[to_tmpval, 1, en, US]

Figure 5-33 Logic Diagram of the Temperature Sensor Function Block

Measured Temperature Value

The **Temperature sensor** function block processes one single measured temperature value delivered from the RTD unit for the assigned sensor. 12 temperature sensor function blocks are always available in each RTD unit function (both via Ethernet and serial), even if fewer sensors are connected to the RTD unit.

Various temperature sensor types are supported: Pt100, Ni100, and Ni120 sensors. The function block is notified regarding the selection of connected type via the **Sensor type** parameter.

The function block delivers a measured temperature value in °C or °F as an output variable. The measured temperature value is available as an operational measured value and can be monitored by the **Temperature supervision** function.

Error Responses

If the measured input value is determined to be incorrect, the quality attribute of the output measured temperature value is set to **invalid**. The statuses for Health and Error take the statuses in accordance with the following table:

Table 5-5 Error response

Error Description	Health Status	Error Status
Sensor or line short circuited	Alarm	Yes
Sensor or line interrupted	Alarm	Yes

Error Description	Health Status	Error Status
Measured temperature value outside the valid measuring range specified in the technical data. The valid measuring range depends on the sensor type.	Alarm	Yes
Sensor not connected	OK	No

5.2.7.6 Application and Setting Notes

Parameter: Sensor type

- Default setting (`_:11611:102`) **Sensor type** = *Pt 100*

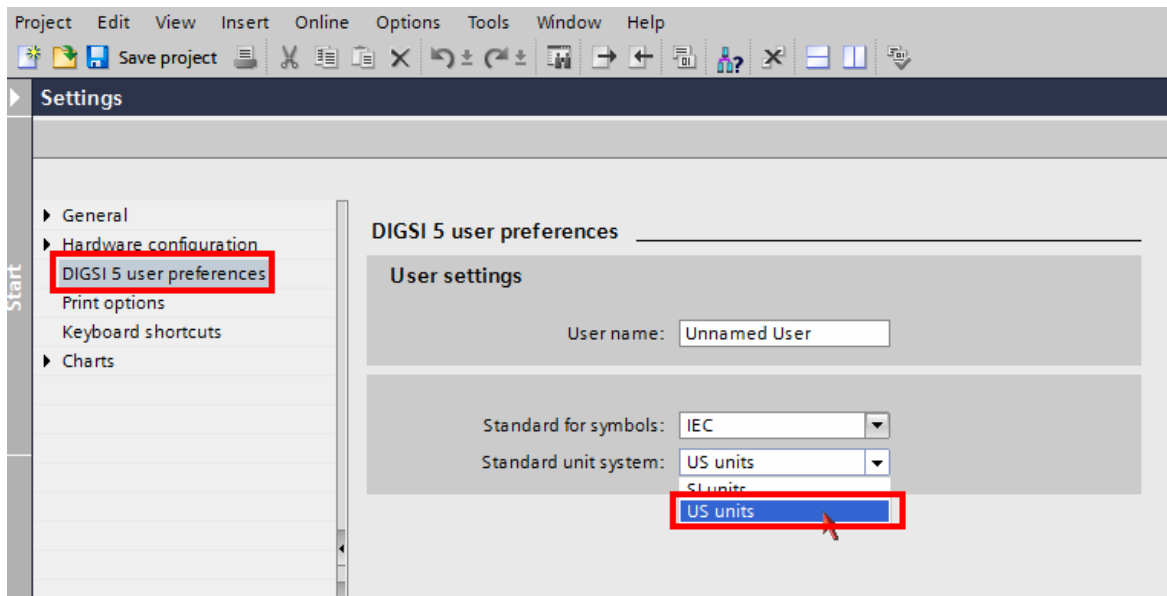
The **Sensor type** parameter is used to set the sensor element used. You can select between *Pt 100*, *Ni 100* and *Ni 120*.

Parameter: Temperature unit

To change the display and evaluation of measured temperature values from °C to °F, adapt the DIGSI user default settings accordingly.

Proceed as follows:

- In DIGSI select the menu item **Extras --> Settings**.
- In the **Settings** view select the menu item **DIGSI 5 User preferences**.
- Under **Standard unit system** change the setting value of the unit system used from *SI units* to *US units*.



[scfahrt-190214-01, 1, en_US]

Figure 5-34 Change of the Display Between °C and °F

The following settings and information table shows only 1 of the 12 sensors, as the setting possibilities of the 12 sensors do not differ.

5.2.7.7 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:103	General:Port		- port E - port F - port J - port N - port P	port J
Sensor 1				
_:11611:102	Sensor 1:Sensor type		- Pt 100 - Ni 100 - Ni 120	Pt 100

5.2.7.8 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:53	General:Health	ENS	O
_:2311:56	General:Failure	SPS	O
Sensor 1			
_:11611:52	Sensor 1:Health	ENS	O
_:11611:60	Sensor 1:Failure	SPS	O
_:11611:80	Sensor 1:TmpOut	MV	O

5.2.8 RTD Unit, Serial

5.2.8.1 Overview

The **RTD unit serial** function:

- Communicates with an external RTD unit serial via the Slave Unit Protocol (SUP) and records the measured temperatures from the RTD unit
- Provides the captured temperatures to the temperature supervision function
- Monitors communication with the RTD unit

The **RTD unit Serial** function is set up structurally in the same manner as the **RTD unit Ether.** function. The mode of operation is also identical (see [5.2.7.3 Communication with an RTD Unit](#)).

5.2.8.2 Application and Setting Notes

Parameter: Port

- Default setting (**_:2311:103**) **Port** = **F**

With the parameter **Port**, you set the slot for the communication module that will be used for the connection with an external RTD unit.

If you want to connect the external RTD unit to an Ethernet plug-in module, set the parameter **Port** = **Port F**, **Port E**, **Port P**, or **plug-in module position**.

Parameter: Channel number

- Default setting (**_:2311:105**) **Channel number** = **1**

A serial communication module optionally uses 2 channels. With the parameter **Channel number**, you set the channel number (1 or 2) through which the RTD unit is connected to the device. The communication module inputs are labeled with the channel numbers.

Parameter: Slave address

- Default setting (`_:2311:106`) **Slave address** = 1

With the parameter **Slave address**, you define the device address of the RTD unit. If only one RTD unit is connected to the serial bus, the default value 1 can be used. The same device address has to be set on the RTD unit. The device address is important for distinguishing among several RTD units connected to a serial bus. Set a unique device address (for example 1, 2, and 3 when connecting 3 RTD units) for each RTD unit and the same device address for the parameter **Slave address** in the 3 **RTD unit serial** functions.

The following settings and information table shows only 1 of the 12 sensors, as the setting possibilities of the 12 sensors do not differ.

5.2.8.3 Parameter

Addr.	Parameter	C	Setting Options	Default Setting
General				
<code>_:2311:103</code>	General:Port		• port F • port E • port P • port N • port J	port J
<code>_:2311:105</code>	General:Channel number		1 to 2	1
<code>_:2311:106</code>	General:Slave address		1 to 254	1
Sensor 1				
<code>_:11611:102</code>	Sensor 1:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 2				
<code>_:11612:102</code>	Sensor 2:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 3				
<code>_:11613:102</code>	Sensor 3:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 4				
<code>_:11614:102</code>	Sensor 4:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 5				
<code>_:11615:102</code>	Sensor 5:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100

Addr.	Parameter	C	Setting Options	Default Setting
Sensor 6				
_:11616:102	Sensor 6:Sensor type		- Pt 100 - Ni 100 - Ni 120	Pt 100
Sensor 7				
_:11617:102	Sensor 7:Sensor type		- Pt 100 - Ni 100 - Ni 120	Pt 100
Sensor 8				
_:11618:102	Sensor 8:Sensor type		- Pt 100 - Ni 100 - Ni 120	Pt 100
Sensor 9				
_:11619:102	Sensor 9:Sensor type		- Pt 100 - Ni 100 - Ni 120	Pt 100
Sensor 10				
_:11611:102	Sensor 10:Sensor type		- Pt 100 - Ni 100 - Ni 120	Pt 100
Sensor 11				
_:11611:102	Sensor 11:Sensor type		- Pt 100 - Ni 100 - Ni 120	Pt 100
Sensor 12				
_:11611:102	Sensor 12:Sensor type		- Pt 100 - Ni 100 - Ni 120	Pt 100

5.2.8.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:53	General:Health	ENS	O
_:2311:56	General:Failure	SPS	O
Sensor 1			
_:11611:52	Sensor 1:Health	ENS	O
_:11611:60	Sensor 1:Failure	SPS	O
_:11611:80	Sensor 1:TmpOut	MV	O
Sensor 2			
_:11612:52	Sensor 2:Health	ENS	O
_:11612:60	Sensor 2:Failure	SPS	O
_:11612:80	Sensor 2:TmpOut	MV	O
Sensor 3			
_:11613:52	Sensor 3:Health	ENS	O

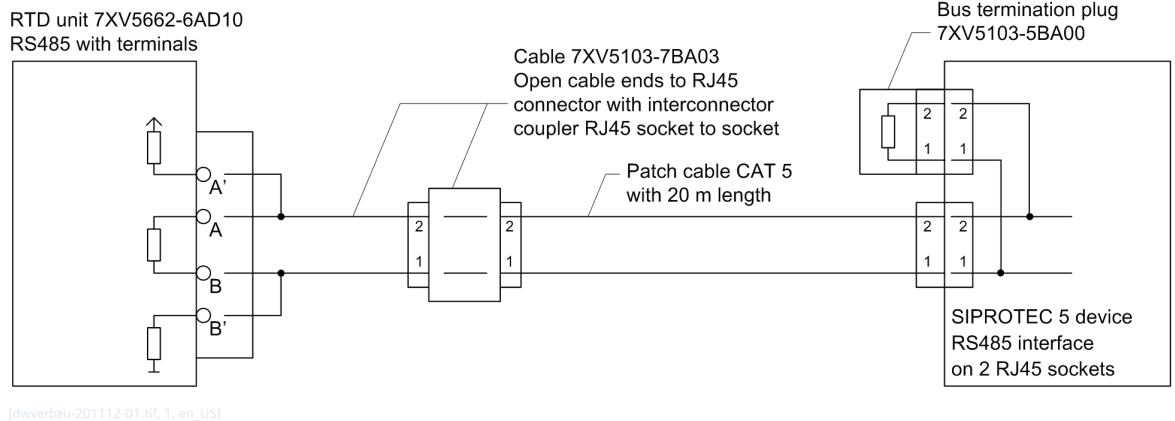
No.	Information	Data Class (Type)	Type
_:11613:60	Sensor 3:Failure	SPS	O
_:11613:80	Sensor 3:TmpOut	MV	O
Sensor 4			
_:11614:52	Sensor 4:Health	ENS	O
_:11614:60	Sensor 4:Failure	SPS	O
_:11614:80	Sensor 4:TmpOut	MV	O
Sensor 5			
_:11615:52	Sensor 5:Health	ENS	O
_:11615:60	Sensor 5:Failure	SPS	O
_:11615:80	Sensor 5:TmpOut	MV	O
Sensor 6			
_:11616:52	Sensor 6:Health	ENS	O
_:11616:60	Sensor 6:Failure	SPS	O
_:11616:80	Sensor 6:TmpOut	MV	O
Sensor 7			
_:11617:52	Sensor 7:Health	ENS	O
_:11617:60	Sensor 7:Failure	SPS	O
_:11617:80	Sensor 7:TmpOut	MV	O
Sensor 8			
_:11618:52	Sensor 8:Health	ENS	O
_:11618:60	Sensor 8:Failure	SPS	O
_:11618:80	Sensor 8:TmpOut	MV	O
Sensor 9			
_:11619:52	Sensor 9:Health	ENS	O
_:11619:60	Sensor 9:Failure	SPS	O
_:11619:80	Sensor 9:TmpOut	MV	O
Sensor 10			
_:11611:52	Sensor 10:Health	ENS	O
_:11611:60	Sensor 10:Failure	SPS	O
_:11611:80	Sensor 10:TmpOut	MV	O
Sensor 11			
_:11611:52	Sensor 11:Health	ENS	O
_:11611:60	Sensor 11:Failure	SPS	O
_:11611:80	Sensor 11:TmpOut	MV	O
Sensor 12			
_:11611:52	Sensor 12:Health	ENS	O
_:11611:60	Sensor 12:Failure	SPS	O
_:11611:80	Sensor 12:TmpOut	MV	O

5.2.9 Communication with RTD Unit

5.2.9.1 Integration of a Serial RTD Unit (Ziehl TR1200)

Connection of the Communication Lines

[Figure 5-35](#) shows how you connect the RTD unit to the SIPROTEC 5 device. Note that Pin 1 of the RJ45 plug is connected to RTD-B and Pin 2 is connected to RTD-A.



[dwverbau-201112-01.tif, 1, en_US]

Figure 5-35 Connection of the RTD Unit to the SIPROTEC 5 Device

Adding a USART Module

Add a USART-AB-1EL or a USART-AC-2EL USART module in DIGSI to the device. The USART module must be inserted at one of the plug-in positions for communication modules in the base module or in the CB202 expansion module (refer to the following figure).

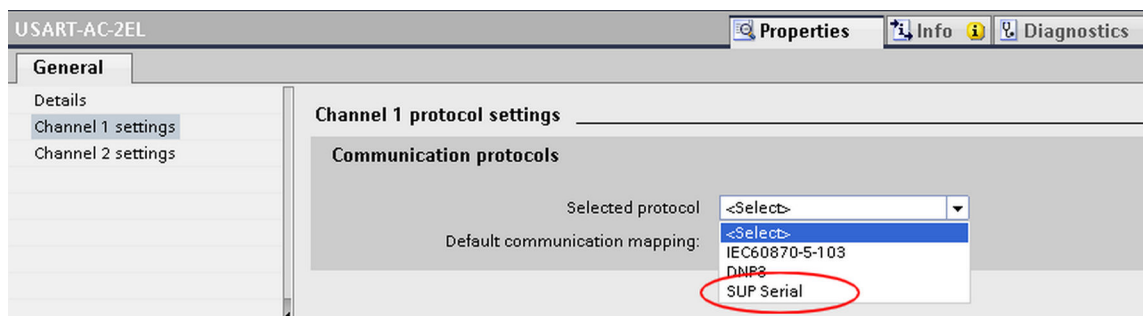


[scauser3-190214-01, 1, en_US]

Figure 5-36 Insertion Position for a USART Module

Selecting the SUP Protocol

Select the Slave Unit Protocol (SUP). This protocol is responsible for the communication between the SIPROTEC 5 device and the RTD Unit.



[scauser4-301012-01.tif, 1, en_US]

Figure 5-37 Selecting the SUP Protocol

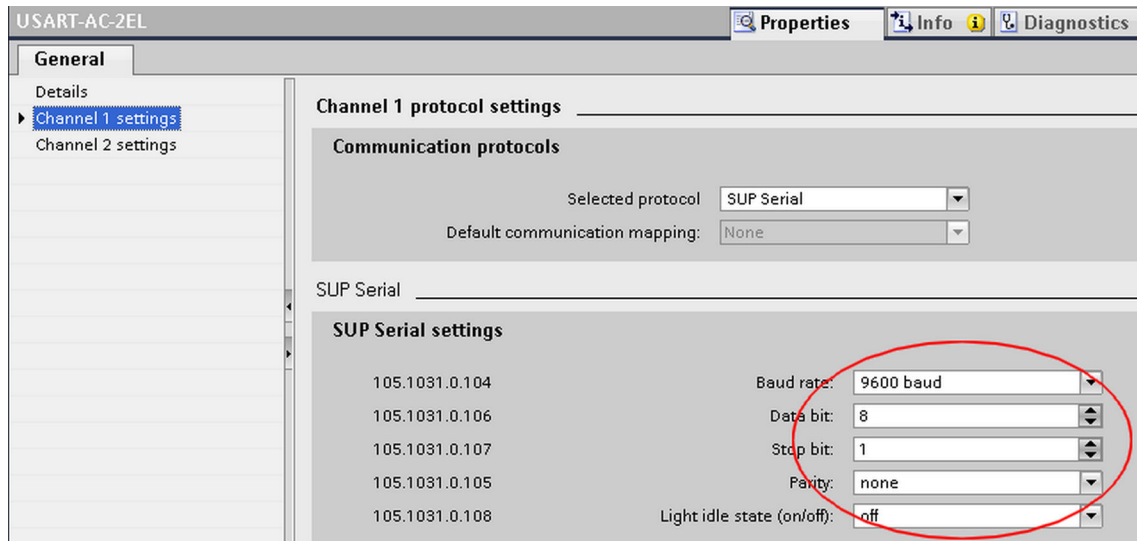
Communication Settings

Make the communications settings for the relevant serial channels. For this, use the default settings specified by the RTD box. Normally, you must adapt only the parameterization of the SIPROTEC 5 device to the settings of the RTD box. Make sure that the setting values in both devices are the same. The setting of the parameter **Non-flickering light (on/off)** : is not relevant for the RS485 interface.



NOTE

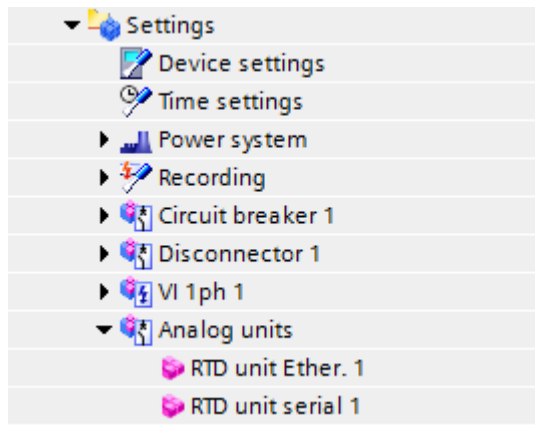
The driver for the USART module for the SUP protocol is not preinstalled as standard for the initial use of this interface (following the firmware update).



[scauser5-301012-01.tif, 1, en_US]

Figure 5-38 Making the Communication Settings

With the selection of the SUP protocol for the RTD box DIGSI automatically adds the function group **Analog units** to your device configuration. You can now instantiate the function **RTD unit serial 1** (refer to the following figure).



[sc_auser6, 1, en_US]

Figure 5-39 Analog-Unit Instance

Now, set the channel number over which the SUP protocol runs. In addition, set the slave address of the RTD unit. This address must be set with the same value in the RTD box (refer to the following figure).

The following device configuration must be set on the TR1200 RTD unit when the RTD unit is used for the first time:

- Bus protocol: mod
- Device address: 1
- Baud rate: 9600
- Parity: no

[scauser7-220114-01-DE, 1, en_US]

Figure 5-40 Setting the Port, Channel Number, and Slave Address

Finally, load the configuration in the device.

5.2.9.2 Integration of an RTD Unit Ether. (TR1200 IP)

Device Configuration

In the DIGSI, insert an Ethernet module into the provided slot, thus adding the module to the device configuration. [Figure 5-41](#) displays the available slots in the base module or on the expansion module CB202. Alternatively, you can also use the integrated Ethernet interface port J.

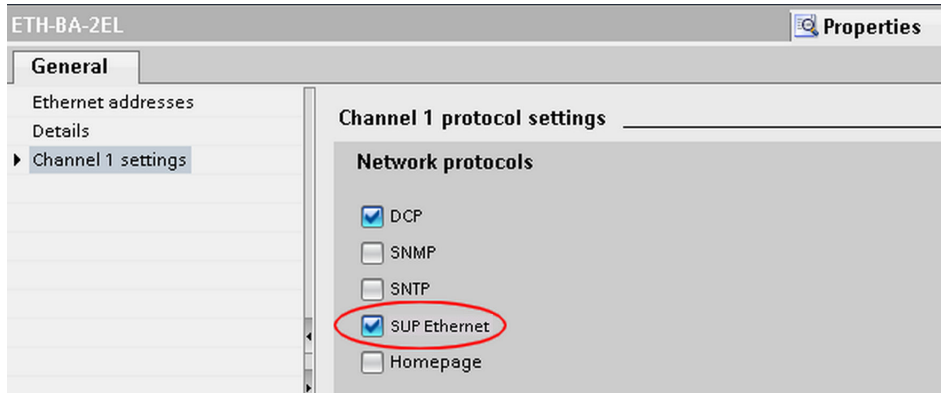


[sc_autcp1, 1, en_US]

Figure 5-41 Inserting an Ethernet Module

Communication Settings

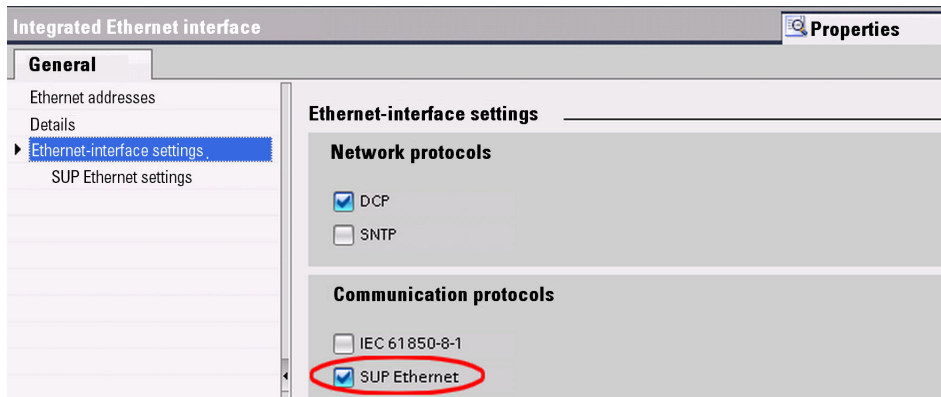
Activate the SUP Ethernet protocol for the Ethernet module.



[sc_autcp2, 1, en_US]

Figure 5-42 SUP Ethernet Protocol Activation

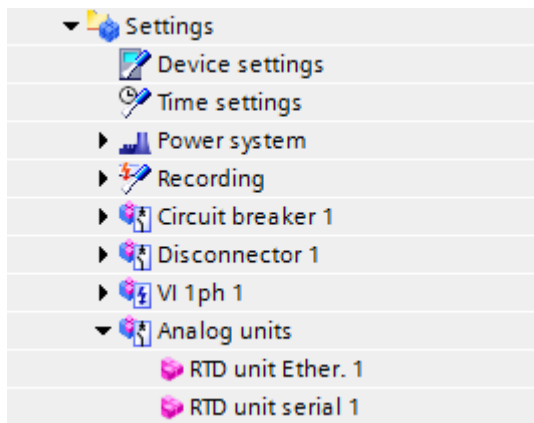
This protocol is also available for Port J of the integrated Ethernet interface of the base module (refer to following figure).



[sc_autcp3, 1, en_US]

Figure 5-43 SUP Ethernet Protocol Activation (Base Module)

With the selection of the SUP protocol for the RTD unit, DIGSI automatically adds the **Analog units** function group and the **RTD unit Ether.** function to your device configuration (refer to the following figure).



[sc_auser6, 1, en_US]

Figure 5-44 Analog Unit Instance

Now, set the port over which the SUP protocol runs. In addition, set the IP address of the RTD unit (refer to the following figure). This address must be set with the same value in the RTD unit.

General

826.1761.2311.103
826.1761.2311.104

Port: port F
IP address: 10 . 16 . 60 . 1

Add new stage Delete stage

[sc_autcp5, 1, en_US]

Figure 5-45 Setting the Port and IP Address

Finally, load the configuration in the device.

5.2.9.3 Temperature Simulation without Sensors

Connect a resistor on the sensor terminals of the RTD unit. Using this resistor, simulate a constant temperature. The resistance value should be around 50 Ω to 200 Ω .

If you want to simulate a changeable temperature, connect an adjustable resistor of maximum 470 Ω instead of a fixed resistor.

5.2.10 Temperature Acquisition via Protocols

5.2.10.1 Overview

The function **Temperature acquisition via protocols**:

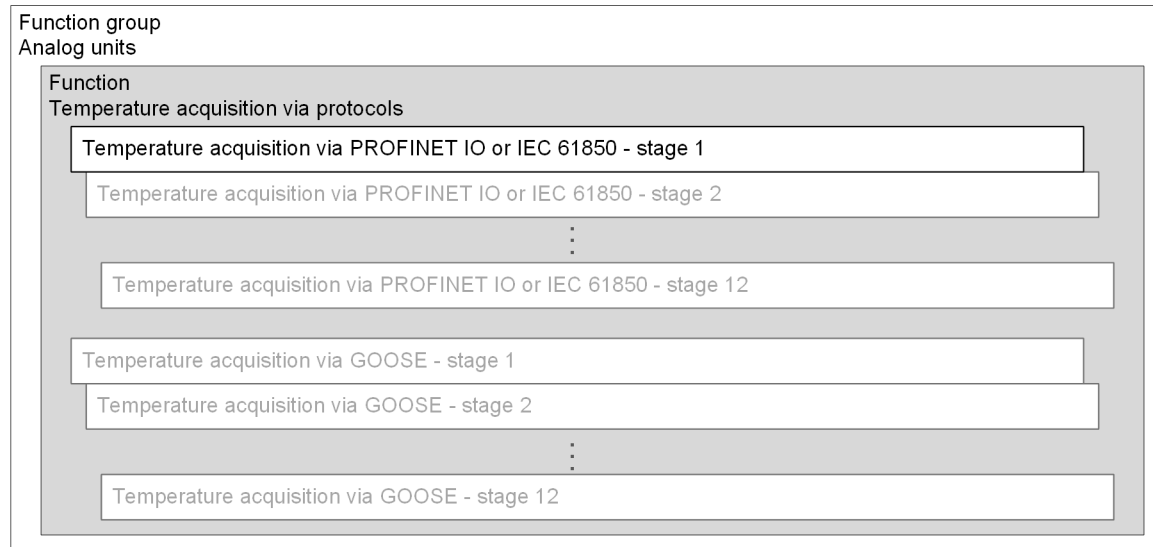
- Obtains the temperature from a power-plant control system or from another protection device
- Processes the temperature, for example, supervises the temperature in the CFC
- Transfers the temperature to other protection devices

5.2.10.2 Structure of the Function

The function **Temperature acquisition via protocols** can work only in the function group **Analog units**. In this function, the following stages can operate simultaneously:

- 12 stages **Temperature acquisition via PROFINET IO or IEC 61850**
The stage can obtain the temperature from a power-plant control system via the PROFINET IO protocol or the IEC 61850 protocol.
- 12 stages **Temperature acquisition via GOOSE**
The stage can obtain the temperature from another SIPROTEC 5 protection device via the GOOSE protocol.

The function **Temperature acquisition via protocols** comes factory-set with 1 stage **Temperature acquisition via PROFINET IO or IEC 61850**.

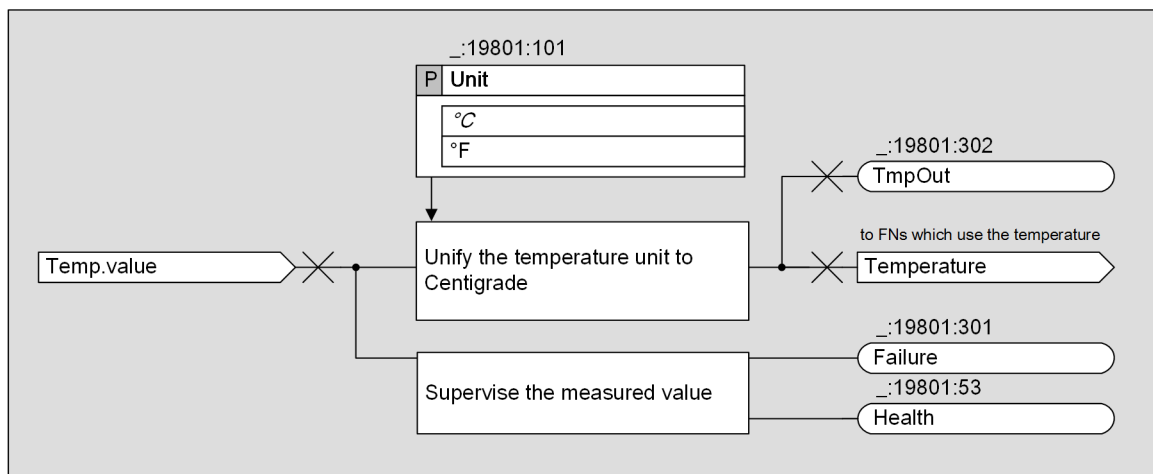


[dw_structure_TmpviaProt, 1, en_US]

Figure 5-46 Structure/Embedding of the Function

5.2.10.3 Stage Temperature Acquisition via PROFINET IO or IEC 61850

Logic



[lo_tmppval, 1, en_US]

Figure 5-47 Logic Diagram of the Stage

The stage **Temperature acquisition via PROFINET IO or IEC 61850** supports 2 protocols:

- PROFINET IO protocol
If you set the PROFINET IO protocol for the temperature acquisition, you can only get the analog value.
- IEC 61850 protocol
If you set the IEC 61850 protocol for the temperature acquisition, you get the analog value, the quality, and the time stamp.

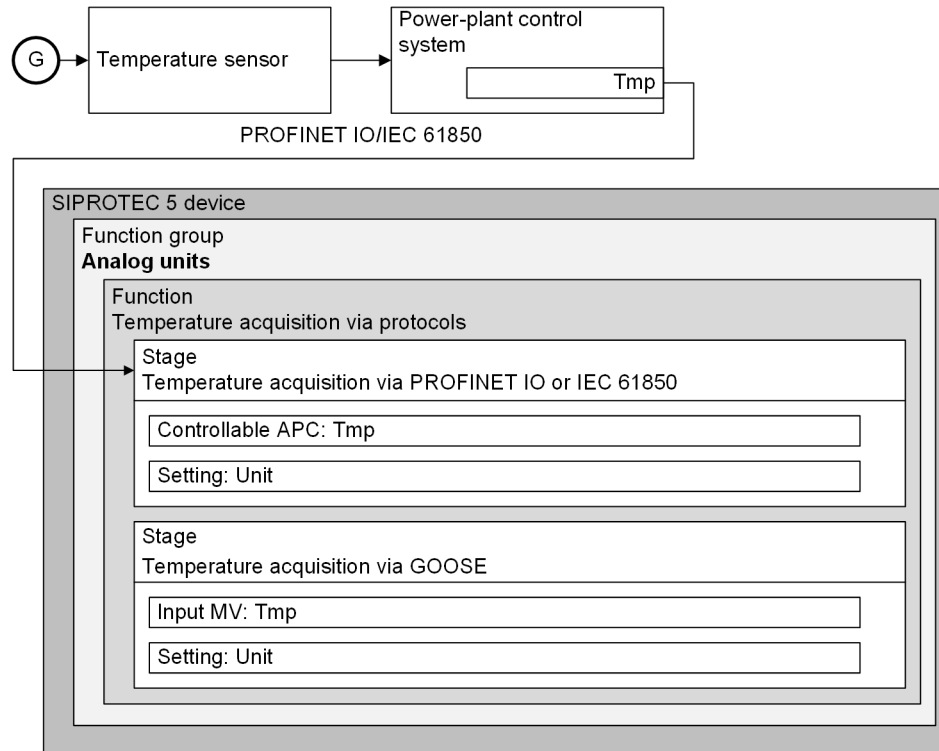
Invalid Temperature Indication

If the received temperature is invalid, the failure indication *Temperature failure* is issued.

Stage Application

You can use the stage **Temperature acquisition via PROFINET IO or IEC 61850** for the following purposes:

- Acquire the cold-gas temperature from the power-plant control system
- Process the received cold-gas temperature value
- Send the processed cold-gas temperature value to other functions for further processing



[dw_app-example_IEC, 1, en_US]

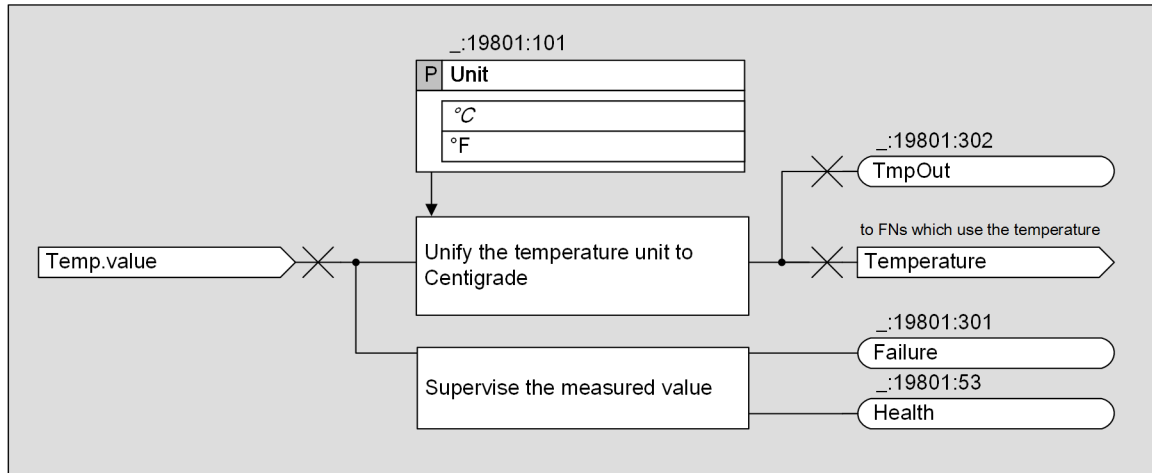
Figure 5-48 Application Example

The following table explains the data.

Data Name	Description
Tmp	With this variable, you can set the PROFINET IO protocol or the IEC 61850 protocol for the temperature acquisition. In the stage Temperature acquisition via PROFINET IO or IEC 61850 , the data type is APC.
Unit	With this parameter, you can select the unit °F or °C for the temperature which is acquired from the power-plant control system.

5.2.10.4 Stage Temperature Acquisition via GOOSE

Logic



[lo_tmprval, 1, en_US]

Figure 5-49 Logic Diagram of the Stage

Invalid Temperature Indication

If the received temperature is invalid, the failure indication *Temperature failure* is issued.

Stage Application

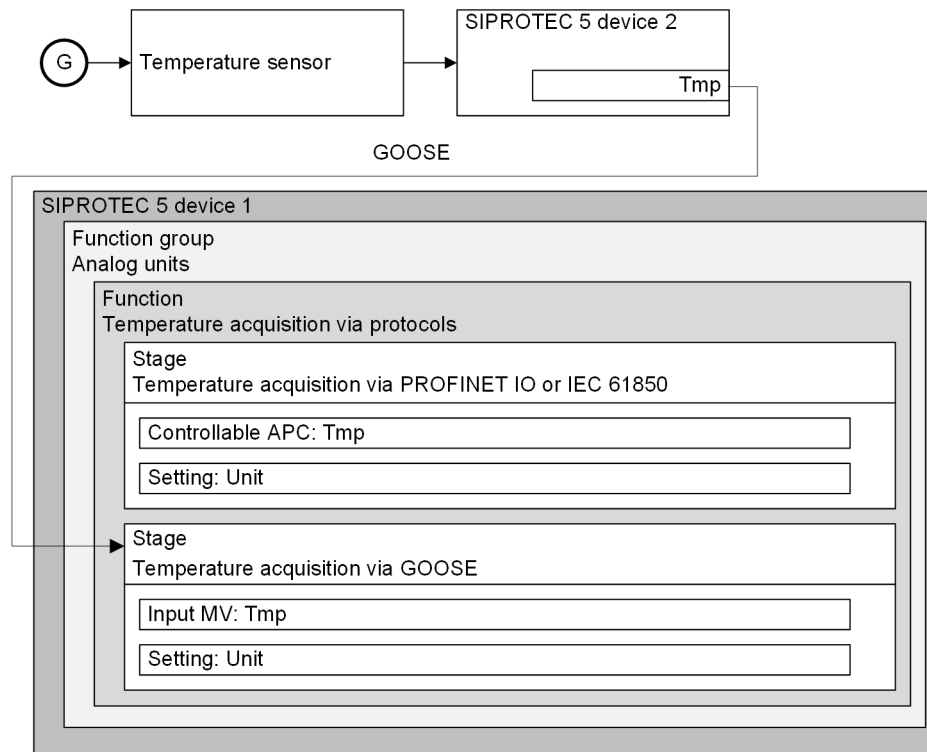
The following terms are used for the stage **Temperature acquisition via GOOSE**:

- Source device
SIPROTEC 5 protection device that provides data
- Target device
SIPROTEC 5 protection device that requests data from the source device

In the target device, you can use the stage **Temperature acquisition via GOOSE** for the following purposes:

- Acquire the cold-gas temperature from the source device
- Process the received cold-gas temperature value
- Send the processed cold-gas temperature value to other functions for further processing

In the following figure, the source device is SIPROTEC 5 device 2 and the target device is SIPROTEC 5 device 1.



[dw_app-example_GOOSE, 2, en_US]

Figure 5-50 Application Example

The following table explains the data.

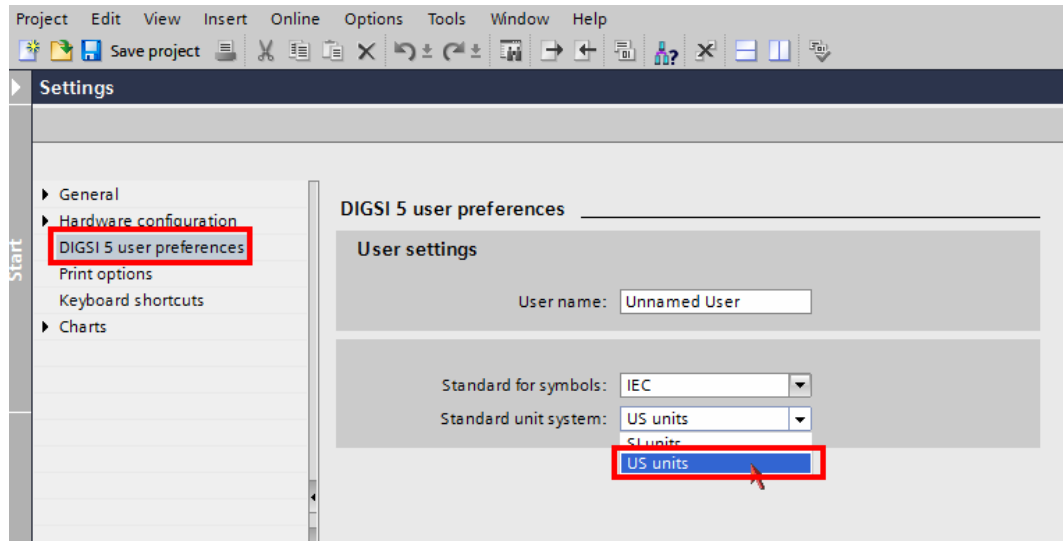
Data Name	Description
Tmp	With this variable, you can set the GOOSE protocol for the temperature acquisition. In the stage Temperature acquisition via GOOSE , the input measured value with a COM template is designed to acquire the data from another SIPROTEC 5 protection device.
Unit	With this parameter, you can select the unit °F or °C for the temperature which is acquired from another SIPROTEC 5 protection device.

5.2.10.5 Application and Setting Notes

Change of the Temperature Unit

Commonly, the temperature unit °C is used in the display and evaluation of measured temperature values.

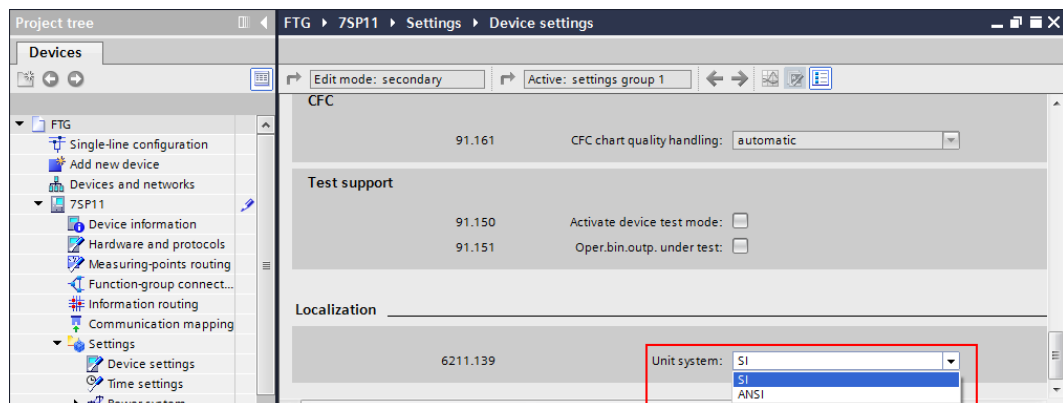
- To change the temperature unit from °C to °F for all devices in the current DIGSI project, proceed as follows:
 - In DIGSI, select the menu item **Options > Settings**.
 - In the **Settings** view, select the menu item **DIGSI 5 user preferences**.
 - Set the parameter **Standard unit system** to **US units**.



[scfahrt-190214-01, 1, en_US]

Figure 5-51 Change of the Temperature Unit between °C and °F for all Devices

- To change the temperature unit from °C to °F for 1 device, proceed as follows:
 - In the project tree, navigate to your device and select **Settings > Device settings**.
 - In the **Device settings** view, navigate to the menu item **Localization**.
 - Set the parameter **Unit system** to **ANSI**.



[sc_SITmp, 1, en_US]

Figure 5-52 Change of the Temperature Unit between °C and °F for 1 Device



NOTE

If the parameter **Unit system** is set to **ANSI**, only the unit of the measuring values and parameters changes to °F.

The unit of the following data is still °C:

- Other temperature data in the device
- The temperature thresholds in DCF

Parameter: Unit

- Default setting (**_:19801:101**) **Unit** = °C

You use the setting **Unit** to specify which physical unit of the source data the measured values represent. The possible setting values are listed in the settings table.

5.2.10.6 Settings

Addr.	Parameter	C	Setting Options	Default Setting
<i>Tmp.Ctl 1</i>				
_:19801:101	Tmp.Ctl 1:Unit		• °C • °F	°C

5.2.10.7 Information List

No.	Information	Data Class (Type)	Type
<i>Tmp.Ctl 1</i>			
_:19801:300	Tmp.Ctl 1:Tmp	APC	C
_:19801:53	Tmp.Ctl 1:Health	ENS	O
_:19801:301	Tmp.Ctl 1:Failure	SPS	O
_:19801:302	Tmp.Ctl 1:TmpOut	MV	O

6 Control Functions

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6.1 Introduction

6.1.1 Overview

The SIPROTEC 5 series of devices offers powerful command processing capability as well as additional functions that are needed when serving as bay controllers for the substation automation technology or when providing combi-protection. The object model for the devices is based on the IEC 61850 standard, making the SIPROTEC 5 series of devices ideally suited for use in systems employing the IEC 61850 communication protocol. In view of the function blocks necessary for the control functions, other logs are also used.

6.1.2 Concept of Controllables

The concept of so-called controllables is based on the data model described in IEC 61850. Controllables are objects that can be controlled, such as a switch with feedback. The model of a transformer tap changer, for example, contains controllables. The controllables are identifiable by their last letter **C** of the data type (for example, DPC = Double Point Controllable/Double Command with feedback or BSC = Binary-Controlled Step Position Indication / transformer tap command with feedback).

Information			Source			
			Binary input			
			Basismodul			
Signals	Number	Type	1.1	1.2	1.3	1.4
(All)	(All)	...	...	...	...	...
▼ Circuit break.	202.4261		*	*		
▶ >Ready	202.4261.500	SPS				
▶ >Acquisition blocking	202.4261.501	SPS				
▶ >Reset switch statist.	202.4261.502	SPS				
▶ >Reset AcqBlk&Subst	202.4261.504	SPS				
▶ >External health	202.4261.503	ENS				
▶ >Health	202.4261.53	ENS				
▼ Position	202.4261.58	DPC	OH	CH		
▶ not selected		SPS				
▶ open		SPS				
▶ closed		SPS				
▶ intermediate posi...		SPS				
▶ disturbed position		SPS				
▶ acquisition blk. ac...		SPS				
▶ manual update ac...		SPS				
▶ Trip/open cmd.	202.4261.300	SPS				
▶ Close command	202.4261.301	SPS				
▶ Command active	202.4261.302	SPS				
▶ Definitive trip	202.4261.303	SPS				
▶ Alarm suppression	202.4261.304	SPS				
▶ Op.ct.	202.4261.306	INS				
▶ Break-current phs A	202.4261.311	MV				
▶ Break-current phs B	202.4261.312	MV				
▶ Break-current phs C	202.4261.313	MV				
▶ Break. voltage phs A	202.4261.314	MV				
▶ Break. voltage phs B	202.4261.315	MV				
▶ Break. voltage phs C	202.4261.316	MV				

[sc_control, 1, en_US]

- (1) Position (connect with binary inputs)
- (2) Signalization of the current condition
- (3) Command output (connect with relay)

The trip, opening, and the close commands are connected to the relays. For the trip command, a choice between saved and unsaved output is possible. The position is connected with 2 binary inputs (double-point indication). In addition, signals are available that display the current state of the switch (**not selected**, **off**, **on**, **intermediate position**, **disturbed position**). These signals can be queried in CFC, for example, in order to build interlocking conditions.

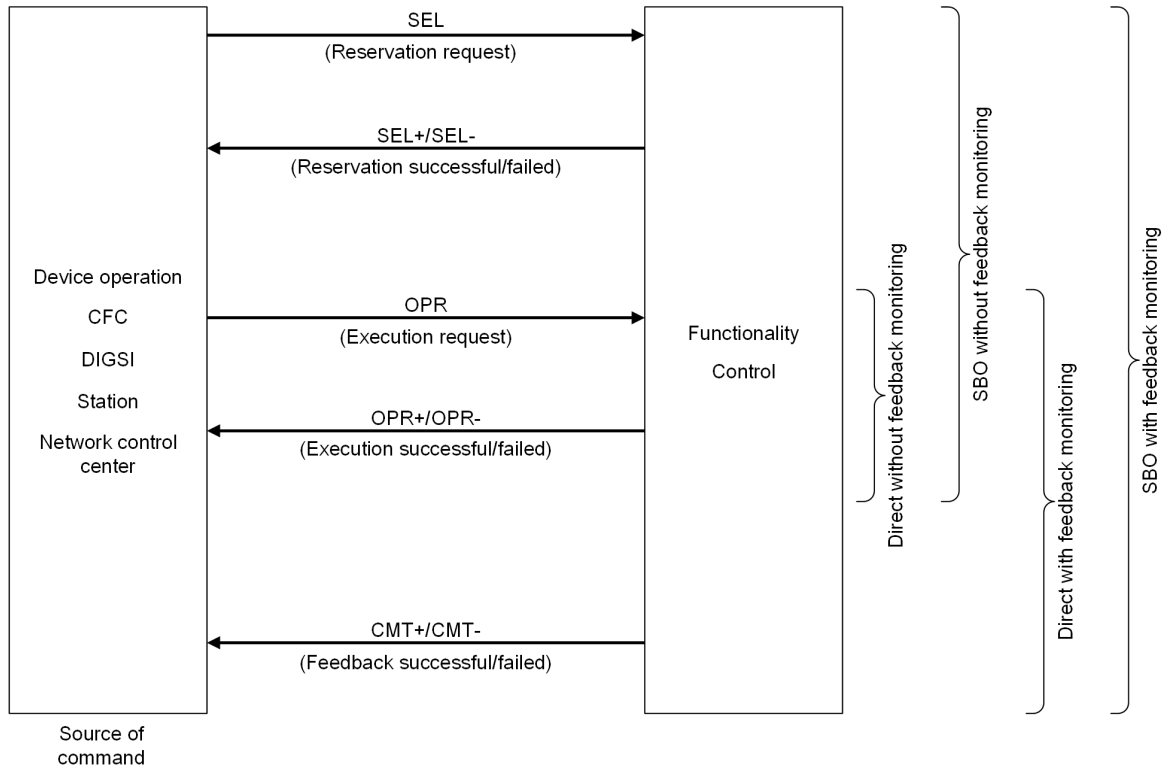
Control Models

You can set the operating mode of the controllables by selecting the control model.

4 different control models are available:

- Direct without feedback monitoring (**direct w. normal secur.**)
- With reservation (SBO)¹⁴ without feedback monitoring (**SBO w. normal secur.**)
- Direct with feedback monitoring (**direct w. enh. security**)
- With SBO with feedback monitoring (**SBO w. enh. security**)

The next figure shows the command sources, command types, and control models.



[dw_steuer, 2, en_US]

Figure 6-1 Command Sources, Command Types, and Control Models

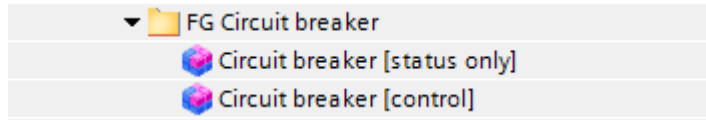
The figure shows the control models (right) with the respective control mechanisms (center). The standard control model for a switching command in an IEC 61850 compliant system is **SBO with feedback monitoring** (**SBO w. enh. security**). This control model is the default setting for newly created switching devices.

¹⁴ SBO: Select Before Operate

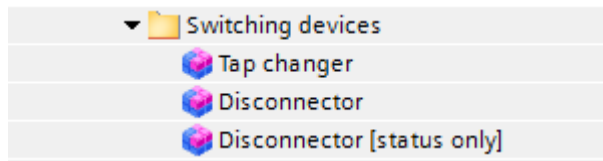
6.2 Switching Devices

6.2.1 General Overview

You can find the following switching devices in the DIGSI 5 library in the function groups **Circuit breaker** and **Switching devices** (see following figures).



[sc_cb_2ausw, 1, en_US]



[scswausw, 1, en_US]

Figure 6-2 Selecting the Remaining Switching Devices Using the DIGSI Switching-Devices Menu

6.2.2 Switching Device Circuit Breaker

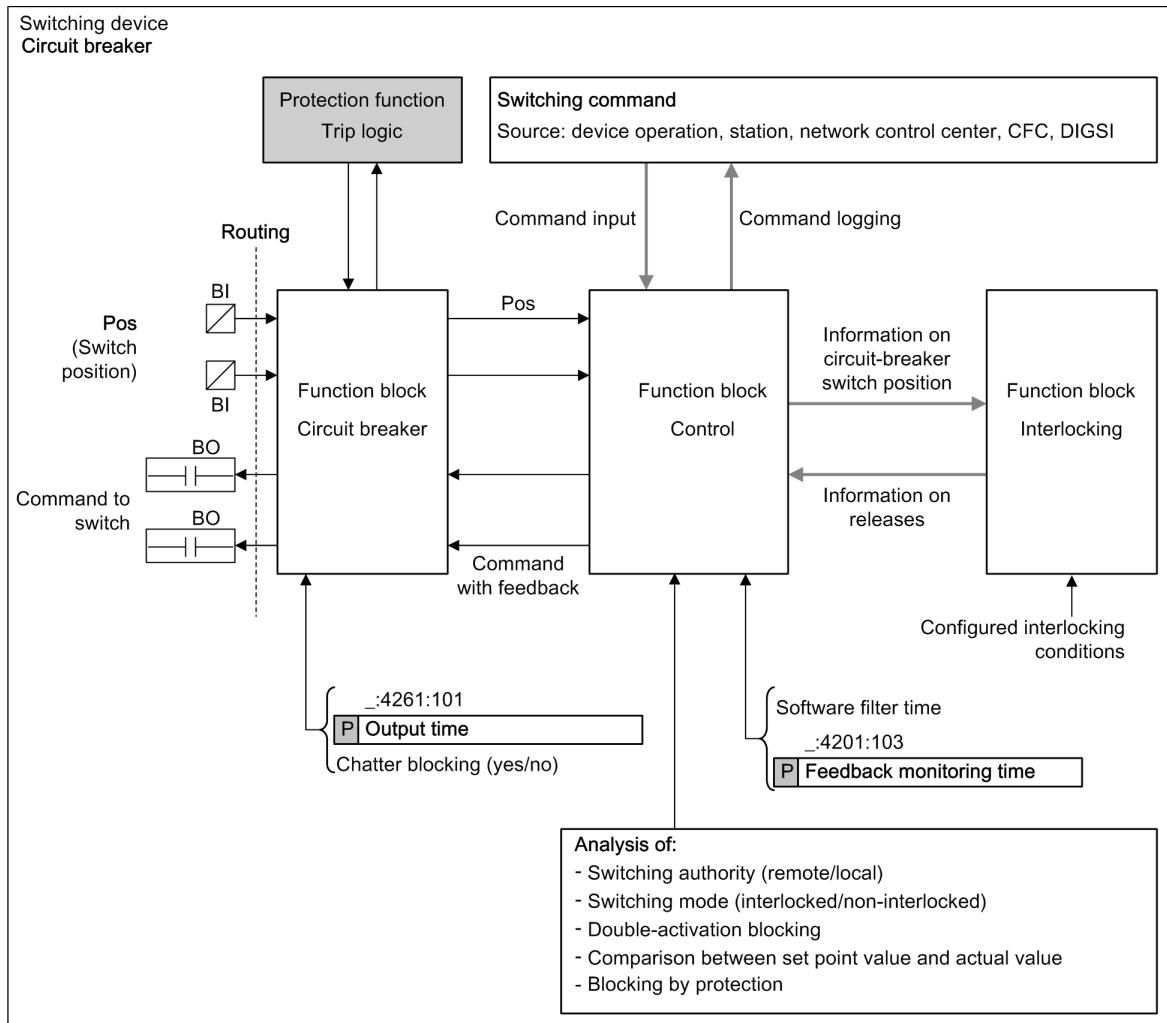
6.2.2.1 Structure of the Circuit-Breaker Switching Device

This chapter describes the control properties of the **Circuit-breaker** switching device.

The **Circuit-breaker** switching device contains the following function blocks that are needed for control:

- Function block **Circuit breaker**
- Function block **Control**
- Function block **Interlocking**

This corresponds to the logical nodes XCBR, CSWI, and CILO in IEC 61850.



[dw_breake, 1, en_US]

Figure 6-3 Control Function Blocks of the Circuit-Breaker Switching Device

The circuit breaker in DIGSI 5 is linked with the binary inputs that acquire the switch position via information routing. The circuit breaker in DIGSI 5 is also linked with the binary outputs that issue the switching commands.

The **Circuit-breaker** switching device is available in the DIGSI 5 library in 2 different variants:

- **Circuit-breaker control**

This switching device contains the function blocks **Control**, **Interlocking**, and **Circuit breaker** needed for control. The standard situation for the control function is that the SIPROTEC 5 device switches all 3 poles of the circuit breaker **On** or **Off** together.

- **Circuit breaker [status only]**

This switching device contains only the function block **Circuit breaker**. It is used to acquire the position of a switch, for example, from a neighboring bay. This object type can be used to model switches that can only be read but not controlled by the SIPROTEC 5 device.

Function Blocks of the Circuit Breaker

Table 6-1 Function Blocks of the Circuit-Breaker Function Group

Function Block	Description	Parameter	Function
Circuit breaker	The Circuit-breaker function block in the SIPROTEC 5 device represents the physical switch.	Output time	The circuit breaker forms the switch position from the positions of the binary inputs and also outputs the command via the binary outputs.
Control	Command processing	Control model SBO time-out Feedback monitoring time Check switching authority Check if pos. is reached Check double activat. blk. Check blk. by protection	Command check, communication with the command source and with the function block Circuit breaker
Interlocking	Switchgear interlocking protection	Interlocking condition (deposited in CFC)	The functionality Interlocking generates the releases for switchgear interlocking protection.

For the setting values of the parameter, refer to [6.2.2.2 Application and Setting Notes](#).

Additional Setting Options of the Circuit-Breaker Switching Element

The setting options of the circuit breaker are assigned to the function blocks on the basis of their relevance. Additional setting options of the circuit breakers that cannot be directly assigned to one of the 3 function blocks are nevertheless available:

Table 6-2 Setting Options of the Controllable **Cmd. with feedback** in the Function Block **Control** of the Circuit Breaker.

Properties	Function	To Be Found in
Software filtering time	Software filtering time for position detection	Position of the function block Control ¹⁵
Retrigger filter (yes/no)	Switching retriggering of the filtering time on/off by changing the position	Position of the function block Control ¹⁵
Message time before filtering (yes/no)	Consideration of the hardware filtering time for position-detection time stamp	Position of the function block Control ¹⁵
Suppress intermediate position (yes/no)	When activated, only the intermediate position is suppressed by the duration of the software filtering time.	Position of the function block Control ¹⁵

¹⁵ First click **Position** and then click the **Details** key in the **Properties** window (below).

Properties	Function	To Be Found in
Treatment of spontaneous position changes (Gen. Software Filt./Spont. Software Filt.)	If you select the General software filter setting, the general settings for software filtering of spontaneous position changes and for position changes caused by a switching command apply. By selecting Spontaneous software filter , a separate filtering is activated for spontaneous position changes.	Position of the function block Control ¹⁵
Spontaneous software filtering time	Software filtering time for spontaneous position changes	Position of the function block Control ¹⁵
Spontaneous retrigger filter (yes/no)	Switching on/off retriggering of the filtering time by spontaneous position change	Position of the function block Control ¹⁵
Spontaneous indication timestamp before filtering (yes/no)	Consideration of the hardware filtering time for position-detection time stamp in case of a spontaneous change	Position of the function block Control ¹⁵
Inhibit intermediate position for a spontaneous chng. (yes/no)	When activated, only the spontaneous change to the intermediate position is suppressed by the duration of the software filtering time.	Position of the function block Control ¹⁵

Table 6-3 Setting Options of the Controllable **Position** in the Circuit-Breaker Function Block (Chatter Blocking)

Properties	Function	To Be Found in
Chatter blocking (yes/no)	Switching chatter blocking on/off	Position of the function block Circuit breaker ¹⁵

Table 6-4 Additional Settings in the Device Settings Having Effects on the Circuit Breaker

Properties	Function	To Be Found in
Number of permissible status changes	Chatter-blocking setting value: Once for the entire device	Device settings (to be found under Settings)
Chatter test time		
Number of chatter tests		
Chatter idle time		
Chatter check time		

The inputs and outputs as well as the setting options of the function blocks **Circuit breaker** and **Control** are described in the next section (refer to [6.2.2.3 Connection Variants of the Circuit Breaker](#)).

Interlocking

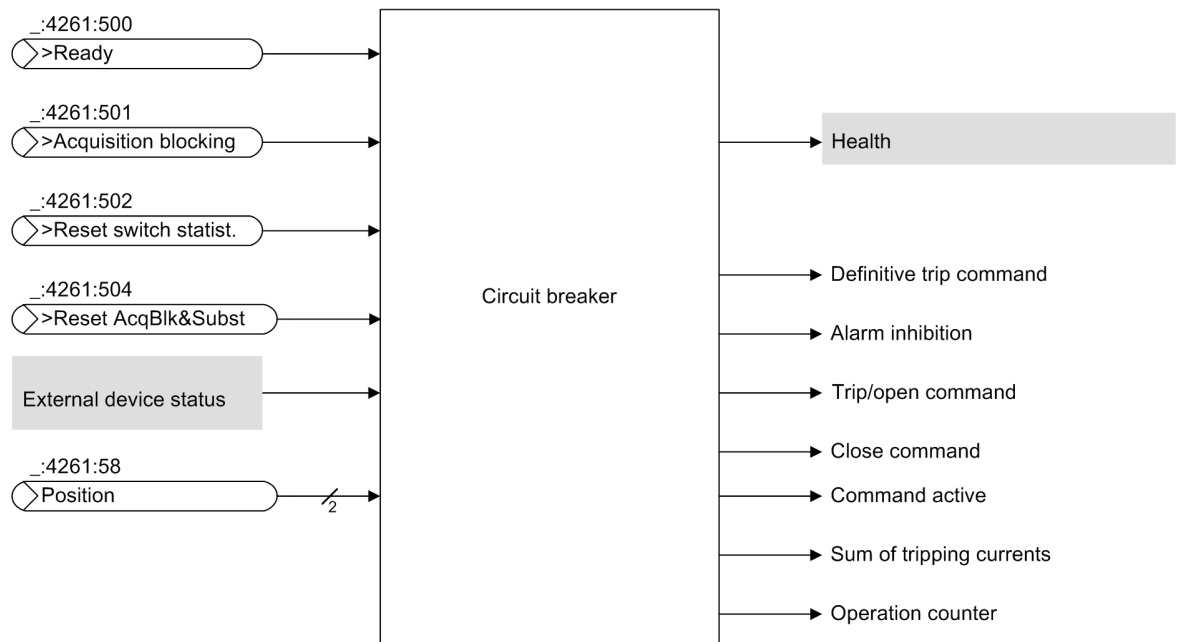
The function block **Interlocking** generates the releases for switchgear interlocking protection. The actual interlocking conditions are deposited in CFC. For more information on this, refer to the general chapter [6.3.1 Command Checks and Switchgear Interlocking Protection](#).

6.2.2.2 Application and Setting Notes

Circuit Breaker

The Circuit-breaker function block in the SIPROTEC 5 device represents the physical switch device. The task of the circuit breaker is to replicate the switch position from the status of the binary inputs.

The following figure shows the logical inputs and outputs of the **Circuit-breaker** function block.



[dw_func_is, 2, en_US]

Figure 6-4 Logical Inputs and Outputs of the Circuit-Breaker Function Blocks

[Table 6-5](#) and [Table 6-6](#) list the inputs and outputs with a description of their function and type. For inputs, the effect of **Quality = invalid** on the value of the signal is described.

EXAMPLE

If the signal `>Ready` has the **Quality = invalid**, then the value is set to **cleared**. In problematic operating states, the circuit breaker should signal that it is not ready for an **Off-On-Off cycle**.

Table 6-5 Inputs of the Circuit-Breaker Function Block

Signal Name	Description	Type	Default Value if Signal Quality = invalid
<code>>Ready</code>	The signal <code>>Ready</code> indicates that the OFF-ON-OFF cycle is possible with the circuit breaker. This signal is used for the AREC standby status.	SPS	Going
<code>>Acquisition blocking</code>	The binary input activates acquisition blocking. You can also set this binary input with an external toggle switch.	SPS	Unchanged
<code>>Reset AcqBlk&Subst</code>	Acquisition blocking and the substitution of the circuit breaker are reset with this input. If the input is activated, setting the acquisition blocking and the substitution is blocked.	SPS	Unchanged
<code>>Reset switch statist.</code>	Among other things, the binary input sets the operation counter for the switch to the value 0.	SPS	Unchanged

Signal Name	Description	Type	Default Value if Signal Quality = invalid
External health	The binary input External health reflects the circuit-breaker status (EHealth). This input will be set by the CFC using the BUILD_ENS block. In turn, BUILD_ENS can query binary inputs that represent the conditions <i>OK</i> , <i>Warning</i> , or <i>Alarm</i> (as a result of the function Trip-circuit supervision).	ENS	Unchanged
Position	The signal Position can be used to read the circuit-breaker position with double-point indication.	DPC	Unchanged

If the quality of the input signal assumes the status **Quality = invalid**, then the standby status (EHealth) of the **Circuit-breaker** function block is set to *warning*.

Table 6-6 Outputs of the Circuit-Breaker Function Block

Signal Name	Description	Type
Definitive trip	Protection has finally been tripped.	SPS
Alarm suppression	The signaling contact for external alarm inhibition is suppressed during the runtime of automatic reclosing (optional) as well as during the command output of switching commands.	SPS
Op.ct.	The information counts the number of switching cycles of the circuit breaker.	INS
Trip/open cmd.	This logic output is responsible for the command output Off .	SPS
Close command	This logic output is responsible for the command output On .	SPS
Command active	The binary output Command active is responsible for signaling a running command (relay active or selected switching device (SEL)).	SPS
CB open hours	The statistical value counts the hours the circuit breaker is open.	INS
Operating hours	The statistical value counts the hours where at least one phase current is greater than the Current thresh. CB open parameter.	INS

Control

It is the task of the controls to execute command checks and establish communication between the command source and the circuit breaker. Using the control settings, you specify how the commands are to be processed (see also chapter [6.3.1 Command Checks and Switchgear Interlocking Protection](#)).

Through the function SBO (Select Before Operate, reservation¹⁶), the switching device is reserved prior to the actual switching operation, thus it remains locked for additional commands. Feedback monitoring provides information about the initiator of the command while the command is in process, that means, informing whether or not the command was implemented successfully. These 2 options can be selected individually in the selection of the control model, so that 4 combinations in total are available (see the following table).

The control makes the following settings available (see next table).

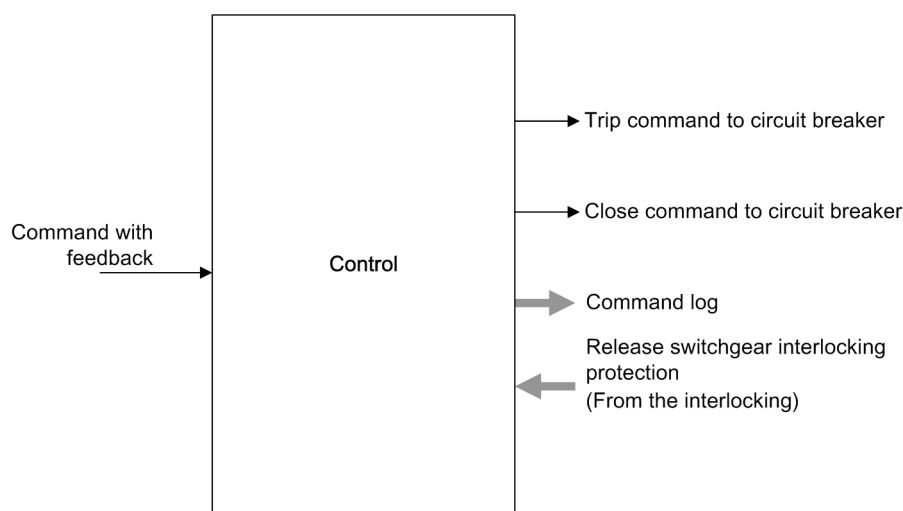
Parameters	Default Setting	Possible Parameter Values
(_:4201:101) Control model	<i>SBO w. enh. security</i> ¹⁷	<i>direct w. normal secur.</i> <i>SBO w. normal secur.</i> <i>direct w. enh. security</i> <i>SBO w. enh. security</i>
(_:4201:102) SBO time-out	<i>30.00 s</i>	0.01 s to 1800 s (Increment: 0.01 s)

¹⁶ In the IEC 61850 standard, reservation is described as **Select before Operate (SBO)**.

¹⁷ This default setting is the standard control model for a switching command in an IEC 61850-compliant system.

Parameters	Default Setting	Possible Parameter Values
(_:4201:103) Feedback monitoring time	1.00 s	0.01 s to 1800 s (Increment: 0.01 s)
(_:4201:104) Check switching authority	yes	no yes advanced
(_:4201:105) Check if pos. is reached	yes	no yes
(_:4201:106) Check double activat. blk.	yes	no yes
(_:4201:107) Check blk. by protection	yes	no yes

The following figure shows the logical inputs and outputs of the **Control** function block.



[dw_steuer1, 1, en_US]

Figure 6-5 Logical Inputs and Outputs of the Control Function Block

Table 6-7 Control Function Block Input and Output

Signal Name	Description	Type	Value if Signal Quality=Invalid
Cmd. with feedback	With the Cmd. with feedback signal, the circuit-breaker position is accepted via the double-point indication of the Circuit-breaker function block and the command is issued.	Controllable (DPC) Unchanged	Unchanged

In the information routing of DIGSI 5, you may select a function key as a possible command source. In addition, it is displayed here if the command is activated by CFC. The logging is routed here.

6.2.2.3 Connection Variants of the Circuit Breaker

For each switching device, you can establish the number of poles (for example, 1-pole, 1.5-pole or 2-pole) that are switched with or without feedback. This results in the necessary amount of information to be processed, thus establishing the command type.

Whether the circuit breaker is triggered 1-, 1.5-, or 2-pole, depends on the design of the auxiliary and control-voltage system. In most cases, the activation of the opening coil of the circuit breaker is 1-pole.

Table 6-8 Meaning of the Abbreviations of the Connection Variants

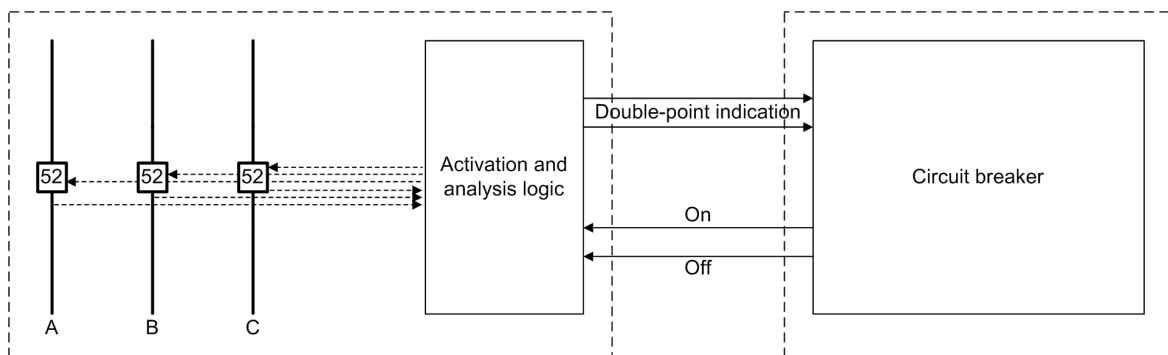
Abbreviation	Meaning of the Abbreviation of the Connection Variants
BO	Binary output
L+; L-	Control voltage
A	Trip command
Gnd	Close command

Table 6-9 Meaning of the Abbreviations in DIGSI

Abbreviation	Description of the Input in DIGSI
V	Unsaved trip command Click the right mouse button and enter V .
X	Close Command Click the right mouse button and enter X for the respective binary output.
OH	The switching-device feedback is in the position OFF , if there is voltage present at the routed binary input (H). Click the right mouse button and enter OH .
OL	The switching-device feedback is in the position OFF , if there is no voltage present at the routed binary input (L). Click the right mouse button and enter OL .
CH	The switching-device feedback is in the position ON , if there is voltage present at the routed binary input (H). Click the right mouse button and enter CH .
CL	The switching-device feedback is in the position ON , if there is no voltage present at the routed binary input (H). Click the right mouse button and enter CL .
TL	Trip command stored Click the right mouse button and enter TL .

Connection Variant: 3-Pole Circuit Breaker

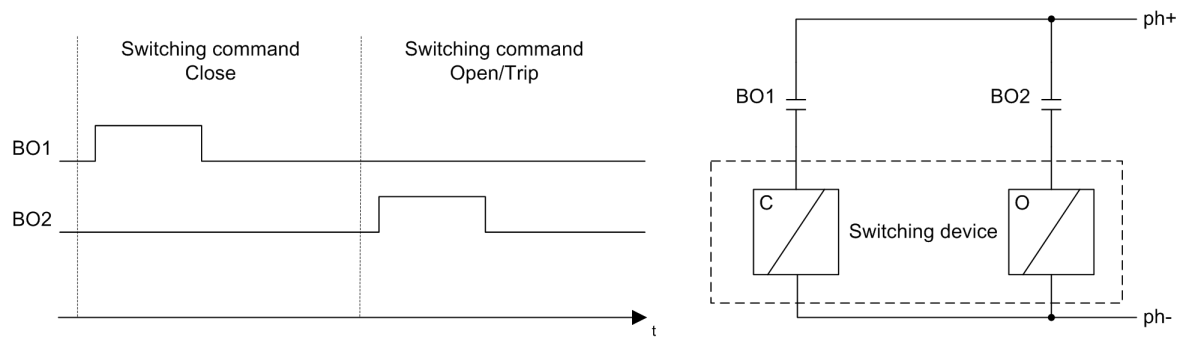
This is the standard type for the control function. All 3 individual poles of the circuit breaker are triggered together by a double command.



[dw_3-pole_ls, 1, en_US]

Figure 6-6 3-Pole Circuit Breaker

1-Pole Triggering



[dw_1-pole, 1, en_US]

Figure 6-7 1-Pole Triggering

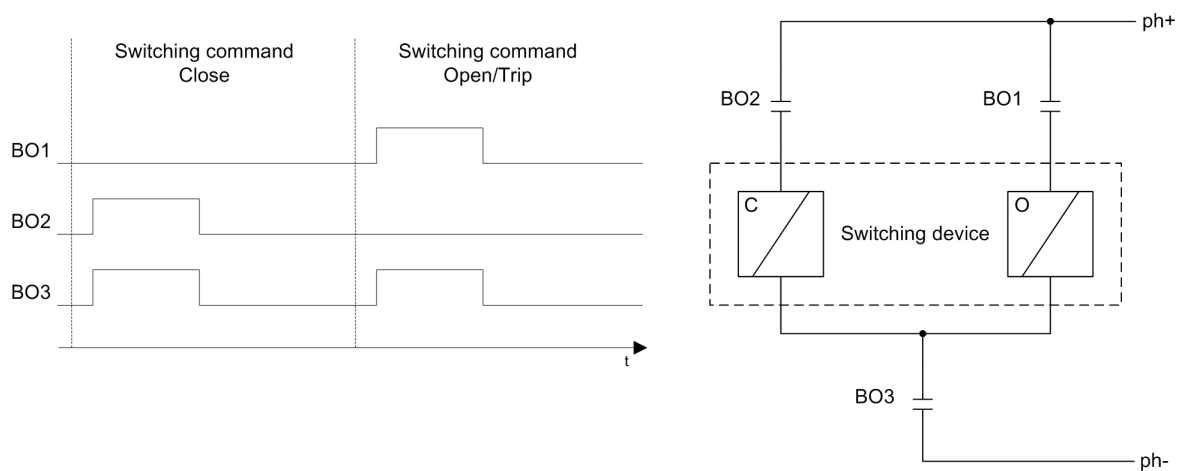
Information			▼ S	► Destination				
				► Binary output				
				► Base module				
Signals	Number	Type		1.1	1.2	1.3	1.4	1.5
(All)	(All)	...	▼	...	...	...	...	...
► Trip logic	301.5341							
▼ Circuit break.	301.4261			*	*			
► >Ready	301.4261.500	SPS						
► >Acquisition blocking	301.4261.501	SPS						
► >Reset switch statist.	301.4261.502	SPS						
► >Reset AcqBlk&Subst	301.4261.504	SPS						
► External health	301.4261.503	ENS						
► Health	301.4261.53	ENS						
► Position 3-pole	301.4261.58	DPC						
► Position 1-pole phsA	301.4261.459	DPC						
► Position 1-pole phsB	301.4261.460	DPC						
► Position 1-pole phsC	301.4261.461	DPC						
► Trip/open cmd. 3-pole	301.4261.300	SPS			U			
► Trip only pole A	301.4261.401	SPS						
► Trip only pole B	301.4261.402	SPS						
► Trip only pole C	301.4261.403	SPS						
► Close command	301.4261.301	SPS		X				

[sc_rang1p_cb1p, 1, en_US]

Figure 6-8 1-Pole Triggering, Routing in DIGSI

You can select the contacts for **On** and **Off** as desired. They need not necessarily be next to one another. The letter **U** represents an unlatched command. Alternatively, **TL** (latched tripping) can be selected.

1.5-Pole Triggering



[dw_5-pole, 1, en_US]

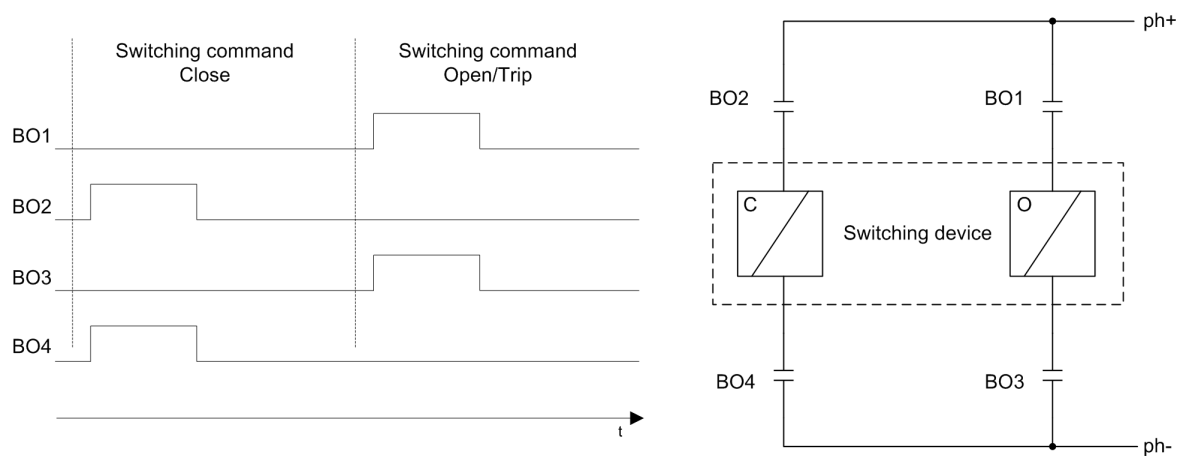
Figure 6-9 1.5-Pole Triggering

Information			▼ S	► Destination				
				► Binary output				
				► Base module				
Signals	Number	Type		1.1	1.2	1.3	1.4	1.5
(All)	(All)	...	...	...	...	...	...	...
► Trip logic	301.5341							
▼ Circuit break.	301.4261			*	*	*		
► Ready	301.4261.500	SPS						
► Acquisition blocking	301.4261.501	SPS						
► Reset switch statist.	301.4261.502	SPS						
► Reset AcqBlk&Subst	301.4261.504	SPS						
► External health	301.4261.503	ENS						
► Health	301.4261.53	ENS						
► Position 3-pole	301.4261.58	DPC						
► Position 1-pole phsA	301.4261.459	DPC						
► Position 1-pole phsB	301.4261.460	DPC						
► Position 1-pole phsC	301.4261.461	DPC						
► Trip/open cmd. 3-pole	301.4261.300	SPS		U		U		
► Trip only pole A	301.4261.401	SPS						
► Trip only pole B	301.4261.402	SPS						
► Trip only pole C	301.4261.403	SPS						
► Close command	301.4261.301	SPS			X	X		

[sc_rang_1p_cb15p, 1, en_US]

Figure 6-10 1.5-Pole Triggering, Routing in DIGSI

2-Pole Triggering



[dw_2-pole-open, 1, en_US]

Figure 6-11 2-Pole Triggering

Information			Source										Destination			
			Binary input										CF Binary output			
			Base module										Base module			
Signals	Number	Type	1.1	1.2	1.3	1.4	2.1	2.2	2.3			1.1	1.2	1.3	1.4	
(All)	(All)	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
Line 1	21															
Circuit breaker 1	301		*	*	*	*	*					*	*	*	*	
Trip logic	301.5341															
Circuit break.	301.4261		*	*	*	*	*					*	*	*	*	
>Ready	301.4261.500	SPS					H									
>Acquisition blocking	301.4261.501	SPS														
>Reset switch statist.	301.4261.502	SPS														
>Reset AcqBlk&Subst	301.4261.504	SPS														
External health	301.4261.503	ENS														
Health	301.4261.53	ENS														
Position 3-pole	301.4261.58	DPC	OH													
Position 1-pole phsA	301.4261.459	DPC		CH												
Position 1-pole phsB	301.4261.460	DPC			CH											
Position 1-pole phsC	301.4261.461	DPC				CH										
Trip/open cmd. 3-pole	301.4261.300	SPS										U	U	U		
Trip only pole A	301.4261.401	SPS										X				
Trip only pole B	301.4261.402	SPS											X			
Trip only pole C	301.4261.403	SPS												X		
Close command	301.4261.301	SPS													X	
Command active	301.4261.302	SPS														

[sc_rang_1p_cb13p, 1, en_US]

Figure 6-12 2-Pole Triggering, Routing in DIGSI

Connection Variant: 1-Pole Circuit Breaker

The 1-pole circuit breaker is used for separate activation and acquisition of the individual poles of a circuit breaker. It is intended for joint use by 1-pole protection and control functions.

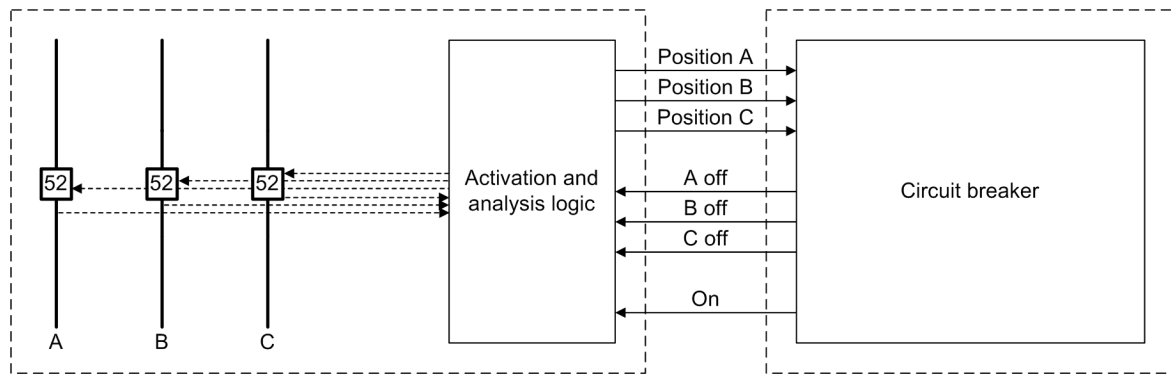


NOTE

The wiring of the **Circuit-breaker** function group with binary inputs and binary outputs occurs 1 time per device.

The control function in this type switches all 3 poles on or off simultaneously.

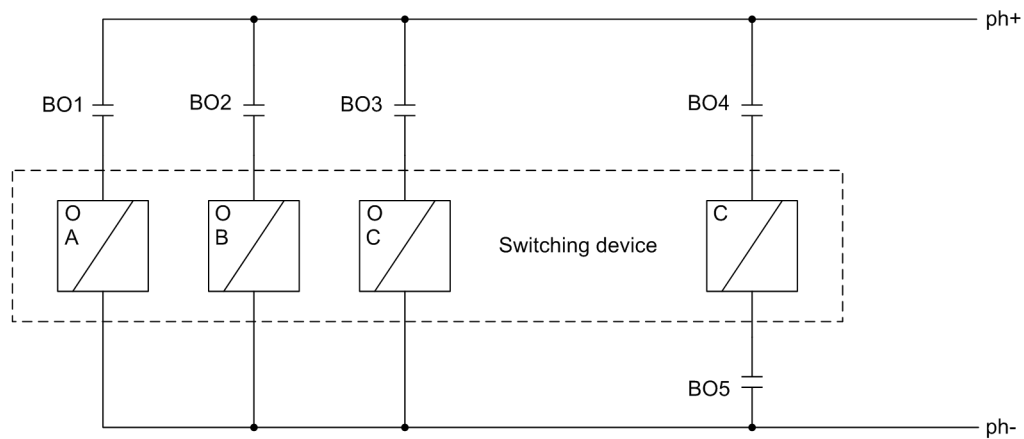
The protection functions can switch off 1-pole. The close command is always 3-pole. Optionally only the open poles are closed.



[dw_1polls, 1, en_US]

Figure 6-13 Circuit Breaker with 1-Pole Triggering

For the circuit breaker with 1-pole triggering, triggering takes place via one relay per phase for the trip command and via a 4th relay for the close command (see next figure).



[dw_1panis, 1, en_US]

Figure 6-14 1-Pole Connection of a Circuit Breaker

Information			▼ S	► Destination				
				► Binary output				
				► Base module				
Signals	Number	Type		1.1	1.2	1.3	1.4	1.5
(All) ▼	(All) ▼	... ▼	▼	...	...	...	...	...
► Trip logic	301.5341							
▼ Circuit break.	301.4261			*	*	*	*	*
► Ready	301.4261.500	SPS						
► Acquisition blocking	301.4261.501	SPS						
► Reset switch statist.	301.4261.502	SPS						
► Reset AcqBlk&Subst	301.4261.504	SPS						
► External health	301.4261.503	ENS						
► Health	301.4261.53	ENS						
► Position 3-pole	301.4261.58	DPC						
► Position 1-pole phsA	301.4261.459	DPC						
► Position 1-pole phsB	301.4261.460	DPC						
► Position 1-pole phsC	301.4261.461	DPC						
► Trip/open cmd. 3-pole	301.4261.300	SPS		U	U	U		
► Trip only pole A	301.4261.401	SPS		X				
► Trip only pole B	301.4261.402	SPS			X			
► Trip only pole C	301.4261.403	SPS				X		
► Close command	301.4261.301	SPS					X	X

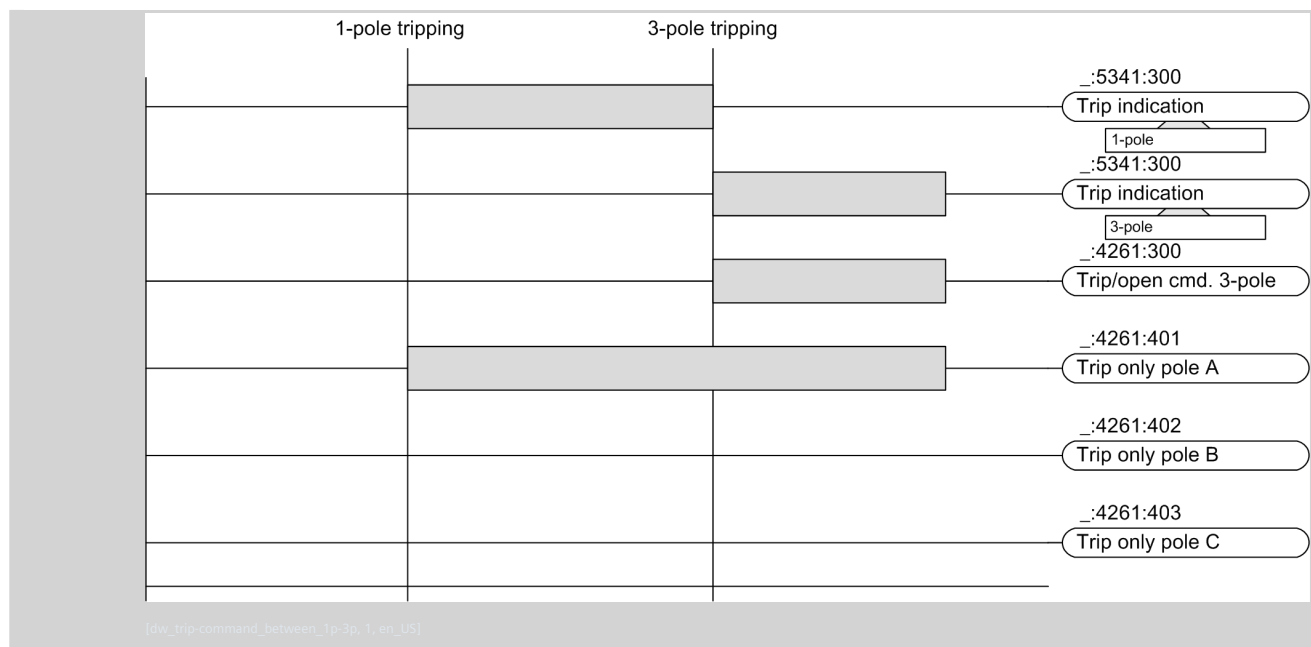
[sc_rang_1p_cb13pz, 1, en_US]

Figure 6-15 Routing in DIGSI

In the previous figure, the switch is connected 1-pole. The protection trip command is routed individually for the 3 phases (**Trip only pole A** to **Trip only pole C**). The protection trip command is routed for the 3 phases (**Trip/open cmd. 3-pole**). The control always switches off the 3 poles of the switch. In addition, the 3 U (Unlatched) routings of the trip command and open command are set to 3-pole. This routing is also used by protection functions that trip 3 poles. The close command is issued simultaneously for all 3 phases.

Example: Trip Command during Transition from 1-Pole to 3-Pole

During a transition from 1-pole to 3-pole tripping **Trip only pole A** remains active. When, for example informing an external AREC whether it is a 1-pole or 3-pole tripping, you can use the indication *Trip logic:Trip indication:1-pole* and *Trip logic:Trip indication:3-pole*.



Acquisition of the Circuit-Breaker Position

The binary inputs for feedback of the switch position are routed as shown in the previous figure (see also see [5.1.2.3 Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information](#)).

Information			Source			
			Binary input			
			Base module			
Signals	Number	Type	1.1	1.2	1.3	1.4
(All) ▼	(All) ▼	... ▼	... ▼	... ▼	... ▼	... ▼
▶ Line 1	21					
▼ Circuit breaker 1	301		*	*	*	*
▶ Trip logic	301.5341					
▼ Circuit break.	301.4261		*	*	*	*
▶ >Ready	301.4261.500	SPS				
▶ >Acquisition blocking	301.4261.501	SPS				
▶ >Reset switch statist.	301.4261.502	SPS				
▶ >Reset AcqBlk&Subst	301.4261.504	SPS				
▶ External health	301.4261.503	ENS				
▶ Health	301.4261.53	ENS				
▶ Position 3-pole	301.4261.58	DPC	OH			
▶ Position 1-pole phsA	301.4261.459	DPC		CH		
▶ Position 1-pole phsB	301.4261.460	DPC			CH	
▶ Position 1-pole phsC	301.4261.461	DPC				CH
▶ Trip/open cmd. 3-pole	301.4261.300	SPS				
▶ Trip only pole A	301.4261.401	SPS				
▶ Trip only pole B	301.4261.402	SPS				
▶ Trip only pole C	301.4261.403	SPS				
▶ Close command	301.4261.301	SPS				

[sc_rang_1p_cb_Hk, 1, en_US]

Figure 6-16 Routing of the 1-Pole in DIGSI

You can find the meaning of abbreviations in [Table 6-8](#) and [Table 6-9](#).

The indication **Command active** can also be routed to a binary output. This binary output is always active if either a close or trip command is pending, or the switching device was selected by the command control.

6.2.2.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Ref. for %-values				
_:2311:101	General:Rated normal current		0.20 A to 100000.00 A	1000.00 A
_:2311:102	General:Rated voltage		0.10 kV to 1200.00 kV	400.00 kV
Breaker settings				
_:2311:112	General:Current thresh. CB open	1 A @ 100 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:2311:136	General:Op. mode BFP		- unbalancing - l> query	unbalancing

Addr.	Parameter	C	Setting Options	Default Setting
<i>Trip logic</i>				
_:5341:103	Trip logic:Reset of trip command		- with I< - with I< & aux.contact - with dropout	with I<
<i>Circuit break.</i>				
_:4261:101	Circuit break.:Output time		0.02 s to 1800.00 s	0.10 s
_:4261:105	Circuit break.:Indicat. of breaking values		- with trip - always	always
<i>Manual close</i>				
_:6541:101	Manual close:Action time		0.01 s to 60.00 s	0.30 s
_:6541:102	Manual close:CB open dropout delay		0.00 s to 60.00 s	0.00 s
<i>Control</i>				
_:4201:101	Control:Control model		- status only - direct w. normal secur. - SBO w. normal secur. - direct w. enh. security - SBO w. enh. security	SBO w. enh. security
_:4201:102	Control:SBO time-out		0.01 s to 1800.00 s	30.00 s
_:4201:103	Control:Feedback monitoring time		0.01 s to 1800.00 s	1.00 s
_:4201:104	Control:Check switching authority		- no - yes - advanced	yes
_:4201:105	Control:Check if pos. is reached		- no - yes	yes
_:4201:106	Control:Check double activat. blk.		- no - yes	yes
_:4201:107	Control:Check blk. by protection		- no - yes	yes
<i>Switching authority</i>				
_:4201:151	Control:Swi.dev. related sw.auth.		0 1	false
_:4201:152	Control:Specific sw. authorities		0 1	true
_:4201:115	Control:Specific sw.auth. valid for		- station - station/remote - remote	station/remote
_:4201:153	Control:Num. of specific sw.auth.		2 to 5	2
_:4201:155	Control:Ident. sw.auth. 1		Freely editable text	

Addr.	Parameter	C	Setting Options	Default Setting
_:4201:156	Control:Ident. sw.auth. 2		Freely editable text	
_:4201:157	Control:Ident. sw.auth. 3		Freely editable text	
_:4201:158	Control:Ident. sw.auth. 4		Freely editable text	
_:4201:159	Control:Ident. sw.auth. 5		Freely editable text	
_:4201:154	Control:Multiple specific sw.auth.		0 1	false
CB test				
_:6151:101	CB test:Dead time		0.00 s to 60.00 s	0.10 s
_:6151:102	CB test:Trip only		0 1	false
_:6151:103	CB test:Consider current criterion		0 1	false
_:6151:104	CB test:Current threshold	1 A @ 100 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A

6.2.2.5 Information List

No.	Information	Data Class (Type)	Type
Trip logic			
_:5341:300	Trip logic:Trip indication	ACT	O
Circuit break.			
_:4261:500	Circuit break.:>Ready	PLC	I
_:4261:501	Circuit break.:>Acquisition blocking	PLC	I
_:4261:502	Circuit break.:>Reset switch statist.	PLC	I
_:4261:504	Circuit break.:>Reset AcqBlk&Subst	PLC	I
_:4261:503	Circuit break.:External health	ENS	I
_:4261:53	Circuit break.:Health	ENS	O
_:4261:58	Circuit break.:Position 3-pole	DPC	C
_:4261:300	Circuit break.:Trip/open cmd. 3-pole	PLC	O
_:4261:301	Circuit break.:Close command	PLC	O
_:4261:302	Circuit break.:Command active	PLC	O
_:4261:303	Circuit break.:Definitive trip	PLC	O
_:4261:304	Circuit break.:Alarm suppression	PLC	O
_:4261:306	Circuit break.:Op.ct.	INS	O
_:4261:307	Circuit break.:ΣI Brk.	BCR	O
_:4261:308	Circuit break.:ΣIA Brk.	BCR	O
_:4261:309	Circuit break.:ΣIB Brk.	BCR	O
_:4261:310	Circuit break.:ΣIC Brk.	BCR	O
_:4261:311	Circuit break.:Break.-current phs A	MV	O

No.	Information	Data Class (Type)	Type
_:4261:312	Circuit break.:Break.-current phs B	MV	O
_:4261:313	Circuit break.:Break.-current phs C	MV	O
_:4261:317	Circuit break.:Break. current 3I0/IN	MV	O
_:4261:314	Circuit break.:Break. voltage phs A	MV	O
_:4261:315	Circuit break.:Break. voltage phs B	MV	O
_:4261:316	Circuit break.:Break. voltage phs C	MV	O
_:4261:322	Circuit break.:CB open hours	INS	O
_:4261:323	Circuit break.:Operating hours	INS	O
Manual close			
_:6541:501	Manual close:>Block manual close	PLC	I
_:6541:500	Manual close:>Input	PLC	I
_:6541:300	Manual close:Detected	PLC	O
Reset LED Group			
_:13381:500	Reset LED Group:>LED reset	PLC	I
_:13381:320	Reset LED Group:LED have been reset	PLC	O
Control			
_:4201:503	Control:>Sw. authority local	PLC	I
_:4201:504	Control:>Sw. authority remote	PLC	I
_:4201:505	Control:>Sw. mode interlocked	PLC	I
_:4201:506	Control:>Sw. mode non-interl.	PLC	I
_:4201:53	Control:Health	ENS	O
_:4201:58	Control:Cmd. with feedback	DPC	C
_:4201:302	Control:Switching auth. station	SPC	C
_:4201:308	Control:Enable sw. auth. 1	SPC	C
_:4201:309	Control:Enable sw. auth. 2	SPC	C
_:4201:310	Control:Enable sw. auth. 3	SPC	C
_:4201:311	Control:Enable sw. auth. 4	SPC	C
_:4201:312	Control:Enable sw. auth. 5	SPC	C
_:4201:313	Control:Switching authority	ENS	O
_:4201:314	Control:Switching mode	ENS	O
Interlocking			
_:4231:500	Interlocking:>Enable opening	PLC	I
_:4231:501	Interlocking:>Enable closing	PLC	I
_:4231:502	Interlocking:>Enable opening(fixed)	PLC	I
_:4231:503	Interlocking:>Enable closing (fixed)	PLC	I
_:4231:53	Interlocking:Health	ENS	O
CB test			
_:6151:53	CB test:Health	ENS	O
_:6151:301	CB test:Test execution	ENS	O
_:6151:302	CB test:Trip command issued	ENS	O
_:6151:303	CB test:Close command issued	ENS	O
_:6151:304	CB test:Test canceled	ENS	O
_:6151:311	CB test:3-pole open-close	SPC	C

6.2.3 Disconnecter Switching Device

6.2.3.1 Structure of the Disconnecter Switching Device

Like the circuit breaker, the **Disconnecter** switching device contains the following 3 function blocks:

- Function block **Disconnecter**
- Function block **Control**
- Function block **Interlocking**

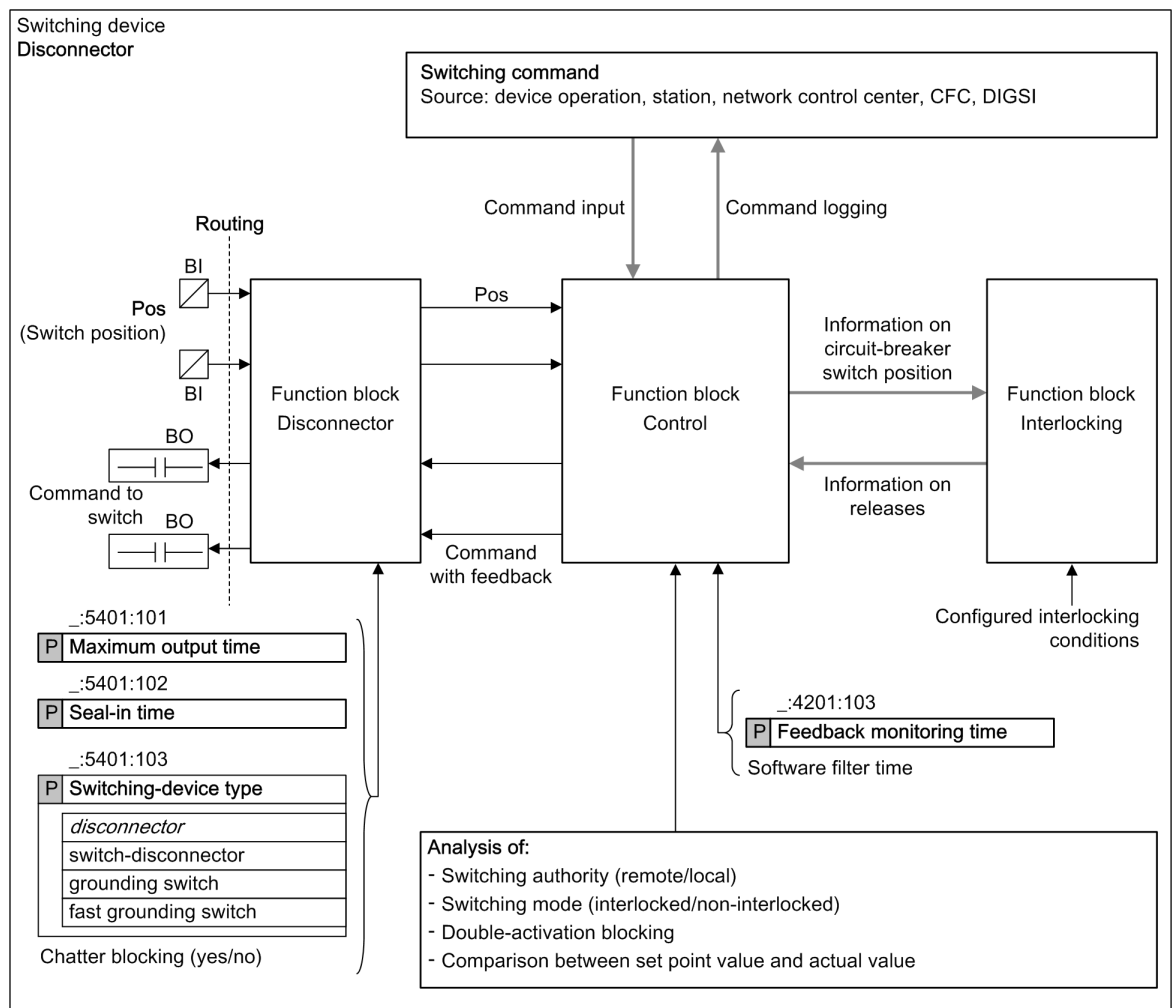
This corresponds to the logical nodes XSWI, CSWI, and CILO in IEC 61850.



NOTE

In contrast to the **Circuit-breaker** switching device, the **Disconnecter** switching device cannot contain any additional functions because protection functions or synchronization can have no effect on the disconnector.

The following figure shows the structure of the **Disconnecter** switching element:



[dw_discon, 2, en_US]

Figure 6-17 Control-Relevant Function Blocks of the Disconnecter Switching Device

The **Disconnecter** switching device behaves like the **Circuit-breaker** switching device. The only difference is the designation of the function block that the physical switch provides (disconnecter instead of circuit breaker). Blocking by protection is not provided in the analysis of the **Control** function block.

The **Disconnecter** switching device is available in the DIGSI 5 library in 2 different variants:

- **Disconnecter with 3-pole connection**
The device switches all 3 poles of the disconnecter on or off simultaneously.
- **Disconnecter without triggering (only status detection, no control)**
This variant is rarely encountered. It is encountered with grounding switches that frequently cannot be controlled, but only provide their current position. In addition, the position of a disconnecter in a neighboring bay can be acquired.

Function Blocks of the Disconnecter

Table 6-10 Function Blocks of the Disconnecter Function Group

Function Block	Description	Parameter	Function
Discon- nector	The disconnecter represents the physical switch in the SIPROTEC 5 device.	Maximum output time Seal-in time Switching-device type	The disconnecter replicates the switch position from the status of the binary inputs and also transmits the command via the binary outputs.
Control	Command processing	Control model SBO time-out Feedback monitoring time Check switching authority Check if pos. is reached Check double activat. blk.	Command checks, communication with the command source and with the function block Disconnecter
Inter- locking	Switchgear interlocking protection	Interlocking condition (deposited in CFC)	The Interlocking functionality generates the releases for switchgear interlocking protection.

You can find the setting values of the parameter in [6.2.3.2 Application and Setting Notes](#).

Additional Settings of Disconnecter Switching Element

The settings of the disconnecter are assigned to the function blocks on the basis of their relevance. Additional disconnecter settings that cannot be directly assigned to one of the 3 function blocks and are identical to the circuit-breaker settings are available:

Table 6-11 Setting Options of the Controllable **Command with Feedback** in the **Control** Function Block of the Circuit Breaker

Characteristics	Function	To Be Found in
Software filtering time	Software filtering time for position detection	Position of the Control ⁽¹⁾ function block
Retrigger filter (yes/no)	Switching retriggering of the filtering time on/off by changing the position	Position of the Control ⁽¹⁾ function block
Message time before filtering (yes/no)	Consideration of the hardware filtering time for position-detection time stamp	Position of the Control ⁽¹⁾ function block

Characteristics	Function	To Be Found in
Suppress intermediate position (yes/no)	When activated, only the intermediate position is suppressed by the duration of the software filtering time.	Position of the Control ⁽¹⁾ function block
Spontaneous position changes filtered by (Gen. Software Filt./Spont. Software Filt.)	If the General software filter setting is selected, the general settings for software filtering of spontaneous position changes and for position changes caused by a switching command apply. By selecting Spontaneous software filter , a separate filtering is activated for spontaneous position changes.	Position of the Control ⁽¹⁾ function block
Spontaneous software filter time	Software filtering time for spontaneous position changes	Position of the Control ⁽¹⁾ function block
Spontaneous retrigger filter (yes/no)	Switching on/off retriggering of the filtering time by spontaneous position change	Position of the Control ⁽¹⁾ function block
Spontaneous indication timestamp before filtering (yes/no)	Consideration of the hardware filtering time for position-detection time stamp in case of a spontaneous change	Position of the Control ⁽¹⁾ function block
Spontaneous suppress intermediate position (yes/no)	When activated, only the spontaneous change to the intermediate position is suppressed by the duration of the software filtering time.	Position of the Control ⁽¹⁾ function block

(1) First click **Position** and then click the **Details** button in the **Properties** window (below).

Table 6-12 Setting Options of the Controllable **Position** in the Disconnecter Function Block (Chatter Blocking)

Characteristics	Function	To Be Found in
Chatter blocking (yes/no)	Switching chatter blocking on/off	Position of the Disconnecter ⁽¹⁾ function block

(1) First click **Position** and then click the **Details** button in the **Properties** window (below).

Table 6-13 Additional Settings in the Device Settings with Effects on the Disconnecter

Characteristics	Function	To Be Found in
Number of permissible state changes	Chatter-blocking setting value: Once for the entire device	Device settings (to be found under Settings)
Chatter test time		
Number of chatter tests		
Chatter dead time		
Chatter test time		

The inputs and outputs as well as the setting options of the **Disconnecter switch** function block are described in [6.2.3.3 Trigger Variants of the Disconnecter](#). The **Control** function block is described identically as the **Circuit-breaker** function block, with the exception that the command check blocking is available through protection only with the circuit breaker.

You can find more information on this in [6.2.2.2 Application and Setting Notes](#).

Interlocking

The **Interlocking** function block generates the releases for switchgear interlocking protection. The actual interlocking conditions are deposited in CFC. For more information on this, see the general chapter [6.3.1 Command Checks and Switchgear Interlocking Protection](#).

6.2.3.2 Application and Setting Notes

Disconnecter

The disconnector represents the physical switch in the SIPROTEC 5 device. The task of the disconnector is to replicate the switch position from the status of the binary inputs.

The **Disconnecter** function block is linked automatically via the information matrix with the binary inputs that register the switch position and with the binary outputs that issue the switching commands.

The **Disconnecter** function block makes the following settings available (see next table).

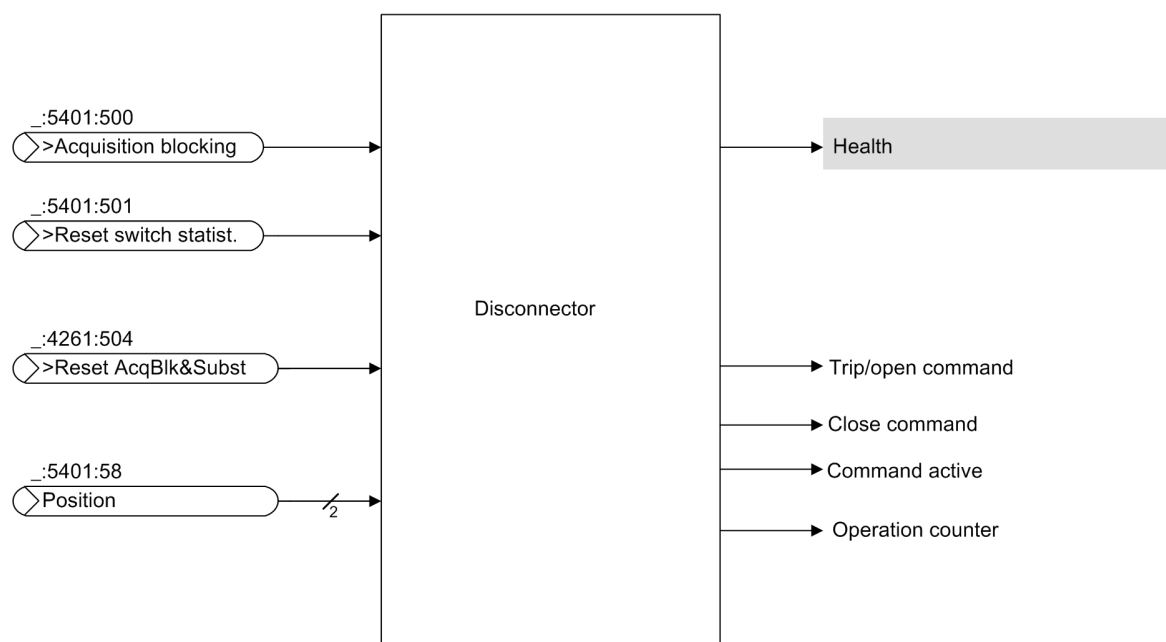
Parameters	Default Setting	Possible Parameter Values
(_:5401:101) Maximum output time The Maximum output time specifies the duration of the output pulse created by the switching command.	<i>10.00 s</i>	0.02 s to 1800 s (Increment: 0.01 s)
(_:5401:102) Seal-in time If the target actuating position is not yet attained although feedback has already been received, the output time is extended by the Seal-in time . The Seal-in time is relevant for equipment that sends feedback before the switching operation is completely performed. The Seal-in time is only considered for control models with feedback monitoring.	<i>0.00 s</i>	0 s to 60 s
(_:5401:103) Switching-device type The Switching-device type specifies the type of the switching device.	<i>disconnecter</i>	<i>switch-disconnector</i> <i>disconnecter</i> <i>grounding switch</i> <i>fast grounding switch</i>



NOTE

The parameter **Switching-device type** is effective only on the IEC 61850 interface. This parameter is used to set the disconnector switching device type for communication via IEC 61850. It is a mandatory data object in the IEC 61850 standard.

The following figure shows the logical inputs and outputs of the **Disconnecter** function block.



[dw_out_inp, 2, en_US]

Figure 6-18 Logical Inputs and Outputs of the Disconnecter Function Block

[Table 6-14](#) and [Table 6-15](#) list the inputs and outputs with a description of their function and type. For inputs, the effect of **Quality = invalid** on the value of the signal is described.

Table 6-14 Inputs of the Disconnecter Function Block

Signal Name	Description	Type	Value if Signal Quality=Invalid
>Acquisition blocking	The binary input activates acquisition blocking. You can also set this binary input with an external toggle switch.	SPS	Unchanged
>Reset AcqBlk&Subst	Acquisition blocking and the substitution of the circuit breaker are reset with this input. If the input is activated, setting of the acquisition blocking and of the substitution is blocked.	SPS	Unchanged
>Reset switch statist.	The binary input sets the operation counter for the switch to the value 0.	SPS	Unchanged
Position	The binary input Position can be used to read the disconnecter position with double-point indication.	DPC	Unchanged

If the quality of the input signal assumes the status **Quality = invalid**, then the standby status (Health) of the **Disconnecter** function block is set to *warning*.

Table 6-15 Outputs of the Disconnecter Function Block

Signal Name	Description	Type
Open command	This binary output is responsible for the command output Off .	SPS
Close command	This binary output is responsible for the command output On .	SPS

Signal Name	Description	Type
Command active	The binary output Command active is a running command for the signalization (command active or selected switching device). During Command active either an On or Off command is active.	SPS
Op.ct.	The information counts the number of disconnecter switching cycles.	INS

Control

It is the task of the controls to execute command checks and establish communication between the command source and the disconnecter. Using the control settings, you specify how the commands are to be processed (see also chapter [6.3.1 Command Checks and Switchgear Interlocking Protection](#)).

Through the function SBO (Select Before Operate, reservation¹⁸), the switching device is reserved prior to the actual switching operation, thus it remains locked for additional commands. Feedback monitoring provides information about the initiator of the command while the command is in process, that means, informing whether or not the command was implemented successfully. These two options can be selected individually in the selection of the control model, so that 4 combinations in total are available (see the following table).

The control makes the following settings available (see next table).

Parameters	Default Setting	Possible Parameter Values
(_:4201:101) Control model	<i>SBO w. enh. security¹⁹</i>	<i>direct w. normal secur.</i> <i>SBO w. normal secur.</i> <i>direct w. enh. security</i> <i>SBO w. enh. security</i>
(_:4201:102) SBO time-out	<i>30.00 s</i>	-
(_:4201:103) Feedback monitoring time	<i>10.00 s</i>	-
(_:4201:104) Check switching authority	<i>yes</i>	<i>no</i> <i>yes</i> <i>advanced</i>
(_:4201:105) Check if pos. is reached	<i>yes</i>	<i>no</i> <i>yes</i>
(_:4201:106) Check double activat. blk.	<i>yes</i>	<i>no</i> <i>yes</i>

6.2.3.3 Trigger Variants of the Disconnecter

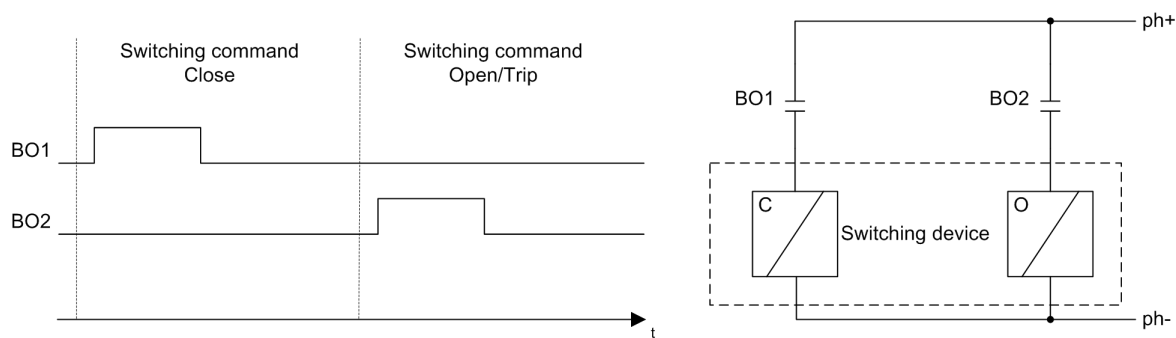
The activation types are identical to those for the circuit breaker. The meaning of abbreviations can be found in [6.2.2.3 Connection Variants of the Circuit Breaker](#) and [6.2.2.3 Connection Variants of the Circuit Breaker](#).

Whether the disconnecter is triggered for 1-, 1.5-, or 2-phases depends on the design of the auxiliary and control voltage system.

¹⁸ In the IEC 61850 standard, Reservation is described as **Select before Operate (SBO)**.

¹⁹ This default setting is the standard control model for a switching command in an IEC 61850-compliant system.

1-Pole Triggering



[dw_1ptren, 1, en_US]

Figure 6-19 1-Pole Triggering

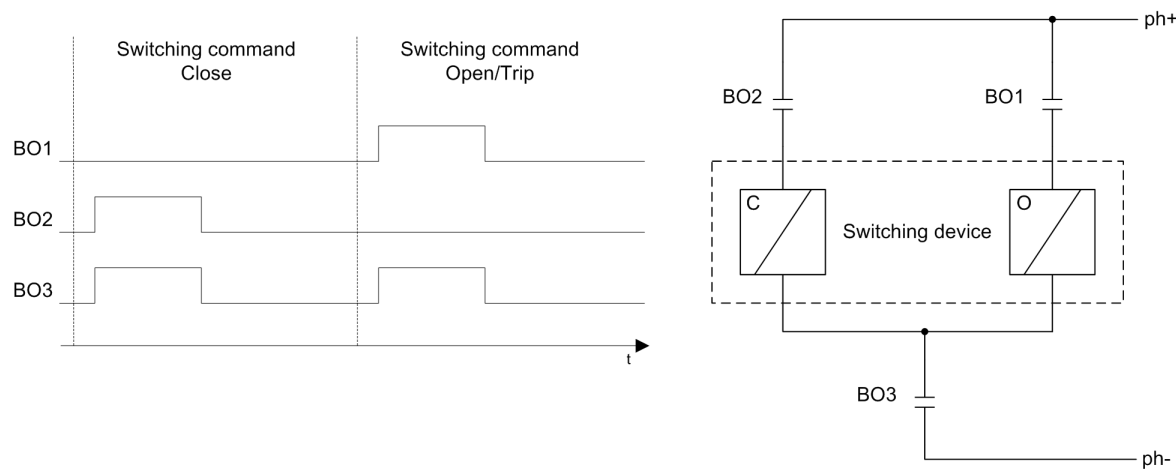
Information			▼ S	► Destination			
				► Binary output			
				► Basismodul			
Signals	Number	Type		1.1	1.2	1.3	1.4
(All)				...	...	...	...
▼ Disconnecter 1	601			*	*		
▼ Disconnecter	601.5401			*	*		
>Acquisition blocking	601.5401.500	SPS					
>Reset switch statist.	601.5401.501	SPS					
>Reset AcqBlk&Subst	601.5401.504	SPS					
► Health	601.5401.53	ENS					
► Position	601.5401.58	DPC					
Open command	601.5401.300	SPS			X		
Close command	601.5401.301	SPS		X			

[sclangtrenn1p, 1, en_US]

Figure 6-20 1-Pole Triggering, Routing in DIGSI

You can select the contacts for **On** and **Off** as desired. They need not necessarily be next to one another.

1.5-Pole Triggering



[dw_5-pole, 1, en_US]

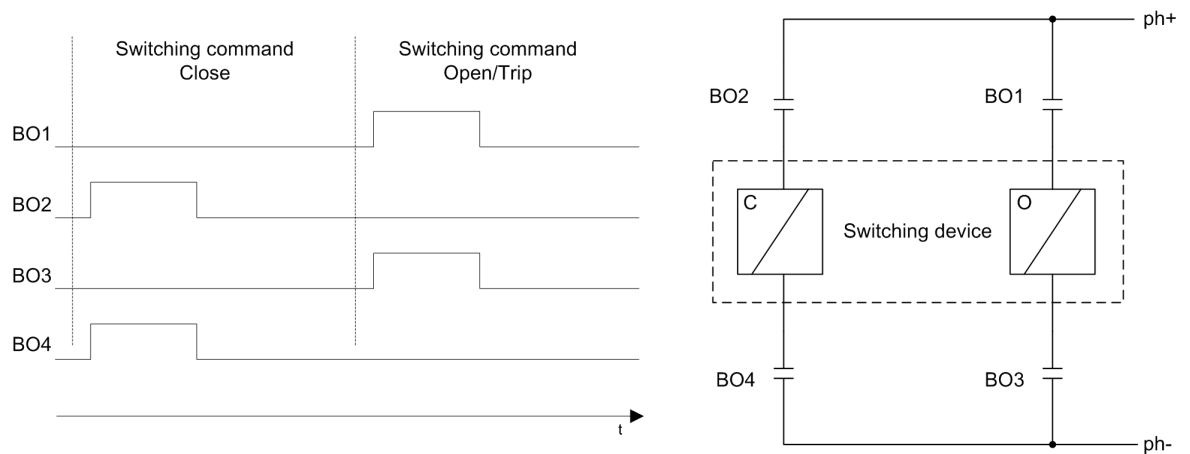
Figure 6-21 1.5-Pole Triggering

Information			▼ S	► Destination			
				► Binary output			
				► Basismodul			
Signals	Number	Type		1.1	1.2	1.3	1.4
▼ Disconnecter 1	(All)	...	▼	...	...	...	...
▼ Disconnecter	601.5401			*	*	*	
▶ >Acquisition blocking	601.5401.500	SPS					
▶ >Reset switch statist.	601.5401.501	SPS					
▶ >Reset AcqBlk&Subst	601.5401.504	SPS					
▶ Health	601.5401.53	ENS					
▶ Position	601.5401.58	DPC					
▶ Open command	601.5401.300	SPS		X		X	
▶ Close command	601.5401.301	SPS			X	X	

[scrangtrenn15p, 1, en_US]

Figure 6-22 1.5-Pole Triggering, Routing in DIGSI

2-Pole Triggering



[dw_2-pole-open, 1, en_US]

Figure 6-23 2-Pole Triggering

Information			▼ S	► Destination			
				► Binary output			
				► Basismodul			
Signals	Number	Type		1.1	1.2	1.3	1.4
(All)				...	...	...	...
▼ Disconnecter 1	601			*	*	*	*
▼ Disconnecter	601.5401			*	*	*	*
>Acquisition blocking	601.5401.500	SPS					
>Reset switch statist.	601.5401.501	SPS					
>Reset AcqBlk&Subst	601.5401.504	SPS					
▶ Health	601.5401.53	ENS					
▶ Position	601.5401.58	DPC					
Open command	601.5401.300	SPS		X		X	
Close command	601.5401.301	SPS			X		X

[sclangtrenn2p, 1, en_US]

Figure 6-24 2-Pole Triggering, Routing in DIGSI

The feedback is routed via the position with the disconnecter.

6.2.3.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Control				
_:4201:101	Control:Control model		- status only - direct w. normal secur. - SBO w. normal secur. - direct w. enh. security - SBO w. enh. security	SBO w. enh. security
_:4201:102	Control:SBO time-out		0.01 s to 1800.00 s	30.00 s
_:4201:103	Control:Feedback monitoring time		0.01 s to 1800.00 s	10.00 s

Addr.	Parameter	C	Setting Options	Default Setting
_:4201:104	Control:Check switching authority		- no - yes	yes
_:4201:105	Control:Check if pos. is reached		- no - yes	yes
_:4201:106	Control:Check double activat. blk.		- no - yes	yes
Disconnecter				
_:5401:101	Disconnecter:Maximum output time		0.01 s to 1800.00 s	10.00 s
_:5401:102	Disconnecter:Seal-in time		0.00 s to 60.00 s	0.00 s
_:5401:103	Disconnecter:Switching-device type		- switch-disconnector - disconnector - grounding switch - fast grounding switch	disconnector

6.2.3.5 Information List

No.	Information	Data Class (Type)	Type
Control			
_:4201:503	Control:>Sw. authority local	SPS	I
_:4201:504	Control:>Sw. authority remote	SPS	I
_:4201:505	Control:>Sw. mode interlocked	SPS	I
_:4201:506	Control:>Sw. mode non-interl.	SPS	I
_:4201:53	Control:Health	ENS	O
_:4201:58	Control:Cmd. with feedback	DPC	C
_:4201:302	Control:Switching auth. station	SPC	C
_:4201:308	Control:Enable sw. auth. 1	SPC	C
_:4201:309	Control:Enable sw. auth. 2	SPC	C
_:4201:310	Control:Enable sw. auth. 3	SPC	C
_:4201:311	Control:Enable sw. auth. 4	SPC	C
_:4201:312	Control:Enable sw. auth. 5	SPC	C
_:4201:313	Control:Switching authority	ENS	O
_:4201:314	Control:Switching mode	ENS	O
Interlocking			
_:4231:500	Interlocking:>Enable opening	SPS	I
_:4231:501	Interlocking:>Enable closing	SPS	I
_:4231:502	Interlocking:>Enable opening(fixed)	SPS	I
_:4231:503	Interlocking:>Enable closing (fixed)	SPS	I
_:4231:53	Interlocking:Health	ENS	O
Disconnecter			
_:5401:500	Disconnecter:>Acquisition blocking	SPS	I
_:5401:501	Disconnecter:>Reset switch statist.	SPS	I
_:5401:53	Disconnecter:Health	ENS	O
_:5401:58	Disconnecter:Position	DPC	C
_:5401:300	Disconnecter:Open command	SPS	O
_:5401:301	Disconnecter:Close command	SPS	O

No.	Information	Data Class (Type)	Type
_:5401:302	Disconnecter:Command active	SPS	O
_:5401:305	Disconnecter:Op.ct.	INS	O

6.3 Control Functionality

6.3.1 Command Checks and Switchgear Interlocking Protection

Before switching commands can be issued by the SIPROTEC 5 device, several steps are used to check the command:

- Switching mode (interlocked/non-interlocked)
- Switching authority (local/DIGSI/station/remote)
- Switching direction (set=actual)
- Bay interlocking and substation interlocking
- 1-out-of-n check (double-activation blocking)
- Blocking by protection function

Confirmation IDs (with Inactive RBAC)

SIPROTEC 5 devices can operate using role-based access control (RBAC). If RBAC is active in the device, the authorizations to execute various actions are linked directly to the role concept.

If RBAC is inactive in the device, various actions are secured using the **confirmation IDs**. The following **confirmation IDs** from the **Safety** menu apply to the control functions:

Enter confirmation ID			
Active	Scope of operation	Action	Description
☒	Settings	Change...	Allows changing the settings and device mode, loading the firmware, setting the counters, deleting logs.
☐	Fct.Key/PB operation		Allows operating via function keys and push-buttons only with entering the confirmation ID for "Setting".
☒	Switching	Change...	Allows switching operations
☒	Switch.Jinterl.check	Change...	Allow switching operations. Interlocking checks can be switched on and off.
☒	Switch./switch.auth.	Change...	Allows switching operations. The switching authority can be changed.

[sc_conf, 2, en_US]

Figure 6-25 Confirmation IDs in DIGSI 5: Settings Menu

The following table identifies the meanings of the confirmation IDs:

Table 6-16 Relevant Confirmation IDs for Controls

Confirmation ID	Meaning	Description
Setting	Changing settings	The confirmation ID is requested before the device parameters can be changed.
Operation (function keys)	Process data access via function buttons	Access to process data is possible with the help of push-buttons and function buttons. The confirmation ID of Set/operation is requested.
Switching	General release for control of switching devices	The confirmation ID is usually not needed for bay controllers. In the case of protection devices, this confirmation ID can be used to safeguard control of switching devices.

Confirmation ID	Meaning	Description
Switch./interl.check	Switching non-interlocked	Switching mode: Release for switching without querying the interlocking conditions (S1 operation). The fixed interlocking conditions (for example, >Enable opening(fixed) and >Enable closing(fixed)) are still queried if this is set in the parameters. The confirmation ID is queried only for devices without a key switch; otherwise it is replaced with the key switch position.
Switch./switch.auth.	Release for switching authority Local	The confirmation ID is queried only for devices without a key switch; otherwise it is replaced with the key switch position.

The confirmation IDs are preset with the following values:

- Setting 222222
- Switching 333333
- Switch./interl.check 444444
- Switch./switch.auth. 666666

If you have configured a device with key switches, the confirmation IDs for non-interlocked switching and switching authority are not displayed or editable in DIGSI; the function is handled by the position of the key switch.

To increase security, change these codes with DIGSI.

Switching Mode (Interlocked/Non-Interlocked)

The switching mode determines whether or not the switchgear interlocking that has been configured in the CFC is checked before the command is output.

You can change the switching mode with the key switch **S1** (interlocking off/normal). For devices without a key switch, you can change the switching mode with a corresponding menu item on the display (after input of a confirmation ID). You can also set the switching mode for switching commands from the sources DIGSI, station or remote.



DANGER

If the switching mode = non-interlocked, the switchgear interlocking protection is shut off.

Erroneous switching operations can lead to severe or fatal injuries.

- ✧ Ensure manually that all checks have been implemented.

In addition, you can set the switching mode directly with a binary input or CFC. Use the **General** function block (see next figure).

Signals	Fav	Number	Type
(All) ... (All) ...			
▼ General		91	
◆ >SG choice bit 1	☆	91.500	SPS
◆ >SG choice bit 2	☆	91.501	SPS
◆ >SG choice bit 3	☆	91.502	SPS
◆ >Sw. authority local	☆	91.503	SPS
◆ >Sw. authority remote	☆	91.504	SPS
◆ >Sw. mode interlocked	☆	91.505	SPS
◆ >Sw. mode non-interl.	☆	91.506	SPS
🔑 Switching auth. station	☆	91.308	SPC
▼ ◆ Switching authority	☆	91.311	ENS
◆ local			SPS
◆ DIGSI			SPS
◆ station			SPS
◆ remote			SPS
▼ ◆ Switching mode	☆	91.312	ENS
◆ interlocked			SPS
◆ non-interlocked			SPS
▼ ◆ Sw.authority key/set	☆	91.309	ENS
◆ local			SPS
◆ remote			SPS
▼ ◆ Sw.mode key/set	☆	91.310	ENS
◆ interlocked			SPS
◆ non-interlocked			SPS

[sc_moscha, 1, en_US]

Figure 6-26 Switching Mode in Function Block General

The following table shows the effects of changing the switching mode to use command checks.

Table 6-17 Relationship Between Switching Mode and Command Checks

Command Check	Switching Mode	
	Interlocked	Non-Interlocked
Switching authority	Checked	Checked
Switching direction (set=actual)	Checked	Checked
Fixed interlocking conditions	Checked	Checked
Interlocking conditions	Checked	Not checked
1-out-of-n check (double-activation blocking)	Checked	Not checked
Blocking by protection function	Checked	Not checked

Switching Authority

The switching authority determines which command source is allowed. The following command sources are possible:

- **Local:**
A switching command from the local control (cause-of-error source **Local**) is possible only if the switching authority is set to **Local** and the device is capable of on-site operation. Setting the switching authority to **Local** is typically accomplished with key switch **S5** (Local/Remote). In this case, commands from all other sources are rejected. If the switching authority is set to **Local**, the setting cannot be changed **remotely**.
- **DIGSI:**
A switching command from DIGSI (connected via USB or Ethernet, cause-of-error source **Maintenance**) is accepted only if the switching authority in the device is set to **Remote**. Once DIGSI has signed on the device for command output, no commands from other command sources or a different DIGSI PC will be executed.
- **Station:**
This switching authority level can be activated via a parameter in the **General** function block. A switching command from the station level (cause-of-error source **Station** or **Automatic station**) is accepted if the switching authority is set to **Remote** and the controllable **Station switching authority** is set. This is accomplished by a command from the substation automation technology. Switching commands from the device or from outside the station (cause-of-error source **Local**, **Remote** or **Automatic remote**) are rejected.
Full support of the switching-authority level is assured only when using the IEC 61850 protocol.
- **Remote:**
This switching authority level stands from remote control directly from the network control center or (if the switching authority level **Station** is not activated) generally for **Remote** control. The cause-of-error source is **Automatic remote**. Commands from this level are accepted if the switching authority is set to **Remote** and the controllable **Station switching authority** is not set. Switching commands from the device or from the station (cause-of-error source **Local**, **Station** or **Automatic station**) are rejected.

Signals	Fav	Number	Type
(All) ... (All) ...			
General		91	
>SG choice bit 1	☆	91.500	SPS
>SG choice bit 2	☆	91.501	SPS
>SG choice bit 3	☆	91.502	SPS
>Sw. authority local	☆	91.503	SPS
>Sw. authority remote	☆	91.504	SPS
>Sw. mode interlocked	☆	91.505	SPS
>Sw. mode non-interl.	☆	91.506	SPS
Switching auth. station	☆	91.308	SPC
Switching authority	☆	91.311	ENS
local			SPS
DIGSI			SPS
station			SPS
remote			SPS
Switching mode	☆	91.312	ENS
interlocked			SPS
non-interlocked			SPS
Sw.authority key/set	☆	91.309	ENS
local			SPS
remote			SPS
Sw.mode key/set	☆	91.310	ENS
interlocked			SPS
non-interlocked			SPS

[sc_moscha, 1, en_US]

Figure 6-27 Display of Switching Authority and Switching Mode in Information Routing (in Function Block General)

Sw. authority key/set and **Sw.mode key/set** indicate the current state of the key switch or parameter for switching authority or switching mode and provide this information for further processing in the CFC. In the CFC, for example, it is possible to set up an automatic routine to ensure that the switching authority is automatically set to **Local** when the key switch is set to **non-interlocked**.

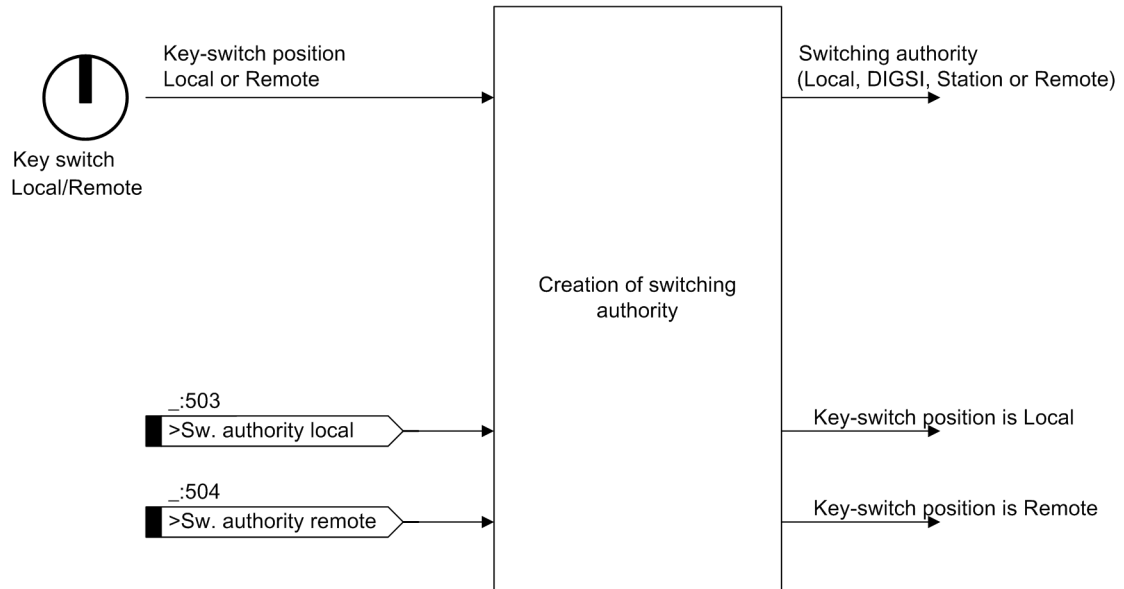
The following table shows the dependency of the switching mode on the key-switch position and the switching authority. In the case of switching commands from **Remote**, the information on whether switching is to be made to locked or unlocked is also sent. For this reason, the position of the key switch is irrelevant for the switching mode in these cases. The information in the table assumes that, in the case of **remote** switching commands or those from the **station**, the switching mode is **interlocked** in each case.

Table 6-18 Dependency of the Switching Mode on the Key-Switch Position and Switching Authority

Key Switch for Switching Mode	Switching Authority		
	Local	Remote	Station
Interlocked	Interlocked	Interlocked	Interlocked
Not interlocked	Non-interlocked	Interlocked	Interlocked

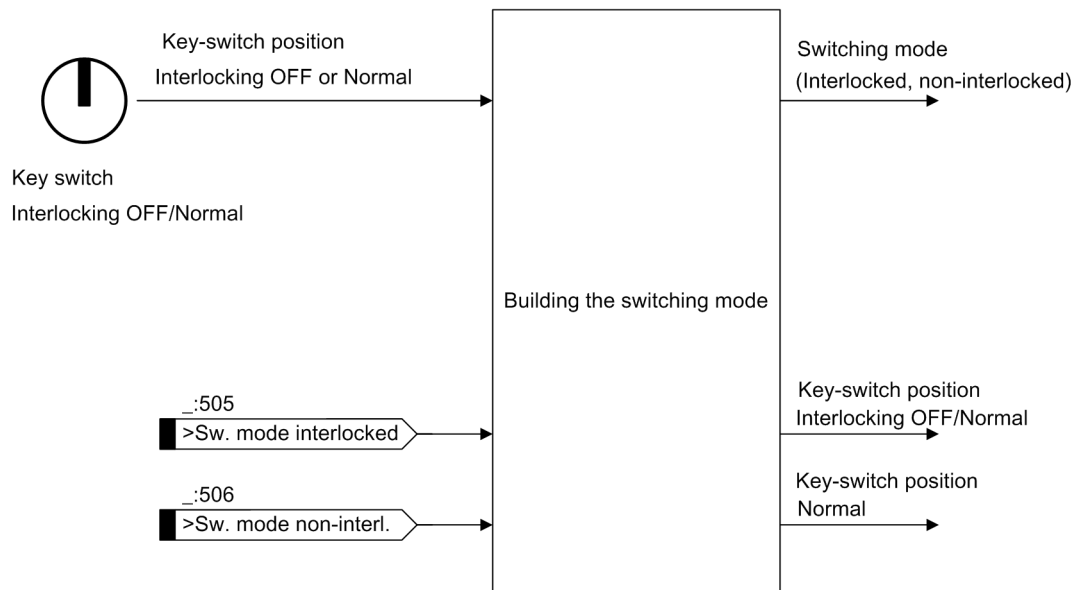
The signals shown in [Figure 6-27](#) in DIGSI 5 information routing have the following relationship:

- In terms of switching authority and switching mode, the respective key switch position serves as the input signal and the input signals in the matrix.
- The state of the switching authority and switching mode is indicated by corresponding output signals.
- The **Switching authority** and **Switching mode** functions link the input signals and in this way establish the output signals (see [Figure 6-28](#) and [Figure 6-29](#)).



[dw_authority, 1, en_US]

Figure 6-28 Establishing Switching Authority



[dw_modsch, 1, en_US]

Figure 6-29 Establishing Switching Mode

In the case of both functions, the input signals overwrite the state of the key switch. This allows external inputs to also set the switching authority or switching mode, if desired (for instance, by querying an external key switch).

The following additional settings are available for the switching authority:

- **Enable sw.auth. station** (defined in IEC 61850 Edition 2):
If you would like to use this switching authority, set the check mark **General/Control**.
- **Multiple sw.auth. levels:**
This option permits switching commands from several command sources in the device if the switching authority **Remote** is selected. Subsequently, a distinction between these command sources can also be made. You can find more details in the following table. Activate this option by setting the check mark **General/Control**.
- **Specific sw. authorities:**
You can enable additional options for the switching authority check. You can find more information about these options in [Specific Switching Authority, Page 301](#). By default, these are not used.
- **Shows interlock.cond. HMI:**
You can activate the parameter to show the status of interlocking conditions in the device. For additional information refer to [Specific Switching Authority, Page 301](#). By default, this parameter is inactive.

General			
Device			
91.101	Rated frequency:	50 Hz	 
91.102	Minimum operate time:	0.00 s	 
91.115	Set. format residu. comp.:	Kr, Kx	 
91.138	Block monitoring dir.:	off	 
Chatter blocking			
91.123	No. permis.state changes:	0	 
91.127	Initial test time:	1 s	 
91.124	No. of chatter tests:	0	 
91.125	Chatter idle time:	1 min	 
91.137	Subsequent test time:	2 s	 
Measurements			
91.111	Energy restore interval:	10 min	
91.112	Energy restore time:	none	
91.120	Energy restore:	latest value	
91.121	Energy restore by A.time:	☐	
91.104	Average calc. interval:	60 min	
91.105	Average update interval:	60 min	
91.106	Average synchroniz. time:	hh:00	
Control			
91.118	Enable sw.auth. station:	☐	 
91.119	Multiple sw.auth. levels:	☐	 
91.152	Specific sw. authorities:	☐	 
91.166	Shows interlock.cond. HMI:	☐	 

[sc_akt_hoh, 2, en_US]

Figure 6-30 How to Activate the Station Switching Authority and to Enable Several Switching-Authority Levels

Table 6-19 Effect on Switching Authority when Several Switching-Authority Levels Are Enabled with/without Activation of the Station Switching Authority

Release Several Switching Authority Levels	Switching Authority in the Device	Status of DIGSI in the Device	Station Switching Authority Activated	State of the Station Switching Authority	Resulting Switching Authority
No	Local	–	–	–	Local
	Remote	Signed on	–	–	DIGSI
		Not signed on	No	–	Station and remote
			Yes	Set	Station
				Not set	Remote
Yes	Local	–	–	–	Local
	Remote	Signed on	–	–	DIGSI
		Not signed on	No	–	Local and station and remote
			Yes	Set	Local and station
				Not set	Local and station and remote

The following table shows the result of the switching-authority check, based on the set switching authority and the cause of the command. This overview represents a simplified normal case (no multiple command sources when using Station and Remote).

Table 6-20 Result of a Switching-Authority Check

Cause Source	Switching Authority			
	Local	DIGSI	Station	Remote
Local	Release	Blocked	Blocked	Blocked
Station	Blocked	Blocked	Release	Blocked
Remote	Blocked	Blocked	Blocked	Release
Local automatic operation	Release	Release	Release	Release
Station automatic operation	Blocked	Blocked	Release	Blocked
Remote automatic operation	Blocked	Blocked	Blocked	Release
DIGSI	Blocked	Release	Blocked	Blocked

Specific Switching Authority

Special switching authorities can be configured as extension of the switching-authority check. This makes it possible to differentiate the **Remote** command sources at the bay level. Switching authority can be routed to or revoked from different control centers that can, for example, belong to different companies. Thus, precisely one of these command sources can switch at a certain time. This function is based on extending the switching-authority check by verifying the identifier of the command source (field **Originator/orident** of switching command). In order to turn on the function, go to **General/Control** and set the check mark for the parameter **Specific sw. authorities**. More settings for the configuration of the identifiers and the behavior of the function as well as additional signals appear (see [Figure 6-32](#)). In order to permit an additional command source to switch, you must activate this specific switching authority. In order to do this, set the controllable **Enable sw. auth. 1** to **Enable sw. auth. 5**.

General			
Device			
91.101	Rated frequency:	50 Hz	 
91.102	Minimum operate time:	0.00	s  
91.115	Set. format residu. comp.:	Kr, Kx	 
91.138	Block monitoring dir.:	off	 
Chatter blocking			
91.123	No. permis.state changes:	0	 
91.127	Initial test time:	1	s  
91.124	No. of chatter tests:	0	 
91.125	Chatter idle time:	1	min  
91.137	Subsequent test time:	2	s  
Measurements			
91.111	Energy restore interval:	10	min
91.112	Energy restore time:	none	
91.120	Energy restore:	latest value	
91.121	Energy restore by A.time:	☐	
91.104	Average calc. interval:	60	min
91.105	Average update interval:	60 min	
91.106	Average synchroniz. time:	hh:00	
Control			
91.118	Enable sw.auth. station:	☐	 
91.119	Multiple sw.auth. levels:	☐	 
91.152	Specific sw. authorities:	☒	 
91.153	Specific sw.auth. valid for:	station/remote	 
91.154	Num. of specific sw.auth.:	2	 
91.156	Ident. sw.auth. 1:	ID1	 
91.157	Ident. sw.auth. 2:	ID2	 
91.155	Multiple specific sw.auth.:	☐	 
91.166	Shows interlock.cond. HMI:	☐	 

[sc_act additional options sw authority, 4, en_US]

Figure 6-31 Activating Additional Options of the Switching Authority

The additional parameters allow you to set the following options:

- **Specific sw.auth. valid for** (for *station/remote*, only *remote* or only *station*):
With this parameter, you determine for which command source the extended switching-authority check is used.

Table 6-21 Result Derived from the Combination of the Parameter Value **Specific sw.auth. valid for** and the Level of the Command Source (Field **Originator/orCat** of the Switching Command)

Command Source	Specific sw.auth. valid for		
	<i>station</i>	<i>station/remote</i>	<i>remote</i>
Local, local automatic	No check	No check	No check
Station, station automatic	Check	Check	No check

Command Source	Specific sw.auth. valid for		
	station	station/remote	remote
Remote, remote auto-matic	No check	Check	Check
DIGSI	No check	No check	No check

- **Num. of specific sw.auth.:**
With this parameter, you determine how many specific switching authorities are available. This determines the number of parameters **Identifier switching authority** as well as the controllable **Active. Sw. auth.**
- **Identifier switching authority 1 to Identifier switching authority 5:**
The number of names that appear corresponds to the number set in the previous parameter. You can select the names as you wish, 1 to 64 characters are allowed. The command check verifies whether these titles correspond with those sent by the command source. This applies to the switching commands as well as to the activation of a specific switching authority. The requirement for this is the system interface IEC 61850. The field **Originator/orident** is used.
- **Multiple specific sw.auth.** ensures the simultaneous validity of the various command sources. The following table shows how to determine the resulting specific switching authority when activating the command sources of Remote or Station. If this parameter is activated, all parameterized command sources get permissible automatically (see last row in the table) and they cannot be deactivated via the controllable **Enable sw. auth. 1** to **Enable sw. auth. 5**. Otherwise, the enabled command source with the lowest number has always the highest priority and prevails against the other numbers.

Table 6-22 Determining Switching Authority if Multiple Command Sources Are Available

Multiple specific sw.auth.	Enable sw. auth. 1	Enable sw. auth. 2	Enable sw. auth. 3	Enable sw. auth. 4	Enable sw. auth. 5	Resulting Specific Switching Authority
No	On	*	*	*	*	Switch. auth. 1
No	Off	On	*	*	*	Switch. auth. 2
No	Off	Off	On	*	*	Switch. auth. 3
No	Off	Off	Off	On	*	Switch. auth. 4
No	Off	Off	Off	Off	On	Switch. auth. 5
No	Off	Off	Off	Off	Off	None
Yes	On	On	On	On	On	All

The * symbol in the previous table refers to any value.

Switching auth. station	91.308	SPC			
▼ Enable sw. auth. 1	91.324	SPC			
♦ off		SPS			
♦ on		SPS			
▼ Enable sw. auth. 2	91.325	SPC			
♦ off		SPS			
♦ on		SPS			
▼ ♦ Switching authority	91.311	ENS			
♦ local		SPS			
♦ DIGSI		SPS			
♦ station		SPS			
♦ remote		SPS			
▼ ♦ Switching mode	91.312	ENS			
♦ interlocked		SPS			
♦ non-interlocked		SPS			
▼ ♦ Sw.authority key/set	91.309	ENS			
♦ local		SPS			
♦ remote		SPS			
▼ ♦ Sw.mode key/set	91.310	ENS			
♦ interlocked		SPS			
♦ non-interlocked		SPS			

[sc_sw authority and mode in info routing, 1, en_US]

Figure 6-32 Display of Switching Authority and Switching Mode in the Information Routing (in Function Block General), Example of 2 Activated Remote Switching Authorities

Individual Switching Authority and Switching Mode for the Switching Devices

In a standard case, the functionalities switching authority, switching mode, and specific switching authority as described in the previous sections, are applicable to the entire bay unit and, therefore, are valid for all switching devices that are controlled by this bay unit. In addition, you can configure an individual switching authority and specific switching authority as well as individual switching modes for single switching devices. Therefore, individual switching devices can accept various switching authorities and switching modes simultaneously.

This is offered for the following function groups and function blocks:

- **Circuit-breaker** function group
- **Disconnecter** function group
- **Transformer tap changer** function group
- **Switching sequence** function block

This allows to select individual settings for each switching device. This is useful if, for example, switching devices of different utilities are managed within a single bay.

In order to activate this option, go to the function block **Control** of a switching device and set the parameter **Check switching authority** to **advanced**. An additional table containing initially 2 parameters is displayed.

Control		
401.4201.101	Control model:	SBO w.enh. security
401.4201.102	SBO time-out:	30.00 s
401.4201.103	Feedback monitoring time:	1.00 s
401.4201.104	Check switching authority:	advanced
401.4201.105	Check if pos. is reached:	yes
401.4201.106	Check double activat. blk.:	yes
401.4201.107	Check blk. by protection:	yes

Switching authority		
401.4201.151	Swi.dev. related sw.auth.:	☐
401.4201.152	Specific sw. authorities:	☐

[sc_add parameters sw authority sw device, 1, en_US]

Figure 6-33 Additional Parameters for Switching Authorities in the Parameters of a Switching Device

When activating the parameter **Swi.dev. related sw.auth.**, an individual switching authority as well as an individual switching mode for this switching device are configured. Additional signals are displayed in the **Control** function block of the corresponding switching device.

Control		
401.4201.101	Control model:	SBO w.enh. security
401.4201.102	SBO time-out:	30.00 s
401.4201.103	Feedback monitoring time:	1.00 s
401.4201.104	Check switching authority:	advanced
401.4201.105	Check if pos. is reached:	yes
401.4201.106	Check double activat. blk.:	yes
401.4201.107	Check blk. by protection:	yes

Switching authority		
401.4201.151	Swi.dev. related sw.auth.:	☒
401.4201.152	Specific sw. authorities:	☐

[sc_extended parameters sw authority sw device, 1, en_US]

Figure 6-34 Expanded Parameters for the Switching Authority in the Switching Device

Control	401.4201			
>Sw. authority local	401.4201.503	SPS		
>Sw. authority remote	401.4201.504	SPS		
>Sw. mode interlocked	401.4201.505	SPS		
>Sw. mode non-interl.	401.4201.506	SPS		
Health	401.4201.53	ENS		
ok		SPS		
warning		SPS		
alarm		SPS		
Cmd. with feedback	401.4201.58	DPC		
Switching auth. station	401.4201.302	SPC		
Switching authority	401.4201.313	ENS		
local		SPS		
DIGSI		SPS		
station		SPS		
remote		SPS		
Switching mode	401.4201.314	ENS		
interlocked		SPS		
non-interlocked		SPS		

[sc_switching auth sw mode changeable, 1, en_US]

Figure 6-35 Individually Modifiable Switching Authority and Switching Mode for Switching Devices

The new input signals that are displayed allow you to set the individual switching authority and switching mode for the switching devices. For this switching device, these inputs overwrite the central switching

authority and the switching mode. The outputs *Switching authority* and *Switching mode* indicate the states only for this switching device.

When activating **Specific sw. authorities**, an individual specific switching authority for this switching device is configured. Additional parameters are displayed.

The screenshot shows a configuration window for 'Control' and 'Switching authority'.

Control

ID	Parameter	Value	Unit	Icon
401.4201.101	Control model:	SBO w. enh. security		
401.4201.102	SBO time-out:	30.00	s	
401.4201.103	Feedback monitoring time:	1.00	s	
401.4201.104	Check switching authority:	advanced		
401.4201.105	Check if pos. is reached:	yes		
401.4201.106	Check double activat. blk.:	yes		
401.4201.107	Check blk. by protection:	yes		

Switching authority

ID	Parameter	Value	Unit	Icon
401.4201.151	Swi.dev. related sw.auth.:	☐		
401.4201.152	Specific sw. authorities:	☒		
401.4201.115	Specific sw.auth. valid for:	station/remote		
401.4201.153	Num. of specific sw.auth.:	2		
401.4201.155	Ident. sw.auth. 1:	ID1		
401.4201.156	Ident. sw.auth. 2:	ID2		
401.4201.154	Multiple specific sw.auth.:	☐		

[sc_parameters FB control all additional options, 1, en_US]

Figure 6-36 Parameters of the FB Control with All Additional Options

The functionality of the specific switching authority for the individual switching device and the significance of the additional parameters is identical to the operating mode of the central specific switching authority. Additional signals are displayed in the **Control** function block.

▼	Control	202.4201			
▶	Health	202.4201.53	ENS		
	Cmd. with feedback	202.4201.58	DPC		
	Switching auth. stati...	202.4201.302	SPC		
▼	Enable sw. auth. 1	202.4201.308	SPC		
	off		SPS		
	on		SPS		
▼	Enable sw. auth. 2	202.4201.309	SPC		
	off		SPS		
	on		SPS		

[sc_specific sw authority changeable per sw device, 1, en_US]

Figure 6-37 Specific Switching Authority, Modifiable for Each Switching Device

Switching Direction (Set = Actual)

With this check, you avoid switching a switching device into a state that has already been achieved. For instance, before a trip command is issued to a circuit breaker, its current position is determined. If this circuit breaker is already in the **OFF** position, no command is issued. This is logged accordingly.

Switchgear Interlocking Protection

Switchgear interlocking protection means avoiding maloperation by checking the bay and substation interlocking and thus preventing equipment damage and personal injury. The interlocking conditions are always system-specific and for this reason are stored as CFC charts in the devices.

SIPROTEC 5 devices recognize 2 different types of interlocking conditions:

- Normal interlocking conditions:
These can be revoked by changing the switching mode to **non-interlocked**.

- Non-revocable (fixed) interlocking conditions:

These are still checked even if the switching mode is set to **non-interlocked**.

Application: Replacing mechanical interlocking, for example, that prevent actuation of a medium-voltage switch.

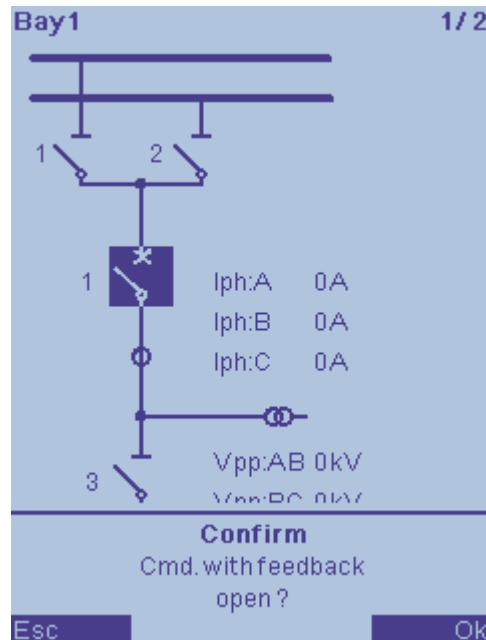
Each of the 2 categories has 2 release signals (for the *On* and *Off* switching directions) that represent the result of the interlocking plan, so that interlocking is in effect during the command check (see the figure below). The default setting for all release signals is **TRUE**, so that no switchgear interlocking checks take place if no CFC charts have been prepared.

Information			Source									
			Binary input									
			Base module									
Signals	Number	Type	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8		
(All)	(All)	...	...	...	...	...	...	...	...	...		
▼ Circuit breaker 1	201											
▶ Trip logic	201.5341											
▶ Circuit break.	201.4261											
▶ Manual close	201.6541											
▶ Control	201.4201											
▼ Interlocking	201.4231											
▶ >Enable opening	201.4231.500	SPS										
▶ >Enable closing	201.4231.501	SPS										
▶ >Enable opening (fixed)	201.4231.502	SPS										
▶ >Enable closing (fixed)	201.4231.503	SPS										
▶ Health	201.4231.53	ENS										

[sc_verrie, 1, en_US]

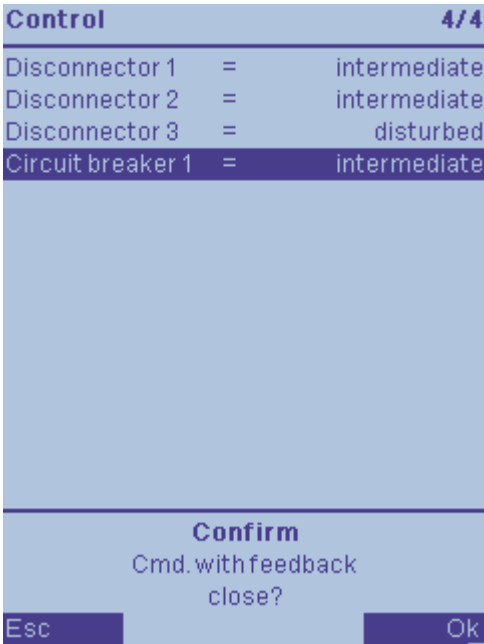
Figure 6-38 Interlocking Signals in Function Block Interlocking

By default, the status of interlocking conditions is not visible in the device, see the following figure.



[sc_HMI_WO_Position, 1, en_US]

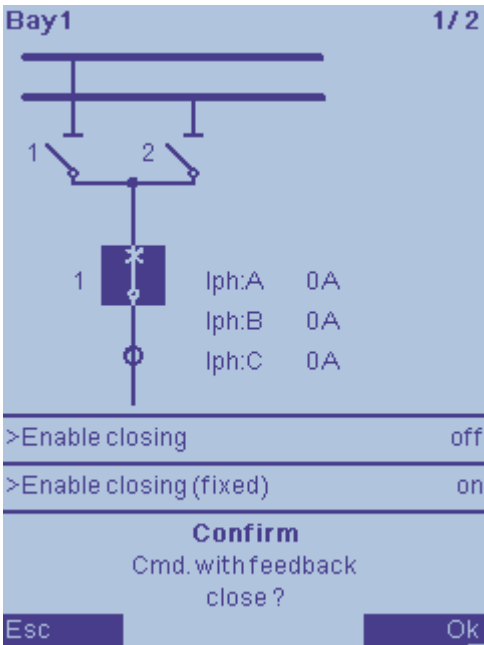
Figure 6-39 The Status of Interlocking Conditions is not Visible in the Control Display



[sc_HMI_WO_Position2, 1, en_US]

Figure 6-40 The Status of Interlocking Conditions is not Visible in the Control Menu

But, if you activate the parameter **Shows interlock.cond. HMI** by navigating to **Settings > Device settings > General > Control** in DIGSI 5, you can get the status of interlocking conditions in the device.



[sc_HMI_W_Position, 1, en_US]

Figure 6-41 The Status of Interlocking Conditions is Visible in the Control Display

Control		4/4
Disconnecter 1	=	intermediate
Disconnecter 2	=	intermediate
Disconnecter 3	=	disturbed
Circuit breaker 1	=	intermediate
>Enable closing		off
>Enable closing (fixed)		on
Confirm Cmd. with feedback close?		
Esc		Ok

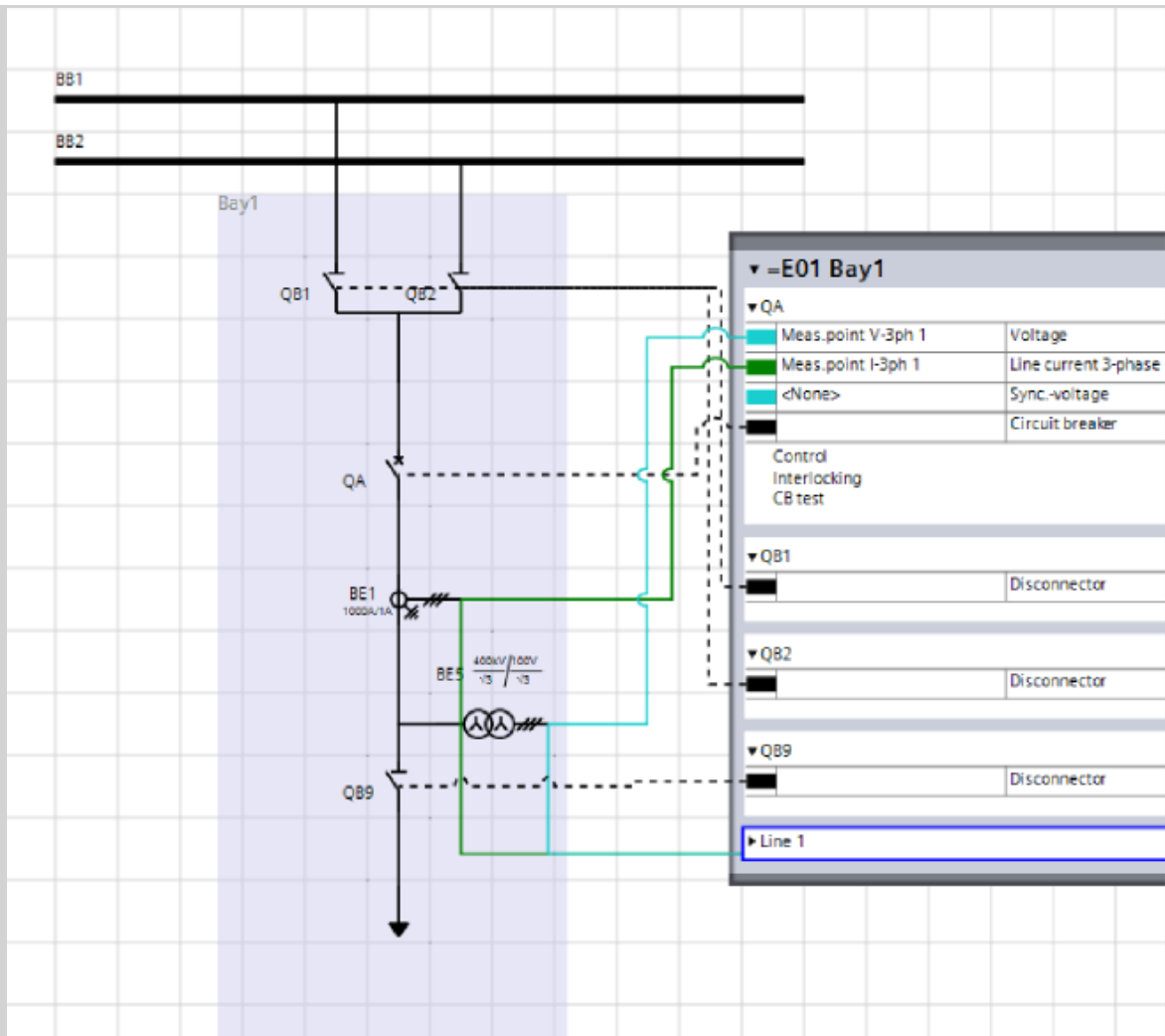
Figure 6-42 The Status of Interlocking Conditions is Visible in the Control Menu

EXAMPLE

For Interlocking

For the making direction of the circuit breaker QA in bay E01 (see the figure below), it is necessary to check whether the disconnectors QB1, QB2, and QB9 are in the defined position, that is, either **On** or **Off**. Opening the circuit breaker QA should be possible at any time.

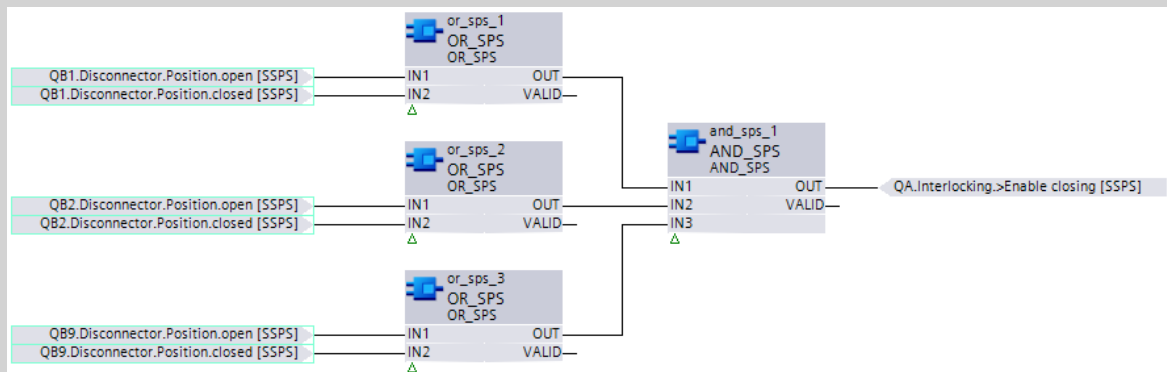
The interlocking equations are: QA_On = ((QB1 = On) or (QB1 = Off)) and ((QB2 = On) or (QB2 = Off)) and ((QB9 = On) or (QB9 = Off)). There is no condition for opening.



[sc_abgang_1_en_US]

Figure 6-43 Feeder Bay for a Double Busbar System

The CFC chart that is required to implement the interlocking equation is shown in the next figure.



[sc_verpla_1_en_US]

Figure 6-44 Interlocking Chart for Bay Interlocking

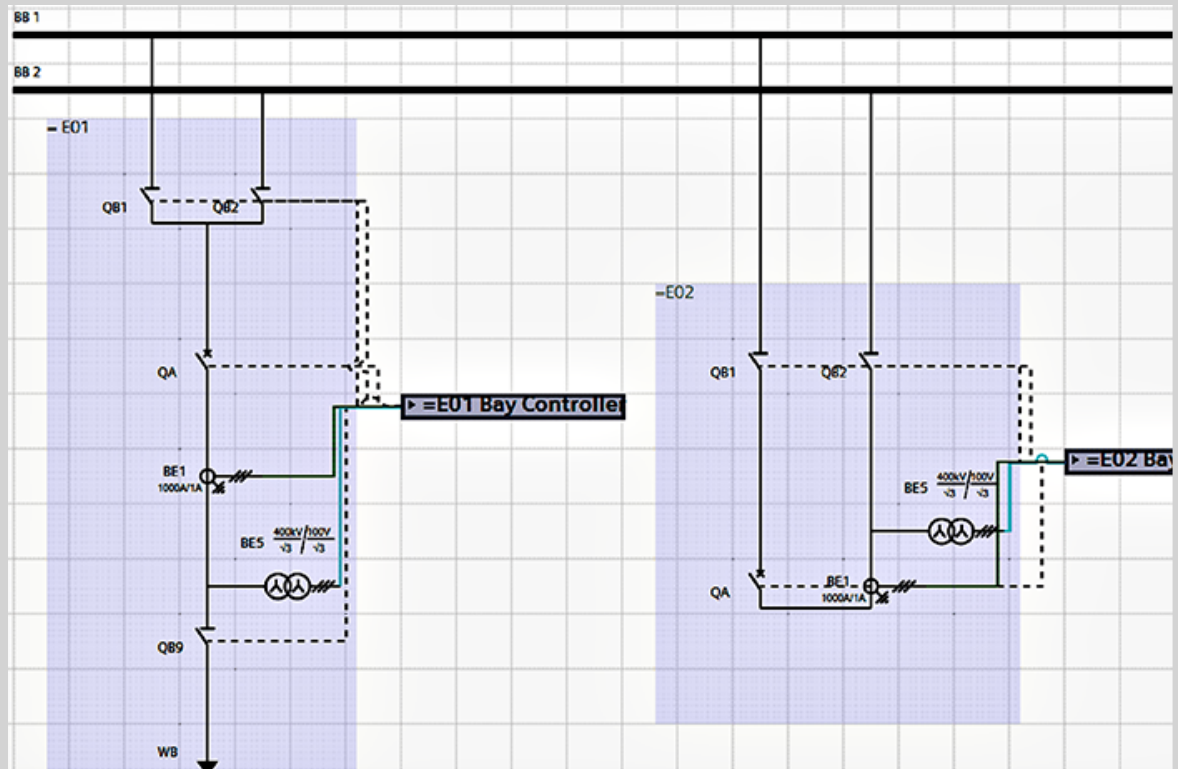
Since the **Disconnector** function block provides the defined position *On* or *Off*, the exclusive OR gate XOR is not necessary for the linkage. A simple OR suffices.

As can be seen in the CFC chart, the result of the check is connected to the **>Release on signal** in the **Interlocking** function block in the **Circuit breaker QA** function group (see [Figure 6-44](#)).

EXAMPLE

For System Interlocking

This example considers the feeder = E01 from the previous example (bay interlocking) and additionally the coupler bay = E02 (see the figure below).



[sc_system, 1, en_US]

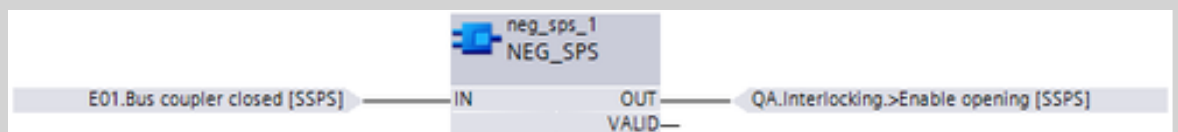
Figure 6-45 System with Feeder and Coupler Bays

The circuit breaker QA in coupler bay = E02 will be considered next. As the multibay interlocking condition, you must provide the bus-coupler circuit-breaker command block at the end:

If the 2 busbars in bay = E01 are connected, that is, if the 2 disconnectors QB1 and QB2 in bay = E01 are closed, the circuit breaker QA in bay = E02 is not allowed to be switched off. Accordingly, bay = E01 in the CFC of the device generates the indication *Bus coupler closed* from the positions of the switches QB1 and QB2 and, using IEC 61850-GOOSE, transmits it to bay = E02 in the device. You must then store the following interlocking condition in bay = E02:

QA_Off = NOT (= E01/Bus coupler closed)

In the CFC chart for the bus coupler device = E02, you must create the following CFC chart (see the figure below).



[sc_planve, 1, en_US]

Figure 6-46 Interlocking Chart for System Interlocking

1-Out-of-n Check (Double-Activation Blocking)

The double-activation blocking prevents 2 commands from being executed in the device simultaneously. You can set the device-internal check for each switching device as a parameter in the **Control** function block. The default setting is **yes**, that is, double-activation blocking is active (see the figure below).

Control			
201.4201.101	Control model:	SBO w. enh. security	
201.4201.102	SBO time-out:	30.00 s	
201.4201.103	Feedback monitoring time:	1.00 s	
201.4201.104	Check switching authority:	yes	
201.4201.105	Check if pos. is reached:	yes	
201.4201.106	Check double activat. blk.:	yes	
201.4201.107	Check blk. by protection:	yes	

[sc_double, 1, en_US]

Figure 6-47 Activating the Double-Activation Blocking

With SIPROTEC 5, it is also possible to achieve multibay double-activation blocking. In this case, send the signal **not selected** to other devices for analysis using IEC 61850-GOOSE. This signal is available under **Position** in every **Circuit breaker** or **Disconnecter** function block in the switching device function groups (see figure below).

▼ Circuit breaker 1	201	
▶ Trip logic	201.5341	
▼ Circuit break.	201.4261	
▶ >Ready	201.4261.500	SPS
▶ >Acquisition blocking	201.4261.501	SPS
▶ >Reset switch statist.	201.4261.502	SPS
▶ >Reset AcqBlk&Subst	201.4261.504	SPS
▶ External health	201.4261.503	ENS
▶ Health	201.4261.53	ENS
▼ Position	201.4261.58	DPC
▶ not selected		SPS
▶ open		SPS
▶ closed		SPS
▶ intermediate position		SPS
▶ disturbed position		SPS
▶ acquisition blk. active		SPS
▶ manual update active		SPS

[sc_notselected, 1, en_US]

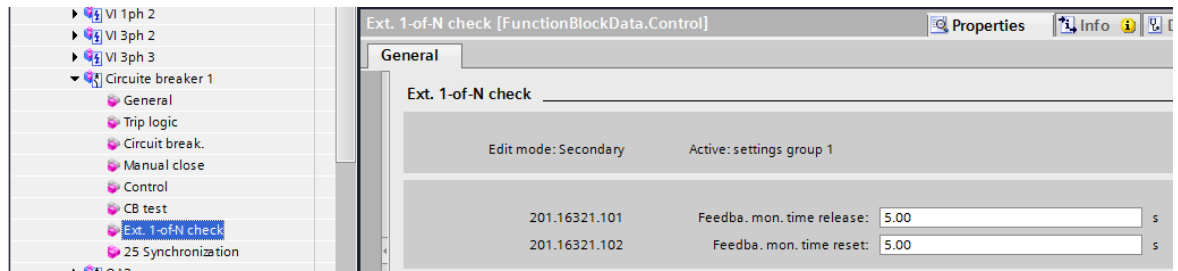
Figure 6-48 Signal **not selected** in the Circuit-Breaker Function Block

The signal is then queried in the CFC interlocking conditions for the associated switching devices and is used to generate the release signal (for example, **>Release on**).

External 1-of-N Check (Cross-Bay Double-Activation Blocking)

The function block **Ext. 1-of-N check** offers another option to implement a cross-bay 1-out-of-n check. You can select this function block in the FG **Circuit breaker – Control** in the DIGSI library. This function makes it possible to interlock other switching devices across all bays before the allocation of the switching device takes place in its own assigned bay or before the switching operation can be executed.

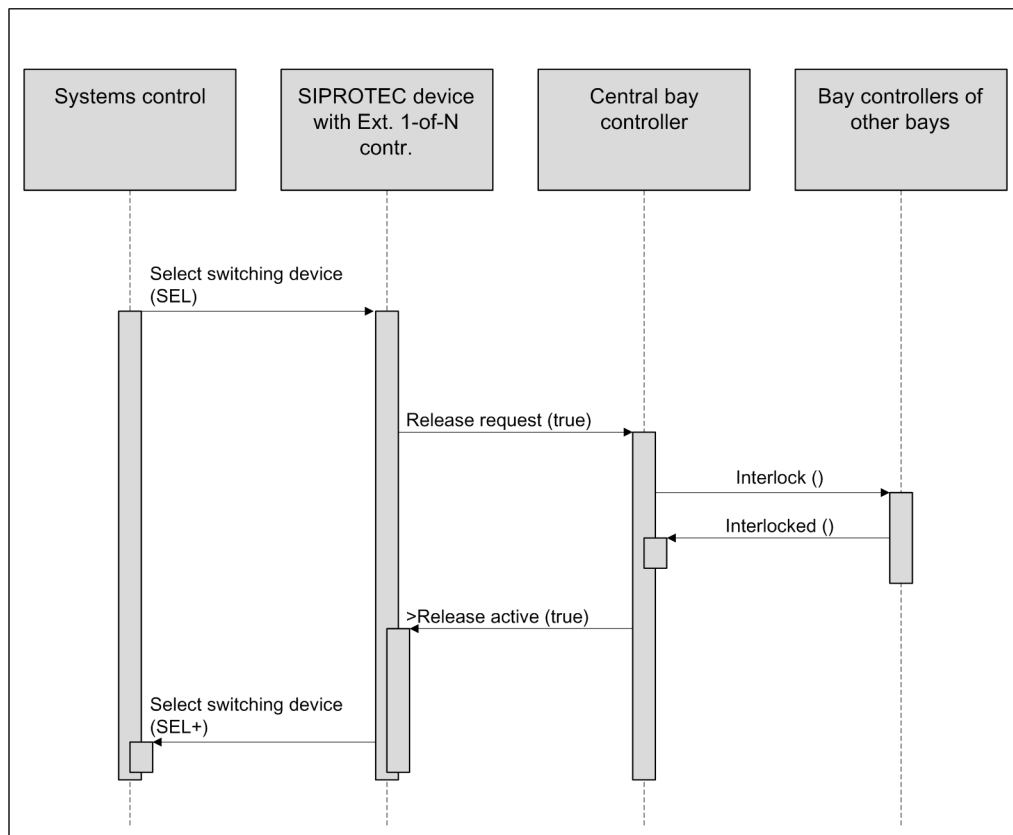
You can use the function block **Ext. 1-of-N check** in the **Circuit breaker** and **Disconnecter** function groups. In order to use the function, a control model **with feedback monitoring** must be configured in the circuit-breaker control.



[sc_library properties info routing ext 1-out-of-n control, 1, en_US]

Figure 6-49 Command Execution

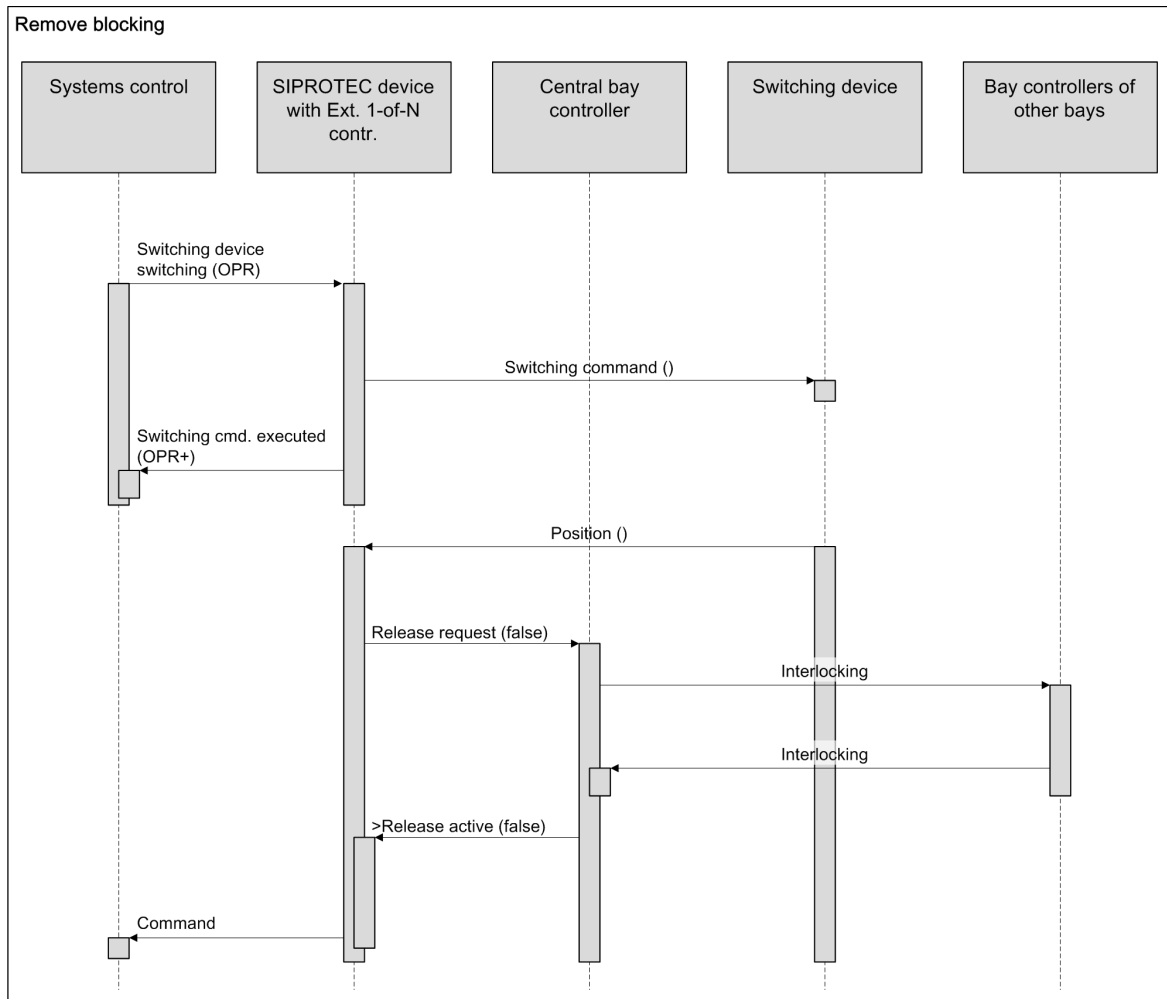
If the external 1-of-N check is instantiated, the output *Release request* prompts a central bay controller before executing a switching command. This bay controller must permit the switching operation (see the following figure). If the allocated switching devices were locked in another bay, the release is issued. Only when the release was issued via the input *>Release active* is the allocation (**Control model: SBO w. enh. security**) or the switching command (**Control model: direct w. enh. security**) executed and confirmed. The central bay controller is parameterized to reject a 2nd switching request.



[dw_set blocking, 1, en_US]

Figure 6-50 Setting the Blocking

Once the switch position has been reached, interlocking of the switching devices is canceled via the output *Release request*. The switching command is completed and acknowledged with CMT (see the following figure) only when interlocking termination has been acknowledged positively via the input *>Release active*.



[dw_remove blocking, 2, en_US]

Figure 6-51 Terminating the Blocking

User I/O Objects of the External 1-of-N Check Function Block

Name	I/O	Description	Range
<i>Release request</i>	O	This output remains active from the time of the switching prompt until the new position is reached.	true/false
<i>>Release active</i>	I	If this input is set, the switching device is released for switching operation. As long as this input is set, this switching device is blocked for additional switching operations.	true/false

Blocking by Protection Function

- Default setting (`_ :107`) **Check blk. by protection = yes**

In devices with protection and control functions, Siemens recommends that no switching commands can be issued while protection functions have picked up.

The default setting for blocking by the protection function is therefore **yes**. If necessary, you can disable this blocking. You can find the settings on the same page as the double-activation blocking (see [Figure 6-47](#)).

**NOTE**

Remember, for instance, that pickup of the thermal overload protection can create a fault as well and thus prevent switching commands.

**NOTE**

The command check **Blocking by protection function** is only available for controlling circuit breakers, because in this case a unique relationship with protection functions has been configured. In disconnectors, this relationship is not always unique, precisely with regard to the 1 1/2 circuit-breaker layout, and it must be mapped for each system using CFC charts.

To carry out the command check **Blocking by protection function** for disconnectors, use the following indications (if present) in your interlocking conditions:

- Group indication: **Pickup** (Function group **VI 3-phase**, **VI 1-phase** or **V 3-phase**)
- Circuit-breaker failure protection: **Pickup** (**Circuit-breaker failure protection**)

6.3.2 Command Logging

All commands in the sequence are logged. The command log contains:

- Date and time
- Name of the switching device (or function group)
- Reason for the transmission (SEL = Selected, OPR = Operate, CMT = Command execution end, SPN = Spontaneous)
- Status or switching direction

EXAMPLE

The following example illustrates control of a circuit breaker QA1 for various cases.

- Successful command output
- Interrupted command
- Command interrupted by switchgear interlocking
- Command ended due to missing feedback
- Spontaneous change of switch position without command output

The following figures indicate command logging for various scenarios of the standard control model SBO with feedback monitoring.

Operational log		2/11
26.03.2013	14:53:01.022	
Bay 2		
Circuit brk. 3pole 1		
Control:Cmd. with feedback		
		SEL+ open
26.03.2013	14:53:01.727	
Bay 2		
Circuit brk. 3pole 1		
Circuit break.:Trip/open cmd.		
		on
26.03.2013	14:53:01.727	
Bay 2		
Circuit brk. 3pole 1		
Control:Cmd. with feedback		
		OPR+ open
26.03.2013	14:53:01.745	
Bay 2		
Delete		

[sc_bbcon_1, 1, en_US]

Figure 6-52 Positive Case (Display 1)

Operational log		4/11
26.03.2013	14:53:01.727	
Bay 2		
Circuit brk. 3pole 1		
Control:Cmd. with feedback		
		OPR+ open
26.03.2013	14:53:01.745	
Bay 2		
Circuit brk. 3pole 1		
Circuit break.:Health		
		warning
26.03.2013	14:53:01.755	
Bay 2		
Circuit brk. 3pole 1		
Circuit break.:Health		
		ok
26.03.2013	14:53:01.825	
Bay 2		
Delete		

[sc_bbcon_2, 1, en_US]

Figure 6-53 Positive Case (Display 2)

Operational log		11/11
	intermediate position	
26.03.2013	14:53:03.789	
Bay 2		
Circuit brk. 3pole 1		
Control:Cmd. with feedback		
	intermediate position	
26.03.2013	14:53:04.462	
Bay 2		
Circuit brk. 3pole 1		
Circuit break.:Position		
	open	
26.03.2013	14:53:04.462	
Bay 2		
Circuit brk. 3pole 1		
Control:Cmd. with feedback		
	CMT+ open	
*****End*****		
Delete		

[sc_bbcon_3_1, en_US]

Figure 6-54 Positive Case (Display 3)

Operational log		3/5
	closed	
26.03.2013	15:05:02.922	
Bay 2		
Circuit brk. 3pole 1		
Control:Cmd. with feedback		
	SEL+ open	
26.03.2013	15:05:06.362	
Bay 2		
Circuit brk. 3pole 1		
Circuit break.:Position		
	closed	
26.03.2013	15:05:06.362	
Bay 2		
Circuit brk. 3pole 1		
Control:Cmd. with feedback		
	CNC+ open	
*****End*****		
Delete		

[sc_bbcon_4_1, en_US]

Figure 6-55 Positive Case with Command Cancellation

```

Operational log 1/1
26.03.2013 15:10:46.752
Bay 2
Circuit brk. 3pole 1
Control:Cmd. with feedback
SEL- open
*****End*****
Delete

```

Figure 6-56 Negative Case (Blocked by Switchgear Interlocking)

Operational log		2/199
25.03.2013	13:08:21.907	
Bay 2		
Circuit brk. 3pole 1		
Control:Cmd. with feedback		
		SEL+ close
25.03.2013	13:08:24.272	
Bay 2		
Circuit brk. 3pole 1		
Circuit break.:Close command		
		on
25.03.2013	13:08:24.272	
Bay 2		
Circuit brk. 3pole 1		
Control:Cmd. with feedback		
		OPR+ close
25.03.2013	13:08:24.370	
Bay 2		
Delete		

Figure 6-57 Negative Case (Expiration of Feedback Supervision Time) (Display 1)

Operational log		4/199
25.03.2013	13:08:24.272	
Bay 2		
Circuit brk. 3pole 1		
Control:Cmd.with feedback		
		OPR+ close
25.03.2013	13:08:24.370	
Bay 2		
Circuit brk. 3pole 1		
Circuit break.:Close command		
		off
25.03.2013	13:08:34.270	
Bay 2		
Circuit brk. 3pole 1		
Circuit break.:Position		
		open
25.03.2013	13:08:34.270	
Bay 2		
Delete		

[sc_bbcon_8_1, en_US]

Figure 6-58 Negative Case (Expiration of Feedback Supervision Time) (Display 2)

Operational log		7/199
Circuit break.:Close command		
		off
25.03.2013	13:08:34.270	
Bay 2		
Circuit brk. 3pole 1		
Circuit break.:Position		
		open
25.03.2013	13:08:34.270	
Bay 2		
Circuit brk. 3pole 1		
Control:Cmd.with feedback		
		CMT- open
25.03.2013	13:09:03.542	
Bay 2		
Circuit brk. 3pole 1		
Circuit break.:Position		
		SPN intermediate
Delete		

[sc_bbcon_9_1, en_US]

Figure 6-59 Negative Case (Expiration of Feedback Supervision Time) (Display 3)



[sc_bicon_6_1_en_US]

Figure 6-60 Spontaneous Status Change

Depending on the transmission reason, the desired control value or the actual state value of the controllable and the switching device can be contained in the log.

The following table shows the relationship.

Table 6-23 Relationship between the Reason for Transmission and the Value Logged

Reason for Transmission	Value
Selected (SEL)	Desired value
Operate (OPR)	Desired value
Command cancellation (CNC)	Desired value
Command execution and termination (CMT)	Actual value
Spontaneous change (SPN)	Actual value

6.3.3 Application Notes and Setting Notes for the External 1-of-n Check Function Block

Parameter: **Feedba. mon. time release**

- Default setting (`_:101`) **Feedba. mon. time release** = 5.00 s

With the parameter **Feedba. mon. time release**, you specify the time within which the release request must be confirmed via the input *>Release active*.

Parameter: **Feedba. mon. time reset**

- Default setting (`_:102`) **Feedba. mon. time reset** = 5.00 s

With the parameter **Feedba. mon. time reset**, you specify the time within which the withdrawal of the release requests must be confirmed via the input *>Release active*.

6.3.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Control				
_:101	Control:Control model		- status only - direct w. normal secur. - SBO w. normal secur. - direct w. enh. security - SBO w. enh. security	SBO w. enh. security
_:102	Control:SBO time-out		0.01 s to 1800.00 s	30.00 s
_:103	Control:Feedback monitoring time		0.01 s to 1800.00 s	1.00 s
_:104	Control:Check switching authority		- no - yes	yes
_:105	Control:Check if pos. is reached		- no - yes	yes
_:106	Control:Check double activat. blk.		- no - yes	yes
_:107	Control:Check blk. by protection		- no - yes	yes

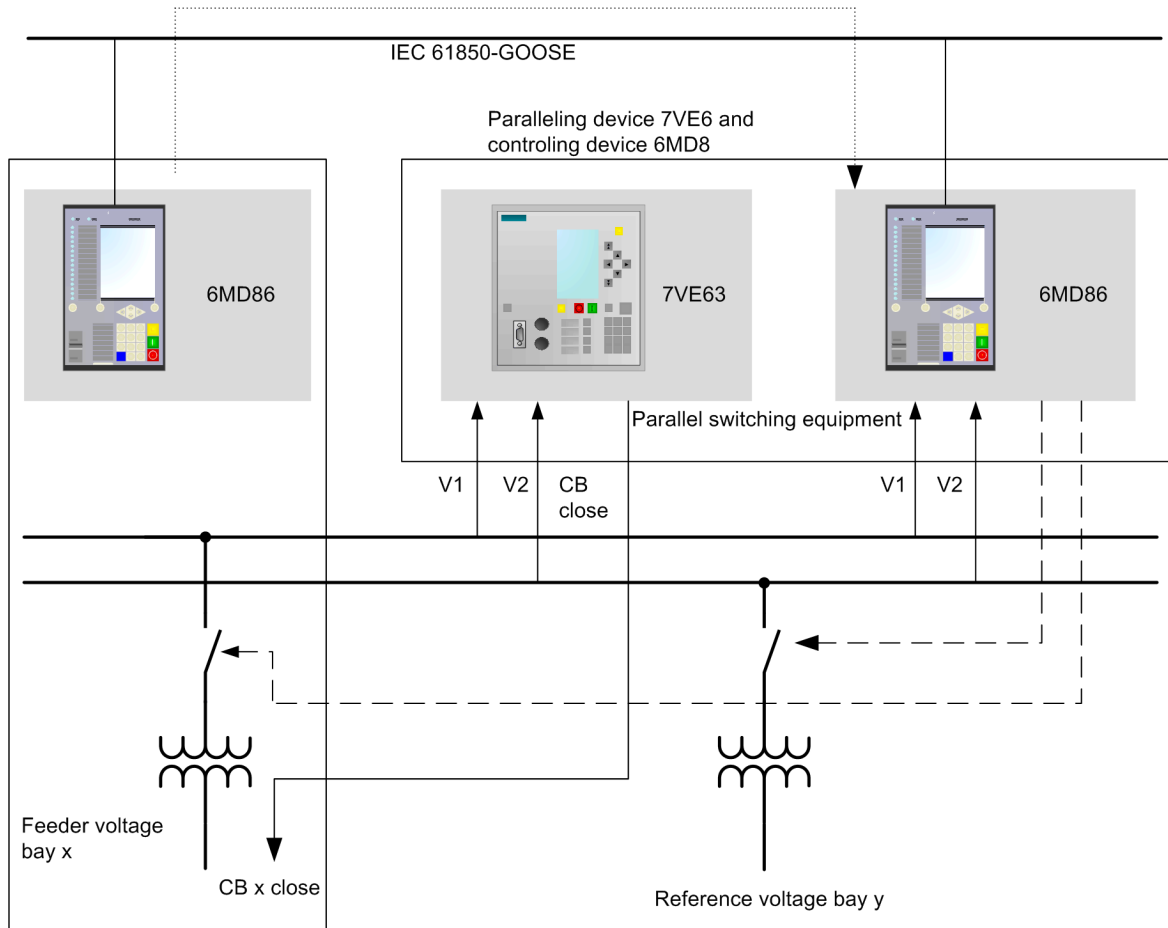
6.3.5 Information List

No.	Information	Data Class (Type)	Type
Control			
_:53	Control:Health	ENS	O
_:58	Control:Cmd. with feedback	DPC	C

6.4 External Synchronization

6.4.1 Description

The purpose of the **External synchronization** function is to control an external synchronization device.



[dw_ctrl_ext_sync_device, 1, en_US]

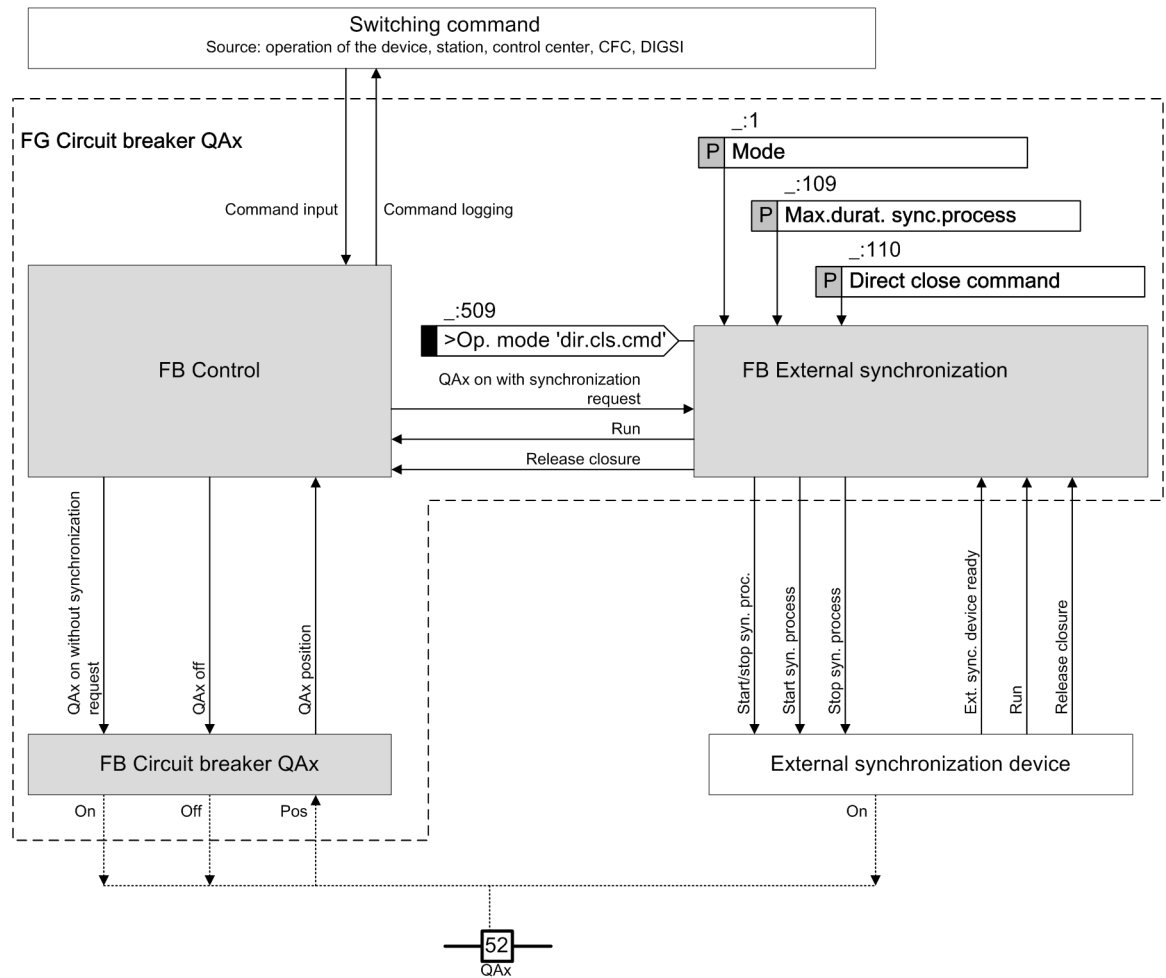
Figure 6-61 Triggering an External Synchronization Device

The bay controller in bay x should switch the circuit breaker in bay x in synchrony. The synchronization check is carried out in the central paralleling device 7VE6. In addition to the paralleling device, another central bay controller ensures the switching of the correct measuring voltages and the routing of the CB close command from the 7VE6 to the correct circuit breaker in bay x. The bay controller x provides the information to the central bay controller via IEC61850-GOOSE.

The **External synchronization** is designed as a function block which can be used in the Circuit-breaker function group. The additional **External synchronization** function block integrates the external synchronization into command processing, so that the corresponding feedback can be forwarded to the command source.

If a circuit-breaker close command with a synchronization requirement is present, the external synchronization device is started. After successfully checking the synchronization conditions, the close command is issued from the external synchronization device to the circuit breaker. If a circuit-breaker close command without synchronization requirement is present, the circuit-breaker close command is issued directly from the **Circuit-breaker** function group to the circuit breaker. Also, each circuit-breaker trip command is issued directly to the circuit breaker.

In case of a failure of the external synchronization device, you can also close the circuit breaker directly without considering the synchronization conditions.

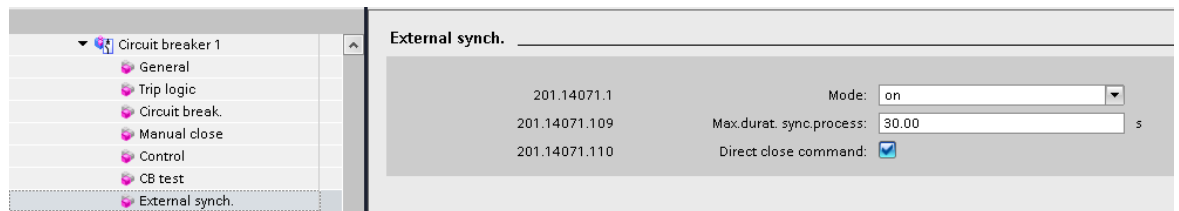


[dw_extsyn-02, 1, en_US]

Figure 6-62 Interaction between Control and External Synchronization

Parameterization with DIGSI

In the DIGSI library, the function is visible inside the **Circuit-breaker** function group as the **External synchronization** function block. You can instantiate the function block in the **Circuit-breaker** function group and the **Circuit-breaker (control)** function group. You can instantiate only 1 **External synchronization** function block within these function groups at a time.



[scextsyn-041116-01, 1, en_US]

Figure 6-63 Instantiating the **External Synchronization** Function Block in the **Circuit-Breaker** Function Group

It is not possible to jointly instantiate the **External synchronization** function block with the **25 synchronization** function in the same **Circuit-breaker** function group.

Notes for Optional Input Interconnections

You have the option of connecting the input signals *>Close cmd. released* and *>In progress*. If you omit these interconnections, observe the following instructions:

Input *>Close cmd. released*:

If you do not interconnect the input signal *>Close cmd. released*, the execution of a circuit-breaker close command with synchronization requirement is confirmed directly (execution successful: OPR+), as soon as the output signal *Start syn. process* is set. In this case, the (`_:109`) **Max.durat. sync.process** setting has no meaning. If you use a control model with feedback monitoring, consider that the feedback monitoring will start immediately when the *Start syn. process* signal is tripped. The (`_:4201:103`) **Feedback monitoring time** setting must therefore be set higher than the maximum synchronization time of the external synchronization device plus the circuit-breaker make time. If *>Close cmd. released* is not routed, the output *Start/stop syn. proc.* is not set.

Input *>In progress*:

The interconnection of the input signal *>In progress* is intended to check whether the synchronization device has received the *Start syn. process* signal. If you do not interconnect this input signal and the external synchronization device rejects a start command, the negative acknowledgment of the circuit-breaker close command does not occur until the maximum synchronization time (parameter (`_:109`) **Max.durat. sync.process**) has expired.

Input *>Op. mode 'dir.cls.cmd'*:

In case of a failure of the external synchronization device, you can also close the circuit breaker directly without considering the synchronization conditions. To do this, activate the input signal *>Op. mode 'dir.cls.cmd'* or the parameter (`_:110`) **Direct close command**. The close command is then issued directly by the bay controller.

6.4.2 Application and Setting Notes (External Synchronization)

Parameter: Mode

- Default setting (`_:1`) **Mode** = *on*

With the **Mode** parameter, you switch the external synchronization function on or off. If you set the **Mode** parameter to *off*, a circuit-breaker close command with synchronization requirement is rejected.

Parameter: Max.durat. sync.process

- Default setting (`_:109`) **Max.durat. sync.process** = *30 s*

The **Max.durat. sync.process** parameter defines the maximum synchronization time. The time starts when the **External synchronization** function block sends a close command to the external synchronization device. The command must be executed within this time. If the close command is not executed within this time, the **External synchronization** function block sends a command to cancel closing to the external synchronization device.

Parameter: Direct close command

- Default setting (`_:110`) **Direct close command** = *no*

In case of a failure of the external synchronization device the **Direct close command** parameter is used to close the circuit breaker directly without considering the synchronization conditions. If the parameter is activated a close command with synchronization requirement will not be transmitted to the external synchronization device, but directly carried out by the bay controller.

6.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
External sync.				
_:1	External sync.:Mode		- off - on - test	on
_:109	External sync.:Max.durat. sync.process		0.00 s to 3600.00 s; ∞	30.00 s
_:110	External sync.:Direct close command		0 1	false

6.4.4 Information List

No.	Information	Data Class (Type)	Type
External sync.			
_:506	External sync.:>Synch. device ready	SPS	I
_:508	External sync.:>In progress	SPS	I
_:507	External sync.:>Close cmd. released	SPS	I
_:509	External sync.:>Op. mode 'dir.cls.cmd'	SPS	I
_:52	External sync.:Behavior	ENS	O
_:54	External sync.:Health	ENS	O
_:55	External sync.:Start syn. process	SPS	O
_:56	External sync.:Stop syn. process	SPS	O
_:57	External sync.:Start/stop syn. proc.	SPS	O

6.5 Switching Sequences

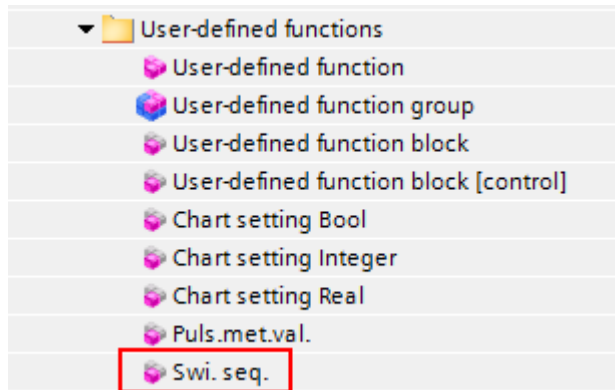
6.5.1 Overview of Functions

Switching sequences may be running inside the device that switch the switchgear automatically in a prespecified sequence.

A switching sequence consists of a special function block **Switching sequence** (Swi. seq.) from the DIGSI 5 Library and the project-specific list of the switching commands that are generated in the CFC.

6.5.2 Function Description

The function block **Switching sequence** is located in folder **User-defined functions** in the DIGSI 5 Library.



[sc_udeffb, 1, en_US]

Figure 6-64 Function Block **Switching Sequence** in the Library

These function blocks can be used in the information matrix on the highest level (level of the function groups) or in a user-defined function group.

One **Switching sequence** function block is used per switching sequence. The function block is the interface for controlling and monitoring the condition of the CFC switching sequence. The task of the function block is to verify the relative conditions for control commands, for example, switching authority, interlocking conditions, etc. You can connect the signals of the function block with the CFC chart. They start and stop the switching sequence and provide data about the status of the switching sequence (see [Figure 6-65](#)). The CFC chart is used to activate the switching device that must be switched. The CFC blocks define, among other things, the switching devices that must be switched.

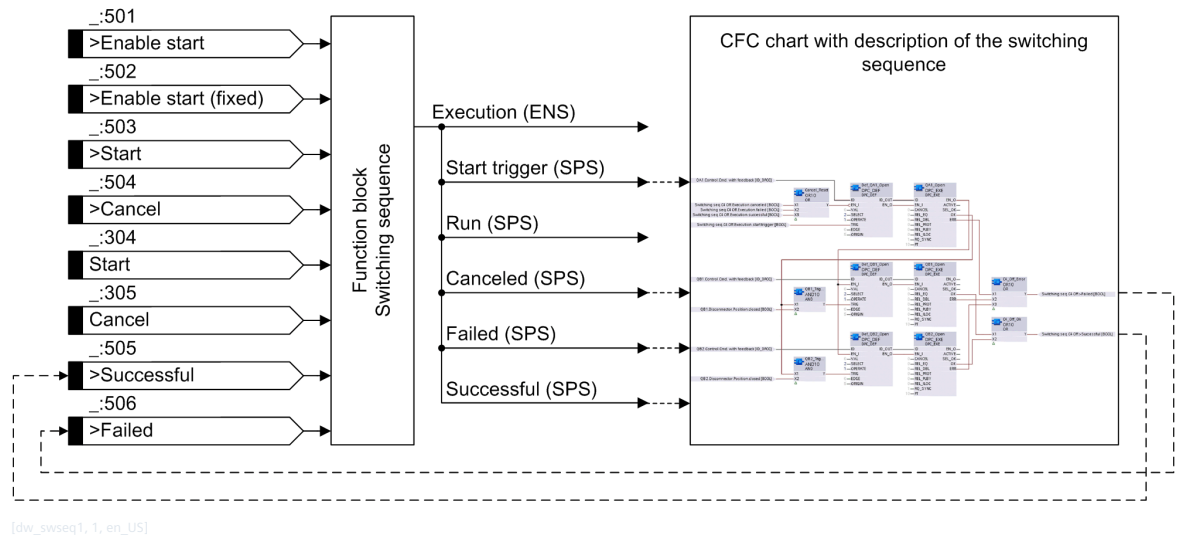


Figure 6-65 Switching Sequence Function Block

Starting and Canceling a Switching Sequence

One of the following methods can be used to start a switching sequence:

- On-site operation: menu or display page
- Input **>Start** during rising edge, for example, via binary input
- Controllable **Start** for the start via a communication protocol, for example, IEC 61850, T103, or DNP
- Input **>Start** via a function key
- Controllable **Start** via a function key

One of the following methods can be used to cancel a switching sequence:

- On-site operation: menu or display page
- Input **>Cancel** during rising edge, for example, via binary input
- Controllable **Cancel** for the cancelation via a communication protocol, for example, IEC 61850, T103, or DNP
- Input **>Cancel** via a function key
- Controllable **Cancel** via a function key

On-Site Operation

If at least one **Switching sequence** function block is used in the device, a new **Switching sequences** entry is shown in the first line of the **Control** menu. If this menu item is selected, an overview of all switching sequences and the current status will be displayed (see [Figure 6-66](#), example with 2 switching sequences). You can start or cancel the switching sequences from this menu.

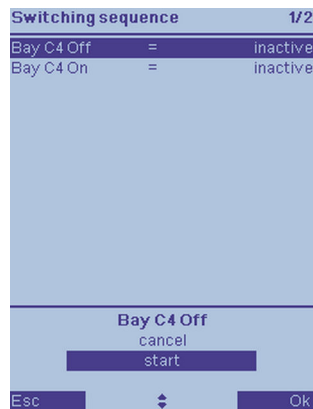
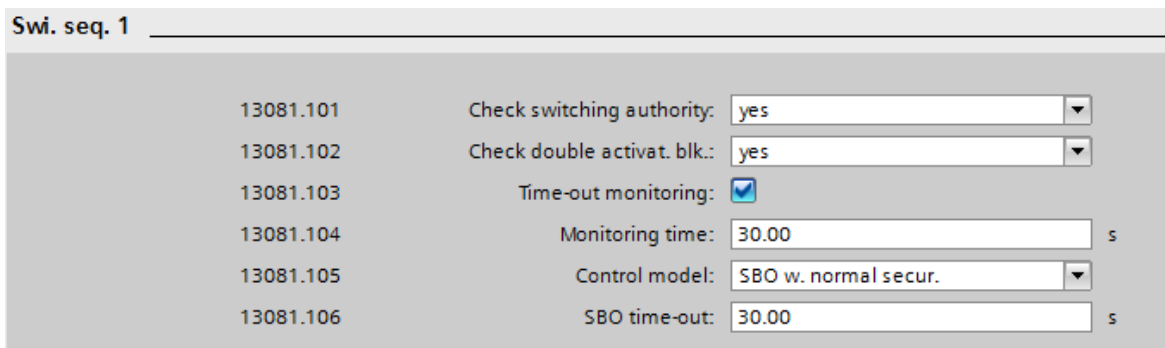


Figure 6-66
Overview of the Switching Sequences on the Device Display

6.5.3 Application and Setting Notes

The function block offers similar settings to the **Control** function block of a circuit breaker or disconnecter (see chapter [6.2.1 General Overview](#)).



[sc_ccs4pa, 1, en_US]

Figure 6-67 Settings of the **Switching Sequence** Function Block

Parameter: **Check switching authority**

- Default setting (`_:101`) **Check switching authority** = **yes**

With the **Check switching authority** parameter, you can determine whether the switching authority should be checked before the execution of the switching sequence.

Parameter: **Check double activat. blk.**

- Default setting (`_:102`) **Check double activat. blk.** = **yes**

With the **Check double activat. blk.** parameter, you can determine whether the double activation of switching devices should be checked. The setting value **yes** indicates that a switching sequence will be started only if no switching commands for a circuit breaker and disconnecter are active, provided that double-activation blocking was activated for those switching devices.

Parameter: **Time-out monitoring**

With the **Time-out monitoring** parameter, you can determine whether the feedback from the process should be evaluated. The feedback is gathered via the inputs *>Successful* and *>Failed*.

Parameter: **Monitoring time**

- Default setting (`_:104`) **Monitoring time** = **30.00 s**

With the **Monitoring time** parameter, you can determine the duration of the monitoring time.

Parameter: Control model

- Default setting (`_:105`) **Control model** = *SBO w. normal secur.*

With the **Control model** parameter, you select between *direct w. normal secur.* or *SBO w. normal secur.* to start the switching sequence.

It is not possible to set a control model for cancelation of the switching sequence. The control model *direct w. normal secur.* is always used to cancel the function.

Information

The **Switching sequence** function block provides the following data:

▼ Swi. seq. 1	13081	
▶ >Enable start	13081.501	SPS
▶ >Enable start (fixed)	13081.502	SPS
▶ >Start	13081.503	SPS
▶ >Cancel	13081.504	SPS
▶ >Successful	13081.505	SPS
▶ >Failed	13081.506	SPS
▶ Health	13081.53	ENS
▼ Execution	13081.302	ENS
▶ start trigger		SPS
▶ running		SPS
▶ canceled		SPS
▶ failed		SPS
▶ successful		SPS
▶ Start	13081.304	SPC
▶ Cancel	13081.305	SPC
▶ Switching auth. station	13081.303	SPC

[sc_info1, 1, en_US]

Figure 6-68 Data Provided by the **Switching Sequence** Function Block

In the **Switching sequence** function block, the interlocking is analog to the **Interlocking** function block and it is possible to use it in the switching sequence:

- **>Enable start**: Connection to interlocking conditions (CFC) for the start of the entire switching sequence. Not in effect in the **non-interlocked** switching mode.
- **>Enable start (fixed)**: Non-revocable interlocking conditions for the start of the entire switching sequence. In effect regardless of the switching mode.

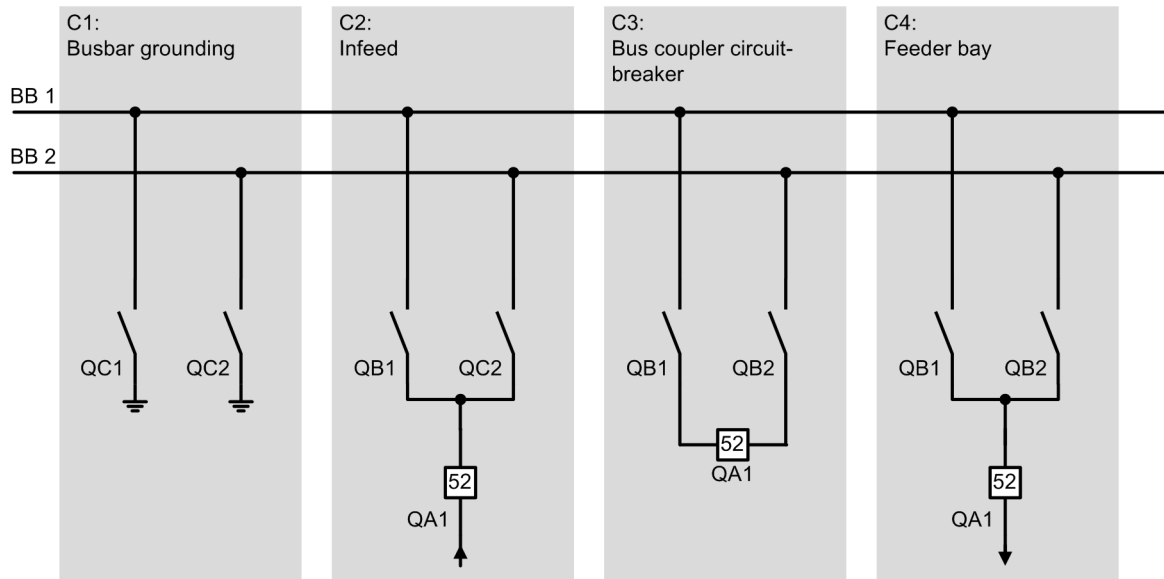
If the time-out monitoring is activated (parameter **Time-out monitoring**), the process feedback must take place via the inputs **>Successful** and **>Failed**. If the last switching command of the switching sequence was executed successfully, the input **>Successful** usually is set. To do this, connect the feedback of the last switching command from the CFC with this input of the function block during the device parameterization.

If a switching command fails, this feedback can be captured by the input **>Failed**. The active switching sequence will be ended immediately and does not have to wait for a time-out.

The indication **Execution** signals the current state of the switching sequence. The events *running*, *canceled*, *failed*, and *successful* are generated only while the time-out monitoring is activated. The event *Start Trigger* is used to start the switching sequence in the CFC chart.

Example for a Switching Sequence with CFC

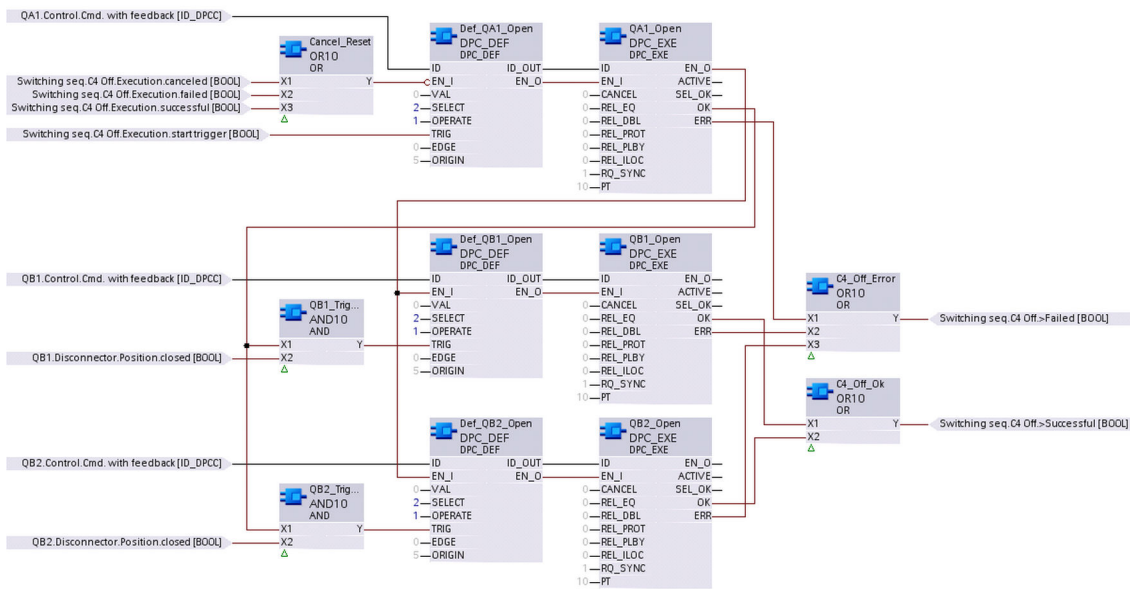
The following figure shows a single-line diagram for a substation with 4 bays: Busbar grounding, infeed, bus-coupler circuit-breaker, and feeder bay.



[dw_bspunt, 1, en_US]

Figure 6-69 Example of a Substation

The switching sequence **C4 Off** (Figure 6-70) should switch off feeder bay C4. The circuit breaker is opened; followed by opening of one of the 2 busbar disconnectors.



[sc_ssc4as, 1, en_US]

Figure 6-70 CFC Switching Sequence C4 Off

Command Execution

As described in section [Starting and Canceling a Switching Sequence, Page 327](#), the display page or the **Control** menu can be used to start the switching sequence. The *Start Trigger* signal for indication *Execution* is used to recognize the start and initiates the switching sequence by pickup of **TRIG** in the DPC-DEF building block of circuit breaker QA1. Building blocks DPC-DEF and DPC-EXE are always used in pairs. The DEF building block controls the type and nature of the command

- **VAL** = Switching direction (0 = Off, 1 = On)
- **SELECT** = Select switching device (2 = Select with a value suitable for the preset control model *SBO w. enh. security*)
- **OPERATE** = Switch switching device (1 = Switching device is switched on or off)

Using the connected DPC-EXE building block, the command checks can be deactivated (**REL_...**). In the application example, all inputs are set to 0 and therefore, all checks are activated.

After the open command of circuit breaker QA1 is acknowledged via the auxiliary contacts, the **OK** output of the CFC block DPC_EXE becomes active and triggers the next switching object. With the input **PT** the signal for the **OK** output is time-delayed (in the example by 10 ms) and creates a dead time between individual switching commands and the switching sequence. This dead time is important for the updating of the interlocking conditions.

If QB1 is closed, QB1 will be opened. If QB2 is closed, QB2 will be opened. In order to implement this logic, the **OK** output signal of QA1 is linked with the respective positions of circuit breakers QB1 and QB2 via the logical AND function. This signal serves as a trigger for the trip command of QB1 or QB2.

Because in this example the time-out monitoring is activated, the feedback about the successful or unsuccessful execution of the switching sequence must be parameterized. The **Switching sequence** function block provides the inputs *>Successful* and *>Failed*. In order to acknowledge the entire switching sequence positively, the OR operation of the **OK** outputs for the disconnectors QB1 and QB2 is sufficient. The feedback of all failed executions takes place via the OR operation of all **ERR** outputs of the switching devices. The benefit of such assessment is the fact that, in case of a failure, waiting for the time-out is not necessary, but the active switching sequence can be ended immediately.

In this example, the use of the **EN_I** input of building block DPC-DEF fulfills 2 tasks:

- Cancellation of the entire switching sequence
- Resetting of the outputs **OK** and **ERR** on building block DPC-EXE

By linking all **EN_I** inputs and **EN_O** outputs of building blocks DPC-DEF and DPC-EXE, the execution of the switching sequence can be controlled centrally since the value is transmitted between the building blocks. Only if input **EN_I** on the DPC-EXE is set to 1, a switching command is issued. If the input drops back to 0 while a command is being processed, this command will be canceled. With this behavior, cancellation of an entire switching sequence can be achieved. As recognition of a cancellation, the *cancelled* signal of the indication *Execution* is used in the CFC chart and connected with the input **EN_I** of the first switching device, in this example, with the DPC-DEF building block of circuit breaker QA1.

Since the **OK** and **ERR** outputs of the DPC-EXE building block maintain their value until execution of the next command, it is necessary to reset the continuous output after each execution of the switching sequence for correct execution of the entire CFC switching sequence multiple times. In this case, the use of the **EN_I** input is also helpful. In the input drops back to 0, the **OK** and **ERR** outputs are also reset to 0. The triggers for ending the switching sequence are the events *failed* and *successful*. For this reason, in the above example, the signals *failed* and *successful* of the indication *Execution* were connected with **EN_I** of the DPC-DEF building block.

6.5.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
<i>Swi. seq. #</i>				
_:101	Swi. seq. #:Check switching authority		- no - yes - advanced	yes
_:102	Swi. seq. #:Check double activat. blk.		- no - yes	yes
_:103	Swi. seq. #:Time-out monitoring		0 1	true
_:104	Swi. seq. #:Monitoring time		0.02 s to 3600.00 s	30.00 s
_:105	Swi. seq. #:Control model		- direct w. normal secur. - SBO w. normal secur.	SBO w. normal secur.
_:106	Swi. seq. #:SBO time-out		0.01 s to 1800.00 s	30.00 s
<i>Switching authority</i>				
_:151	Swi. seq. #:Swi.dev. related sw.auth.		0 1	false
_:152	Swi. seq. #:Specific sw. authorities		0 1	true
_:115	Swi. seq. #:Specific sw.auth. valid for		- station - station/remote - remote	station/remote
_:153	Swi. seq. #:Num. of specific sw.auth.		2 to 5	2
_:154	Swi. seq. #:Multiple specific sw.auth.		0 1	false

6.5.5 Information List

No.	Information	Data Class (Type)	Type
<i>Swi. seq. #</i>			
_:501	Swi. seq. #:>Enable start	SPS	I
_:502	Swi. seq. #:>Enable start (fixed)	SPS	I
_:503	Swi. seq. #:>Start	SPS	I
_:504	Swi. seq. #:>Cancel	SPS	I
_:505	Swi. seq. #:>Successful	SPS	I
_:506	Swi. seq. #:>Failed	SPS	I
_:53	Swi. seq. #:Health	ENS	O
_:302	Swi. seq. #:Execution	ENS	O
_:304	Swi. seq. #:Start	SPC	C
_:305	Swi. seq. #:Cancel	SPC	C

6.6 User-Defined Function Block [Control]

6.6.1 Overview of Functions

The **User-defined function block [control]** allows the switching-authority check of a control command, the check of whether the position has been reached, a double-activation blocking, and the definition of interlocking conditions for user-defined controllables.

6.6.2 Function Description

The **User-defined function block [control]** is located in the folder **User-defined functions** in the DIGSI 5 Library.

You can instantiate the user-defined function blocks on the top level (in parallel to other function groups) as well as within function groups and functions.

The task of the function block is to check the switching authority and the interlocking conditions for the user-defined control commands instantiated within it. For these control commands, the function block checks whether the required switch position is equal to the current switch position (actual/set point comparison). If you activate the double-activation blocking, commands from switching objects and user-defined control signals will be rejected as long as a command is still being performed for one of the other switching objects for which double-activation blocking has also been set.

With the binary release signals, you can determine a switchgear interlocking protection for all the user-defined control signals instantiated in the function block. Unlike the switching devices (circuit breaker, disconnector), there is only one release input here, since there is only one switching direction for the signal types INC and APC. The signal types DPC, SPC, and BSC have 2 switching directions, but still only one release input. This release input can be operated based on the result of a logic created in the CFC, or can be directly connected to a binary input or a variable. If the input **>Enable** is activated, the switching command can be performed. If it is not activated, the switching command is rejected, with the reason *Interlocking violation*.

This applies in a similar way to the input **>Enable (fixed)**, although with this input, the interlocking cannot be revoked by key switch S1 or an *unlocked* switching authority.

The following table shows the reaction of the function to the assignment of its inputs.

Input >Enable	Input >Enable (fixed)	Effect on control command
1	0	Rejected
0	1	Successful if device mode = <i>unlocked</i> Rejected if device mode = <i>locked</i>
1	1	Successful
0	0	Rejected



NOTE

The default setting for the state of the inputs is **1**, that is, the switching commands are not locked.

You can instantiate every user-defined signal (for example, SPS, DPC, INC) in the function block and route the corresponding indications (see following figure).

Information			Source					
			Binary input					
			Basismodul					
Signals	Number	Type	1.1	1.2	1.3	1.4	2.1	2.2
(All)	(All)	...	...	...	...	...	...	...
U-def.FB ctl.1	851.15931				*	*		
>Enable	851.15931.501	SPS						
>Enable (fixed)	851.15931.502	SPS						
Mode (controllable)	851.15931.51	ENC						
Behavior	851.15931.52	ENS						
Health	851.15931.53	ENS						
Switching auth. station	851.15931.302	SPC						
BSC		BSC						
APC		APC						
SPC		SPC			H			
DPC		DPC				CH		
INC		INC						

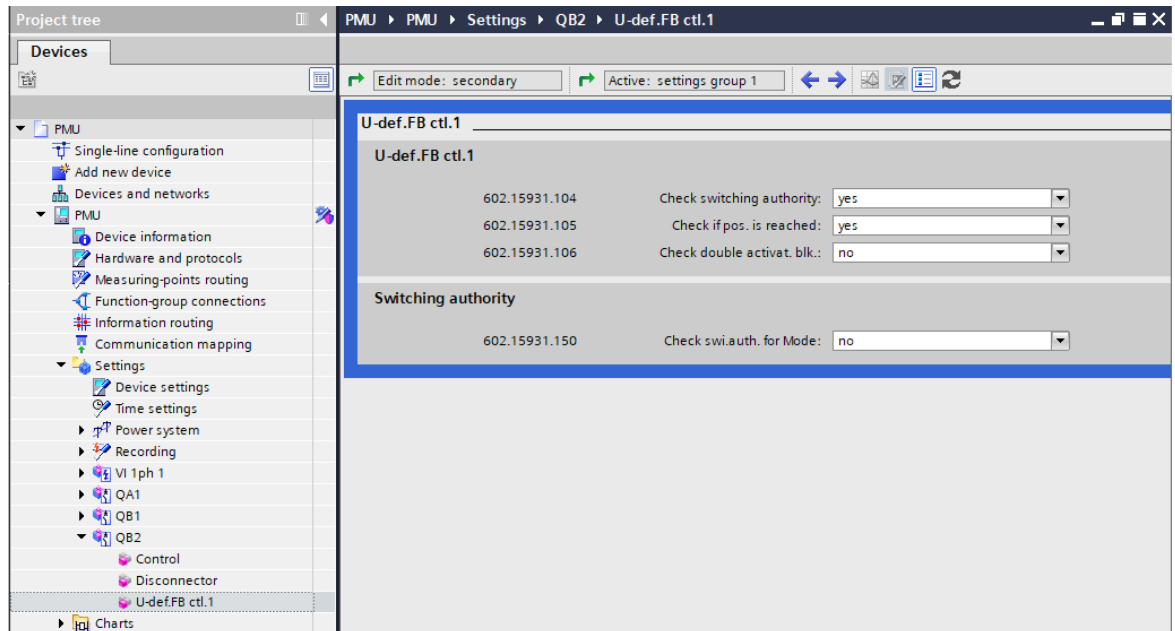
[sc_user_01, 1, en_US]

Figure 6-71 Information Routing with Inserted User-Defined Function Block [Control]: Process Indications and Some Single-Point Indications

6.6.3 Application and Setting Notes

The function block contains the parameters (**_:104**) **Check switching authority**, (**_:105**) **Check if pos. is reached**, (**_:106**) **Check double activat. blk.**, and (**_:150**) **Check swi.auth. for Mode**. The parameter settings **Check switching authority** and **Check if pos. is reached** affect all controllables instantiated in the function block. Other signal types are not affected by these parameters and objects.

On the other hand, the parameter setting **Check swi.auth. for Mode** affects the controllable **Mode (controllable)** of the function block.



[sc_user_02, 1, en_US]

Figure 6-72 Parameterization Options of the User-Defined Function Block [Control]

Parameter: Check switching authority

- Default setting (_:104) **Check switching authority = yes**

With the **Check switching authority** parameter, you determine whether the command source of switching commands must be checked (see chapter [6.3.1 Command Checks and Switchgear Interlocking Protection](#)).

Parameter: Check if pos. is reached

- Default setting (_:105) **Check if pos. is reached = yes**

With the **Check if pos. is reached** parameter, you check at a switching command whether the switching direction equals the current position.

Parameter: Check double activat. blk.

- Default setting (_:106) **Check double activat. blk. = no**

With the **Check double activat. blk.** parameter, you check whether commands from switching objects and user-defined control signals should be rejected, as long as a command is still being executed for one of the other objects.

Parameter: Check swi.auth. for Mode

- Default setting (_:150) **Check swi.auth. for Mode = no**

With the **Check swi.auth. for Mode** parameter, you specify whether the switching authority for the command source must be checked when switching the controllable **Mode (controllable)** to the mode **On**, **Off**, or **Test**. If you set the parameter **Check swi.auth. for Mode** to **yes**, the switching command is only executed with the appropriate switching authority (see chapter [6.3.1 Command Checks and Switchgear Interlocking Protection](#)).

6.6.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
<i>U-def.FB ctl.#</i>				
_:104	U-def.FB ctl. #: Check switching authority		- no - yes - advanced	yes
_:105	U-def.FB ctl. #: Check if pos. is reached		- no - yes	yes
_:106	U-def.FB ctl. #: Check double activat. blk.		- no - yes	no
<i>Switching authority</i>				
_:150	U-def.FB ctl. #: Check swi.auth. for Mode		- no - yes	no
_:151	U-def.FB ctl. #: Swi.dev. related sw.auth.		0 1	false
_:152	U-def.FB ctl. #: Specific sw. authorities		0 1	true
_:115	U-def.FB ctl. #: Specific sw.auth. valid for		- station - station/remote - remote	station/remote
_:153	U-def.FB ctl. #: Num. of specific sw.auth.		2 to 5	2
_:155	U-def.FB ctl. #: Ident. sw.auth. 1		Freely editable text	
_:156	U-def.FB ctl. #: Ident. sw.auth. 2		Freely editable text	
_:157	U-def.FB ctl. #: Ident. sw.auth. 3		Freely editable text	
_:158	U-def.FB ctl. #: Ident. sw.auth. 4		Freely editable text	
_:159	U-def.FB ctl. #: Ident. sw.auth. 5		Freely editable text	
_:154	U-def.FB ctl. #: Multiple specific sw.auth.		0 1	false

6.6.5 Information List

No.	Information	Data Class (Type)	Type
<i>U-def.FB ctl.#</i>			
_:501	U-def.FB ctl. #: >Enable	SPS	I
_:502	U-def.FB ctl. #: >Enable (fixed)	SPS	I
_:503	U-def.FB ctl. #: >Sw. authority local	SPS	I
_:504	U-def.FB ctl. #: >Sw. authority remote	SPS	I
_:505	U-def.FB ctl. #: >Sw. mode interlocked	SPS	I
_:506	U-def.FB ctl. #: >Sw. mode non-interl.	SPS	I
_:51	U-def.FB ctl. #: Mode (controllable)	ENC	C

No.	Information	Data Class (Type)	Type
_:52	U-def.FB ctl. #:Behavior	ENS	O
_:53	U-def.FB ctl. #:Health	ENS	O
_:302	U-def.FB ctl. #:Switching auth. station	SPC	C
_:308	U-def.FB ctl. #:Enable sw. auth. 1	SPC	C
_:309	U-def.FB ctl. #:Enable sw. auth. 2	SPC	C
_:310	U-def.FB ctl. #:Enable sw. auth. 3	SPC	C
_:311	U-def.FB ctl. #:Enable sw. auth. 4	SPC	C
_:312	U-def.FB ctl. #:Enable sw. auth. 5	SPC	C
_:313	U-def.FB ctl. #:Switching authority	ENS	O
_:314	U-def.FB ctl. #:Switching mode	ENS	O

6.7 CFC-Chart Settings

6.7.1 Overview of Functions

If you want to process a parameter in a CFC chart and this parameter is to be changeable during runtime using DIGSI or HMI, you can use the function blocks **CFC chart of Boolean parameters**, the **CFC chart of integer parameters** and the **CFC chart of floating-point parameters**. Instantiate the appropriate function block depending on the parameter value needed (logical, integer, or floating point). In this way, the current value of the parameter can then be used in the CFC chart at runtime.

6.7.2 Function Description

You can find the CFC-chart parameters **Chrt sett.Bool**, **Chart setting Int**, and **Chrt sett.real** in the DIGSI library in the **User-defined functions** folder. Drag and drop the desired function block into a function group or a function. Set the appropriate parameter value of the function block in DIGSI using the parameter editor or via HMI under the **Settings** menu item. You can then use the parameter as an input signal in CFC charts.

With **Exp. options**, you define the range and the unit of the value. This prevents users from entering incorrect setting values.



NOTE

The user-defined function groups and the user-defined functions can be used to group the CFC-chart parameters. You can rename for the function block and change the parameter value in the DIGSI Information routing matrix to suit your specific application.

Signals	Number	Type
(All)	(All)	...
QB6	603	
E:ETH-BA-2EL	102	
User-defFG1	851	
Reset LED Group	851.13381	
Chart setting Bool	851.15901	
Setting value	851.15901....	SPS
Chart setting Int	851.15871	
Setting value	851.15871....	INS
Chart setting Real	851.15841	
Setting value	851.15841....	MV

[sc_cfc_param, 1, en_US]

Figure 6-73 CFC-Chart Parameters within Information Routing

6.7.3 Application and Setting Notes

Parameter: `Chrt sett.Bool`

- Default setting `Chrt sett.Bool = False`

You can use the parameter `Chrt sett.Bool` in a CFC chart as an input signal with a Boolean value. This input value can then be changed during the runtime of the CFC chart.

Parameter: `Chart setting Int`

- Default setting `Chart setting Int = 10`

You can use the parameter `Chart setting Int` in a CFC chart as an input signal with an integer value. This input value can then be changed during the runtime of the CFC chart.

Parameter: `Chrt sett.real`

- Default setting `Chrt sett.real = 100.000`

You can use the parameter `Chrt sett.real` in a CFC chart as an input signal with a floating-point number. This input value can then be changed during the runtime of the CFC chart.

6.7.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
<i>Chrt sett.Bool</i>				
_:105	Chrt sett.Bool:Value		• 0 • 1	false

Addr.	Parameter	C	Setting Options	Default Setting
<i>Chart setting Int</i>				
_:105	Chart setting Int:Value		-2147483648 to 2147483647	10

Addr.	Parameter	C	Setting Options	Default Setting
<i>Chrt sett.real</i>				
_:105	Chrt sett.real:Value		-10000000000.000 % to 10000000000.000 %	100.000 %

6.7.5 Information List

No.	Information	Data Class (Type)	Type
<i>Chrt sett.Bool</i>			
_:305	Chrt sett.Bool:Setting value	SPS	O

No.	Information	Data Class (Type)	Type
<i>Chart setting Int</i>			
_:305	Chart setting Int:Setting value	INS	O

No.	Information	Data Class (Type)	Type
<i>Chrt sett.real</i>			
_:305	Chrt sett.real:Setting value	MV	O

6.8 Tap Changers

6.8.1 Function Description

With the device control function, you can change a transformer tap by moving it higher or lower and monitor the proper execution of the adjusting commands.

The function has built-in comprehensive options for measuring the tap changer position as well as supervision and monitoring functions. The supervision and monitoring functions are used to check the voltage and supply information about the tap position for adaptive matching of the transformer differential protection

The following options are provided for control:

- Direct user commands via the device keypad or routed binary inputs
- User-defined conditions via the CFC

If the tap changer reaches the end positions, the control function issues the (*_:301*) *End higher pos.reached* or (*_:302*) *End lower pos.reached* indication.

The transformer tap controller is controlled by the function group **Tap changer**, which you can select from the DIGSI library (group **Switching devices**).

▼ Tap changer 1	161		*	*	*	*
▼ Tap changer	161.5461		*	*	*	*
>Acquisition blocking	161.5461.500	SPS				
>Enable	161.5461.501	SPS				
>Reset AcqBlk&Subst	161.5461.504	SPS				
▶ Health	161.5461.53	ENS				
End higher pos.reached	161.5461.301	SPS				
End lower pos.reached	161.5461.302	SPS				
▼ Position	161.5461.308	BSC	X	X	X	X
acquisition blk. active		SPS				
manual update active		SPS				
Higher command	161.5461.305	SPS				
Lower command	161.5461.306	SPS				
Command active	161.5461.307	SPS				
Motor sup. time expired	161.5461.309	SPS				
Trigger motor prot. sw.	161.5461.310	SPS				
Position failure	161.5461.311	SPS				
Op.ct.	161.5461.312	INS				
Reset failure	161.5461.319	SPC				
Switching auth. station	161.5461.317	SPC				

[sc, tsddig, 1, en, US]

Figure 6-74 Tap Changer Functionality in the DIGSI Information Matrix

The central element is the Controllable **Position** of type BSC (Binary Controlled Step Position Information, based on IEC 61850). You connect this Controllable in the matrix to the desired number of binary inputs that indicate the current tap position.

For more information, refer to [6.8.2 Application and Setting Notes](#).

The **Position** Controllable also contains parameters. If you wish to change the settings, you must select the Controllable in the DIGSI information matrix and change the settings by way of the Properties dialog. The taps are controlled via the commands **Higher command** and **Lower command**, each of which must be connected to one binary output.

Example

The following 2 figures show a CFC chart as an example for transformer tap control with the routing of the function keys for stepping up or stepping down.

Information			Source							
			Function keys							
			Basismodul							
Signals	Number	Type	1	2	3	4	5	6	7	8
(All) ▼	(All) ▼	... ▼	... ▼	... ▼	... ▼	... ▼	... ▼	... ▼	... ▼	... ▼
▶ General	162.2311									
▼ Tap changer	162.13981		*	*						
▶ >Acquisition blocking	162.13981....	SPS								
▶ >Enable	162.13981....	SPS								
▶ Health	162.13981.53	ENS								
▶ End higher pos.reach...	162.13981....	SPS								
▶ End lower pos.reached	162.13981....	SPS								
▶ Position	162.13981....	BSC								
▶ Higher command	162.13981....	SPS								
▶ Lower command	162.13981....	SPS								
▶ Command active	162.13981....	SPS								
▶ Motor sup. time expir...	162.13981....	SPS								
▶ Trigger motor prot. sw.	162.13981....	SPS								
▶ Position failure	162.13981....	SPS								
▶ Op.ct.	162.13981....	INS								
▶ Reset failure	162.13981....	SPC								
▶ Motor activ		SPS								
▶ User_def_higher		SPS	P							
▶ User_def_lower		SPS		P						
▼ 90V v.Contr.zw	162.14011									
▶ >Block	162.14011.81	SPS								
▶ >Reset min./max.	162.14011.85	SPS								
▶ Health	162.14011.53	ENS								
▶ Inactive	162.14011.54	SPS								
▶ Behavior	162.14011.52	ENS								
▶ End Higher pos. Auto	162.14011....	SPS								
▶ End Lower pos. Auto	162.14011....	SPS								
▶ Cmd. with feedback	162.14011....	BSC								
▶ Block auto	162.14011....	SPC								
▶ Operating mode	162.14011....	SPC								
▶ Bandwidth >	162.14011....	SPS								

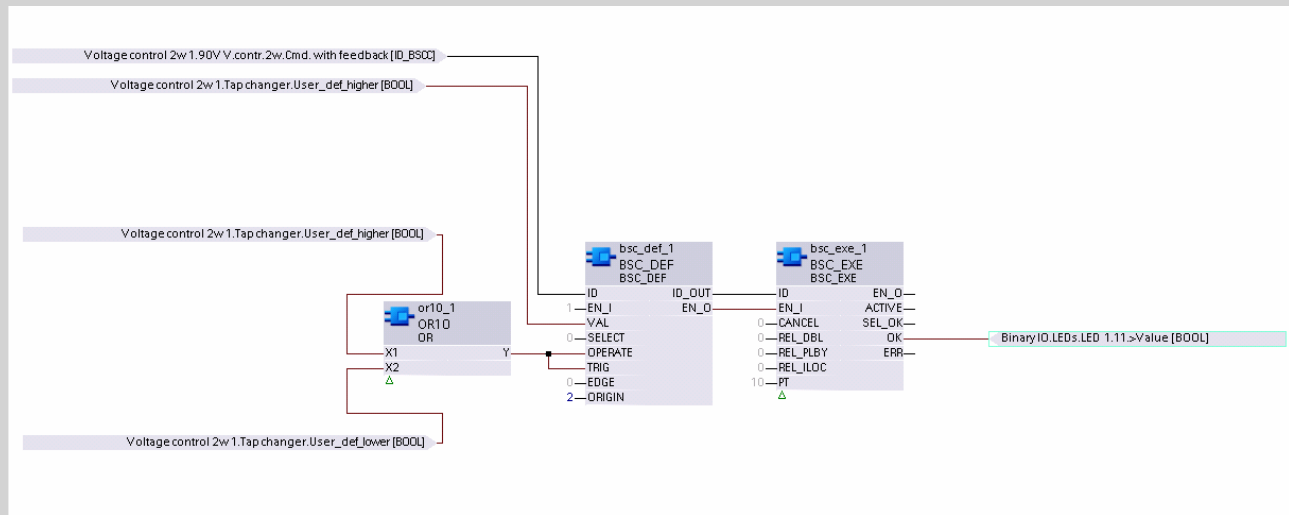
[schlued-280316-01_2_en_US]

Figure 6-75 Routing of the Function Keys and CFC Signals

To use the function keys, you create 2 user-defined single-point indications (SPS). These are used for the function keys (for example, <F1>, Higher function key and <F2>, Lower function key) and as the input signals for the appropriate CFC blocks. In addition, you must use the controllable **Cmd. with feedback** for the CFC chart and set the control model to **direct w. enh. security**.

You can select the control direction using the following values at the **Val** input of the **BSC_DEF** building block:

- 1 means **step up**
- 0 means **step down**



[sc_bscdv_en_us]

Figure 6-76 CFC Chart

Pressing the function keys to step up or down incrementally can be displayed using this simple CFC chart.

Motor Supervision Time

The runtime of the motor-drive mechanism can be monitored from the device. This function is used to identify failures of the motor-drive mechanism during the switching procedure and to trip actions if necessary. To use the **Motor supervision time**, you must route the motor sliding contact (most significant binary input) and set the proper motor runtime.

The motor sliding contact is active until the tap changer has reached the new position. This time is compared to the **Motor supervision time**. If the new tap position is not reached within the motor runtime, the *Motor sup. time expired* indication is set. The *Trigger motor prot. sw.* indication with which the motor can be switched off is output for a duration of 1.5 s.

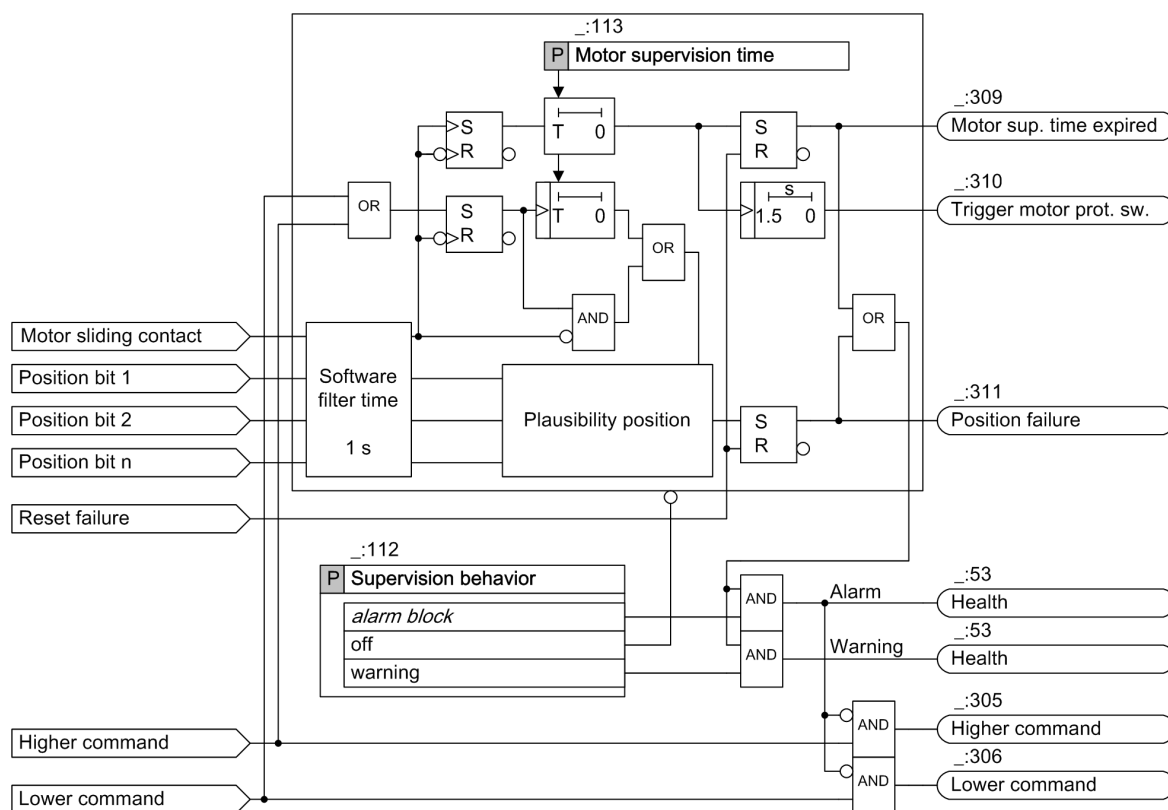
Adjusting-Command Supervision

Adjusting-command supervision is used for checking the proper operation of the tap-changer mechanism. The **Tap changer** function calculates the next logical tap position as a result of the higher/lower tap command. The time of position detection is determined as a function of the availability of the motor sliding contact. After resetting the active motor sliding contact, the **Tap changer** function reads the new tap position value. If the value for the calculated tap position could not be received within the parameterized time **Motor supervision time**, the error message *Position failure* is output.

The following position errors of the tap changer are taken into consideration during this:

- Invalid tap position: The tap position is outside the predefined range of **minimum value** and **maximum value**
- Adjusting command in the wrong direction (for example, if a higher tap was commanded and the tap changer responds with a lower position and vice versa)
- No operation of the tap changer (for example, if the tap-changer motor is defective or the position indication is not functioning)
- Illogical tap-change operation (for example, if no logical tap position following the previous position is indicated)

The value of 0 during an unexpected interruption of the auxiliary voltage represents a special case. An invalid tap-changer position without a corresponding adjusting command is signaled in the **Position** controllable only as an invalid tap position.



[io_tcmoue, 3, en_US]

Figure 6-77 Position and Motor Supervision Logic

The user-defined signals **Higher command** and **Lower command** are provided via a CFC chart (refer to [Figure 6-76](#)).

Supervision Behavior

Depending on the setting of the **Supervision behavior** parameter, the function reaches a health state of **Alarm** or **Warning**. You can set the parameter **Supervision behavior** to **off**, **alarm block** or **warning**.

In the **alarm block** mode, the function is set to the health state **Alarm**. All tap-changer commands are blocked.

In the **warning** mode, the function is set to the health state **Warning**. Executing tap-changer commands is still possible.

You can manually reset the health state of **alarm block** or **warning** using the controllable **Reset errors** (Main menu → Device functions → Reset functions → Tap changer). As an alternative to this, you can also switch off the supervision function and then switch it on again.

Operating Counter

The device counts the number of successfully completed adjusting commands with the **Op. ct.** switching cycle counting value. The counting and memory levels are protected against an auxiliary-voltage failure. The switching cycle counting value can be set to 0 or to any other starting value.

You can access the statistical values via the operation panel on the device (measured values/statistics), via DIGSI, or using various communication protocols.

6.8.2 Application and Setting Notes

Parameters of the Tap Changer Function Group

Tap changer			
Control			
161.5461.104	Check switching authority:	yes	
161.5461.108	Control model:	SBO w. enh. security	
161.5461.109	SBO time-out:	30.00 s	
161.5461.110	Feedback monitoring time:	10.00 s	
Tap changer			
161.5461.111	Maximum output time:	1.50 s	
161.5461.112	Supervision behavior:	alarm block	
161.5461.113	Motor supervision time:	10 s	
161.5461.116	Highest tap changer pos.:	Lowest voltage tap	
161.5461.114	Lowest tap position:	1	
161.5461.115	Highest tap position:	15	

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Figure 6-78 Parameters of the Tap Changer



NOTE

If run positions, this means internal tap changer positions without voltage changes, are available, the following must be observed:

If these tap changer positions contain a suffix a and c or + and -, and additional switching pulses are not required, adjust the parameter for the feedback and motor supervision time to the actual motor runtime when passing through a run position. Siemens recommends parameterization with capturing of the motor sliding contact.

Parameter: Check switching authority

- Default setting (`_:104`) **Check switching authority** = **yes**

With the **Check switching authority** parameter, you specify whether the switching authority (on site, remote) is checked in the case of an adjusting command (see also chapter [6.3.1 Command Checks and Switchgear Interlocking Protection](#)).

Parameter: Control model

- Default setting (`_:108`) **Control model** = **SBO w. enh. security**

Use the **Control model** parameter to specify the control model according to IEC 61850-7-2. The following selection options are available:

- **direct w. normal secur.**
- **SBO w. normal secur.**
- **direct w. enh. security**
- **SBO w. enh. security**
- **status only**

Parameter: SBO time-out

- Default setting (`_:109`) **SBO time-out = 30 s**

With this setting, you specify the time for detecting the time-out of the SBO command. The range of values extends from 0.01 s to 1800.00 s. This is the time that can elapse between command acceptance and command execution (command model as per IEC 61850-7-2).

Parameter: Feedback monitoring time

- Default setting (`_:110`) **Feedback monitoring time = 10 s**

Reaching a new tap position after the switching command is monitored. If a new tap position is not reached, you specify with this setting the time when the command is canceled. The range of values extends from 0.01 s to 1800.00 s.

Parameter: Maximum output time

- Default setting (`_:111`) **Maximum output time = 1.50 s**

This parameter specifies the maximum output time. The range of values extends from 0.01 s to 1800.00 s. For activating motors to change the tap position, a time of 1.50 s is practical.

Parameter: Supervision behavior

- Default setting (`_:112`) **Supervision behavior = alarm block**

You can select whether the supervision is switched off (*off*) or if only a warning is indicated (*warning*). With the **alarm block** setting, an alarm indication is generated and the function is blocked.

Parameter: Motor supervision time

- Default setting (`_:113`) **Motor supervision time = 10 s**

After the motor supervision time has elapsed, the indication *Motor sup. time expired* is displayed. You can find additional information in section [Motor Supervision Time, Page 342](#). The range of values extends from 5 s to 100 s.

Parameter: Highest tap changer pos.

- Default setting (`_:116`) **Highest tap changer pos. = Lowest voltage tap**

With the **Highest tap changer pos.** parameter, you specify whether the lowest or highest voltage is present at the highest tap changer position.

Additional Settings (Properties Dialog Position)

Additional settings are assigned to the controllable *Position*. To display and adjust the settings, select *Position* in the DIGSI information matrix and select the Properties dialog. To do this, click the **Properties** tab.

Details

Name:

Original name:

General

Minimum value:

Maximum value:

Tap-display offset:

Number of bits for tap code:

Number of tap positions:

Tap-coding type:

Moving contact (highest binary input): ☐

Software filter

Software filter time: ms

Retrigger filter: ☒

Indication timestamp before filtering: ☐

Chatter blocking

Chatter blocking: ☐

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Figure 6-79 Properties Dialog

Parameter: Minimum value

- Default setting **Minimum value** = 1

Parameter: Maximum value

- Default setting **Maximum value** = 15

The parameters **Minimum value** and **Maximum value** are initially calculated by DIGSI 5 on the basis of the tap coding, the **Number of tap positions** and the **Tap-display offset**. They represent the allowed control area of the position value. Positions outside this area are defined as invalid. This control area can be further restricted within the initially set physical range (see **Number of tap positions** and **Tap-display offset**).

Parameter: Tap-display offset

- Default setting **Tap-display offset** = 0

If you want to move the height of the displayed value in a positive or the negative direction with respect to the height of the actual value, enter the value for this in the **Tap-display offset** field.

Parameter: Number of bits f. tap code

- Default setting **Number of bits f. tap code** = 4

With the **Number of bits f. tap code** parameter, you set the number of bits you need for encoding the transformer taps. The number is dependent on the selected **Encoding** and on the **Moving contact**. For example, you need 3 bits for 7 binary-encoded transformer taps. The range of values extends from 2 to 32.

Parameter: Number of tap positions

- Default setting **Number of tap positions** = **15**

With the **Number of tap positions** parameter, you set the number of transformer taps. The range of values extends from 2 to 127. The output of the tap position is limited from -63 to +63. If the number of taps is > 63, set the **Tap-display offset** parameter so that the output of the tap position is within the range of -63 to +63.

Parameter: Tap-coding type

- Default setting **Tap-coding type** = **binary**

In the **Tap-coding type** list box, select the interpretation type of the indication pending at the binary input. You can select from the following options:

- **binary**
- **1-of-n**
- **BCD**
- **table**
- **BCD signed**
- **gray**

The tap changer position can also be routed via a GOOSE signal (BSC) or a 20-mA measuring transducer input. You can find more information on this in the document **Measuring the transformer tap changer using an analog measuring transducer input in SIPROTEC 5** in the Download area under *SIPROTEC 5 and DIGSI 5 downloads* → *SIPROTEC 5 General* → *Application Notes* → *Control*.

A selection of tap-coding types is described in greater detail using examples in the following text.

Routing of the Binary Inputs (Tap-Coding Type binary)

The following table shows the routing of 3 binary inputs (BI 1 to BI 3) with 4 transformer tap positions designated 3 to 6. BI4 is the moving contact. The encoding is in **binary**.

Table 6-24 Routing of the Binary Inputs (Tap-Coding Type binary)

	Example					
	BI1	BI2	BI3	BI4	BI5	BI6
Tap changer	X	X	X	X	–	–
Meaning	Bit 1	Bit 2	Bit 3	Moving contact	–	–
Tap = 1	1	0	0		–	–

With 3 binary inputs, a maximum of $2^3 - 1 = 7$ tap positions can be mapped in binary code. If all routed binary inputs indicate 0, this is interpreted as a connection error and is reported by Position --- or **-64** with quality **invalid**. The representation of transformer taps should start with the metered value 3. You must configure the information properties as follows for the example:

Tap-coding type:	binary
Number of tap positions:	7
Number of bits f. tap code:	4
Tap-display offset:	2
Moving contact (highest binary input):	Yes

The 3 binary inputs must be numbered sequentially, for example, BI 1, BI 2, BI 3, and BI 4 for the moving contact.

Routing of the Binary Inputs (Tap-Coding Type BCD)

The following table shows the routing of 6 binary inputs (BI 1 to BI 6) with 39 transformer tap positions designated 1 to 39. The encoding is in **BCD**. BI 7 is the moving contact.

Table 6-25 Routing of the Binary Inputs (Tap-Coding Type BCD)

	Example						
	BI1	BI2	BI3	BI4	BI5	BI6	BI7
Tap changer	X	X	X	X	X	X	X
Meaning	BCD 1	BCD 2	BCD 4	BCD 8	BCD 10	BCD 20	Moving contact
Tap = 21	1	0	0	0	0	1	–

With 6 binary inputs, a maximum of 39 tap positions can be mapped with the tap-coding type of BCD. This yields the number of tap positions from 1 to 39. If all routed binary inputs indicate 0, this is detected as tap 0. The 7 binary inputs must be numbered sequentially, for example, BI 1, BI 2, BI 3, BI 4, BI 5, BI 6, and BI 7 for the moving contact.

Tap-coding type:	BCD
Number of tap positions:	39
Number of bits f. tap code:	7
Tap-display offset:	0
Moving contact (highest binary input):	Yes

Individual Tap-Coding Type (table)

With the **table** parameter setting, you can specify an individual **Tap-coding type**.

In the **Representation of encoding** section, select the number system in which your code table entries will take place, alternatively:

- **Binary (2 characters)**
- **Octal (8 characters)**
- **Decimal (10 characters)**
- **Hexadecimal (16 characters)**

The selected option is valid for all inputs in the **Encoding** column.

If you change the number system and there are already entries in this column, these will be converted to the new number system. The selection area becomes visible as soon as you have selected the setting **table** in the **Tap-coding type** list box.

Code table

Code table:

Level	Encod..
1	000001
2	000010
3	000011
4	000100
5	000101
6	000110
7	000111
8	001000
9	001001

Representation of encoding:

☒ Binary (2)
 ☐ Octal (8)
 ☐ Decimal (10)
 ☐ Hexadecimal (16)

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Figure 6-80 Code Table for the Tap-Coding Type table

**NOTE**

If the binary inputs used for encoding are all inactive, this indicates an invalid tap position (regardless of the display offset). For an invalid tap position, the display shows the position --- or -64 with quality **invalid**, exception BCD signed, see [Routing of the Binary Inputs \(Tap-Coding Type BCD signed\)](#), Page 349.

Enter the encoding for the tap in the **Encoding** column in the **Code table**. Enter the value according to the number system previously selected. Select the desired number of taps and number of bits for tap coding. Taps with the same encoding and taps with 0 coding are not permitted.

Routing of the Binary Inputs (Tap-Coding Type BCD signed)

The following table shows the routing of 3 binary inputs (BI 1 to BI -3) with 7 transformer tap positions designated 3 to 3. The encoding uses **BCD signed**.

Table 6-26 Routing of the Binary Inputs (Tap-Coding Type BCD signed)

	Example					
	BI1	BI2	BI3	BI4	BI5	BI6
Tap changer	X	X	X	–	–	–
Meaning	BCD 1	BCD 2	Sign	–	–	–
Tap = 1	1	0	1	–	–	–

Using 3 binary inputs, a maximum of 7 tap positions can be mapped with the tap coding type of BCD signed. This yields the number of tap positions from -3 to 3. If all routed binary inputs indicate 0, this is recognized as tap 0. The 3 binary inputs must be numbered sequentially.

Tap-coding type:	BCD signed
Number of tap positions:	7
Number of bits f. tap code:	3
Tap-display offset:	0
Moving contact (highest binary input):	No

Routing the Tap Position to Binary Outputs

For the output of the adjusting commands, route the information **step up** and **step down** on one relay each, see following figure.

Information			Source													Destination		
			Binary input													Binary output		
			Base module													Base module		
Signals	Number	Type	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.1	2.2	2.3			1.1	1.2	1.3
(All)	(All)	...	...	...	...	...	...	...	...	...	...	...	...	...	(All)	...	...	...
Tap changer 1	161		*	*	*	*										*	*	
>Acquisition blocking	161.5461.500	SPS																
>Enable	161.5461.501	SPS																
>Reset AcqBlk&Subst	161.5461.504	SPS																
>Health	161.5461.53	ENS																
End higher pos.reach...	161.5461.301	SPS																
End lower pos.reached	161.5461.302	SPS																
Position	161.5461.308	BSC	X	X	X	X												
Higher command	161.5461.305	SPS														X		
Lower command	161.5461.306	SPS															X	
Command active	161.5461.307	SPS																
Motor sup. time expir...	161.5461.309	SPS																
Trigger motor prot. sw.	161.5461.310	SPS																
Position failure	161.5461.311	SPS																
Op.ct.	161.5461.312	INS																
Reset failure	161.5461.319	SPC																
Switching auth. station	161.5461.317	SPC																

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Figure 6-81 Routing the Tap Setting Commands

Parameter: Moving contact (highest binary input)

- Default setting **Moving contact (highest binary input)** = *no*

If the tap position is only to be recognized as valid and implemented when the motor sliding contact signals that it has reached the taps, then activate the **Moving contact (highest binary input)** option. If this parameter is set, the new position is only labeled with an * when the moving contact drops out.

Parameter: Software filter time

- Default setting **Software filter time** = *1000 ms*

With this parameter, you set the **Software filter time** for capturing the tap position. The range of values extends from 0 ms to 100 000 ms. Within this time, brief changes on the binary inputs are suppressed.

Parameter: Retrigger filter

- Default setting **Retrigger filter** = *Yes*

With this parameter, you switch retriggering of the filtering time by a position change on or off.

Parameter: Indication timestamp before filtering

- Default setting **Indication timestamp before filtering** = *no*

With this parameter, you specify whether the hardware filtering time is accounted for in the time stamp of position capture.

Parameter: Chatter blocking

- Default setting **Chatter blocking** = *no*

With this parameter, you switch **Chatter blocking** on or off.

6.8.3 Settings (Properties Dialog)

The settings listed here can only be reached and changed by way of the **Properties** dialog of the **Position** Controllable.

Addr.	Parameter	C	Range of Values	Default Setting
General Information				
-	Minimum value		Calculated	-
-	Maximum value		Calculated	-
-	Tap-display offset		-63 to +63	0
-	Number of bits f. tap code		2 to 32	4
-	Number of tap positions		2 to 63	15
-	Tap-coding type		• binary • 1-of-n • BCD • table • BCD signed • gray	binary
Software filter				
-	Software filter time		0 ms to 100 000 ms	1000 ms

6.8.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Control				
_:104	Tap changer:Check switching authority		• no • yes • advanced	yes
_:108	Tap changer:Control model		• status only • direct w. normal secur. • SBO w. normal secur. • direct w. enh. security • SBO w. enh. security	SBO w. enh. security
_:109	Tap changer:SBO time-out		0.01 s to 1800.00 s	30.00 s
_:110	Tap changer:Feedback monitoring time		0.01 s to 1800.00 s	10.00 s
Tap changer				
_:111	Tap changer:Maximum output time		0.02 s to 1800.00 s	1.50 s
_:112	Tap changer:Supervision behavior		• off • warning • alarm block	alarm block
_:113	Tap changer:Motor supervision time		5 s to 100 s	10 s
_:116	Tap changer:Highest tap changer pos.		• Lowest voltage tap • Highest voltage tap	Lowest voltage tap

Addr.	Parameter	C	Setting Options	Default Setting
_:114	Tap changer:Lowest tap position		-64 to 64	1
_:115	Tap changer:Highest tap position		-64 to 64	15
Switching authority				
_:117	Tap changer:Swi.dev. related sw.auth.		0 1	false
_:118	Tap changer:Specific sw. authorities		0 1	true
_:119	Tap changer:Specific sw.auth. valid for		- station - station/remote - remote	station/remote
_:120	Tap changer:Num. of specific sw.auth.		2 to 5	2
_:121	Tap changer:Multiple specific sw.auth.		0 1	false

6.8.5 Information List

No.	Information	Data Class (Type)	Type
Tap changer			
_:500	Tap changer:>Acquisition blocking	SPS	I
_:501	Tap changer:>Enable	SPS	I
_:507	Tap changer:>Sw. authority local	SPS	I
_:508	Tap changer:>Sw. authority remote	SPS	I
_:509	Tap changer:>Sw. mode interlocked	SPS	I
_:510	Tap changer:>Sw. mode non-interl.	SPS	I
_:504	Tap changer:>Reset AcqBlk&Subst	SPS	I
_:53	Tap changer:Health	ENS	O
_:301	Tap changer:End higher pos.reached	SPS	O
_:302	Tap changer:End lower pos.reached	SPS	O
_:308	Tap changer:Position	BSC	C
_:305	Tap changer:Higher command	SPS	O
_:306	Tap changer:Lower command	SPS	O
_:307	Tap changer:Command active	SPS	O
_:309	Tap changer:Motor sup. time expired	SPS	O
_:310	Tap changer:Trigger motor prot. sw.	SPS	O
_:311	Tap changer:Position failure	SPS	O
_:312	Tap changer:Op.ct.	INS	O
_:313	Tap changer:Switching authority	ENS	O
_:314	Tap changer:Switching mode	ENS	O
_:319	Tap changer:Reset failure	SPC	C
_:317	Tap changer:Switching auth. station	SPC	C
_:320	Tap changer:Enable sw. auth. 1	SPC	C
_:321	Tap changer:Enable sw. auth. 2	SPC	C
_:322	Tap changer:Enable sw. auth. 3	SPC	C

No.	Information	Data Class (Type)	Type
_:323	Tap changer:Enable sw. auth. 4	SPC	C
_:324	Tap changer:Enable sw. auth. 5	SPC	C

7 Supervision Functions

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7.1 Overview

SIPROTEC 5 devices are equipped with an extensive and integrated supervision concept. Continuous supervision:

- Ensures the availability of the technology used
- Avoids subfunction and overfunction of the device
- Protects persons and primary technical devices
- Offers effective assistance during commissioning and testing

The following areas are monitored:

- Supervision the resource consumption of the application
- Supervision of the secondary system, including the external auxiliary power supply
- Supervision of device hardware
- Supervision of device firmware
- Supervision of hardware configuration
- Supervision of communication connections

When the supervision functions pick up, that will be displayed and also indicated. Error responses are defined for the device. The error responses are grouped in defect severities.

The supervision functions work selectively. When the supervision functions pick up - as far as possible - only the affected parts of the hardware and firmware are blocked. If this is not possible, the device goes out of operation into a secure state (fallback mode). In addition to safety, this warrants a high degree of availability.

7.2 Resource-Consumption Supervision

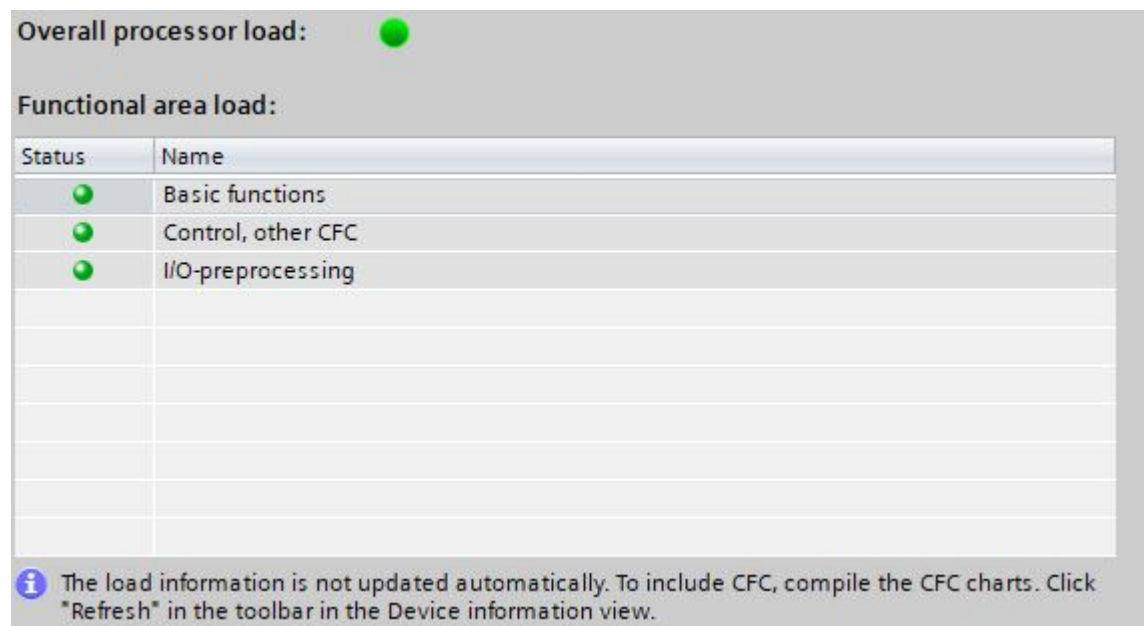
7.2.1 Load Model

SIPROTEC 5 devices are freely configurable. A load model is integrated in DIGSI 5. The load model prevents you from overloading the device with an excessively large application.

The load model shows the device utilization and the response times for device functions. If it determines that an application created is likely to overload the device, DIGSI prevents the application from being loaded into the device.

In this rare case, you must then reduce the application in order to be able to load it into the device.

The load model can be found in the DIGSI 5 project tree under **Name of the device** → **Device information**. In the operating range, select the **Resource consumption** setting sheet. The following figure shows an example of the view of the load model in DIGSI 5:



[sc_pload_6md84, 1, en_US]

Figure 7-1 Visualization of the Load Model in DIGSI

A green total display for the processor response time indicates that the device is not overloaded by the present application. On the other hand, if you see a red exclamation mark, the planned application is overloading the device.

The list below the total display shows the individual functional areas. These areas combine functions with the same real-time requirements. A green display in front of an area (see [Figure 7-1](#)) indicates that the response times of the functions grouped in this area can be maintained. A red exclamation mark indicates that functions may have longer response times than specified in the Technical data for the device. In such a case, loading of the application into the device is blocked.

The following table provides an overview of the functional areas and the most important influencing quantities on device utilization:

Functional Area	Short Description	Change in Load
CFC event-triggered, fast	CFC charts that must be processed especially fast (for example, to invoke interlockings between protection functions)	Adding or removing CFC charts in the fast event-triggered process range - Create CFC chart - Delete CFC chart - Change the process range in the properties of the CFC chart Add to or remove from CFC charts in the fast event-triggered process area
Measuring points	Provision of measured values for protection, control, and measurement functions	Adding or removing - Measuring points (in the Measuring-points routing Editor) - Function groups that provide measured-value preprocessing for insertable functions (for example, Circuit-breaker function group)
- FG connections - Fast GOOSE	- Interaction between individual function groups, for example, between the Line function group and the Circuit-breaker function group - Fast GOOSE communication	Adding or removing - Protection functions and their stages - Circuit-breaker function groups - Fast GOOSE connections
CFC event-triggered, standard GOOSE	CFC charts with a maximum processing time of 40 ms	Adding or removing CFC charts in the event-triggered process range - Create CFC chart - Delete CFC chart - Change the process range in the properties of the CFC chart Add to or remove from CFC charts in the event-triggered process area
- Control - Other CFC chart - Operational measured values	- Control and interlocking - CFC charts in the area of control, measured-value preprocessing, and event-controlled - Operational measured values	Adding or removing - Function blocks for control and interlocking - CFC charts in the control area - Switching devices (except circuit breakers), for example, Disconnecter function groups - Operational measured values - CFC charts in the measured values area

If the load model displays a warning, bear in mind the following general instructions:

The areas named in the table are listed in descending order of real-time requirements. If a warning appears to the effect that the guaranteed response times may be exceeded in an area, you can return to the permitted area by taking the following measures:

- Reduce the functional scope in the marked area (red exclamation mark)
- Reduce the functional scope in another area with higher real-time requirements

When you have reduced the application, check the display in resource consumption! If a function or stage has been switched off, it will continue to represent a load for the area. If you do not need the function or stage, delete it rather than switching it off.

Use the general **Circuit-breaker** function group only in the following cases:

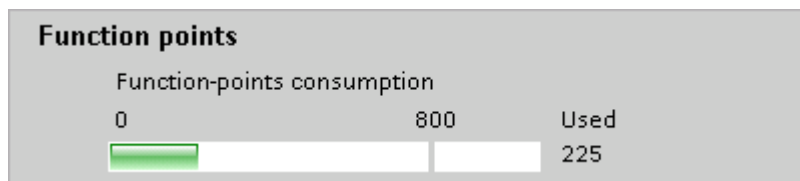
- Interaction with a protection-function group is essential.
That is to say, operate indications of protection functions cause the circuit breaker assigned to the **Circuit-breaker** function group to be switched off.
- You want to use functions such as the automatic reclosing function or circuit-breaker failure protection in the **Circuit-breaker** function group.

If a circuit breaker is only to be modeled for control purposes, use the **Circuit-breaker [state only]** function group.

7.2.2 Function Points

When you order a SIPROTEC 5 device, you are also ordering a function-points account for use of additional functions.

The following figure illustrates consumption of function points in the current application with respect to the existing function-points account.



[sc_fpunkt, 1, en, US]

Figure 7-2 Resource Overview: Function-Points Consumption

The remaining white bar shows the function points that have not yet been used up by your configuration. The number of function points available in a device depends on the device purchase order (position 20 of the product code). You can also order function points subsequently, and so increase the function-points account for the device.



NOTE

Find out the function-points requirement for the desired application before ordering the device. For this, you can use the device configurator. Alternatively, you order the device with 0 function points and create the license file with the required point credits ad hoc using the SIPROTEC function point manager (see [2.2 Application Templates/Adaptation of Functional Scope](#)).

7.2.3 CFC Resources

Task Levels of the CFC Function

A CFC chart, and thus the configured CFC function, runs in the SIPROTEC 5 device on exactly one of the 4 task levels. The individual task levels differ, on the one hand, in the priority of processing tasks and, on the other, in the cyclic or event-triggered processing of the CFC charts.

You can select between the following task levels:

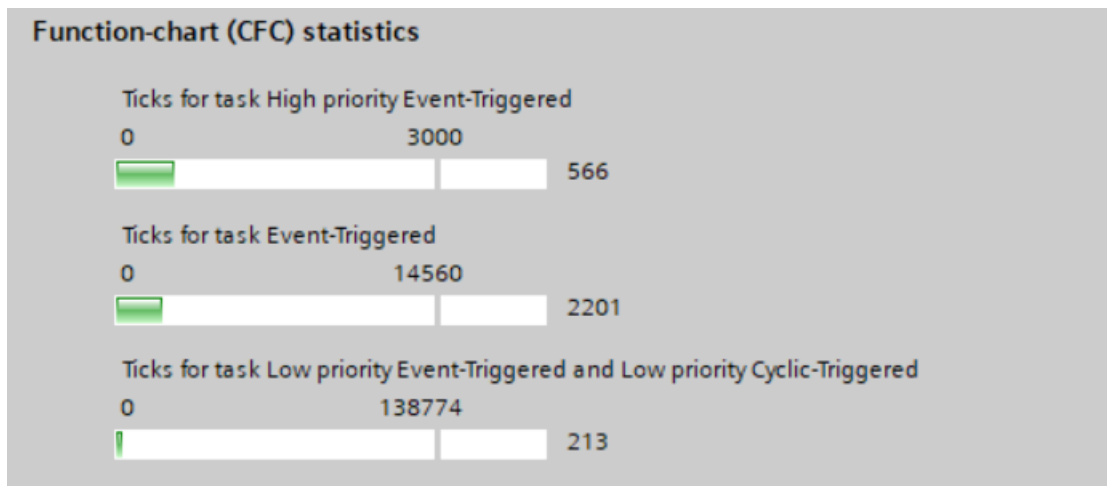
Task Level	Description
High priority Event-triggered	Use the High priority Event-triggered task level for time-critical tasks, for example, if a signal should block a protection function within 2 ms to 3 ms. Functions on this task level are processed in an event-triggered way with the highest priority. Each change to a logical input signal is immediately processed. Processing can interrupt the execution of protection functions and functions on the Event-Triggered task level.
Event-triggered	Use the Event-triggered task level preferably for logic functions that need not be executed with highest priority. Each change to a logical input signal is immediately processed. Protection functions or functions on the High priority Event-triggered task level can disrupt processing. Functions on the Event-triggered task level are typically processed within a maximum of 5 ms in all devices. For busbar protection or line protection, the functions on the Event-triggered task level are processed within a maximum of 10 ms.
Low priority Cyclic-triggered	Use the Low priority Cyclic-triggered task level for processing measured values. Functions on this task level are processed cyclically every 500 ms.
Low priority Event-triggered	Use the Low priority Event-triggered task level preferably for logic functions that should be executed with lower priority than functions in the Event-triggered task level. If the available ticks of the Event-triggered task level shown in the following figure are sufficient for the required CFC functionality, you do not need to use the Low priority Event-triggered task level.

All CFC function blocks can be assigned to all the task levels. There are no device-specific function blocks. If enough ticks are available, all CFC charts can be created in the same task level. A tick is the measure of the performance requirement of CFC blocks.

The number of available ticks for each task is calculated depending on the created device configuration. This calculation is based on the previously described load model. In this process, it is recommended to create all selected functions and objects first followed by configuration of the CFC charts so that a realistic information about the remaining system capacitance for CFC charts is available. Significantly exceeding the typical response time is prevented by the load model by limiting the number of CFC function blocks in the corresponding task level via the number of ticks available.

The typical response times for CFC tasks are listed in the Technical Data.

The following figure shows an example of the CFC chart capacitances in DIGSI calculated by the load model. The ticks available for each task are shown here. The green bars represent the ticks used in the task levels. You reach this dialog with the following call: Device → Device information → Resource consumption.



[sc_cfc-statistic, 2, en_US]

Figure 7-3 CFC Statistics



NOTE

High priority Event-triggered CFC charts have the highest priority and are processed before all other tasks. At this level, a considerable smaller number of ticks are available than at all other tasks. It is recommended to configure only very-high-priority logic functions at this task and to configure the other logic functions in any other level.



NOTE

Empty CFC charts also consume system resources. Empty charts that are not required any more should be deleted.

7.3 Supervision of the Device Hardware

7.3.1 Overview

The correct state of the device hardware is a requirement for the correct functioning of the device. The failure or erroneous function of a hardware component leads to device malfunctions.

The following modules of the device hardware are monitored:

- Base module
- Expansion modules
- Plug-in modules on the interface locations

The error responses result, depending on type and degree of the error, as follows:

Hardware errors where the device remains in operation.

The error is indicated. The signals/data affected by the failure are marked as **invalid**. In this way, the affected protection functions can go into a secure state. Such errors are, for example:

- Failure communication module (module x)
- Measuring-transducer module failure (module x)
- USB interface
- Integrated Ethernet interface
- Real-time clock device
- A/D converter (fast current sum)
- Battery voltage
- Faulty or missing compensation values (magnitude/phase)

Failures which can partially be corrected by a restart of the device. The device goes briefly out of operation.

Such errors are, for example:

- Memory error (RAM) in the base module
- Defective module
- Module-connection error (PCB Link)
- Control circuit error binary output
- Outage of an internal auxiliary voltage



NOTE

If the error has not be rectified after 3 unsuccessful attempts, the system automatically recognizes it as a severe device malfunction. The device goes permanently out of operation into a secure state (fallback mode).

Fatal device errors with outage of central components: The device goes permanently out of operation into a secure state (fallback mode).

Such errors are, for example:

- Memory error (flash) in the base module
- CPU/Controller/FPGA error in the base module
- 3 unsuccessful restarts in a row

You can find the detailed description of the error responses in table form at the end of this chapter. You will find corresponding corrective measures there.

Device Operating Hours

The *Device operating hours* statistical value counts the operating hours of the physical device. The starting time and the time in Fallback mode are not considered.

You can neither reset nor change the statistical value.

7.4 Supervision of Device Firmware

The device firmware determines essentially the functionality of the device.

The following supervisions ensure the stable function of the device:

- Supervisions of the data and version consistency
- Supervision of the undisturbed sequential activity of the device firmware
- Supervision of the available processor performance

When you start the device, load data via the interfaces and these supervisions of the device firmware will be in effect during the continuous operation. Depending on the type and severity of error, the following error responses will result:

Firmware failures where the device remains in operation.

The error is indicated. The signals/data affected by the failure are marked as **invalid**. In this way, the affected protection functions can go into a secure state. Such errors are, for example, errors in time synchronization (loss and errors).

Failures which can partially be corrected by a restart of the device. The device goes briefly out of operation.

Such errors are, for example:

- Device startup with faulty new parameter set. The old parameter set is still present.
- Overloading of the processor
- Program-sequence error

Fatal firmware error. The device goes permanently out of operation into a secure state (fallback mode).

Such errors are, for example:

- Device startup with faulty new parameter set. No usable parameter set is present.
- Device startup with version error
- CFC-runtime error
- 3 unsuccessful restarts in a row

You can find the detailed description, in table form, of the fault responses at the end of chapter [7.7 Error Responses and Corrective Measures](#). You will find corresponding corrective measures there.

7.5 Supervision of Hardware Configuration

The modular hardware concept requires adherence to some rules within the product family and the modular system. Configuration errors show that the hardware configuration saved in the device does not agree with the hardware actually detected. Impermissible components and unallowed combinations must be detected just as missing configured components are.

Depending on the type and severity of error, the following error responses will result: The identified hardware configuration errors are assigned to the defect severities as follows:

Configuration errors for which the device remains in operation.

The failure is indicated. The signals/data affected by the failure are marked as **invalid**. In this way, the affected protection functions can go into a secure state. Such errors are, for example, errors in the IE-converter configuration (normal/sensitive).

Fatal configuration error: The device goes permanently out of operation into a secure state (fallback mode).

Such errors are, for example:

- Missing hardware module (module x)
- Incorrect hardware module (module x)
- Incorrect hardware combination
- Incorrect plug-in module (module x)

You can find the detailed description of the error responses in table form at the end of this chapter. You will find corresponding corrective measures there. You can resolve configuration errors through another synchronization with DIGSI.

7.6 Supervision of Communication Connections

SIPROTEC 5 devices offer extensive communication options via fixed and optional interfaces. Beyond the hardware supervision, the transferred data must be monitored with respect to their consistency, failure, or outage.

Supervision

With the supervision of the communication connections, every communication port is monitored selectively.

- Failures are detected and indicated via the operational log. The device remains in operation!
- Additionally, each port is equipped with a separate communication log which displays details of the failures, for example the error rate.

Marking Fault Signals/Data

The signals/data affected by the failure are marked as **invalid**. In this way, the affected protection functions can go into a secure state. In the following, some examples are named:

- GOOSE signals can automatically be set to defined values in case of disturbed IEC 61850 communication.
- Disturbed protection interfaces set phasor values, analog measured values, and binary information to **invalid**, for example for the differential protection. Binary signal traces can be set to defined values in cases of failures.
- Disturbed time-synchronization signals can lead to an automatic change of the source of time synchronization.

You can correct communication failures by checking the external connections or by replacing the affected communication modules.

For further information on error responses, see to [7.7.4 Defect Severity 3](#). Corresponding corrective measures are also be described there.

7.7 Error Responses and Corrective Measures

7.7.1 Overview

When device errors occur and the corresponding supervision functions pick up, this is displayed on the device and also indicated. Device errors can lead to corruption of data and signals. These data and signals are marked and tagged as **invalid**, so that affected functions automatically go into a secure state. If the supervision functions pick up, this will lead to defined error responses.

How Do Device Errors Make Themselves Noticeable

In case of a device error the supervision functions of the device pickup. The device responds according to the type and severity of the error. To report an error, supervision functions use outputs on the device and indications.

Run LED (green)	The external auxiliary voltage is present. The device is ready for operation.
Error LED (red)	The device is not ready for operation. The life contact is open.
Life contact	Signaling of device readiness following successful device startup.
Group-warning indication <i>Group warning</i>	The device remains in operation and signals an error via the prerouted LED and the log.
Log of the device	Indications of causes for defects and corrective measures

Determination of Causes for Defects and Corrective Measures

To determine the cause for defect and the corresponding corrective measure, proceed step by step.

- Step 1:** Pick up of supervisions leads to one of the following defect severities in all cases.
- **Defect severity 1:**
Internal or external device error that is reported. The device remains in operation.
 - **Defect severity 2:**
Severe device failure, the device restarts (reset) to correct the cause for defect.
 - **Defect severity 3:**
Severe device failure, the device goes to a safe condition (fallback mode), as the correction of defects cannot be implemented by a restart. In fallback mode, the protection and automated functions are inactive. The device is out of operation.
 - **Defect severity 4:**
Severe device-external failure, the device switches the protection and automatic functions to inactive for safety, but remains in operation. Normally, the user can correct the fault by himself.
- Step 2:** For every defect severity, you will find detailed tables with information about causes for defects, error responses, and corrective measures in the following chapters.

Table 7-1 Error Responses

	Group-Warning Indication Group Warning	Indication in Operational Log	Indication in Device-Diagnosis Log	Indication of the Life Contact	All Protection and Automation Functions are inactive	Device restart (Reset)	Fallback Mode
Defect Severity 1	x	x	x	–	–	–	–
Defect Severity 2	–	–	x	x	During the starting time of the device	x	–
Defect Severity 3	–	–	x	x	x	–	x
Defect Severity 4	–	x	–	x	x	–	–

7.7.2 Defect Severity 1

Defect severity 1 faults allow the continued safe operation of the device. Defect severity 1 faults are indicated. The device remains in operation.

When the supervision functions pick up, corrupted data and signals are marked as **invalid**. In this way, the affected functions can go into a secure state. Whether functions are blocked is decided in the appropriate function itself. For more detailed information, refer to the function descriptions.

Life contact	Remains activated
Red error LED	Is not activated

Log

For every device fault, a corresponding supervision indication is generated. The device records these indications with a real-time stamp in the operational log. In this way they are available for further analyses. If supervisions in the communication interfaces area of the device pick up, there is a separate communication log available for each port. Extended diagnostic indications and measured values are available there. The device-diagnosis log contains expanded fault descriptions. There you also receive recommendations of corresponding corrective measures for each detected device error.

There is further information on handling the logs in [3.1 Indications](#).

Group-Warning Indication Group Warning

As delivered, all monitoring indications of Defect Severity 1 are routed to the signal (`_ : 301`) **Group warning**. In this way, a device error can be indicated with only one indication. The majority of supervision indications are permanently connected to the **Group warning** (**Group warning** column = fixed). However, some supervision indications are routed flexibly to the **Group warning** via a logic block chart (**Group warning** column = CFC). If necessary, the routings via a CFC chart can be taken from the group indication again.

In delivery condition, the **Group warning** is routed to an LED.

The following logic diagram shows the correlation.

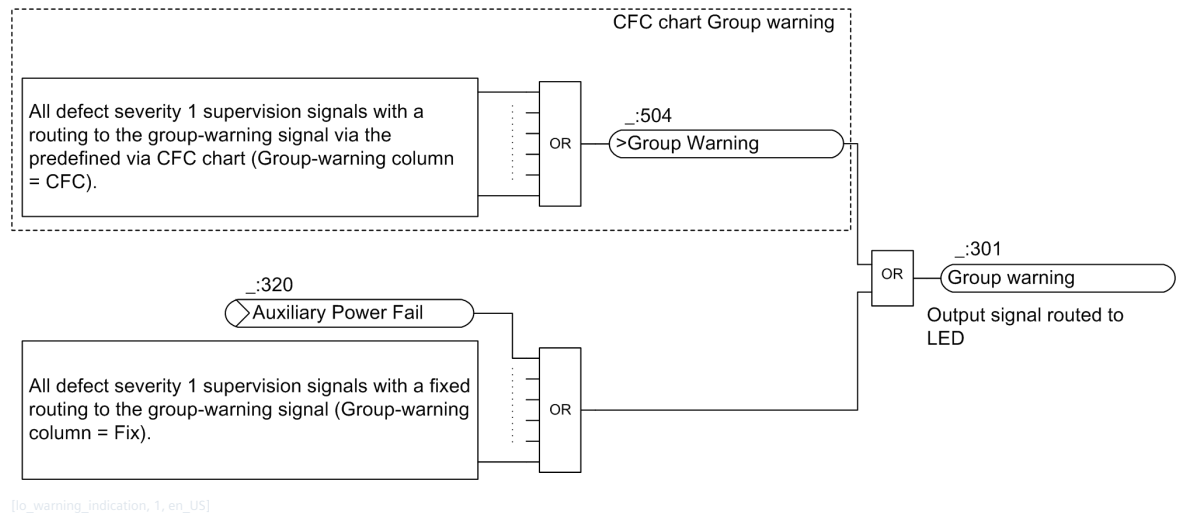


Figure 7-4 Forming the Warning Group Indication Group Warning

Overview of Errors

Indication	Type	Group Warning	Explanation
General:			
(_:53) Health	ENS	CFC	If the Health of an individual function block, for example a protection stage or an individual function, goes to the <i>Warning</i> or <i>Alarm</i> state, this state generates up to the general group indication Health (_:53) via the associated function group. Check from the operational log from which function or function block the error originates. In the associated function description, there is additional information as to why the Standby of the function or a function block can change.
(_:53) Health = Warning	SPS		
(_:53) Health = Alarm	SPS		

Indication	Type	Group Warning	Explanation
Device:			
_:320 Auxiliary Power Fail	SPS	Fixed	Fault with the auxiliary power supply: Check the external power supply. This message does not appear if the device has a redundant PS204 power supply module, and is replaced by the messages described below for a device with PS204.
(_:305) Battery failure	SPS		Battery fault: Replace the device battery. To avoid data loss, Siemens recommends replacing the device battery with the device supply voltage switched on. You can find more information on battery disposal in the hardware manual from version V07.80 (order number: C53000-G5040-C002-D).
_:312 Compensation error x	ENS		Calibration error in module x: Contact the Customer Support Center. Quality: Measured values are marked with the quality attribute of <i>questionable</i> (measured value display with ≈).
_:314 Offset error x	ENS		Offset error on module x: If this indication persists after the device start, contact the Customer Support Center. Quality: Measured values are marked with the quality attribute of <i>questionable</i> (measured value display with ≈).
_:306 Clock fail	SPS		Internal time failure • Check the time settings first. • Then replace the device battery. • If the fault is not remedied, contact the Customer Support Center. Quality: The internal time is marked with the quality attribute of <i>Clock Failure</i> .
(_:319) Error memory	SPS		Checksum (cyclic redundancy check) error in monitored memory areas of the device
Measuring transducer error (x)	ENS		Hardware failure on the measuring-transducer module on plug-in module position E/F/M/N/P: Contact the Customer Support Center.

Indication	Type	Group Warning	Explanation
Device with redundant PS204 power supply module:			
_:330 Power sup. Module fail. x	INS	CFC	Internal device error on the power supply module at position x ²⁰ : - The device remains in operation because it has a redundant power supply module, provided it is intact. - Exchange the defective power supply module so that redundancy is reestablished!
_:331 Power sup. Module OK x	INS		No internal device error in the power supply module at position x ²⁰ .
_:332 Pow. sup. aux. pow. fail. x	INS		Error in the external auxiliary power supply module at position x ²⁰ : - The device remains in operation because it has a redundant power supply module, provided it is intact. - Check the auxiliary power supply module.
_:333 Power sup. aux. pow. OK x	INS		The external auxiliary power supply module at position x ²⁰ is OK.
_:334 Power sup. Module fail. x	SPS	Fixed	At least one power supply module has an internal device error
_:335 Pow. sup. aux. pow. fail. x	SPS	Fixed	At least one power supply module does not have an adequate auxiliary power supply
Handling an alarm:			
(_:504) > Group Warning	SPS	Fixed	Input signal for user-defined generation of group warning
Time sync.:			
(_:305) Time sync. error	SPS	Fixed	Time synchronization error, the timing master is faulty: - Check the external time source first. - Check the external connections. - If the fault is not remedied, contact the Customer Support Center. Quality: The internal time is marked with the quality attribute of <i>Clock not synchronized</i> .
Power-system data: meas. point V-3ph: Volt.Trans.Cir.B: (_:500) > Open	SPS	CFC	Voltage-transformer circuit breaker is open. Blocking: Appropriate functions are either blocked definitively or the blocking can be set individually.

²⁰ x refers to the PCB assembly slot (x = 1, 2, 3, ...)

Indication	Type	Group Warning	Explanation
2 devices prot. comm.: Protection interface #:			Protection interface connection defective:
(_:303) Connection broken	SPS	CFunc-tionC ²¹	- Check the connections and the external communication infrastructure. - If the fault is not remedied, contact the Customer Support Center. Transferred Signals: Faulty or not received telegrams are detected at the receive end and discarded. They do not result in failure of the applications. Configured binary signals are reset after a time that can be set.
(_:316) Error rate / min exc.	SPS		
(_:317) Error rate / hour exc.	SPS		
(_:318) Time delay exceeded	SPS		
(_:320) Time delay jump	SPS		
Device: (_:343) SEU happened	SPS		SEU memory fault: Cosmic radiation can result in a Single Event Upset, which can be detected through bit flips (changes in the status of a bit) in the memory blocks. A reset to reinitialize the memory is initiated. You will find additional explanations on the physical background in a special SEU whitepaper.

7.7.3 Defect Severity 2

Faults of defect severity 2 are fatal device faults that lead to an immediate restart of the device (reset).

This occurs when the device data is corrupted (for example, RAM memory), if a restart prevents restoration of data consistency. The device goes briefly out of operation, a failure is avoided.

Life contact	Is terminated during the restart
Red error LED	Is activated during the restart



NOTE

If the fault of defect severity 2 has not been removed after 3 unsuccessful restarts (reset), the fault is automatically assigned to defect severity 3. The device will automatically turn to the fallback mode.

Log

For every device error with a subsequent restart (reset), only the restart can be detected in the operational log. The actual supervision indication is entered in the device-diagnosis log at the point in time of the fault detection and before the restart. These indications are recorded with a real-time stamp and are thus available for later analyses. The device-diagnosis log contains expanded fault descriptions. There, you also receive recommendations of corresponding corrective measures for each detected device error.

For further information on handling the logs, refer to chapter 3.

Overview of Errors

Number	Device-Diagnosis Log
826	Processor error on the base module: If the fault occurs numerous times, contact the Customer Support Center.
830	FPGA hardware error on the base module: Contact the Customer Support Center.
834	Memory error (short term): Reset initiated.
3823	Program run error: If the fault occurs numerous times, contact the Customer Support Center.

²¹ The indications are not pre-routed in the logic block chart. The indications must be added to by the user in the logic block chart!

Number	Device-Diagnosis Log
826	CPU overload: If the fault occurs numerous times, contact the Customer Support Center.
11160	SEU memory fault (short term): Reset initiated
Miscellaneous	Internal firmware error: If the fault occurs numerous times, contact the Customer Support Center.

7.7.4 Defect Severity 3

Faults of defect severity 3 are fatal device faults that lead to device immediately going into the fallback mode. The signal (:301) *Physical health* goes to the **Alarm** state. The **Warning** state is not supported for this signal.

Fatal device errors are errors that cannot be resolved by a restart of the device. In this case, contact the Customer Support Center. The device goes permanently out of operation, a failure is avoided. In the fallback mode, minimal operation of the device via the on-site operation panel and DIGSI is possible. In this way, for example, you can still read out information from the device-diagnosis log.

Life contact	Is terminated in the fallback mode
Red error LED	Is activated in the fallback mode

Log

For every device error that immediately leads to entry into the fallback mode, entries from supervision messages and the signal (:301) *Physical health* into the operational log are not possible. The actual supervision indication is entered in the device-diagnosis log at the point in time of the fault detection, that is, before entry into the fallback mode. These indications are recorded with a real-time stamp and are thus available for later analyses. The device-diagnosis log contains expanded fault descriptions. There, you are offered recommendations of corresponding corrective measures for each detected device error.

You can find further information on handling the logs in chapter [3.1 Indications](#).

Overview of Errors

Number	Device-Diagnosis Log
2822	Memory error (continuous) Contact the Customer Support Center.
4727, 5018-5028	Hardware failure at module 1-12: Contact the Customer Support Center.
4729	Device bus error (repeated): - Check the module configuration and the module connections. - Contact the Customer Support Center.
4733	Incorrect hardware configuration: Synchronize the hardware configuration of the device with DIGSI.
5037-5048	Wrong module 1-12 detected: Synchronize the hardware configuration of the device with DIGSI.
5031-5035	Identified wrong plug-in module on plug-in module position E/F/M/N/P: Synchronize the hardware configuration of the device with DIGSI.
	Wrong application configuration: Search for the cause in the operational log and load a valid configuration to the device.
3640, 4514	Data-structure error: Contact the Customer Support Center.
956	Firmware-version error: Contact the Customer Support Center.

Number	Device-Diagnosis Log
2013, 2025	Signature error: Contact the Customer Support Center.
	CFC error: In DIGSI, check your CFC chart for the cause.
5050-5061	Binary-output error in module 1 - 12: Contact the Customer Support Center.
5088, 5089	A missing display configuration was established: Synchronize the hardware configuration of the device with DIGSI.

7.7.5 Defect Severity 4 (Group Alarm)

Errors of defect severity 4 are not device failures in the classical meaning. These errors do not affect the device hardware and are not detected or reported by internal device supervision functions. The condition of the defect severity 4 – the group alarm – is set user-specifically by the binary input signal ($\_ : 503$) *>Group alarm*. If the binary input signal is reset, the device is no longer in the *Group alarm* condition and all functions return to the normal operating state.

If the group alarm is generated, the device reacts as follows:

- The group indication ($\_ : 300$) *Group alarm* is generated and recorded in the operational log.
- The life contact is terminated.
- The red Error LED is activated.
- All protection and automation functions are blocked.
- The device remains in operation, does not carry out any restart (reset), and does not switch to the safe condition (Fallback mode).
- The signals managed internally are marked with the *invalid* quality attribute. Signals managed internally are, for example, measured values, binary input and output signals, GOOSE and CFC signals.

In the delivery condition, every device has the CFC chart **Process mode inactive**, that initiates the Group alarm (see chapter [7.8 Group Indications](#)).

Life contact	Is terminated in case of Group alarm
Red error LED	Is initiated in case of Group alarm

Log

The group indication ($\_ : 300$) *Group alarm* is recorded in the operational log. Depending on the cause of the initiation, further information can be found in the operational log.

You can find further information on handling the logs in chapter 3.

7.8 Group Indications

The following group indications are available:

- *(_:300) Group alarm*
- *(_:301) Group warning*
- *(_:302) Group indication*

You can find the signals in the DIGSI 5 project tree under **Name of the device** → **Information routing**. In the operating range, you can find the signals under **Alarm handling** (see the following figure).

Information			Source		
			Binary input		
			Basismodul		
Signals	Number	Type	1.1	1.2	1.3
(All)	(All)	...	...	...	...
▶ General	91				
▶ Device	4171				
▼ Alarm handling	5971				
▶ >Group Alarm	5971.503	SPS			
▶ >Group Warning	5971.504	SPS			
▶ >Group Indication	5971.505	SPS			
▶ Behavior	5971.52	ENS			
▶ Health	5971.53	ENS			
▶ Group alarm	5971.300	SPS			
▶ Group warning	5971.301	SPS			
▶ Group indication	5971.302	SPS			

[sc_grwarn, 1, en_US]

Figure 7-5 Group Monitoring Indication in the DIGSI 5 Information Routing Matrix

Group Indication Group Alarm

The indication *(_:300) Group alarm* is the group indication for defect severity 4 monitoring. This monitoring has a special purpose, as it is set user-specifically by a binary input signal and not by internal device supervision. Nevertheless, the response of the device is serious, such as blocking all protection and automatic functions (see chapter [7.7.5 Defect Severity 4 \(Group Alarm\)](#)).

If the binary input signal *(_:503) >Group Alarm* is set, the group indication *(_:300) Group alarm* becomes active. If the binary input signal *(_:503) >Group Alarm* is reset, the signal *(_:300) Group alarm* is also reset and the device returns to the normal operating state.

In the delivery condition, every device has the CFC chart **Process mode inactive**, that initiates the *>Group Alarm*. This CFC chart checks whether the device is still accidentally in the simulation or commissioning mode.

You can adapt the CFC chart as needed. You can find the CFC chart in the DIGSI 5 project tree under **Name of the device** → **Charts**.

Group Indication Group Warning

The indication *(_:301) Group warning* is the group indication for defect severity 1 monitoring. Some error messages of defect severity 1 are firmly linked to the signal *(_:301) Group warning*, others are connected flexibly in the device delivery condition via a CFC chart. This assignment is described in chapter [7.7.2 Defect Severity 1](#).

In the delivery condition, every device has the CFC chart **Group warning**, that initiates the *Group warning*.

You can adapt the CFC chart as needed. You can find the CFC chart in the DIGSI 5 project tree under **Name of the device** → **Charts**.

The group-warning indication (`_:301`) *Group warning* is prerouted to an LED of the base module.

Group Indication

The *Group indication* is exclusively for user-specific purposes. There is no internal device supervision function that activates this indication. If the binary input signal (`_:505`) *>Group indication* is set, the indication (`_:302`) *Group indication* becomes active and is recorded in the operational log. This warning indication does not result in blocking a protection function. If the binary input signal is reset, the signal (`_:302`) *Group indication* drops out. Using a CFC chart, you can define when the binary input signal (`_:505`) *>Group indication* is to be set.

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8.1 Disconnect-Switch Monitoring

8.1.1 Overview of Functions

The function **Disconnecter supervision**:

- Detects and reports temporal changes in the switching procedure of disconnectors

8.1.2 Structure of the Function

The function **Disconnecter supervision** can be used in the function group **Disconnecter**.

The function consists of 2 independent operating procedures:

- **Mechanical switching time open**
Monitoring of the mechanical switching time for the opening operation, detected via the feedback contacts
- **Mechanical switching time close**
Monitoring of the mechanical switching time for the closing operation, detected via the feedback contacts

8.1.3 General Functionality

8.1.3.1 Description

Start Criterion for the Function Disconnecter Supervision

The operating procedure **Mechanical switching time close** is started if one of the following criteria is met:

- The disconnector is closed via a command.
- The binary input signal *>Start calc. for close* is initiated, for example, via an external signal.

The operating procedure **Mechanical switching time open** is started if one of the following criteria is met:

- The disconnector is opened via a command.
- The binary input signal *>Start calc. for open* is initiated, for example, via an external signal.

8.1.3.2 Application and Setting Notes

Parameter: Mode

- Default setting (**_:26671:1**) **Mode** = *on*

With the parameter **Mode**, you can switch the disconnector supervision *on*, *off*, or in *test* mode.

8.1.3.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:26671:1	Discon. monit.:Mode		• off • on • test	on

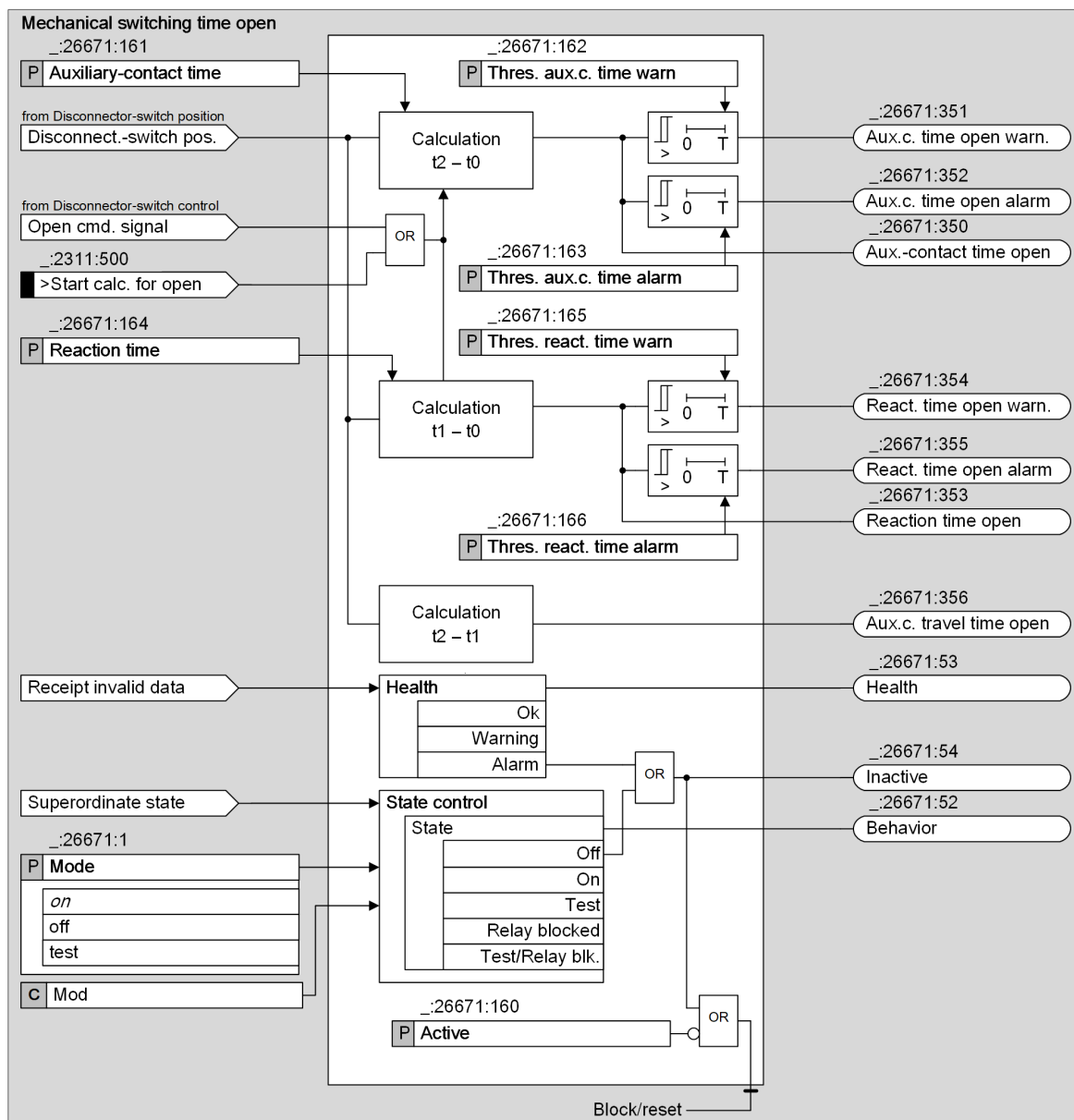
8.1.3.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:500	General:>Start calc. for open	SPS	I
_:2311:501	General:>Start calc. for close	SPS	I

8.1.4 Mechanical Switching Time Open

8.1.4.1 Description

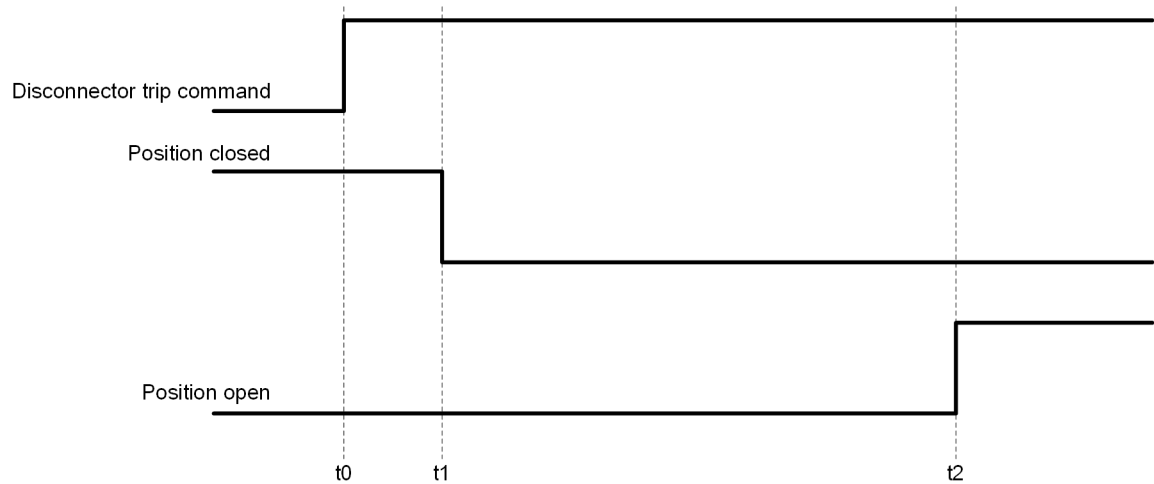
Logic of the Stage



[io_mechanical_make-time_open, 1, en_US]

Figure 8-1 Logic of the Stage Mechanical Switching Time for Disconnecter

Method of Operation



[dw_charact_dcs-maketime_op, 1, en_US]

- 1) $t2 - t0$: Auxiliary contact time open operation
- 2) $t1 - t0$: Reaction time open operation
- 3) $t2 - t1$: Auxiliary contact dead time open operation

The stage for monitoring the **mechanical switching time open** of the disconnector calculates the time between the start criterion ($t0$) and the time when the disconnector-switch position changes to the **intermediate position** ($t1$). The stage measures the time between the start criterion ($t0$) and the time when the disconnector-switch position changes to **open** ($t2$). Additionally, the stage calculates the time of the auxiliary contacts between the **intermediate position** ($t1$) until the **open** position is reached ($t2$).

The start criterion can be either the switching command **open** of the disconnector or the input signal *>Start calc. for open*.

You can define 2 independent threshold values for monitoring the measured time $t1-t0$. If a threshold value is exceeded, the corresponding output *warning/Alarm* is activated for 100 ms. You can define 2 independent threshold values for monitoring the measured time $t2-t0$. If a threshold value is exceeded, the corresponding output *warning/Alarm* is activated for 100 ms. For $t2-t1$, the calculated time must be displayed. There is no warning or alarm threshold.

For monitoring the mechanical switching times, you must route the open and closed disconnector-switch position in the function group **Disconnecter**. If you route only one or no disconnector feedback, the function **Mechanical switching time open** cannot work and issues the state *warning*.

8.1.4.2 Application and Setting Notes

Parameter: Auxiliary-contact time

- Default setting (`_:26671:161`) **Auxiliary-contact time = 10 s**

With the parameter **Auxiliary-contact time**, you can define the duration between the disconnector trip command and the feedback contacts signaling the **open** position.

Parameter: Thres. aux.c. time warn

- Default setting (`_:26671:162`) **Thres. aux.c. time warn = 12 s**

With the parameter **Thres. aux.c. time warn**, you define by how many seconds the auxiliary-contact time may be undercut or exceeded for the output *Aux.c. time open warn*. to be set. The output *Aux.c. time open warn*. drops out after 100 ms.

Parameter: Thres. aux.c. time alarm

- Default setting (`_:26671:163`) **Thres. aux.c. time alarm = 14 s**

With the parameter **Thres. aux.c. time alarm**, you define by how many seconds the auxiliary-contact time may be undercut or exceeded for the output *Aux.c. time open alarm* to be set. The output *Aux.c. time open alarm* drops out after 100 ms.

Parameter: Reaction time

- Default setting (**_:26671:164**) **Reaction time = 2 s**

With the parameter **Reaction time**, you define the duration between the disconnecter trip command and the feedback contacts signaling the **intermediate position**.

Parameter: Thres. react. time warn

- Default setting (**_:26671:165**) **Thres. react. time warn = 2.4 s**

With the parameter **Thres. react. time warn**, you define by how many seconds the reaction time may be undercut or exceeded for the output *React. time open warn*. to be set. The output *React. time open warn*. drops out after 100 ms.

Parameter: Thres. react. time alarm

- Default setting (**_:26671:166**) **Thres. react. time alarm = 2.8 s**

With the parameter **Thres. react. time alarm**, you define by how many seconds the reaction time may be undercut or exceeded for the output *React. time open alarm* to be set. The output *React. time open alarm* drops out after 100 ms.

8.1.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Mechanical sw. time open				
_:26671:160	Discon. monit.:Active		• 0 • 1	false
_:26671:161	Discon. monit.:Auxiliary-contact time		0.02 s to 1800.00 s	10.00 s
_:26671:162	Discon. monit.:Thres. aux.c. time warn		0.02 s to 1800.00 s	12.00 s
_:26671:163	Discon. monit.:Thres. aux.c. time alarm		0.02 s to 1800.00 s	14.00 s
_:26671:164	Discon. monit.:Reaction time		0.02 s to 1800.00 s	2.00 s
_:26671:165	Discon. monit.:Thres. react. time warn		0.02 s to 1800.00 s	2.40 s
_:26671:166	Discon. monit.:Thres. react. time alarm		0.02 s to 1800.00 s	2.80 s

8.1.4.4 Information List

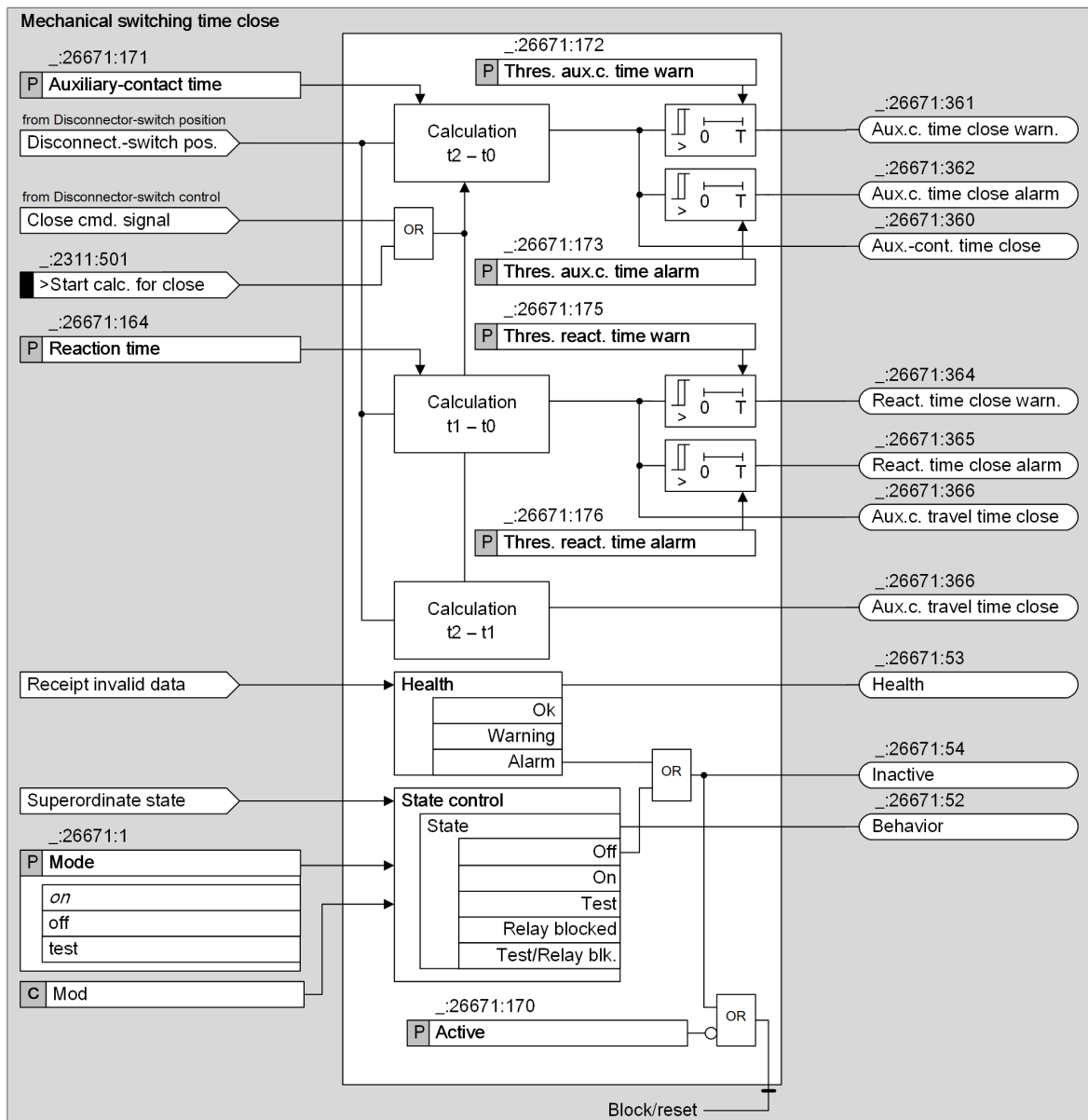
No.	Information	Data Class (Type)	Type
Discon. monit.			
_:26671:51	Discon. monit.:Mode (controllable)	ENC	C
_:26671:54	Discon. monit.:Inactive	SPS	O
_:26671:52	Discon. monit.:Behavior	ENS	O
_:26671:53	Discon. monit.:Health	ENS	O
_:26671:350	Discon. monit.:Aux.-contact time open	MV	O
_:26671:351	Discon. monit.:Aux.c. time open warn.	SPS	O

No.	Information	Data Class (Type)	Type
_:26671:352	Discon. monit.:Aux.c. time open alarm	SPS	O
_:26671:353	Discon. monit.:Reaction time open	MV	O
_:26671:354	Discon. monit.:React. time open warn.	SPS	O
_:26671:355	Discon. monit.:React. time open alarm	SPS	O
_:26671:356	Discon. monit.:Aux.c. travel time open	MV	O

8.1.5 Mechanical Switching Time Close

8.1.5.1 Description

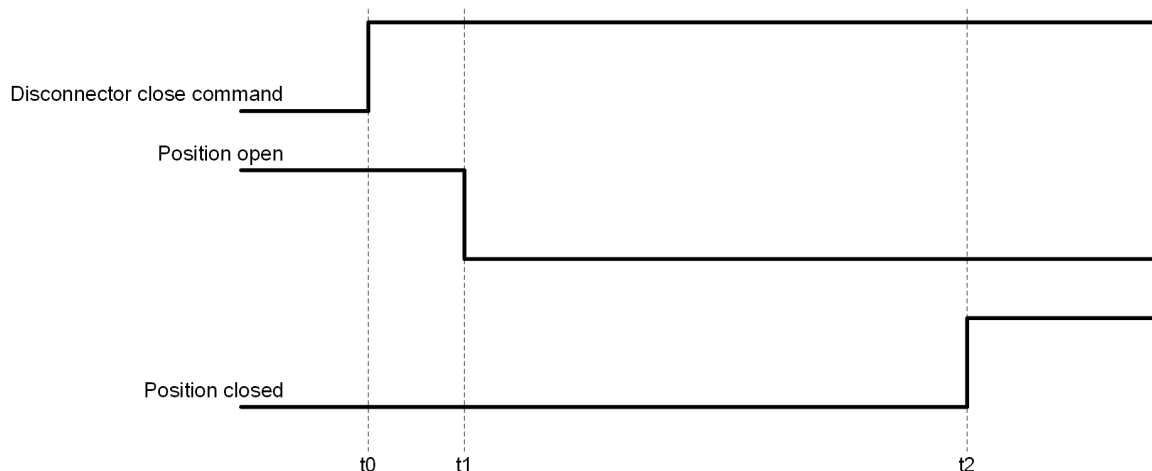
Logic of the Stage



[lo_mechanical_break-time_do_1_en_US]

Figure 8-2 Logic of the Stage Mechanical Switching Time Close for Disconnect

Method of Operation



[dw_charact_dcs-breaktime_clo, 1, en_US]

- 1) $t_2 - t_0$: Auxiliary contact time close operation
- 2) $t_1 - t_0$: Reaction time close operation
- 3) $t_2 - t_1$: Auxiliary contact dead time close operation

The stage for monitoring the **mechanical switching time close** of the disconnecter measures the time between the disconnecter close command (t_0) and the time when the disconnecter-switch position changes to the **intermediate position**. The stage measures the time between the disconnecter close command (t_0) and the time when the disconnecter-switch position changes to **closed** (t_2). Additionally, the stage calculates the time of the auxiliary contacts between the **intermediate position** (t_1) until the **closed** position is reached (t_2).

The start criterion can be either the disconnecter close command or the input signal *>Start calc. for close*.

You can define 2 independent threshold values for monitoring the measured time $t_1 - t_0$. If a threshold value is exceeded, the corresponding output *warning/Alarm* is activated for 100 ms. You can define 2 independent threshold values for monitoring the measured time $t_2 - t_0$. If a threshold value is exceeded, the corresponding output *warning/Alarm* is activated for 100 ms. For $t_2 - t_1$, only the measured time must be reported. There is no warning or alarm threshold.

For monitoring the mechanical switching times, you must route the open and closed disconnecter-switch position in the function group **Disconnecter**. If you route only one or no disconnecter feedback, the function **Mechanical switching time close** cannot work and issues the state *warning*.

8.1.5.2 Application and Setting Notes

Parameter: Auxiliary-contact time

- Default setting (`_:26671:171`) **Auxiliary-contact time** = 10 s

With the parameter **Auxiliary-contact time**, you define the duration between the disconnecter close command and the feedback contacts signaling the **closed** position.

Parameter: Thres. aux.c. time warn

- Default setting (`_:26671:172`) **Thres. aux.c. time warn** = 12 s

With the parameter **Thres. aux.c. time warn**, you define by how many seconds the auxiliary contact time may be undercut or exceeded for the output *Aux.c. time close warn*. to be set. The output *Aux.c. time close warn*. drops out after 100 ms.

Parameter: Thres. aux.c. time alarm

- Default setting (`_:26671:173`) **Thres. aux.c. time alarm = 14 s**

With the parameter **Thres. aux.c. time alarm**, you define by how many seconds the auxiliary contact time may be undercut or exceeded for the output *Aux.c. time close alarm* to be set. The output *Aux.c. time close alarm* drops out after 100 ms.

Parameter: Reaction time

- Default setting (`_:26671:174`) **Reaction time = 2 s**

With the parameter **Reaction time**, you define the duration between the disconnect close command and the feedback contacts signaling the **intermediate position**.

Parameter: Thres. react. time warn

- Default setting (`_:26671:175`) **Thres. react. time warn = 2.4 s**

With the parameter **Thres. react. time warn**, you define by how many seconds the reaction time may be undercut or exceeded for the output *React. time close warn*. to be set. The output *React. time close warn*. drops out after 100 ms.

Parameter: Thres. react. time alarm

- Default setting (`_:26671:176`) **Thres. react. time alarm = 2.8 s**

With the parameter **Thres. react. time alarm**, you define by how many seconds the reaction time may be undercut or exceeded for the output *React. time close alarm* to be set. The output *React. time close alarm* drops out after 100 ms.

8.1.5.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Mechanical sw. time close				
<code>_:26671:170</code>	Discon. monit.:Active		• 0 • 1	false
<code>_:26671:171</code>	Discon. monit.:Auxiliary-contact time		0.02 s to 1800.00 s	10.00 s
<code>_:26671:172</code>	Discon. monit.:Thres. aux.c. time warn		0.02 s to 1800.00 s	12.00 s
<code>_:26671:173</code>	Discon. monit.:Thres. aux.c. time alarm		0.02 s to 1800.00 s	14.00 s
<code>_:26671:174</code>	Discon. monit.:Reaction time		0.02 s to 1800.00 s	2.00 s
<code>_:26671:175</code>	Discon. monit.:Thres. react. time warn		0.02 s to 1800.00 s	2.40 s
<code>_:26671:176</code>	Discon. monit.:Thres. react. time alarm		0.02 s to 1800.00 s	2.80 s

8.1.5.4 Information List

No.	Information	Data Class (Type)	Type
Discon. monit.			
<code>_:26671:51</code>	Discon. monit.:Mode (controllable)	ENC	C
<code>_:26671:54</code>	Discon. monit.:Inactive	SPS	O
<code>_:26671:52</code>	Discon. monit.:Behavior	ENS	O
<code>_:26671:53</code>	Discon. monit.:Health	ENS	O

No.	Information	Data Class (Type)	Type
_:26671:360	Discon. monit.:Aux.-cont. time close	MV	O
_:26671:361	Discon. monit.:Aux.c. time close warn.	SPS	O
_:26671:362	Discon. monit.:Aux.c. time close alarm	SPS	O
_:26671:363	Discon. monit.:Reaction time close	MV	O
_:26671:364	Discon. monit.:React. time close warn.	SPS	O
_:26671:365	Discon. monit.:React. time close alarm	SPS	O
_:26671:366	Discon. monit.:Aux.c. travel time close	MV	O

8.2 User-Defined Metered Values

8.2.1 Function Description of Pulse-Metered Values



NOTE

You can define additional metered values through DIGSI for user-specific applications.

Use pulse meters; then you can define the respective metered values through DIGSI and set parameters for them analogously to the energy values. You can read out the metered values on the display of the device or via DIGSI.

Through settings, you can individually set how each pulse-metered value is processed:

- Parameter **Restore time**
Hour-related point in time when the device will provide a metered value at the communication interface for transmission. After this, the transfer takes place in accordance with the selected protocol.
Note: If the parameter is activated through a time setting, the parameter **Restore interval** will automatically be deactivated.
- Parameter **Restore interval**
Adjustable period in minutes until the first and every further transfer of the metered value to the communication interface of the device. After this, it will be transferred in accordance with the selected log.
Note: If the parameter is activated through a time setting, the parameter **Restore time** will automatically be deactivated.

In addition, restoring can be triggered via a routable binary input (**>Restore trigger**) or via a logical internal binary input. The rising edge of the binary input leads to restoring and thus to provision of the metered value at the communication interface.

The counter pulse of any external/internal pulse generator is connected to the device via a routable binary input (**>Pulse input**). If this does not deliver any plausible values, this can be signaled to the device via another routable binary input (**>External error**).

In compliance with IEC 61850, in the event of an external error, the quality of the pulse-metered value changes to the state **Questionable**. No more pulses are added as long as the external error persists. Once the external fault condition has been cleared, pulses are added again.

The quality of the pulse-metered value remains **Questionable** until a new meter content is specified for the pulse-metered value by:

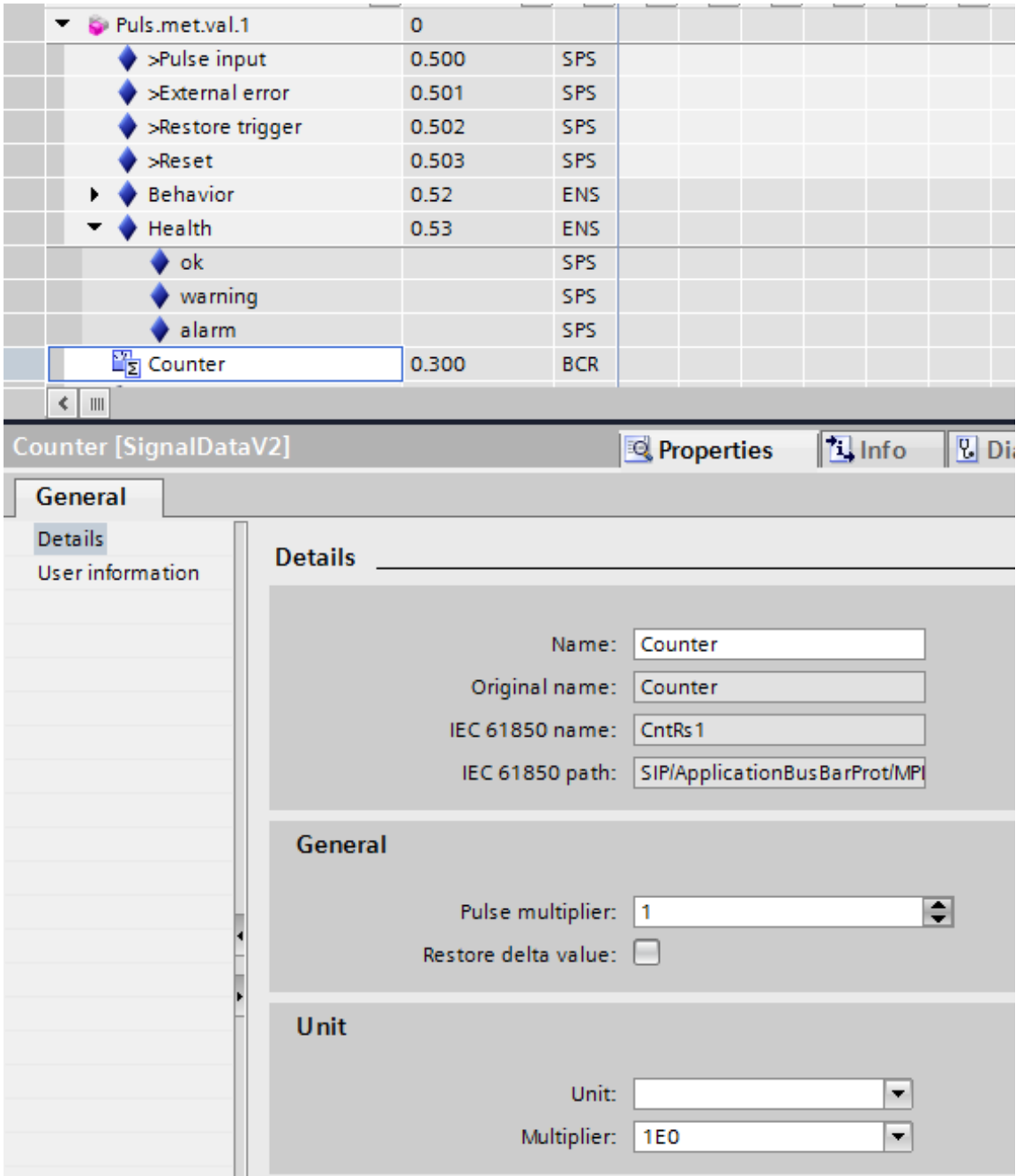
- Confirmation of the current meter content via **Setting**
- **Setting** a new meter content
- **Resetting** the meter content to 0

- Parameter **Edge trigger**
Through settings, you can select between counting only with a rising edge or with rising and falling edges on the pulse input.

The pulse counter can be reset to 0. You can perform this resetting via the rising edge of a routable binary input (**>Reset**) or via operation on the device.

To display the counting amount at the device display, use DIGSI to set the desired weighting of the counter pulses, the unit of the metered value and a multiplication factor for every pulse generator. You can also assign a user-specific name.

To do this, open the functional area **Pulse-metered value** in DIGSI information routing. (see [Figure 8-3](#)). Select the metered value and enter the settings under **Properties**.



[sc_omvimp, 2, en_US]

Figure 8-3 Setting with DIGSI, General Settings, Pulse-Metered Values

8.2.2 Application and Setting Notes for Pulse-Metered Values

The functionality **Pulse-metered values** is not preconfigured. If you want to use the functionality, you must load it from the library into the respective function group.

The parameters can be set individually for every pulse counter. You will find the setting parameters in DIGSI in the project tree under **Parameter > Function group**. The maximum repetition rate when detecting the pulse-metered values is 50 Hz.

For pulse-metered values, the following described settings and binary inputs are available.

Parameter: Restore time

- Default setting (`_:101`) **Restore time** = *none*

Parameter Value	Description
<i>none</i>	Deactivated
<i>hh:00</i>	Transfer on the full hour
<i>hh:15</i>	Transfer 15 minutes after the full hour
<i>hh:30</i>	Transfer 30 minutes after the full hour
<i>hh:45</i>	Transfer 45 minutes after the full hour

Note: If the parameter is activated through a time setting, the parameter **Restore interval** is not in effect and will be deactivated automatically.

Parameter: Restore interval

- Default setting (`_:102`) **Restore interval** = *0 min*

Parameter Value	Description
<i>0 min</i>	Deactivated
<i>1 min to 60 min</i>	Cyclical transfer after the set time 1 minute to 60 minutes

Note: If the parameter is activated through a time setting, the parameter **Restore time** is not in effect and will be deactivated automatically.

Parameter: Edge trigger

- Default setting (`_:103`) **Edge trigger** = *rising edge*

Parameter Value	Description
<i>rising edge</i>	Counting with rising edge at the pulse input
<i>rising & falling edge</i>	Counting with rising and falling edge at the pulse input

Parameter: Restore by absolute time

- Default setting: (`_:104`) **Restore by absolute time** = *False*

Parameter Value	Description
<i>False</i>	Deactivated
<i>True</i>	The cyclic restoring of setting Restore interval after the set time is also synchronized with the system time. Example: Restore interval = 30 min; current system time: 12:10 o'clock. First restoring operation: 12:30 o'clock; next restoring operation: 13:00 o'clock, etc.

Input Signals: >Pulse input, >External error, >Restore trigger, >Reset

Binary inputs	Description
>Pulse input	Input for the counting pulses of an external pulse generator
>External error	Indication that the counter pulses of the external pulse generator are faulty. The indication has an effect on the quality identifier of the pulse value.
>Restore trigger	The transfer of the metered values is initiated via a binary input.
>Reset	The rising edge at the binary input resets the pulse counter to 0.

The amount of energy indicated by a pulse generator is to be displayed as a measured value.
1 pulse corresponds to 100 Wh.
The pulse weighting, the SI unit, and the factor must be adjusted to one another.
Display value = Calculated metered value * Pulse weighting * Factor * SI unit.

If the check box **Restore delta value** is activated, the differential value is transferred at the restore time set via the communication interface. The difference value is formed by subtracting the counter content of the last restoring operation from the current counter content.

You route the logical signal **>Pulse input** to a binary input to which the pulse generator is connected.

Set the following values:

Name	Active Power Meter
Pulse weighting	100
Restore differential value	Activated
SI unit	Wh
Factor	1

The factor is used for adaptation to larger units (for instance, 1000 for kWh). It is adjustable in powers of ten (1, 10, 100, 1000, etc.). The following figure shows the signals that can be arranged in the DIGSI information matrix. Open the function group where you created the pulse-metered value, for example, Line 1. There, you will find the function area **Pulse-metered value**. Here you will also find the logical signals next to the metered value. Select the metered value and enter the settings under **Properties**.

The screenshot displays the DIGSI software interface. The top section shows a tree view of signals. Under 'Puls met val 1', there are several sub-signals: '>Pulse input', '>External error', '>Restore trigger', '>Reset', '>Behavior', '>Health', and 'Counter'. The 'Counter' signal is selected. The bottom section shows the 'Counter' properties dialog. The 'General' tab is active, showing fields for Name, Original name, IEC 61850 name, and IEC 61850 path. The 'Pulse multiplier' is set to 1.000, and the 'Restore delta value' checkbox is checked. The 'Unit' is set to 'Wh' and the 'Multiplier' is set to '1E0'.

[sc_impzwe, 1, en_US]

Figure 8-4 Setting with DIGSI

8.3 Statistic Values

8.3.1 Statistical Values of the Primary System

The device has statistical values for circuit breakers and disconnectors.

The following values are available for each circuit breaker:

- Total number of switching operations of the circuit breaker initiated by the device

The following values are available for each disconnector switch:

- Total number of switching operations of the disconnector switch initiated by the device

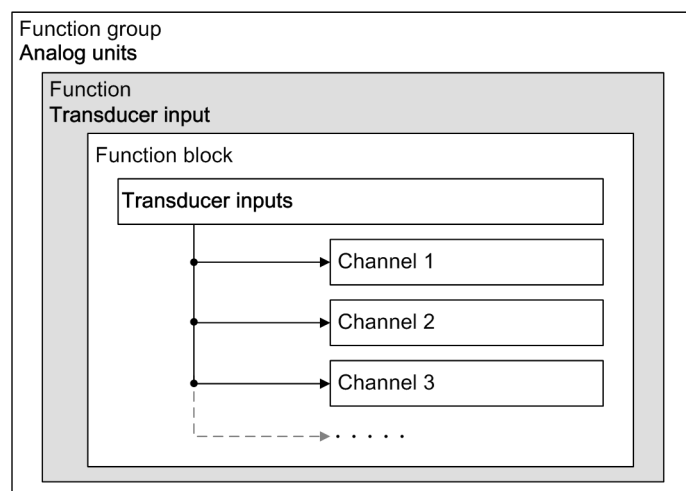
8.4 Measuring Transducers

8.4.1 Overview of Functions

Measuring transducers with an input rated at 20 mA can be used in the devices. 4 such inputs are available as module ANAI-CA-4EL, which can be plugged into a communication module slot (for instance, port E or F). Up to 4 such modules can be plugged in. Typically, slowly changing process variable such as temperature or gas pressure are recorded with such 20-mA measured values and reported to the substation automation technology.

8.4.2 Structure of the Function

The measuring-transducer blocks are embedded in the **Analog units** function group and contain input and output channels that are configurable independently of each other.

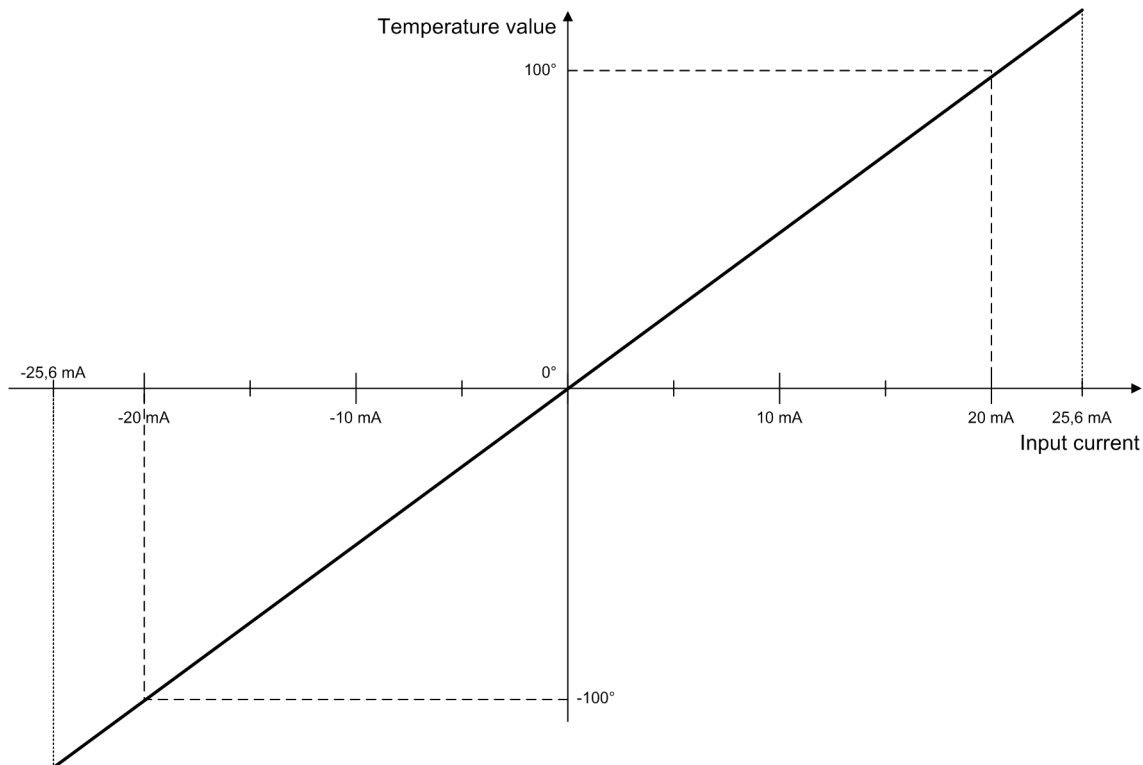


[dw_strumu, 1, en_US]

Figure 8-5 Structure/Embedding of the Function

8.4.3 Function Description

The 20-mA inputs typically transmit a value which represents a physical quantity such as a temperature or a pressure. Therefore, the device must contain a characteristic curve that assigns the physical quantity to the 20-mA value. If the parameter **Range active** is not activated (no x in the check box), the function operates over the range -25.6 mA to +25.6 mA. The setting of the range for the scaled value goes from a usable range of -25.6 mA to +25.6 mA. The following figure shows an example.



[dw_klbsp_1, 3, en_US]

Figure 8-6 Characteristic Curve of a 20-mA Input (Example 1)

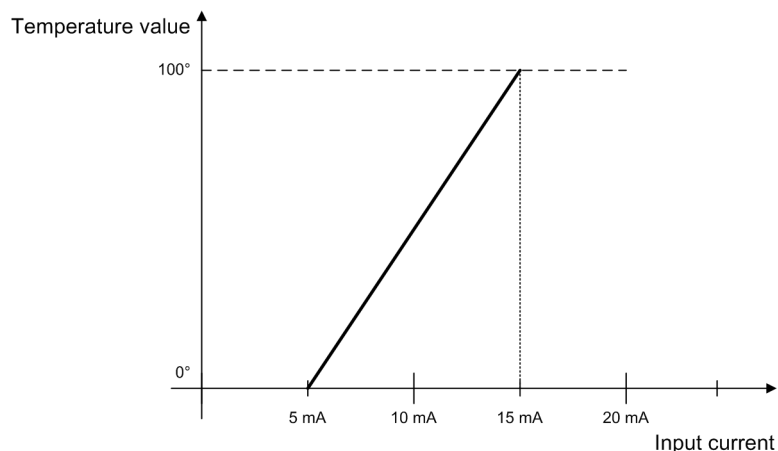
In this example, the measured value 0 mA means a temperature of 0 degrees Celsius and the measured value 20 mA means a temperature of 100 degrees Celsius. Thus, **Unit** = °C and **Conversion factor** = 100 are entered. The resolution (decimal place) of the temperature value can be selected; for one decimal place, select **Resolution** = 0.1.

Meas.trans.in1	
826.1832.5491.101	Meas. transduc. I/O type: Current input
826.1832.5491.103	Unit: °C
826.1832.5491.108	Resolution: 0.1
826.1832.5491.107	Range active: ☐
826.1832.5491.104	Conversion factor: 100

[sc_transd, 1, en_US]

Figure 8-7 Parameter Settings for Example 1

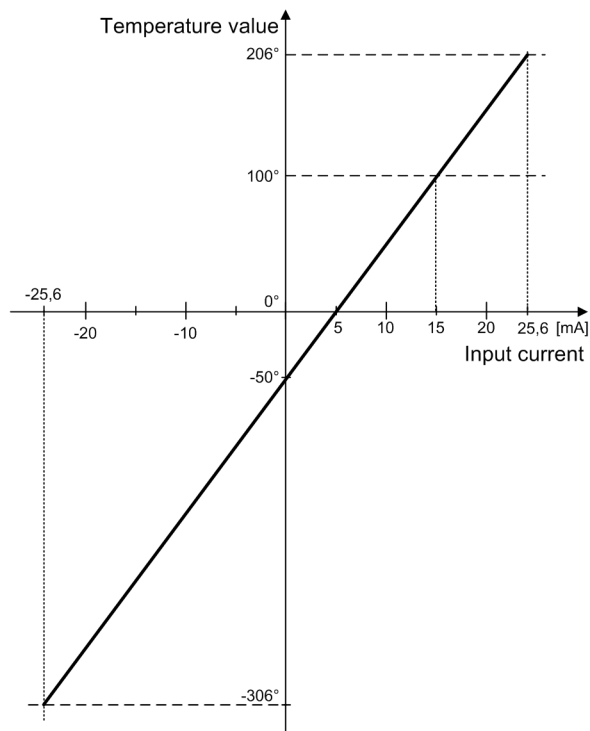
If a value smaller than -25.6 mA or larger than +25.6 mA is applied to the measuring-transducer input, the measured value is marked as outside the range of values. If the parameter **Range active** is activated, the 2 additional parameters **Upper limit** and **Lower limit** appear. Both limiting values indicate the input currents in mA, for which the value set by the **Conversion factor** (**Upper limit**) and the value 0 (**Lower limit**) of the calculated measurand are valid (see following figure).



[dw_kl_example_2, 1, en_US]

Figure 8-8 Characteristic Curve of a 20-mA Input (Example 2)

In this example, **Range active** is selected. The **Upper limit** is at 15 mA, the **Lower limit** is at 5 mA and the **Conversion factor** remains at 100. Overall, this results in a characteristic curve as shown in the following figure, taking into account all possible valid measured values from -25.6 mA to +25.6 mA. The parameter **Upper limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Upper limit** setting. The parameter **Lower limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Lower limit** setting.



[dw_klges_2, 3, en_US]

Figure 8-9 Total Characteristic Curve in Example 2

[sc_trans2, 2, en_US]

Figure 8-10 Parameter Setting for Example 2

Each measuring-transducer input provides the scaled measured value (these are the temperature values in the examples) and the original current measured value in mA in the information routing for further processing.

Table 8-1 Measuring-Transducer Measured Values

Measured Value		Display
TD scale MV (_:301)		
	Primary	Measured value converted to the sensor
	Secondary	–
	Percent	100 % $\triangleq$ parameter (_:104) Conversion factor (for (_:107) Range active = <i>false</i>) 100 % $\triangleq$ max. absolute value of the parameter (_:109) Upper limit - Sensor or of the parameter (_:110) Lower limit - Sensor (for (_:107) Range active = <i>true</i>)
TD direct MV (_:302)		
	Primary	–
	Secondary	-20.000 mA to +20.000 mA or -10 V to +10 V
	Percent	100 % $\triangleq$ 20 mA or 10 V

The measuring-transducer values can be displayed in the display image and processed with CFC charts.

8.4.4 Application and Setting Notes

Parameter: Unit

- Recommended setting value (_:103) **Unit** = °C

With the parameter **Unit**, you set the physical unit of measurement the measured values. The possible setting values are listed in the settings table.

Parameter: Conversion factor

With the parameter (_:104) **Conversion factor**, you set the conversion factor for the measuring transducer.

Parameter: Resolution

- Default setting (_:108) **Resolution** = 0.1

With the parameter **Resolution**, you set the resolution of the scaled values.

Parameter: Range active

- Default setting (`_:107`) **Range active** = *false*

If you do not activate the parameter **Range active** (no cross in the check box), the function operates over the range -25.6 mA to +25.6 mA. The setting of the range for the scaled value goes from a usable range of -25.6 mA to +25.6 mA.

If you activate the parameter **Range active**, the 4 additional parameters **Upper limit**, **Upper limit - Sensor**, **Lower limit**, and **Lower limit - Sensor** appear.

Parameter: Upper limitLower limitUpper limit - Sensor and Lower limit - Sensor

- Default setting (`_:105`) **Upper limit** = *20.000 mA*
- Default setting (`_:109`) **Upper limit - Sensor** = *100*
- Default setting (`_:106`) **Lower limit** = *4.000 mA*
- Default setting (`_:110`) **Lower limit - Sensor** = *100*

If you activate the parameter **Range active**, the 4 additional parameters **Upper limit**, **Lower limit**, **Upper limit - Sensor**, and **Lower limit - Sensor** appear. The parameter **Upper limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Upper limit** setting. The parameter **Lower limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Lower limit** setting.

If you keep the preset limiting values, the following conditions are possible:

- If the input current is < 2.000 mA
The function issues the indication *Broken wire* and the quality of the output value is invalid. The functions that use the output value as the measured value can be deactivated.
- If the input current is > 2.500 mA
The indication *Broken wire* drops out.

8.4.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
<i>MT in #</i>				
<code>_:101</code>	MT in #:Meas. transduc. I/O type		• Voltage input • Current input • Voltage output • Current output • Temperature input	Current input

Addr.	Parameter	C	Setting Options	Default Setting
_:103	MT in #:Unit		• % • ° • °C • °F • Ω • Ω/km • Ω/mi • 1/s • A • As • $\cos \varphi$ • cycles • dB • F/km • F/mi • h • Hz • Hz/s • in • J • J/Wh • K • l/s • m • mi • min • p.u. • Pa • periods • rad • rad/s • s • V • V/Hz • VA • VAh • var • varh • Vs • W • W/s • Wh	m

Addr.	Parameter	C	Setting Options	Default Setting
_:108	MT in #:Resolution		1 0.1 0.01 0.001	0.1
_:107	MT in #:Range active		0 1	false
_:104	MT in #:Conversion factor		1 to 10000	100
_:105	MT in #:Upper limit		-20.00 mA to 20.00 mA	20.00 mA
_:109	MT in #:Upper limit - Sensor		-10000 to 10000	100
_:106	MT in #:Lower limit		-20.00 mA to 20.00 mA	4.00 mA
_:110	MT in #:Lower limit - Sensor		-10000 to 10000	100

8.4.6 Information List

No.	Information	Data Class (Type)	Type
MT in #			
_:307	MT in #:Broken wire	SPS	O
_:302	MT in #:TD scale MV	MV	O
_:306	MT in #:TD scale SAV	SAV	O

9 Technical Data

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9.1 General Device Data

9.1.1 Analog Inputs

Measuring-Transducer Inputs (via Module ANAI-CA-4EL)

Insulation class	PELV (Protective Extra Low Voltage) (according to IEC 60255-27)
Connector type	8-pin terminal spring
Input channels	4 differential current inputs
Measuring range	DC -20 mA to +20 mA
Tolerance	0.5 % of the measuring range
Maximum measuring range	DC -25.6 mA to +25.6 mA
Input impedance	140 Ω
ADC type	16-Bit Delta-Sigma
Permissible potential difference between channels	DC 20 V
Galvanic separation from ground/housing	AC 500 V, DC 700 V
Permissible overload	DC 100 mA continuously
Sampling rate	5 Hz

Fast Measuring Transducer Inputs, Voltage (via Module ANAI-CE-2EL, Channel 2, and IO218)

Insulation class	HLV (Hazardous Live Voltage) (in accordance with IEC 60255-27)
Input channels	1 DC voltage input, ANAI-CE-2EL, channel 2 (CH2) 3 DC voltage inputs, IO218
Measuring range	DC 0 V to + 300 V
Tolerance	0.2 % of measuring range
Input impedance	260 k Ω
Galvanic separation against ground/housing	DC 4.6 kV
Max. permissible voltage against ground on the measuring inputs	DC 300 V
Sampling rate	16 kHz

Temperature Inputs

Settings	Value	Note
Insulation class	PELV (Protective Extra Low Voltage) (acc. to IEC 60255-27)	With IO218: RTD and MUX inputs not galvanically separated.
Measurement mode	- Pt 100 Ω - Ni 100 Ω - Ni 120 Ω 3-wire connection, shielded cables	—
Temperature measuring range	-65 °C to +710 °C	For PT100
	-50 °C to +250 °C	For NI100
	-50 °C to +250 °C	For NI120

9.1.2 Supply Voltage

Integrated Power Supply			
For modular devices, the following modules contain a power supply: PS201 – Power supply of the base module and of the 1st device row PS203 – Power supply of the 2nd device row PS204 – Redundant power supply CB202 – Plug-in module assembly with integrated power supply, for example, to accommodate communication modules			
Permissible voltage ranges (PS201, PS203, PS204, CB202)	DC 19 V to DC 60 V	DC 48 V to DC 300 V AC 80 V to AC 265 V, 50 Hz/60 Hz	
Auxiliary rated voltage V _H (PS201, PS203, PS204, CB202)	DC 24 V/DC 48 V	DC 60 V/DC 110 V/DC 125 V/DC 220 V/ DC 250 V or AC 100 V/AC 115 V/AC 230 V, 50 Hz/60 Hz	
Permissible voltage ranges (PS101) Only for non-modular devices	DC 19 V to DC 60 V	DC 48 V to 150 V	DC 88 V to DC 300 V AC 80 V to AC 265 V, 50 Hz/60 Hz
Auxiliary rated voltage V _H (PS101) Only for non-modular devices	DC 24 V/DC 48 V	DC 60 V/DC 110 V/ DC 125 V	DC 110 V/ DC 125 V/ DC 220 V/DC 250 V or AC 100 V/AC 115 V/ AC 230 V, 50 Hz/60 Hz
Superimposed alternating voltage, peak-to-peak, IEC 60255-11, IEC 61000-4-17	≤ 15 % of the DC auxiliary rated voltage (applies only to direct voltage)		
Inrush current	≤ 18 A		
Recommended external protection	Miniature circuit breaker 6 A, characteristic C according to IEC 60898		
Internal fuse			
–	DC 24 V to DC 48 V	DC 60 V to DC 125 V	DC 24 V to DC 48 V AC 100 V to AC 230 V
PS101 Only for non-modular devices	4 A inert, AC 250 V, DC 150 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	2 A time-lag, AC 250 V, DC 300 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	
PS201, PS203, CB202 (to device version xA)	4 A inert, AC 250 V, DC 150 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	2 A time-lag, AC 250 V, DC 300 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	
PS201, PS203, PS204 (Device version xB and higher)	4 A inert, AC 250 V, DC 150 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	3.15 A time-lag, AC 250 V, DC 300 V, UL recognized SIBA type 179200 or Schurter type SPT 5x20	

Integrated Power Supply			
Power consumption (life relay active)			
–	DC	AC 230 V/50 Hz	AC 115 V/50 Hz
1/3 module, non-modular Without plug-in modules	7 W	16 VA	12.5 VA
1/3 base module, modular Without plug-in modules	13 W	55 VA	40 VA
1/6 expansion module	3 W	6 VA	6 VA
1/6 plug-in module assembly without plug-in modules (modules CB202)	3.5 W	14 VA	7 VA
Plug-in module for base module or plug-in module assembly (for example, communication module)	< 5 W	< 6 VA	< 6 VA
Stored-energy time for auxiliary voltage outage or short circuit, modular devices IEC 61000-4-11 IEC 61000-4-29		For $V \geq \text{DC } 24 \text{ V} \geq 50 \text{ ms}$ For $V \geq \text{DC } 110 \text{ V} \geq 50 \text{ ms}$ For $V \geq \text{AC } 115 \text{ V} \geq 50 \text{ ms}$	
Stored-energy time for auxiliary voltage outage or short circuit, non-modular devices IEC 61000-4-11 IEC 61000-4-29		For $V \geq \text{DC } 24 \text{ V} \geq 20 \text{ ms}$ For $V \geq \text{DC } 60 \text{ V} \geq 50 \text{ ms}$ For $V \geq \text{AC } 115 \text{ V} \geq 200 \text{ ms}$	

9.1.3 Binary Inputs

Standard Binary Input

Rated voltage range	DC 24 V to 250 V The binary inputs of SIPROTEC 5 are bipolar, with the exception of the binary inputs on the modules IO230, IO231, IO232, and IO233.	
Current consumption, picked up	Approx. DC 0.6 mA to 2.5 mA (independent of the control voltage)	
Max. power consumption	0.6 W	
Pickup time	Approx. 3 ms	
Dropout time ²²	Capacitive load (supply-line capacitance)	Dropout time
	< 5 nF	< 4 ms
	< 10 nF	< 6 ms
	< 50 nF	< 10 ms
	< 220 nF	< 35 ms

²² Pay attention to the specified dropout times for time-critical applications with active-low signals. If necessary, provide for active discharge of the binary input (for example, a resistor in parallel with the binary input or using a change-over contact).

Control voltage for all modules with binary inputs, except module IO233	Adapt the binary-input threshold to be set in the device to the control voltage.	
	Range 1 for 24 V, 48 V, and 60 V control voltage	$V_{\text{low}} \leq \text{DC } 10 \text{ V}$ $V_{\text{high}} \geq \text{DC } 19 \text{ V}$
	Range 2 for 110 V and 125 V control voltage	$V_{\text{low}} \leq \text{DC } 44 \text{ V}$ $V_{\text{high}} \geq \text{DC } 88 \text{ V}$
	Range 3 for 220 V and 250 V control voltage	$V_{\text{low}} \leq \text{DC } 88 \text{ V}$ $V_{\text{high}} \geq \text{DC } 176 \text{ V}$
Control voltage for binary inputs of the IO233 module	Range for 125 V control voltage	$V_{\text{low}} \leq \text{DC } 85 \text{ V}$ $V_{\text{high}} \geq \text{DC } 105 \text{ V}$
Maximum admissible voltage	DC 300 V	
The binary inputs contain interference suppression capacitors. To ensure EMC immunity, use the terminals shown in the terminal diagrams/connection diagrams to root the binary inputs to the common potential.		

Special Binary Input with Maximized Robustness against Electrical Disturbances and Failures (IO216)

Rated voltage range	DC 220 V The special binary inputs of the SIPROTEC 5 with maximized robustness against electrical disturbances and failures are bipolar and available only on the module IO216.	
Input impedance	50 kΩ to 60 kΩ	
Rejection pulse charge	> 200 μC	
Current consumption, excited	Approx. DC 1.2 mA to 2.0 mA (additionally to the current consumption of the input impedance)	
Power consumption, max.	1.5 W at DC 242 V	
Pickup time	Approx. 3 ms	
Dropout time ²³	Capacitive load (supply-line capacitance)	Dropout time
	< 5 nF	< 3 ms
	< 10 nF	< 4 ms
	< 50 nF	< 5 ms
	< 220 nF	< 10 ms
Control voltage for the module IO216	Range for 220 V control voltage	
	Threshold pickup	158 V to 170 V
	Threshold dropout	132 V to 154 V
Maximum permitted voltage	DC 300 V	
The binary inputs contain interference suppression capacitors. To ensure EMC immunity, use the terminals shown in the terminal diagrams/connection diagrams to connect the binary inputs to the common potential.		

9.1.4 Relay outputs

Standard Relay (Type S)

Rated voltage (AC and DC)	250 V
Rated current (continuous) and total permissible current for contacts connected to common potential	5 A

²³ For time-critical applications with low-active signals, consider the specified dropout times. If necessary, provide for active discharge of the binary input (for example, a resistor in parallel to the binary input or using a change-over contact).

Permissible current per contact (switching on and holding)	30 A for 1 s (make contact only)
Short-time current across closed contact	250 A for 30 ms
Breaking capacity	Max. 30 W (L/R = 40 ms) Max. 360 VA (power factor ≥ 0.35 , 50 Hz to 60 Hz)
Switching time OOT (Output Operating Time) Additional delay of the output medium used	Make time: typical: 8 ms; maximum: 10 ms Break time: typical: 2 ms; maximum: 5 ms
Max. rated data of the output contacts in accordance with UL certification	DC 24 V, 5 A, general purpose DC 48 V, 0.8 A, general purpose DC 240 V, 0.1 A, general purpose AC 240 V, 5 A, general purpose AC 120 V, 1/6 hp AC 250 V, 1/2 hp B300 R300
Interference suppression capacitors across the contacts	4.7 nF, $\pm 20\%$, AC 250 V
Safety/monitoring	2-channel activation

Fast Relay (Type F)

Rated voltage (AC and DC)	250 V
Rated current (continuous) and total permissible current for contacts connected to common potential	5 A
Permissible current per contact (switching on and holding)	30 A for 1 s (make contact only)
Short-time current across closed contact	250 A for 30 ms
Breaking capacity	Max. 30 W (L/R = 40 ms) Max. 360 VA (power factor ≥ 0.35 , 50 Hz to 60 Hz)
Switching time OOT (Output Operating Time) Additional delay of the output medium used	Make time: typical: 4 ms; maximum: 5 ms Break time: typical: 2 ms; maximum: 5 ms
Max. rated data of the output contacts in accordance with UL certification	AC 120 V, 5 A, general purpose AC 250 V, 5 A, general purpose AC 250 V, 1/2 hp B300 R300
Interference suppression capacitors across the contacts	4.7 nF, $\pm 20\%$, AC 250 V
Safety/monitoring	2-channel activation with cyclic testing (make contact only)

High-Speed Relay with Semiconductor Acceleration (Type HS)

Rated voltage	AC 200 V, DC 250 V
Rated current (continuous)	5 A (in accordance with UL approval) 10 A (not UL approved; AWG 14 / 2.5 mm ² copper conductors necessary)
Permissible current per contact (switching on and holding)	30 A for 1 s
Short-time current across closed contact	250 A for 30 ms
Breaking capacity	Max. 2500 W (L/R = 40 ms)

Switching time OOT (Output Operating Time)	Make time: typical: 0.2 ms; maximum: 0.2 ms
Additional delay of the output medium used	Break time: typical: 9 ms; maximum: 9 ms
Max. rated data of the output contacts in accordance with UL certification	B150 Q300
Interference suppression capacitors across the contacts	4.7 nF, $\pm 20\%$, AC 250 V
Safety/monitoring	2-channel activation

Power Relay (for Direct Control of Motor Switches)

Rated voltage (AC and DC)	250 V
Rated current (continuous) and total permissible current for contacts connected to common potential	5 A
Switching power for permanent and periodic operation In order to prevent any damage, the external protection circuit must switch off the motor in case the rotor is blocked.	250 V/4.0 A 220 V/4.5 A 110 V/5.0 A 60 V/5.0 A 48 V/5.0 A 24 V/5.0 A
Turn on switching power for 30 s, recovery time until switching on again is 15 minutes. For short-term switching operations, an impulse/pause ratio of 3 % must be considered. In order to prevent any damage, the external protection circuit must switch off the motor in case the rotor is blocked.	100 V/9.0 A 60 V/10.0 A 48 V/10.0 A 24 V/10.0 A
Permissible current per contact (switching on and holding)	30 A for 1 s
Short-time current across closed contact	250 A for 30 ms
Switching time OOT (Output Operating Time) Additional delay of the output medium used	≤ 16 ms
Max. rated data of the output contacts in accordance with UL certification	DC 300 V, 4.5 A – 30 s ON, 15 min OFF DC 250 V, 1 hp Motor – 30 s ON, 15 min OFF DC 110 V, 3/4 hp Motor – 30 s ON, 15 min OFF DC 60 V, 10 A, 1/2 hp Motor – 30 s ON, 15 min OFF DC 48 V, 10 A, 1/3 hp Motor – 30 s ON, 15 min OFF DC 24 V, 10 A, 1/6 hp Motor – 30 s ON, 15 min OFF
Interference suppression capacitors across the contacts	4.7 nF, $\pm 20\%$, AC 250 V
Safety/monitoring	2-channel activation
The power relays operate in interlocked mode, that is, only one relay of each switching pair picks up at a time thereby avoiding a power-supply short circuit.	

9.1.5 Design Data

Masses

	Device Size Weight of the Modular Devices				
Type of construction	1/3	1/2	2/3	5/6	1/1
Flush-mounting device	4.4 kg	7.2 kg	9.9 kg	12.7 kg	15.5 kg

	Device Size Weight of the Modular Devices				
Surface-mounted device with integrated on-site operation panel	7.4 kg	11.7 kg	15.9 kg	20.2 kg	24.5 kg
Surface-mounted device with detached on-site operation panel	4.7 kg	7.8 kg	10.8 kg	13.9 kg	17.0 kg

Devices with IO240 weigh 0.9 kg more.

	Size	Weight
Detached on-site operation panel	1/3	1.9 kg
Detached on-site operation panel	1/6	1.1 kg

	Device Size Weight of the Non-Modular Devices 7xx81, 7xx82
Type of construction	1/3
Flush-mounting device	3.6 kg
Bracket for non-modular surface-mounting version	1.9 kg

Dimensions of the Base and Expansion Modules

Type of Construction		Max. Total Width x Max. Total Height x Max. Total Depth ²⁴ , Each Rounded up to the Next Full mm (in Inches)
Flush-mounting device	Base module	150 mm x 266 mm x 231 mm (5.91 x 10.47 x 9.09)
	Base module with IO240	150 mm x 266 mm x 277 mm (5.91 x 10.47 x 10.91)
	Base module with IO111	150 mm x 266 mm x 243 mm (5.91 x 10.47 x 9.57)
	Expansion module	75 mm x 266 mm x 231 mm (2.95 x 10.47 x 9.09)
	Expansion module with IO240, IO218	75 mm x 266 mm x 277 mm (2.95 x 10.47 x 10.91)
	Expansion module with IO111	75 mm x 266 mm x 243 mm (2.95 x 10.47 x 9.57)
Surface-mounted device with integrated on-site operation panel	Base module	150 mm x 315 mm x 341 mm (5.91 x 12.4 x 13.43)
	Expansion module	75 mm x 315 mm x 341 mm (2.95 x 12.4 x 13.43)

²⁴ Including current terminal, excluding USB port cover

Type of Construction		Max. Total Width x Max. Total Height x Max. Total Depth ²⁴ , Each Rounded up to the Next Full mm (in Inches)
Surface-mounted device with detached on-site operation panel	Base module	150 mm x 315 mm x 231 mm (5.91 x 12.4 x 9.09)
	Base module with IO240	150 mm x 315 mm x 277 mm (5.91 x 12.4 x 10.91)
	Base module with IO111	150 mm x 315 mm x 243 mm (5.91 x 12.4 x 9.57)
	Expansion module	75 mm x 315 mm x 231 mm (2.95 x 12.4 x 9.09)
	Expansion module with IO240, IO218	75 mm x 315 mm x 277 mm (2.95 x 12.4 x 10.91)
	Expansion module with IO111	75 mm x 315 mm x 243 mm (2.95 x 12.4 x 9.57)

Dimensions of the Device Rows

Type of Construction	Max. Total Width x Max. Total Height x Max. Total Depth ²⁵ , Rounded to full mm (in Inches)				
Device width	1/3	1/2	2/3	5/6	1/1
Flush-mounting device	150 mm x 266 mm x 231 mm (5.91 x 10.47 x 9.09)	225 mm x 266 mm x 231 mm (8.86 x 10.47 x 9.09)	300 mm x 266 mm x 231 mm (11.81 x 10.47 x 9.09)	375 mm x 266 mm x 231 mm (14.76 x 10.47 x 9.09)	450 mm x 266 mm x 231 mm (17.72 x 10.47 x 9.09)
Flush-mounting device with IO240, IO218	150 mm x 266 mm x 277 mm (5.91 x 10.47 x 10.91)	225 mm x 266 mm x 277 mm (8.86 x 10.47 x 10.91)	300 mm x 266 mm x 277 mm (11.81 x 10.47 x 10.91)	375 mm x 266 mm x 277 mm (14.76 x 10.47 x 10.91)	450 mm x 266 mm x 277 mm (17.72 x 10.47 x 10.91)
Flush-mounting device with IO111	150 mm x 266 mm x 243 mm (5.91 x 10.47 x 9.57)	225 mm x 266 mm x 243 mm (8.86 x 10.47 x 9.57)	300 mm x 266 mm x 243 mm (11.81 x 10.47 x 9.57)	375 mm x 266 mm x 243 mm (14.76 x 10.47 x 9.57)	450 mm x 266 mm x 243 mm (17.72 x 10.47 x 9.57)
Surface-mounted device with integrated on-site operation panel	150 mm x 315 mm x 341 mm (5.91 x 12.4 x 13.43)	225 mm x 315 mm x 343 mm ²⁶ (8.86 x 12.4 x 13.43)	300 mm x 315 mm x 343 mm ²⁶ (11.81 x 12.4 x 13.43)	375 mm x 315 mm x 343 mm ²⁶ (14.76 x 12.4 x 13.43)	450 mm x 315 mm x 343 mm ²⁶ (17.72 x 12.4 x 13.43)
Surface-mounted device with detached on-site operation panel	150 mm x 315 mm x 231 mm (5.91 x 12.4 x 9.09)	225 mm x 315 mm x 231 mm (8.86 x 12.4 x 9.09)	300 mm x 315 mm x 231 mm (11.81 x 12.4 x 9.09)	375 mm x 315 mm x 231 mm (14.76 x 12.4 x 9.09)	450 mm x 315 mm x 231 mm (17.72 x 12.4 x 9.09)

²⁴ Including current terminal, excluding USB port cover

²⁵ Including current terminal, excluding USB port cover

²⁶ Including connecting rail

Type of Construction	Max. Total Width x Max. Total Height x Max. Total Depth ²⁵ , Rounded to full mm (in Inches)				
Surface-mounted device with detached on-site operation panel with IO240, IO218	150 mm x 315 mm x 277 mm (5.91 x 12.4 x 10.91)	225 mm x 315 mm x 277 mm (8.86 x 12.4 x 10.91)	300 mm x 315 mm x 277 mm (11.81 x 12.4 x 10.91)	375 mm x 315 mm x 277 mm (14.76 x 12.4 x 10.91)	450 mm x 315 mm x 277 mm (17.72 x 12.4 x 10.91)
Surface-mounted device with detached on-site operation panel with IO111	150 mm x 315 mm x 243 mm (5.91 x 12.4 x 9.57)	225 mm x 315 mm x 243 mm (8.86 x 12.4 x 9.57)	300 mm x 315 mm x 243 mm (11.81 x 12.4 x 9.57)	375 mm x 315 mm x 243 mm (14.76 x 12.4 x 9.57)	450 mm x 315 mm x 243 mm (17.72 x 12.4 x 9.57)

Plug-In Module Dimensions

Type of Construction	Max. Width x Max. Height x Max. Depth (in Inches)
USART-Ax-xEL, ETH-Bx-xEL	61 mm x 45 mm x 121 mm (2.4 x 1.77 x 4.76)
USART-Ax-xFO, ETH-Bx-xFO (without protective cover)	61 mm x 45 mm x 133 mm (2.4 x 1.77 x 5.24)
ANAI-CA-4EL, ANAI-CE-2EL	61 mm x 45 mm x 120 mm (2.4 x 1.77 x 4.72)
ARC-CD-3FO	61 mm x 45 mm x 121 mm (2.4 x 1.77 x 4.76)

Minimum Bending Radii of the Connecting Cables Between the On-Site Operation Panel and the Base Module

Fiber-optic cable	R = 50 mm Pay attention to the length of the cable protection sleeve, which you must also include in calculations.
D-Sub cable	R = 50 mm (minimum bending radius)

Degree of Protection According to IEC 60529

For equipment in the surface-mounting housing	IP54 ²⁷ for front
For equipment in the flush-mounting housing	IP54 ²⁷ for front
For operator protection (back side)	IP2x for current terminal (installed) IP2x for voltage terminal (installed)
Degree of pollution, IEC 60255-27	2
Maximum operating altitude above sea level	2000 m (6561.68 ft)

UL Note

Type 1 if mounted into a door or front cover of an enclosure.
When expanding the device with the 2nd device row, then they must be mounted completely inside an enclosure.

²⁵ Including current terminal, excluding USB port cover

²⁷ The supplied plug-in strips must be used for expansion modules with LEDs.

Tightening Torques for Terminal Screws

Type of Line	Current Terminal	Voltage Terminal with Spring-Loaded Terminals	Voltage Terminal with Screw Connection
Stranded wires with ring-type lug	2.7 Nm	No ring-type lug	No ring-type lug
Stranded wires with boot-lace ferrules or pin-type lugs	2.7 Nm	1.0 Nm	0.6 Nm
Solid conductor, bare (2 mm ²)	2.0 Nm	1.0 Nm	–
Blank stranded wire	Not permitted	1 Nm	0.6 Nm



NOTE

For current and voltage terminals, the maximum speed of the tool must not exceed 640 rpm.



NOTE

Use copper cables only.

Torques for Other Screw Types

Screw Type	Torque
M4 x 20	1.2 Nm
M4 x 8	1.2 Nm
M2.5 x 6	0.39 Nm
Countersunk screw, M2.5 x 6	0.39 Nm
Countersunk screw, M2.5 x 8	0.39 Nm
Collar screw, M4 x 20	0.7 Nm

9.2 Protection Interface and Protection Topology

Setting Values

Mode	On Off	
Synchronization	External synchron. off Telegr. and ext. synch. Telegr. or ext. synch. External synch. only	
Blocking of the unbalanced runtimes	Yes No	
Maximum signal runtime threshold	0.1 ms to 30.0 ms	Increments of 0.1 ms
Maximum runtime difference	0.000 ms to 3.000 ms	Increments of 0.001 ms
Fault indication after	0.05 s to 2.00 s	Increments of 0.01 s
Transm. fail. alarm after	0.0 s to 6.0 s	Increments of 0.1 s
Max. error rate/h	0.000 % to 100.000 %	Increments of 0.001 %
Max. error rate/min	0.000 % to 100.000 %	Increments of 0.001 %

Transmission Rate

Direct connection:	
Transmission rate	2048 kbit/s
Connection via communication networks:	
Supported network interfaces	IP protection communication
	C37.94 at 64 kBit/s or 128 kBit/s or 512 kBit/s
	G703.1 at 64 kBit/s
	G703-T1 at 1.455 MBit/s
	G703-E1 at 2.048 MBit/s
	X.21 at 64 kBit/s or 128 kBit/s or 512 kBit/s
Transmission rate	Pilot wires at 128 kbit/s
	Transmission rate 64 kBit/s at G703.1
	1.455 MBit/s at G703-T1
	2.048 MBit/s at G703-E1
	512 kBit/s or 128 kBit/s or 64 kBit/s at X.21
	128 kBit/s for pilot wires

Transmission Times for Remote Data

Measured with a minimum of 512 kbit/s

Priority 1:		
Response time, total approx.		
For 2 ends	Minimum	3 ms + OOT ²⁸
	Typical	5 ms + OOT
For 3 ends	Minimum	5 ms + OOT
	Typical	9 ms + OOT
For 6 ends	Minimum	10 ms + OOT
	Typical	13 ms + OOT

²⁸ OOT (Output Operating Time): Additional delay of the output medium used, for example, 1 ms with electronic relays

Dropout times, total approx.		
For 2 ends	Typical	15 ms + OOT
For 3 ends	Typical	15 ms + OOT
For 6 ends	Typical	21 ms + OOT

Priority 2		
Response time, total approx.		
For 2 ends	Minimum	4 ms + OOT
	Typical	11 ms + OOT
For 3 ends	Minimum	7 ms + OOT
	Typical	13 ms + OOT
For 6 ends	Minimum	12 ms + OOT
	Typical	18 ms + OOT
Dropout times, total approx.		
For 2 ends	Typical	19 ms + OOT
For 3 ends	Typical	20 ms + OOT
For 6 ends	Typical	27 ms + OOT

Priority 3²⁹		
Response time, total approx.		
For 2 ends	Minimum	
	Typical	95 ms + OOT
For 3 ends	Minimum	
	Typical	145 ms + OOT
For 6 ends	Minimum	
	Typical	195 ms + OOT
Dropout times, total approx.		
For 2 ends	Typical	95 ms + OOT
For 3 ends	Typical	145 ms + OOT
For 6 ends	Typical	195 ms + OOT

²⁹ Times cannot be determined because the signals are transmitted in fragments.

9.3 Trend Recorder

Setting Values

Trend Recorder	Setting Range	Increment
Memory capacity	2 MB to 25 MB	Increments of 1

Number of Recorder Instances

Trend recorder	0 to 2

9.4 Date and Time Synchronization

Date format	DD.MM.YYYY (Europe)
	MM/DD/YYYY (USA)
	YYYY-MM-DD (China)
Time source 1, Time source 2	None IRIG B 002(003) IRIG B 006(007) IRIG B 005(004) with extension according to IEEE C37.118-2005 DCF77 PI (protection interface) ³⁰ SNTP IEC 60870-5-103 DNP3 IEEE 1588 T104
Time zone 1, time zone 2	Local
	UTC
Fault indication after	0 s to 3600 s
Time zone and daylight saving time	Manually setting the time zones
Time zone offset with respect to GMT	-720 min to 840 min
Switching over to daylight saving time	Active
	Inactive
Beginning of daylight saving time	Input: day and time
End of daylight saving time	Input: day and time
Offset daylight saving time	0 min to 120 min [15 min. steps]

³⁰ if provided

9.5 Function Group Analog Units

20-mA Inputs, Ethernet Interface 7XV5674-0KK00-1AA1

Max. number of connected 20-mA units	4
Max. number of channels per 20-mA unit	12

20-mA Unit Serial 7XV5674-0KK30-1AA1 (RS485) and 7XV5674-0KK40-1AA1 (Fiberglass)

Max. number of connected 20-mA units	4
Max. number of channels per 20-mA unit	12

RTD Unit (Ziehl TR1200) 7XV5662-6AD10

Max. number of connected RTD units	4
Max. number of sensors per RTD unit	12
Sensor type	Pt 100 to EN 60751; connection of Ni 100 and Ni 120 sensors possible. The measured values must be converted in the evaluation unit.

Temperature Measured Values

Unit of measurement for temperature	°C or °F, adjustable
Pt 100	-199 °C to 800 °C (-326 °F to 1472 °F)
Ni 100	-54 °C to 278 °C (-65 °F to 532 °F)
Ni 120	-52 °C to 263 °C (-62 °F to 505 °F)
Resolution	1 °C or 1 °F
Tolerance	±0.5 % of the measured value ±1 °C (±0.56 °F)

9.6 Disconnecter Supervision

Setting Values

Threshold value	Mechanical switching time open	0.02 s to 1800.00 s	Increments of 0.01 s
	Mechanical switching time close	0.02 s to 1800.00 s	Increments of 0.01 s
Auxiliary contact time		0.02 s to 1800.00 s	Increments of 0.01 s
Reaction time		0.02 s to 1800.00 s	Increments of 0.01 s

Tolerances

Tolerance of the make-time measured value	±2 ms
Tolerance of the break-time measured value	±2 ms
Tolerance of the reaction-time measured value	±2 ms

9.7 Statistical Values

Statistical Values of the Device

Device operating hours	h
Range	0 h to 99999999 h
Tolerance	1 h

Statistical Values, Circuit Breaker

Op.cnt. (operation counter)	
Range	0 to 999999999
Tolerance	None
ΣI Off (sum of the primary currents switched off)	A, kA, MA, GA, TA, PA primary
Range	0 to 9.2^{e+15}
Operating hours	h
Range	0 h to 99999999 h
Tolerance	1 h
Circuit breaker open hours	h
Range	0 h to 99999999 h
Tolerance	1 h

Statistical Values, Disconnecter

Op.cnt. (operation counter)	
Range	0 to 999999999
Tolerance	None

9.8 CFC

In order to estimate the tick consumption of a CFC chart, you can use the following formula:

$$T_{\text{Chart}} = 5 \cdot n_{\text{Inp}} + 5 \cdot n_{\text{Outp}} + T_{\text{TLv}} + \sum_i T_{\text{int}} + \sum_j T_{\text{Block}}$$

Where:

- n_{Inp} Number of indications routed as input in the CFC chart
- n_{Outp} Number of indications routed as output in the CFC chart
- T_{TLv} 101 Ticks in the High priority Event-triggered level
104 Ticks in the Event-triggered level
54 Ticks in Measurement level
74 Ticks in the Low priority Event-triggered level
- T_{int} Number of internal connections between 2 CFC blocks in one chart
- T_{Block} Used ticks per CFC block (see [Table 9-1](#))

Table 9-1 Ticks of the Individual CFC Blocks

Element	Ticks
ABS_D	2.3
ABS_R	1.5
ACOS_R	6.9
ADD_D4	3.4
ADD_R4	3.3
ADD_XMV	6.4
ALARM	1.8
AND_SPS	1.1
AND10	2.9
APC_DEF	1.2
APC_EXE	1.0
APC_INFO	3.9
ASIN_R	1.3
ATAN_R	1.2
BLINK	1.3
BOOL_CNT	2.0
BOOL_INT	1.5
BSC_DEF	1.3
BSC_EXE	1.1
BSC_INFO	2.7
BUILD_ACD	2.9
BUILD_ACT	2.2
BUILD_BSC	1.2
BUILD_CMV	2.3
BUILD_DEL	2.1
BUILD_DPS	1.4
BUILD_ENS	1.3
BUILD_INS	0.5
BUILD_Q	0.8
BUILD_SPS	0.6

Element	Ticks
BUILD_WYE	3.2
BUILD_XMV	2.9
BUILDQ_Q	3.0
CHART_STATE	5.9
CMP_DPS	1.5
CON_ACD	0.7
CON_ACT	0.5
CONNECT	0.4
COS_R	2.5
CTD	1.8
CTU	1.6
CTUD	2.3
DINT_REAL	3.0
DINT_UINT	3.0
DIV_D	2.9
DIV_R	1.6
DIV_XMV	2.2
DPC_DEF	0.4
DPC_EXE	0.4
DPC_INFO	1.1
DPC_OUT	1.3
DPS_SPS	1.0
DRAGI_R	1.7
ENC_DEF	3.6
ENC_EXE	3.8
EQ_D	1.0
EQ_R	1.9
EXP_R	1.5
EXPT_R	2.7
F_TRGM	0.3
F_TRIG	0.3
FF_D	0.9
FF_D_MEM	1.4
FF_RS	0.7
FF_RS_MEM	1.2
FF_SR	0.8
FF_SR_MEM	1.1
GE_D	0.9
GE_R	1.1
GT_D	0.9
GT_R	1.2
HOLD_D	1.1
HOLD_R	1.0
INC_INFO	0.9
LE_D	1.1
LE_R	1.1
LIML_R	1.5

Element	Ticks
LIMU_R	1.5
LN_R	3.3
LOG_R	1.2
LOOP	1.5
LT_D	0.9
LT_R	0.9
MAX_D	0.9
MAX_R	1.4
MEMORY_D	0.9
MEMORY_R	1.1
MIN_D	0.7
MIN_R	1.3
MOD_D	1.5
MUL_D4	2.5
MUL_R4	2.7
MUL_XMV	2.8
MUX_D	1.2
MUX_R	0.9
NAND10	3.5
NE_D	0.9
NE_R	0.9
NEG	1.2
NEG_SPS	0.8
NL_LZ	3.8
NL_MV	5.6
NL_ZP	2.7
NOR10	3.2
OR_DYN	1.1
OR_SPS	1.3
OR10	2.6
R_TRGM	0.4
R_TRIG	0.4
REAL_DINT	3.0
REAL_SXMV	3.0
SIN_R	0.8
SPC_DEF	0.4
SPC_EXE	0.4
SPC_INFO	0.4
SPC_OUT	0.4
SPLIT_ACD	3.4
SPLIT_ACT	1.0
SPLIT_BSC	1.3
SPLIT_CMV	2.2
SPLIT_DEL	2.0
SPLIT_DPS	1.0
SPLIT_INS	0.5
SPLIT_Q	0.7

Element	Ticks
SPLIT_SPS	0.8
SPLIT_WYE	2.6
SPLIT_XMV	2.1
SQRT_R	0.6
SUB_D	1.3
SUB_R	1.6
SUB_XMV	2.4
SUBST_B	1.0
SUBST_BQ	1.5
SUBST_D	1.0
SUBST_R	1.0
SUBST_XQ	1.4
SXMV_REAL	3.0
TAN_R	1.1
TLONG	2.2
TOF	1.0
TON	1.1
TP	2.5
TSHORT	1.9
UINT_DINT	3.0
XOR2	2.6

A Appendix

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A.3	Typographic and Symbol Conventions	425
A.4	Standard Variants for 6MD84	428

A.1 Order Configurator and Order Options

Order Configurator

The order configurator assists you in the selection of SIPROTEC 5 products. The order configurator is a Web application that can be used with any browser. The order configurator can be used to configure complete devices or individual components, such as communication modules, expansion modules, or other accessories. At the end of the configuration process, the product code and a detailed presentation of the configuration result are provided. The product code unambiguously describes the selected product and also serves as an order number.

Ordering Options

The following ordering options are possible for SIPROTEC 5 products:

- Device
- Single part
- DIGSI 5
- Functional enhancement



NOTE

To order single parts in the order configurator, use the **Single part** link.

Individual parts are:

- Expansion module
- Plug-in module
- Sensors for arc protection
- Operation panel
- Terminal
- Accessories

A.2 Ordering Accessories



NOTE

To order terminals, terminal accessories, and mechanical accessories in the order configurator, use the **Single part** link.

Table A-1 Accessories

Group	Accessories
Terminal	Voltage terminal, terminal block, 14-pole
Terminal	Voltage terminal (power supply) Terminal block, 2-pole ³¹
Terminal	Type A current terminal, 4 x protection (for modular devices)
Terminal	Type A current terminal, 3 x protection and 1 x measurement (for modular devices)
Terminal	Type A current terminal, 4 x measurement (for modular devices)
Terminal	Type B current terminal, 4 x protection (for non-modular devices)
Terminal	Type B current terminal, 3 x protection and 1 x measurement (for non-modular devices)
Terminal	2-pole cross connector for current terminal
Terminal	Terminals for IO110, IO112, IO113 ³¹
Terminal	Terminals and shielding for IO111 ^{31, 32, 33}
Terminal	Terminal set only for IO23x ³¹
Terminal	2-pole cross connector for voltage terminal
Terminal	Cover for current terminal block
Terminal	Cover for voltage terminal block
Terminal	Transport safety, current terminal
Terminal	Transport safety, voltage terminal
Terminal	Terminal set for direct connection to 400 V low voltage
Accessories	USB covers (10 each for CP 100, 150, 200, 300)
Accessories	Cable, integrated operation panel, 0.43 m
Accessories	Cable, detached operation panel, 2.50 m
Accessories	Cable, detached operation panel, 5.00 m
Accessories	Cable set, COM link cable
Accessories	Cover plate for plug-in modules
Accessories	Cover panel 1/6, 5 pcs
Accessories	Set of angle rails
Accessories	10 x labeling strip, LEDs/function keys
Accessories	5 x labeling strips, push-buttons
Accessories	Set of parts, mounting bracket 1/2
Accessories	Set of parts, mounting bracket 2/3

³¹ Recommended tightening torque when screwing down the terminal on the rear plate: 0.3 Nm

³² The set consists of terminals and shielding for the IO111 for the terminal positions M and N.

³³ Only for non-modular devices 7xx82

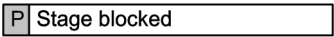
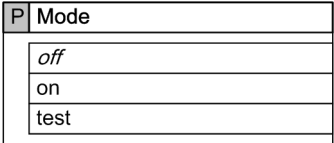
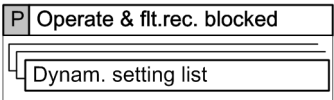
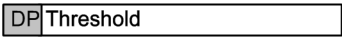
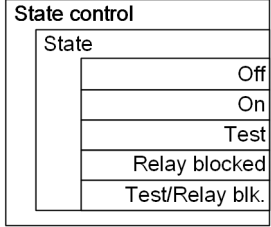
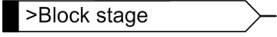
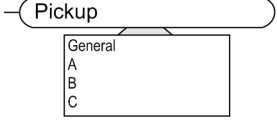
Group	Accessories
Accessories	Set of parts, mounting bracket 5/6
Accessories	Set of parts, mounting bracket 1/1
Accessories	4 x screw cover 1/3, type C11
Accessories	4 x screw cover 1/3, type C22
Accessories	4 x screw cover 1/6, type C21
Accessories	2 x bus termination plate
Accessories	Assembly frame for panel surface mounting for non-modular devices 7xx81 and 7xx82 devices
Accessories	SDHC memory card for 7KE85
Accessories	10 x battery holder
Accessories	Connecting cable for 2nd row
Accessories	DIGSI 5 USB cable 2.0
Accessories	SFP RJ45, 10 units
Accessories	SFP Single-mode, 24 km, 10 units
Sensors for arc protection	Point sensor with line length of 3 m
Sensors for arc protection	Point sensor with line length of 4 m
Sensors for arc protection	Point sensor with line length of 5 m
Sensors for arc protection	Point sensor with line length of 7 m
Sensors for arc protection	Point sensor with line length of 10 m
Sensors for arc protection	Point sensor with line length of 15 m
Sensors for arc protection	Point sensor with line length of 20 m
Sensors for arc protection	Point sensor with line length of 35 m
Sensors for arc protection	Line sensor, length 3 m
Sensors for arc protection	Line sensor, length 10 m
Sensors for arc protection	Line sensor, length 20 m
Sensors for arc protection	Line sensor, length 30 m
Sensors for arc protection	Line sensor, length 40 m
Sensors for arc protection	Supply line for line sensors, length 3 m
Sensors for arc protection	Supply line for line sensors, length 5 m
Sensors for arc protection	Supply line for line sensors, length 10 m

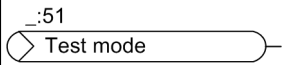
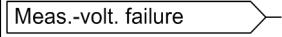
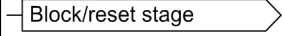
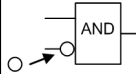
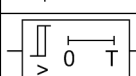
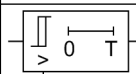
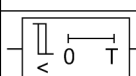
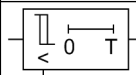
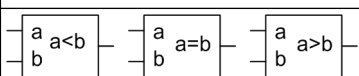
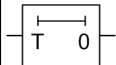
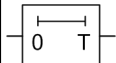
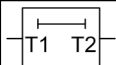
A.3 Typographic and Symbol Conventions

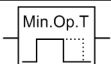
The following typefaces are used to characterize parameters in the text:

Mode	Parameter name
<code>_:661:1</code>	Parameter address _ stands for the address combination from function group:function 661, for example, stands for the address of the setting parameter
<i>off</i>	Parameter state

The following symbols are used in drawings:

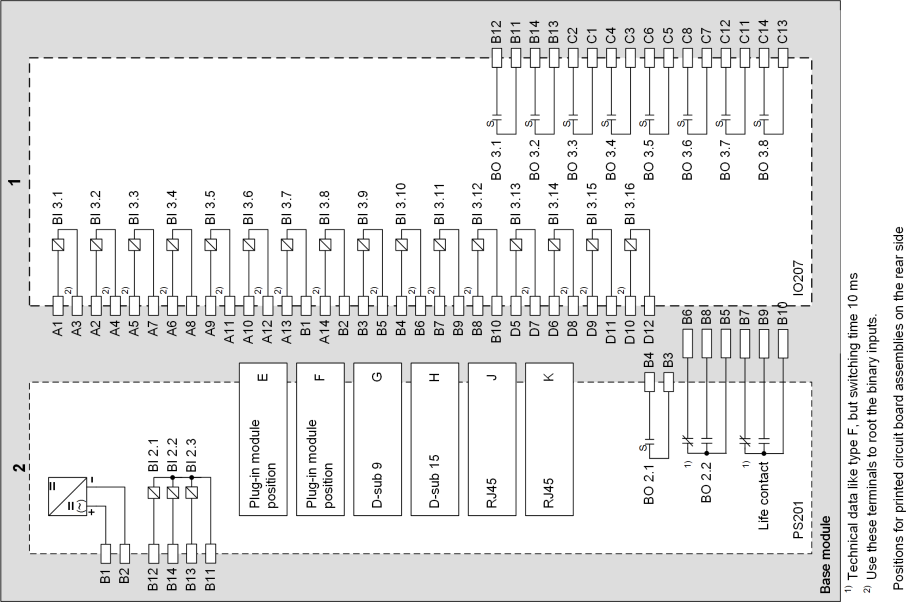
Icon	Description
	Parameter
	Parameters with setting values The default setting is in the 1st position and is displayed in italics.
	Parameters with application-dependent setting values
	Dynamic settings:
	State logic
	Health of a function, stage, or function block
	External binary input signal with indication number
	External output signal with indication number and additional information
	External output signal without indication number
	Measured output value

Icon	Description
	Binary input signal derived from an external output signal
	Internal input signal
	Internal output signal
	Analog input signal
	Reset/block a logic element
	AND gate
	OR gate
	XOR gate
	Negation
	Threshold stage exceeded
	Threshold stage exceeded with reset of input
	Threshold stage shortfall
	Threshold stage shortfall with reset of input
	Threshold stage exceeded with dropout delay
	Threshold stage exceeded with dropout delay and reset of input
	Threshold stage shortfall with dropout delay
	Threshold stage shortfall with dropout delay and reset of input
	Comparators
	Pickup delay
	Dropout delay
	Pickup and dropout delay

Icon	Description
	Trigger the pulse of duration T with a positive signal edge
	Trigger the pulse of duration T with a negative signal edge
	SR-flip-flop, RS-flip-flop, D-flip-flop
	Characteristic curve
	Minimum operate time

A.4 Standard Variants for 6MD84

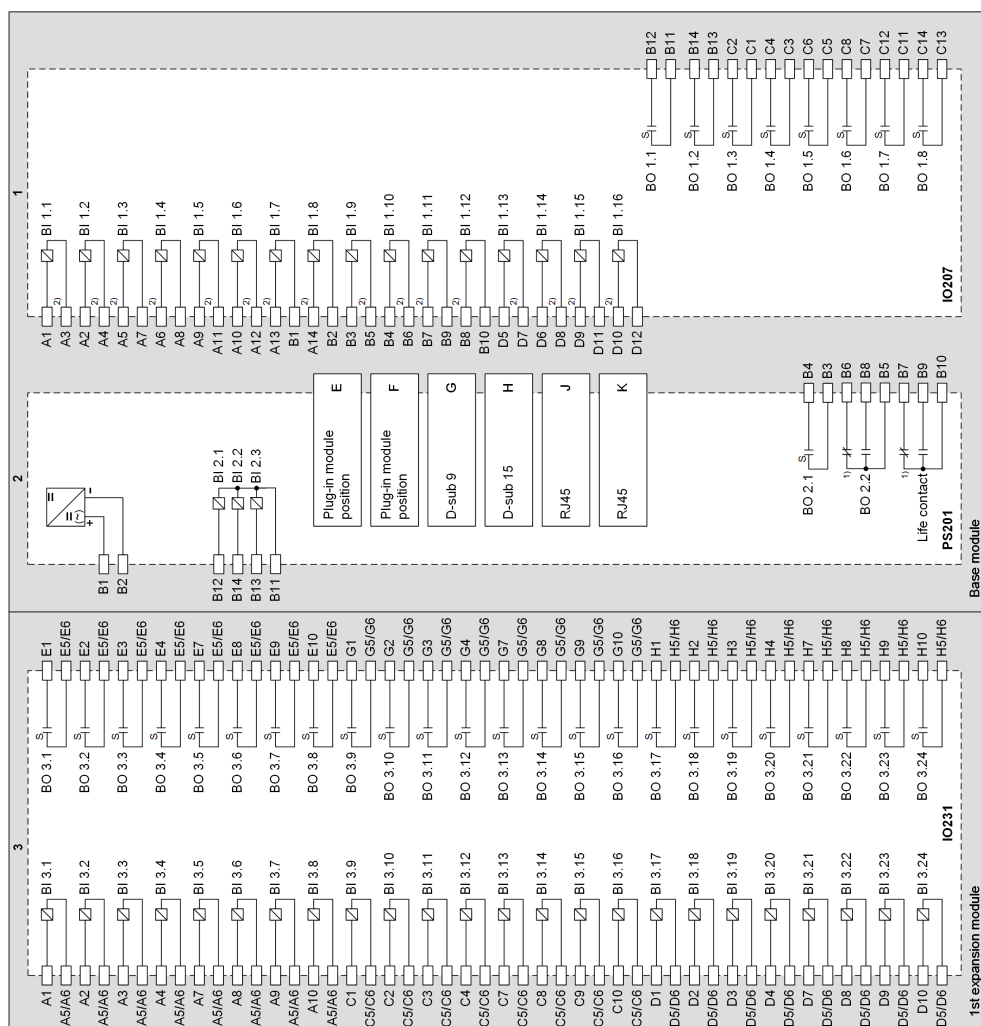
Type1



[sv84Typ-220913-01, 1, en_US]

Figure A-1 Standard Variant Type 1

Type2



¹⁾ Technical data like type F, but switching time 10 ms

²⁾ Use these terminals to root the binary inputs.

Positions for printed circuit board assemblies on the rear side

Figure A-2 Standard Variant Type 2

Literature

- /1/ Distance Protection, Line Differential Protection, and Overcurrent Protection for 3-Pole Tripping – 7SA82, 7SD82, 7SL82, 7SA84, 7SD84, 7SA86, 7SD86, 7SL86, 7SJ86
C53000-G5040-C010
- /2/ Distance and Line Differential Protection, Breaker Management for 1-Pole and 3-Pole Tripping – 7SA87, 7SD87, 7SL87, 7VK87
C53000-G5040-C011
- /3/ Overcurrent Protection – 7SJ82/7SJ85
C53000-G5040-C017
- /4/ Overcurrent Protection – 7SJ81
C53000-G5040-C079
- /5/ Motor Protection – 7SK82/85
C53000-G5040-C024
- /6/ Transformer Differential Protection – 7UT82, 7UT85, 7UT86, 7UT87
C53000-G5040-C016
- /7/ Generator Protection – 7UM85
C53000-G5040-C027
- /8/ Busbar Protection 7SS85
C53000-G5040-C019
- /9/ High-Voltage Bay Controller – 6MD85/86
C53000-G5040-C015
- /10/ Paralleling Device – 7VE85
C53000-G5040-C071
- /11/ Universal Protection – 7SX82/7SX85
C53000-G5040-C607
- /12/ Merging Unit 6MU85
C53000-G5040-C074
- /13/ Fault Recorder – 7KE85
C53000-G5040-C018
- /14/ Compact Class – 7SX800
C53000-G5040-C003
- /15/ Hardware Description
C53000-G5040-C002
- /16/ Communication Protocols
C53000-L1840-C055
- /17/ Process Bus
C53000-H3040-C054
- /18/ DIGSI 5 – Software Description
C53000-D5040-C001

- /19/ SIPROTEC 5 – Security
C53000-H5040-C081
- /20/ PIXIT, PICS, TICS, IEC 61850
C53000-G5040-C013
- /21/ Operation
C53000-G5040-C003
- /22/ Engineering Guide
C53000-G5040-C004
- /23/ High-Speed Busbar Transfer – 7VU85
C53000-G5040-C090

Glossary

ACD

IEC 61850 data type: Directional protection activation information

ACK

Data transfer acknowledgment

ACT

IEC 61850 data type: Protection activation information

Back-up battery

The back-up battery ensures that specified data areas, flags, times and counters are kept retentive.

Bay Controller

Bay controllers are devices with control and supervision functions and optional protection functions.

BCR

IEC 61850 data type: Binary counter reading - dual meter registration

Bit Pattern Indication

A bit pattern indication is a processing function, with the help of which adjacent numerical process information can be logged coherently and processed further in parallel via multiple inputs. The bit pattern length can be chosen from 1 to 6 bytes.

BRCB

See Buffered Report Control Block.

Buffered Report Control Block

Buffered Report Control Block (BRCB) is a form of report controlling. Internal events trigger the immediate sending of reports or saving of events for the transfer. Data values cannot therefore be lost on account of transport flow control conditions or connection interruptions. BRCB provides the functionality **SOE** (See Sequence of Events).

Chatter Blocking

A rapidly intermittent input (for example, owing to a relay contact fault) is disconnected after a parameterizable monitoring time and therefore cannot generate any more signal changes. The function prevents the system from overloading in the event of an error.

CID

See Configured IED Description

Combination Matrix

In an inter-device communication (IDC) group, up to 16 SIPROTEC devices suitable for this can communicate with one another. The combination matrix specifies which devices exchange which information.

Communication branch

A communication branch corresponds to the configuration of 1 to n participants communicating via a joint bus.

Configured IED Description

A Configured IED Description (CID) is a file for data exchange between the IED Configuration Tool and the IED itself.

Container

If an object contains other objects, this is referred to as a container. The object **Folder** for example is such a container.

Continuous Function Chart

The Continuous Function Chart (CFC) is a programming language. It is used for programmable logic controllers. The programming language Continuous Function Chart is not defined in the standard IEC 61131-3, but represents a current extension of IEC programming environments. CFC is a graphic programming language. Function blocks are linked to one another. This represents an essential difference from conventional programming languages, where sequences of commands are entered.

Control display

The control display becomes visible for devices with a large display after pressing the Control key. The diagram contains the switching devices to be controlled in the feeder. The control display serves for implementing switching operations. Specification of this diagram forms part of configuring.

CRC

Cyclic redundancy check - cyclic redundancy test

Data Type

The data type is a value set of a data object, together with the operations allowed on this value set. A data type contains a classification of a data element, such as the determination whether it consists of integers, letters, or similar.

Data unit

Information item with a joint transmission source. Abbreviation: DU = Data Unit

Data window

The right area of the project window visualizes the content of the area selected in the navigation window. The data window contains for example, indications or measured values of the information lists or the function selection for parameterization of the device.

DB

See Double Command.

DC

Double Command – See Double Command.

DCF77

The precise official time is determined in Germany by the Physikalisch-Technische Bundesanstalt PTB in Brunswick. The atomic clock unit of the PTB transmits this time via the long-wave time signal transmitter in Mainflingen near Frankfurt/Main. The emitted time signal can be received within a radius of approx. 1500 km from Frankfurt/Main.

DCP

See Discovery and Basic Configuration Protocol

DEL

Phase-to-phase measured values in a 3-phase system

Device Container

In the component view, all SIPROTEC devices are subordinate to an object of the device container type. This object is also a special object from the DIGSI-5 Manager. However, as there is no component view in the DIGSI 5 Manager, this object only becomes visible in conjunction with STEP 7.

DHCP

See Dynamic Host Configuration Protocol.

DIGSI

Configuration software for SIPROTEC

Discovery and Basic Configuration Protocol

The DCP protocol is used to detect devices without IP addresses and to assign addresses to these devices.

DM

See Double-Point Indication.

Double Command

Double commands (DC) are process outputs, which the on and off command can give separated on different binary outputs.

Double-point indication

Double-point indications (DI) are process indications which visualize 4 process states at 2 inputs: 3 defined states (for example, On/Off and disturbed position) and 1 undefined state (00).

DP

Double-Point Indication – See Double-Point Indication.

DPC

IEC 61850 data type: Double Point Control

DPS

IEC 61850 data type: Double-point status

Drag & Drop

Copying, moving and linking function, used in graphical user interfaces. The mouse is used to highlight and hold objects and then move them from one data area to another.

DU

See Data Unit

Dynamic Host Configuration Protocol

In order to configure PCs automatically, centralized and uniformly in a TCP/IP network, a dynamic assignment of IP addresses is used. DHCP is utilized. The system administrator determines how the IP addresses are to be assigned and specifies the time lapse over which they are assigned. DHCP is defined in the Internet standards RFC 2131 (03/97) and RFC 2241 (11/97).

EB

See Single Command

Electromagnetic Compatibility

Electromagnetic compatibility (EMC) means that an item of electric equipment functions without error in a specified environment. The environment is not influenced in any impermissible way here.

ENC

Enumerated Status Controllable

ENS

Enumerated Status

ESD Protection

The ESD protection is the entirety of all means and measures for the protection of electrostatic-sensitive devices.

Far End Fault Indication

Far End Fault Indication (FEFI) is a special setting of switches. It is always only possible to log a line interruption on the receive line. If a line interruption is detected, the link status of the line is changed. The status change leads to deletion of the MAC address assigned to the port in the switch. However, outage of the receive line from the aspect of the switch can only be detected in the receiver, that is, by the switch. The receiver then immediately blocks the transmit line and signals the connection failure to the other device. The FEFI setting in the switch triggers detection of the error on the receive line of the switch.

FEFI

See Far End Fault Indication.

FG

See Function Group

Fleeting Indication

Fleeting indications are single-point indications present for a very short time, in which only the coming of the process signal is logged and further processed time-correctly.

Floating

Floating means that a free potential not connected to ground is generated. Therefore no current flows through the body to ground in the event of touching.

Folder

This object type helps when structuring a project hierarchically.

Function group

Functions are brought together into function groups (FG). The assignment of functions to current and/or voltage transformers (assignment of functions to measuring points), the information exchange between the function groups via interfaces as well as the generation of group indications are important for this bringing together.

General interrogation

The state of all process inputs, of the status and of the error image are scanned on system startup. This information is used to update the system-side process image. Likewise, the current process state can be interrogated after data loss with a general interrogation (GI).

Generic Object-Oriented Substation Event

GOOSE. IEC 61850 protocol for communication between bay units.

GI

See General Interrogation

GIN

Generic Identification Number

GOOSE

See Generic Object-Oriented Substation Event.

Ground

The conductive ground whose electric potential can be set equal to 0 at every point. In the area of grounding conductors, the ground can have a potential diverging from 0. The term **reference ground** is also used for this situation.

Grounding

The grounding is the entirety of all means and measuring for grounding.

Hierarchy Level

In a structure with superordinate and subordinate objects, a hierarchy level is a level of equal-ranking objects.

High Availability Seamless Redundancy Protocol

Like PRP (Parallel Redundancy Protocol), HSR (High Availability Seamless Redundancy Protocol) is specified in IEC 62439-3. Both protocols offer redundancy without switching time.

The principal function can be found in the definition of PRP. With PRP, the same message is sent via 2 separated networks. In contrast to this, in the case of HSR the message is sent twice in the 2 directions of the ring. The recipient receives it correspondingly via 2 paths in the ring, takes the 1st message and discards the 2nd (see PRP).

Whereas NO messages are relayed in the end device in the case of PRP, a switch function is installed in the HSR node. Thus, the HSR node relays messages in the ring that are not directed at it.

In order to avoid circular messages in the ring, corresponding mechanisms are defined in the case of HSR.

SAN (Single Attached Node) end devices can only be connected with the aid of a REDBOX in the case of HSR. PRP systems and HSR systems can be coupled redundantly with 2 REDBOXES.

HSR

See High Availability Seamless Redundancy Protocol

ICD

See IED Capability Description.

IEC

See International Electrotechnical Commission

IEC address

A unique IEC address must be assigned to each SIPROTEC device within an IEC bus. A total of 254 IEC addresses per IEC bus are available.

IEC communication branch

Within an IEC communication branch, the participants communicate on the basis of the protocol IEC 60870-5-103 via an IEC bus.

IED Capability Description

Data exchange from the IED configuration software (DIGSI) to the system configurator. This file describes the performance properties of an IED.

Initialization string

An initialization string consists of a series of modem-specific commands. If the modem is initialized, these commands are transferred to the modem. The commands can force definite settings for the modem, for example.

Input Data/Input Direction

Data is sent from the protocol slave to the protocol master.

International Electrotechnical Commission

See IEC.

Internet protocol

An Internet protocol (IP) enables the connection of participants which are positioned in different networks.

IP

See Internet protocol

LAN

See Local Area Network.

Link Address

The link address indicates the address of a SIPROTEC device.

List view

The right area of the project window displays the names and symbols of the objects which are within a container selected in the tree view. As the visualization is in the form of a list, this area is also referred to as list view.

Local Area Network

A Local Area Network (LAN) is a regional, local PC network. The PCs are all equipped with a network interface card and work with one another via data exchange. The LAN requires an operating system on each PC and standardized data transport software. The operating systems can be different, as can the data transport

software, but both must support a common transmission protocol (= TCP/IP protocols), so that all PCs can exchange data with one another.

Management Information Base

A Management Information Base (MIB) is a database which continuously saves information and statistics concerning each device in a network. The performance of each device can be monitored with this information and statistics. In this way, it can also be ensured that all devices in the network function properly. MIBs are used with SNMP.

Manufacturing Message Specification

The Standard Manufacturing Message Specification (MMS) serves for data exchange. The standard is used for the transmission protocols IEC 61850 and IEC 60870-6 TASE.2.

MCB

Circuit Breaker

Metered Value

Metered values are a processing function, used to determine the total number of discrete similar events (counter pulses), for example, as integral over a time span. In the power supply utility field, electrical energy is often recorded as a metered value (energy import/delivery, energy transport).

MIB

See Management Information Base.

MICS

Model Implementation Conformance Statement

MMS

See Manufacturing Message Specification.

Model Implementation Conformance Statement

Model Implementation Conformance Statement (see MICS)

The Model Implementation Conformance Statement describes in detail the standard data object models that are supported by the system or by the device.

NACK

Negative acknowledgment

Navigation Window

The left area of the project window visualizes the names and icons of all containers of a project in the form of a hierarchical tree structure.

Object

Each element of a project structure is designated as an object in DIGSI 5.

Object Property

Each object has properties. These can on the one hand be general properties that are common to several objects. Otherwise, an object can also have object-specific properties.

Offline

If there is no communication connection between a PC program (for example, configuration program) and a runtime application (for example, a PC application), the PC program is **offline**. The PC program executes in Offline mode.

Online

If there is a communication connection between a PC program (for example, configuration program) and a runtime application (for example, a PC application), the PC program is **online**. The PC program executes in Online mode.

Optical Switch Module

An Optical Switch Module (OSM) is a process for switching over switches in Ethernet networks that are ring-shaped in structure. OSM is a proprietary process from Siemens, which later became standard under the term MRP. OSM is integrated in the optical Ethernet module EN100-O. OSM is hardly used in IEC 61850 networks. RSTP is used there, this having become established as an international standard.

OSM

See Optical Switch Module.

Output data/Output direction

Data is sent from the protocol master to the protocol slave.

Output indication

Indications can be information provided by the device on events and states. The events and states are provided via binary outputs, for example, startup of the processor system (event) or fault in a device function (state). These are designated as output indications.

Parallel Redundancy Protocol

Parallel Redundancy Protocol (PRP) is a redundancy protocol for Ethernet networks that is specified in IEC 62439-3. Unlike conventional redundancy procedures, such as RSTP (Rapid Spanning Tree Protocol, IEEE 802.1D-2004) PRP offers uninterruptible switching, which avoids any down time in the event of a fault, and thus the highest availability.

PRP is based on the following approach: The redundancy procedure is generated in the end device itself. The principle is simple: The redundant end device has 2 Ethernet interfaces with the same address (DAN, Double Attached Node). Now, the same message is sent twice, in the case of PRP ("parallel") via 2 separated networks, and uniquely marks both with a sequence number. The recipient takes the information that it receives first, stores its ID based on the source address and the sequence number in a duplicate filter and thus recognizes the 2nd, redundant information. This redundant information is then discarded. If the 1st message is missing, the 2nd message with the same content comes via the other network. This redundancy avoids a switching procedure in the network and is thus interruption-free. The end device relays no messages to the other network. Since the process is realized in the Ethernet layer (same MAC address), it is transparent and usable for all Ethernet payload protocols (IEC 61850, DNP, other TCP/IP based protocols). In addition, it is possible to use one of the 2 networks for the transmission of non-redundant messages.

There are 2 versions of PRP: PRP-0 and its successor PRP-1. Siemens implements PRP-1.

Parameterization

Comprehensive term for all setting work on the device. You can parameterize the protection functions with DIGSI 5 or sometimes also directly on the device.

Parameter set

The parameter set is the entirety of all parameters that can be set for a SIPROTEC device.

Participant

In an inter-device communication group, up to 16 SIPROTEC devices suitable for this can communicate with one another. The individually involved devices are referred to as participants.

Participant Address

A participant address consists of the name of the participant, the international dialing code, the local dialing code and the participant-specific telephone number.

Phone Book

Participant addresses for the modem connection are saved in this object type.

PICS

See Protocol Implementation Conformance Statement.

PLC

See Programmable Logic Controller.

PROFIBUS

PROcess Feld BUS, German Process and Fieldbus standard (EN 50170). The standard specifies the functional, electrical and mechanical characteristics for a bit-serial fieldbus.

PROFIBUS Address

A unique PROFIBUS address must be assigned to each SIPROTEC device within a PROFIBUS network. A total of 254 PROFIBUS addresses per PROFIBUS network are available.

Programmable Logic

The programmable logic is a function in Siemens devices or station controllers, enabling user-specific functionality in the form of a program. This logic component can be programmed by various methods: CFC (= Continuous Function Chart) is one of these. SFC (Sequential Function Chart) and ST (Structured Text) are others.

Programmable Logic Controller

Programmable logic controllers (PLC) are electronic controllers whose function is saved as a program in the control unit. The construction and wiring of the device do not therefore depend on the function of the control. The programmable logic controller has the structure of a computer; it consists of CPU with memory, installation/extension groups (for example, DI, AI, CO, CR), power supply (PS) and rack (with bus system). The peripherals and programming language are oriented towards the circumstances of the control system.

Programmable Logic Module

Modules are parts of the user program delimited by their function, structure and intended use.

Project

In terms of content, a project is the replication of a real energy supply system. In graphic terms, a project is represented as a number of objects which are incorporated in a hierarchical structure. Physically, a project consists of a series of directories and files containing project data.

Protection Communication

Protection Data Communication includes all functionalities necessary for data exchange via the protection interface. Protection communication is created automatically during configuration of communication channels.

Protection Device

A protection device detects fault states in distribution networks, taking into account various criteria, such as fault distance, fault direction or fault duration, triggering a disconnection of the defective network section.

Protocol Implementation Conformance Statement

The performance properties of the system to be tested are summarized in the report on the conformity of implementation of a protocol (PICS = Protocol Implementation Conformance Statement).

PRP

See Parallel Redundancy Protocol

Rapid Spanning Tree Protocol

The Rapid Spanning Tree Protocol (RSTP) is a standardized redundancy process with a short response time. In the Spanning Tree Protocol (STP protocol), structuring times in the multidigit second range apply in the case of a reorganization of the network structure. These times are reduced to several 100 milliseconds for RSTP.

Real Time

Real time

Reorganize

The frequent addition and deletion of objects results in memory areas which are no longer used. The reorganization of projects allows these memory areas to be freed up again. The reorganization also leads to VD addresses being reassigned. This results in all SIPROTEC devices having to be reinitialized.

RSTP

See Rapid Spanning Tree Protocol.

SBO

Select before operate

SC

Single command – See Single Command.

SCD

See Substation Configuration Description

Sequence of Events

Acronym: SOE. An ordered, time-stamped log of status changes at binary inputs (also referred to as state inputs). SOE is used to restore or analyze the performance, or an electrical power system itself, over a certain period of time.

Service Interface

Device interface for interfacing DIGSI 5 (for example, through a modem)

SI

See Single-Point Indication.

SI

See System Interface.

SICAM PAS

Power Automation System – Substation automation system, modular in design and based on the Substation Controller SICAM SC and the HMI system SICAM WinCC.

SICAM SCC

The HMI system SICAM SCC (serial communications channel) graphically displays the state of your network. SICAM SCC visualizes alarms and messages, archives the network data, provides the option of intervening manually in the process and manages the system rights of the individual employees.

Simple Network Management Protocol

The Simple Network Management Protocol (SNMP) is an Internet standard protocol and serves for the administration of nodes in an IP network.

Simple Network Time Protocol

The Simple Network Time Protocol (SNTP) is a protocol for the synchronization of clocks via the Internet. With SNTP, client computers can synchronize their clocks via the Internet with a time server.

Single Command

Single commands (SC) are process outputs which visualize 2 process states (for example, On/Off) at an output.

Single-point indication

Single-point indications (SI) are process indications which visualize 2 process states (for example, On/Off) at an input.

SIPROTEC 5 device

This object type represents a real SIPROTEC device with all the contained setting values and process data.

SIPROTEC 5 Variant

This object type represents a variant of an object of the SIPROTEC device type. The device data of this variant can differ from the device data of the original object. However, all variants derived from the original object have its VD addresses. Therefore they always correspond to the same real SIPROTEC device as the original object. In order to document different working states during parameterization of a SIPROTEC device, you can use objects of the type SIPROTEC variant, for example.

SIPROTEC

The registered trademark SIPROTEC designates the product family of protection devices.

Slave Device

A slave may only exchange data with a master after its has been requested to do so by this master. SIPROTEC devices work as slaves. A master computer controls a slave computer. A master computer can also control a peripheral device.

SNMP

See Simple Network Management Protocol.

SNTP

See Simple Network Time Protocol.

SOE

See Sequence of Events.

SP

Single-Point Indication – See Single-Point Indication.

SPC

IEC 61850 data type: Single Point Control

SPS

IEC 61850 data type: Single point status

SPS

See Programmable Logic Controller

Substation Configuration Description

A substation configuration description is an IEC 61850-compliant file for data exchange between the system configurator and the IED configurator. The substation configuration description contains information on the network structure of a substation. The substation configuration description contains for example, information on the assignment of the devices to the primary equipment, as well as on the station-internal communication.

System Interface

Device interface for linking to the control and protection system via various communication protocols

TC

Tap-position command – see Transformer Tap Position Command

TCP

See Transmission Control Protocol.

Time stamp

A time stamp is a value in a defined format. The time stamp assigns a time point to an event, for example, in a log file. Time stamps ensure that events can be found again.

Topological View

The Topological View is oriented to the objects of a system (for example, switchgear) and their relation to one another. The Topological View describes the structured layout of the system in hierarchical form.

Transformer-tap indication

The transformer-tap indication (TM) is a processing function. The transformer tap changes are recorded and further processed with this indication.

Transformer Tap Position Command

Command which changes the tap position in a transformer.

Transmission Control Protocol

The Transmission Control Protocol (TCP) is a transmission protocol for transport services in the Internet. TCP is based on IP and ensures connection of the participants during the data transmission. TCP ensures the correctness of the data and the correct sequence of the data packets.

Tree view

The left area of the project window visualizes the names and icons of all containers of a project in the form of a hierarchical tree structure. This area is referred to as a tree view.

Tunneling

Technology for connecting two networks via a third network, whereby the through traffic is completely isolated from the traffic of the third network.

UDP

See User Datagram Protocol.

Unbuffered Report Control Block

Unbuffered Report Control Block (URCB) is a form of report controlling. Internal events trigger the immediate sending of reports based on **best effort**. If no association exists or if the transport data flow is not fast enough, events can be lost.

URCB

See Unbuffered Report Control Block

USART

Universal Synchronous/Asynchronous Receiver/Transmitter

User Datagram Protocol (UDP)

UDP is a protocol. The same as TCP, the protocol is based on IP. In contrast to this, however, UDP works without a connection and does not have any safety mechanisms. The advantage of UDP in comparison to IP is the higher transmission rate.

UTC

Universal Time Coordinated

Value Indication

Value indications are single-point indications in which a further value is transferred in addition to the actual indication (example: **Fault locator** : Here the distance to the fault location is also indicated in addition to the fault statement **Yes/No**.)

Virtual Bay Device

A virtual bay device comprises all communication objects, as well as their properties and states, which a communication user can utilize in the form of services.

Virtual Device

A VD (Virtual Device) includes all communication objects as well as their properties and stages available to communication users in form of services. A VD can be a physical device, a module of a device or a software module.

WYE

DEL (phase-to-ground related measurements of a 3-phase system)

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