ПРИЛОЖЕНИЕ
№10

SIEMENS
SIPROTEC 5
РЪКОВОДСТВО

SIEMENS

SIPROTEC 5
Overcurrent Protection
7SJ82/7SJ85

V7.30 and higher

Manual

C53000-G5040-C017-7

NOTE

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

Disclaimer of Liability

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Preface

Purpose of the Manual

This manual describes the protection, automation, control, and supervision functions of the SIPROTEC 5 device functions for distance protection and line differential protection.

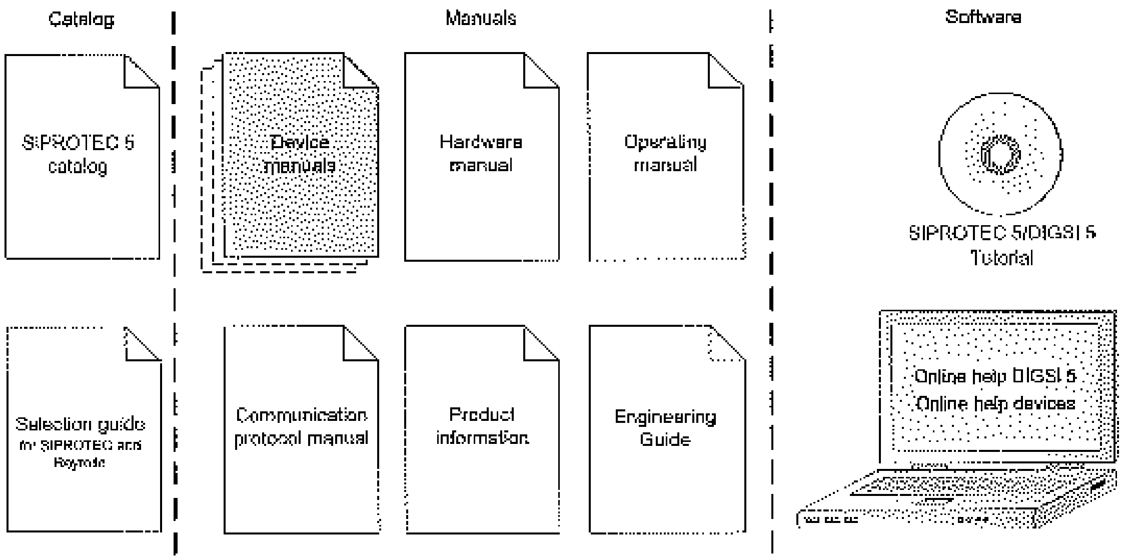
Target Audience

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



- 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.

- 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.

- Selection guide for SIPROTEC and Reyrolle

  The selection guide offers an overview of the device series of the Siemens protection devices, and a device selection table.

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 relating to electromagnetic compatibility (EMC Council Directive 2014/30/EU) and concerning 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) and with the product standard EN 60255-27 (for Low Voltage Directive) by Siemens AG.

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.

Other 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 www.ul.com

Select **Online Certifications Directory** and enter **E194016** as **UL File Number**.

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Additional Support

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

Support

Our Customer Support Center provides a 24-hour service.

Phone:	+49 (180) 524-7000
Fax:	+49 (180) 524-2471
E-Mail:	*support.energy@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 Nürnberg
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Phone:	+49 (911) 433-7415
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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 particular 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 manual 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.

Open Source Software

The product contains, among other things, Open Source Software developed by third parties. The Open Source Software used in the product and the license agreements concerning this software can be found in the Readme_OSS. These Open Source Software files are protected by copyright. Your compliance with those license conditions will entitle you to use the Open Source Software as foreseen in the relevant license. In the event of conflicts between Siemens license conditions and the Open Source Software license conditions, the Open Source Software conditions shall prevail with respect to the Open Source Software portions of the software. The Open Source Software is licensed royalty-free. Insofar as the applicable Open Source Software License Conditions provide for it you can order the source code of the Open Source Software from your Siemens sales contact - against payment of the shipping and handling charges - for a period of at least 3 years since purchase of the Product. We are liable for the Product including the Open Source Software contained in it pursuant to the license conditions applicable to the Product. Any liability for the Open Source Software beyond the program flow intended for the Product is explicitly excluded. Furthermore any liability for defects resulting from modifications to the Open Source Software by you or third parties is excluded. We do not provide any technical support for the Product if it has been modified.

When using DIGSI 5 in online mode, you are provided with the option to go to the main menu **Show Open source information** and read and display the Readme_OSS file containing the original license text and copyright information.

To do this, the following steps are necessary:

- Switch to online mode.
- Select the device.
- Select **online** in the menu bar.
- Click **Show Open source information**.

NOTE

To read the Readme_OSS file, a PDF viewer must be installed on the computer.
In order to operate SIPROTEC 5 devices, a valid DIGSI 5 license is required.

Table of Contents

1 Introduction

1.1 General

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

Analog Inputs

The measuring inputs transform the currents and voltages sent by the instrument transformers and adapt them to the internal processing level of the device. A SIPROTEC 5 device has a current transformer and, depending on the device type, a voltage transformer. The current inputs are therefore intended for the detection of phase currents and ground current. The ground current can be detected sensitively using a core balance current transformer. In addition, phase currents can be detected very sensitively for a particularly precise measurement. The voltage inputs detect the measuring voltage of device functions requiring current and voltage measured values.

The analog values are digitized in the internal microcomputer for data processing.

Microcomputer System

All device functions are processed in the microcomputer 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-outs
- Controlling of signals for the logic functions
- Decision about the trip and close commands
- Storage of indications, fault data, and fault values for fault analysis
- Administration of the operating system and its functions, such as data storage, real-time clock, communication, interfaces, etc.
- 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 cover 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 back are used to realize 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 generally 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.

General Properties

- Powerful multiprocessor
- 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 switches 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
- Storage of min/max measured values (slave pointer function) and storage of long-term average values
- Storage of fault indications for system incidents (faults in system) with real-time assignment and instantaneous values for fault recording
- 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 safety-critical operations on the devices and systems

Redundant Communication

SIPROTEC 5 devices maintain complete 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

2.1 Function Embedding 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!

EXAMPLE

A 1 1/2 circuit-breaker layout of the 7SA86 distance protection device serves as an example. The following protection functions are required for implementation (simplified and reduced):

- Distance protection (21)
- Overcurrent protection, phases (51)
- Circuit-breaker failure protection (50BF), for circuit breakers 1 and 2
- Basic functionality (handling of tripping, etc.)

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.

EXAMPLE

When creating the device in DIGSI 5, you must select the appropriate application template. In the example, select the application template **DIS overhead line, grounded systems, 1 1/2 circuit-breaker layout.** This application template covers the required functional scope. Selecting this application template determines the preconfigured functional scope. This can be changed as necessary (see chapter 2.2 *Adjustment of Application Templates/Functional Scope*).

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 a line, transformer, or circuit breaker.

The function groups bundle functions with regard to the following basic tasks:

- Assignment of functions to current and/or voltage transformers (assignment of functions to the measuring points and thus to the protected object)
- Exchange of information between function groups

When a function is copied into a function group, it automatically works with the measuring points assigned to the function group. Their output signals are also automatically included in the configured interfaces of the function group.

The number and type of function groups differ in the respective application templates, depending on the type of the device and application. You can add, copy, or even delete function groups for a specific application. You can also adapt the functional scope within a function group according to the use case. You can find detailed information on this in the DIGSI 5 Online help.

EXAMPLE

The selected application template **DIS overhead line, grounded systems, 1 1/2 circuit-breaker layout** comprises 3 function groups:

- Protection function group **Line 1**
- Circuit-breaker function group **QA 1**
- Circuit-breaker function group **QA 2**

The following figure shows the embedding of functions via function groups.

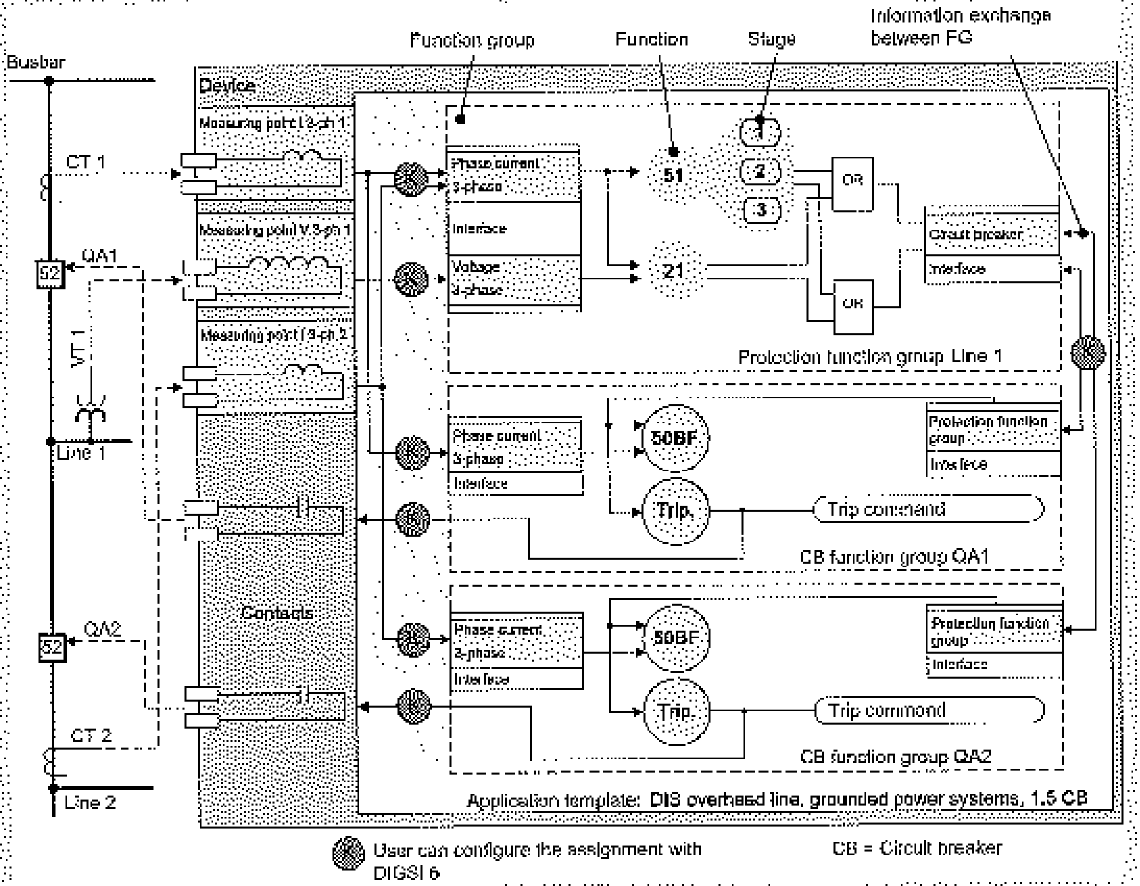

Figure 2-1 Embedding the Functions via Function Groups

Depending on the type of device, there are different types of function groups:

- Protection function groups
- Circuit-breaker function groups

Protection function groups bundle functions that are assigned to one protected object – for example, to the linethe transformer. Depending on the device type and nature of the protected object, there are different types of protection function groups (line, voltage/current 3-phase, transformer, motor, generator, etc.).

Circuit-breaker function groups bundle functions assigned to the local switches – for example, circuit breakers and disconnectors (such as processing of tripping, circuit-breaker failure protection, automatic reclosing).

The number and type of function groups differ in the respective application templates, depending on the type of the device and application. You can add, copy, or even delete function groups for a specific application. You can also adapt the functional scope within a function group according to the use case. Detailed information on this can be found in the DIGSI 5 Online help.

Interface Between Function Group and Measuring Point

The function groups receive the measurands of the current and voltage transformers from measuring points. For this, the function groups are connected to one or more measuring points.

The number of measuring points and the assignment of function groups to the measuring points are preset by the selected application template in accordance with the specific application. Therefore, this specifies which measuring point(s) and the corresponding measurands have to be used by which function within the function group.

EXAMPLE

The measuring points are assigned to the function groups in the application template in Figure 2-1 as follows:

- The protection function group **Line** is assigned to the measuring points **I-3ph 1**, **I-3ph 2** and **V-3ph 1**. The function group therefore receives the measured values from current transformers 1 and 2 and from voltage transformer 1. The currents of measuring points **I-3ph 1** and **I-3ph 2** are added geometrically for feeder-related processing.
- The circuit-breaker function group **QA1** is assigned to the measuring point **I-3ph 1** and receives the measured values from current transformer 1.
- The circuit-breaker function group **QA2** is assigned to the measuring point **I-3ph 2** and receives the measured values from current transformer 2.

The user can change the assignment as needed, that is, function groups can be assigned to any available measuring points of the device.

To check or change the assignment of measuring points to the function groups, double-click **Function-group connections** in the DIGSI 5 project tree.

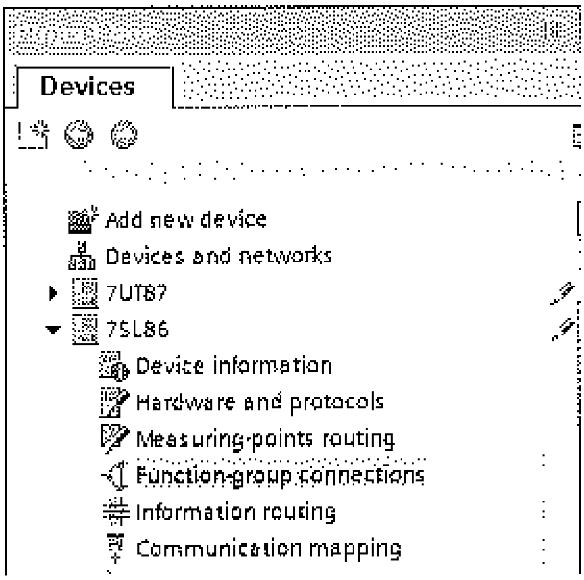

Figure 2-2 Project Tree in DIGSI 5 (Detail)

The window for routing of the measuring points opens in the working area (see the following Figure, does not correspond to the example).

▼ Connect measuring points to function group

	Line 1		Circuit breaker 1	
Measuring point	Voltage 3-phase	Line current 3-phase	Voltage	Line current 3-phase
(All...)	(All...)	(All...)	(All...)	(All...)
Meas.point I-3ph 1		X		X
Meas.point V-3ph 1	X		X	

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Figure 2-3 Connecting Measuring Points and Function Groups

Interface Between Protection and Circuit-Breaker Function Groups

The protection function group(s) is/are connected to one or several circuit-breaker function groups. This connection generally determines:

- Which circuit breaker(s) is/are started by the protection functions of the protection FG.
- Starting the **Circuit-breaker failure protection** function (if available in the Circuit-breaker function group) through the protection functions of the connected protection function group
- Starting the **Automatic reclosing** function (AREC, if available in the Circuit-breaker function group) through the protection functions of the connected Protection function group

Besides the general assignment of the protection function group(s) to the circuit-breaker function groups, you can also configure the interface for specific functionalities in detail. Further information on this is included later in the section. *Figure 2-6* shows how to reach the detail configuration. *Figure 2-7* shows the possible assignments in detail.

These definitions are also set appropriately for the specific application by the selected application template.

The user can change this linkage as needed, that is, protection function groups can be freely assigned to any Circuit-breaker function groups.

To check or change the allocation of the protection function groups to the circuit-breaker function groups, double-click **Function group connections** in the DIGSI 5 project tree → **Name of device** (see following figure).

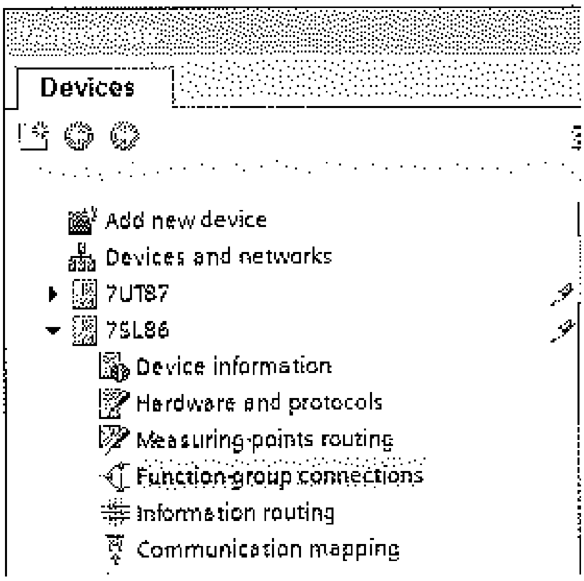

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Figure 2-4 Project Tree in DIGSI 5 (Detail)

The window for general routing of the function groups opens in the working area (see following figure).

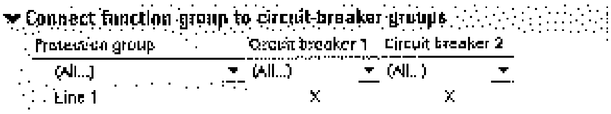


Figure 2-5 Connection of Protection Function Group with Circuit-Breaker Function Group

Besides the general assignment of the protection function group(s) to the circuit-breaker function groups, you can also configure the interface for specific functionalities in detail. Proceed as follows:

- Open the SIPROTEC 5 device folder in the DIGSI 5 project tree.
- Open the function settings folder in the DIGSI 5 project tree.
- Open the respective protection function group in the DIGSI 5 project tree, for example, **Line 1** (see the following figure)

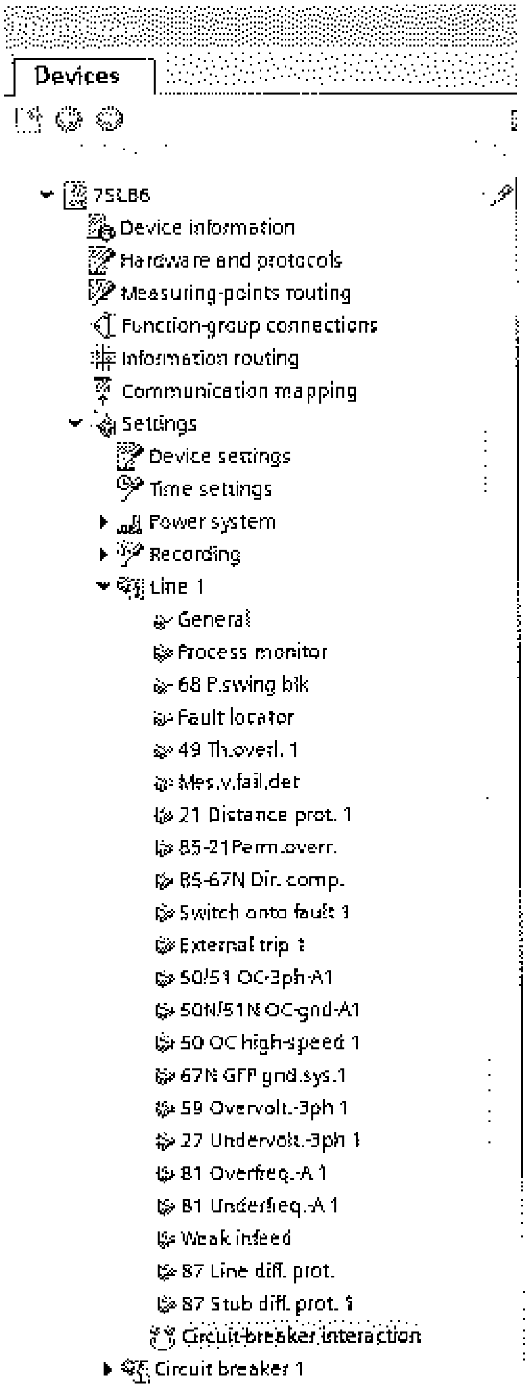


Figure 2-6 Project Tree in DIGSI 5 (Detail)

- Double-click Circuit-breaker interaction (see *Figure 2-6*)
- The window for detailed configuration of the interface between the protection function group and the circuit-breaker function group(s) opens in the working area.
- In this view, configure the interface via the context menu (right mouse button), see *Figure 2-7*.

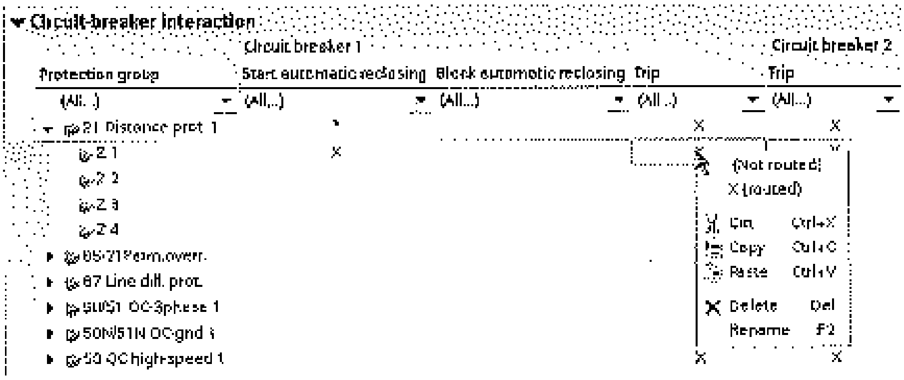


Figure 2-7 Detail Configuration of the Interface Between the Protection Function Group and the Circuit-Breaker Function Group(s)

In the detail configuration of the interface, you define:

- Which operate indications of the protection functions go into the generation of the trip command
- Which protection functions start the automatic reclosing function
- Which protection functions block the automatic reclosing function
- Which protection functions start the Circuit-breaker failure protection function

Functions (FN), Tripping Stages/Function Blocks (FB)

As already illustrated in *Figure 2-1*, functions are assigned to the protected objects or other primary objects via function groups.

Functions can be further subdivided. For example, protection functions often consist of multiple protection stages (for example, the Overcurrent-protection function). Other functions can contain one or more function blocks.

Each stage, each function block, and each function (without stages/function blocks) can be individually switched into specific operating modes (for example, switch on/off). This is termed function control and is explained in chapter *2.3 Function Control*.

To adjust the functionality to the specific application, functions, tripping stages, and function blocks can be added, copied, and deleted (see chapter *2.2 Adjustment of Application Templates/Functional Scope*).

2.2 Adjustment of Application Templates/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 *Figure 2-1* in chapter *2.1 Function Embedding 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 level 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 adjustment of the functional scope consists of adding and deleting functions, tripping 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 chapter *2.1 Function Embedding in the Device*). You must connect newly added protection function groups to a circuit-breaker function group (see chapter *2.1 Function Embedding 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. Further information can be found in the description of application templates, in the chapter *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.

No function points are required to add additional stages in functions.

Extending the Function-Point Credit

You can reorder function points if the function-point credit for the device is not enough.

Proceed as follows:

- Determine the function point requirement of certain functions, for example, with DIGSI 5 or the SIPROTEC 5 Configurator.
- Order the additional function points from your local distributor or at http://www.energy.siemens.com.
- Siemens will provide you with a signed license file for your device, either via e-mail or for downloading.
- Use DIGSI 5 to load the signed license file into 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*).

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 2-8*. It is standardized for all functions. Therefore, this control is not discussed further in the individual function descriptions.

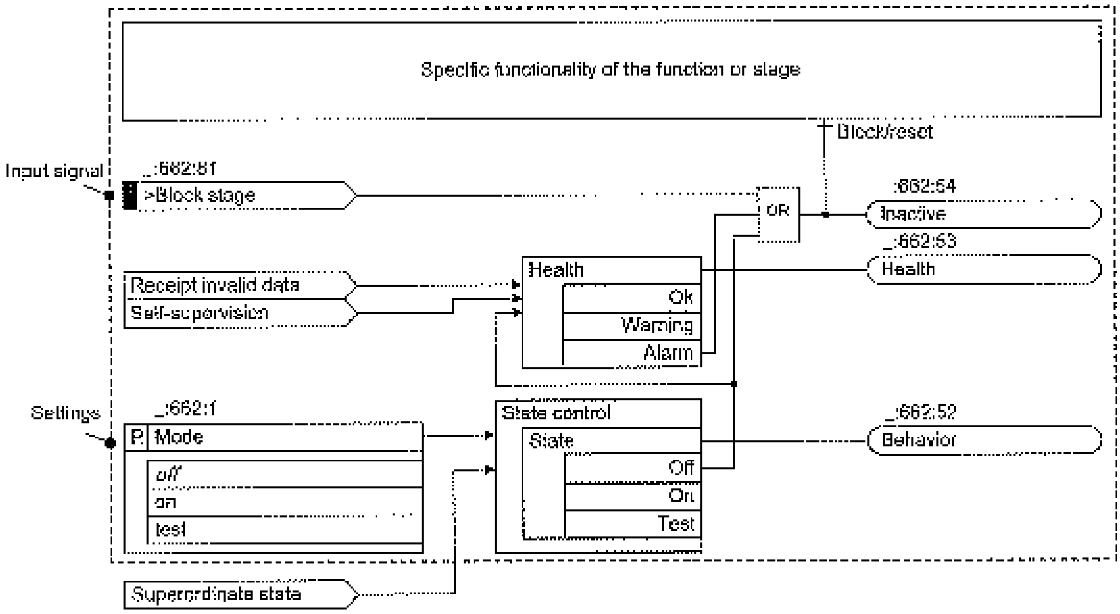


Figure 2-8 General Control of a Function

State Control

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

You set the specified operating state of the function via the parameter **Mode**. The function mode can be set 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
- Certain systems control protocols (IEC 61850, IEC 60870-5-103)

The possibility to adjust the **superordinate state** is limited. For test purposes, the complete device can set into test mode.

The state of the function resulting from the parameter **Mode** and the superordinate state is shown in the following table.

Table 2-1 Resulting State of the Function (from Linkage of Parameter Mode and Superordinate State)

Inputs		**Function State**
Mode Parameter (of the function)	**Superordinate State**	
Off	(any)	Off
(any)	Off	Off
On	On	On
On	Test	Test
Test	On	Test
Test	Test	Test

The following table shows the possible function states:

Table 2-2 Possible Function States

Function State	**Explanation**
On	The function is activated and operating as defined. The prerequisite is that the health of the function is *OK*.
Off	The function is turned off. It does not create any information. The health of a disabled function always has the value *OK*.

<table>
<tr><th>Function State</th><th colspan="2">Explanation</th></tr>
<tr><td rowspan="7">Test</td><td colspan="2">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.</td></tr>
<tr><td>Target of the Information</td><td>Processing</td></tr>
<tr><td>Log</td><td>The indications are provided with the identification Test in the log.</td></tr>
<tr><td>Contact</td><td>An indication routed to contact is not triggering the contact.</td></tr>
<tr><td>Light-emitting diode (LED)</td><td>An indication routed to the LED triggers the LED (normal processing)</td></tr>
<tr><td>CFC</td><td>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.</td></tr>
<tr><td>Protocol</td><td>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 Test state must also be transmitted as information for this state to be taken into account in the application on the receiver end. You must route the Test signal in the DIGSI 5 project tree → Device → Communication routing.
The test mode of the differential protection will be dealt with separately in the application.</td></tr>
</table>

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-supervision can cause the functions to assume the health *Alarm* (see chapter *9 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 switched off
- The function is in the health state *Alarm*
- Function is blocked by an input signal (see *Figure 2-8*)

Blocking of the Operate Indication, No Fault Recording at Pickup

You use the parameter **Blk. Op. Ind. & Fault Rec.** to define whether a function works as a protection or supervision function. Further, you use this to determine the type and scope of the logging (see following table)

Parameter Value	Description
No	The function works as a protection function. It generates an operate indication and starts fault recording with pickup. During fault recording, a fault is created and logged as a fault record in the fault log.
Yes	The function works as a supervision function. The logic runs normally, but without creating the operate indication. The time-out indication is still generated and can be processed further if necessary. No fault recording starts with pickup.

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 explicit 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 the reference numbers follow the hierarchy already shown in *Figure 2-1* :

- 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 2-9*). Only one function and one function group exist in the device. The representation of the stage is simplified.

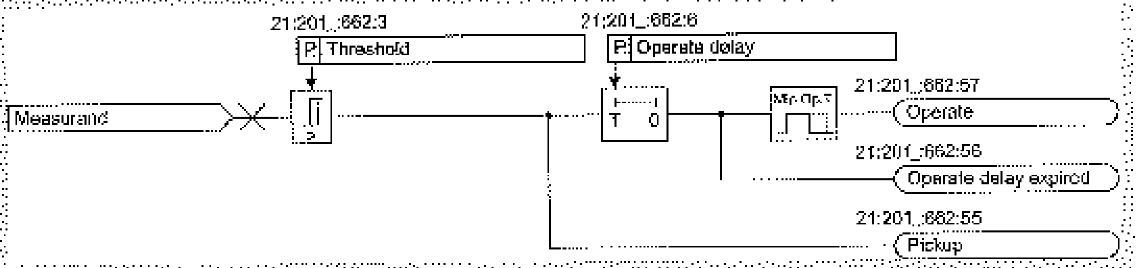


Figure 2-9 Stage of the Overcurrent Protection Function, Phases (without Representation of Stage Control)

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	–

Die Instanznummern ergeben sich wie folgt:

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

A 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

3 System Functions

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):

- Ground-fault log 100 indications
- Fault log 1000 indications
- User-defined log 200 indications
- Operational log 2000 indications

If the maximum capacity of the user-defined log or of the operational is exhausted, the oldest entries disappear before the newest entries. If the maximum capacity of the fault log or of the ground-fault log is reached, the number of the last fault is issued via the signal **Fault log is full**. 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 demand via general interrogation. In DIGSI 5 indications can be tracked spontaneously in online operation 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 will 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***.

Figure 3-1

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

Menu Path	Log
Main menu → Indications →	Operational log Fault log Ground-fault log Setting changes User indications 1 User indications 2
Main menu → Test & Diagnosis → Indications →	Security indications Device diagnosis Communication indications

- ✧ 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 pre-defined. You will find information about this in chapter 3.1.5.1 *General*.
- ✧ Every indication contains date, time and its state as additional information.
- ✧ In some logs you are given the option of deleting the entire indication list by softkey in the footer of the display. To know 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.

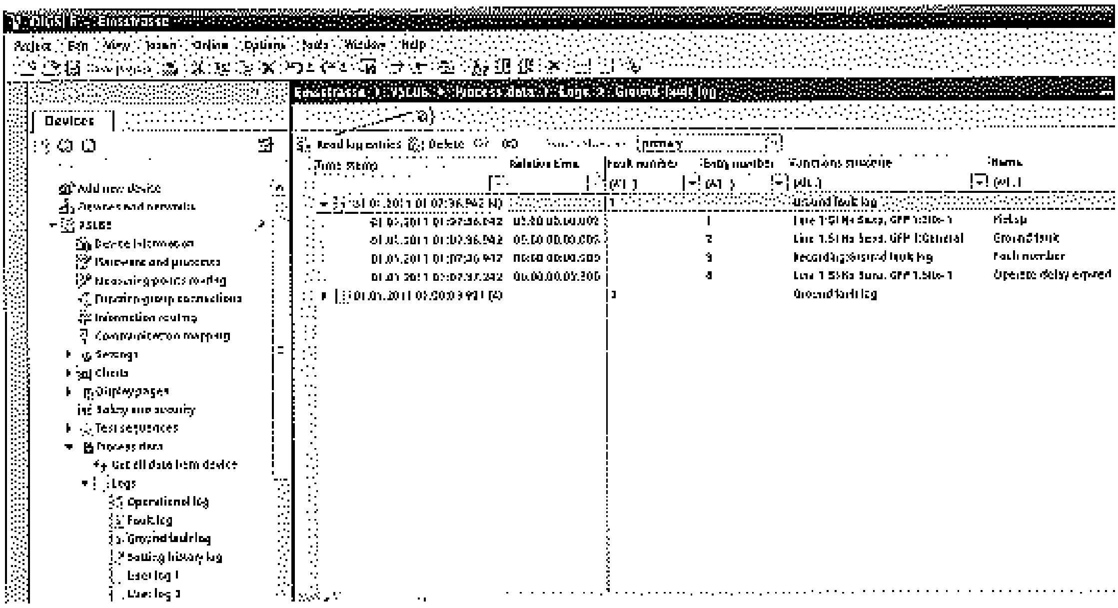
3.1.3 Reading Indications from the PC with DIGSI 5

Procedure

Menu Path (Project)	Log
Project → Device → Process data → Log →	Operational log Fault log Ground-fault log Setting changes User indications 1 User indications 2

Menu Path (Project)	Log
Project → Device → Device information → Log →	Security indication Device diagnosis Communication indications

- 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. A direct connection to your PC can be established via the Ethernet interfaces. It is also possible to access all connected SIPROTEC 5 devices via a data network from your DIGSI 5 PC.
- To reach the desired logs of the SIPROTEC 5 device, use the project-tree window. If you have not set up the device within a project, you can also attain this via **Online access**.
- 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.
- To execute a synchronization with the logs, click the respective button in the headline of the log (see example of ground-fault log in *Figure 3-2 a)*).



[scr]_mel-190-2-01-1-en-US]

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

- You will find additional information about the deletion and saving of logs in chapter *3.1.6 Saving and Deleting the Logs*.
- To determine a relative time for all other indications, you can reference the display of log entries, if needed, to the real time of a certain entry. The real-time stamps of events remain unaffected.
- For this purpose click the respective button in the headline of the log (see example of ground-fault log in *Figure 3-2 a)*).

Setting Relative Time Reference

- Which indications in the selected log can be displayed 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*.

3.1.4 Displaying Indications

Displayed indications in DIGSI 5 and on the on-site operation panel are supplemented 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 indications	Time stamp (date and time), Relative time, Increasing entry number, Value, Indication number, Quality, Cause	Time stamp (date and time), Value
Log for fault indications	Time stamp (date and time), Relative time, Error number, Increasing entry number, Value, Indication number, Quality, Cause	Time stamp (date and time), Error number, Value
Log for ground-fault indications	Time stamp (date and time), Relative time, Error number, Increasing entry number, Value, Indication number, Quality, Cause	Time stamp (date and time), Error number, Value
Spontaneous indication window (DIGSI 5)	Time stamp (date and time), Error number, Increasing entry number, Value, Indication number, Quality, Cause	Time stamp (date and time), Error number, Value

DIGSI 5: Quality Indication Column

Quality	Meaning
Good	Indication is valid
Invalid	Indication is invalid

DIGSI 5: Additional Information Indication Column

The entries in the column for additional information are in the format Cause/Originator/Additional Cause:

- Cause → What was the cause?
- Originator → Who was the originator?
- Additional cause → Supplementary notes

Cause	Meaning
Data change	Value change in an indication
Data update	Update of notification value
General interrogation	General interrogation

Cause	Meaning
Cyclic	Cyclical general inquiry
Quality change	Change of the notification quality

Initiator	Meaning
Bay	Control local
Substation	Control via the substation
Remote control	Control via the network control center
Field (auto)	Control local via automatic function
Station (auto)	Control via the station via automatic function
Distance (auto)	Control via the network control center via automatic function
Maintenance	Maintenance
Process	Device operation (normal)

Additional Cause	Meaning
Switching authority test failed	Switching authority check failed
Selection failed	Selection failed
invalid position	invalid position
Position attained	Position attained
Settings change running	Settings change running
Final position attained	Final position attained
Impermissible mode	Impermissible mode
Blocking through process	Blocking by the process
Interlocked	Interlocked
Synchrocheck failed	Synchrocheck failed
Command already running	Command already running
Not ready	Not ready
1 out of N control failed	1 out of N control failed
Command cancellation	Command cancellation
Monitoring time expired	Monitoring time expired
Cancellation due to trip command	Cancellation due to trip command
Object not selected	Object not selected
No access right	No access right
Final position exceeded	Final position exceeded
Target value not attained	Target value not attained
Loss of connection	Loss of connection
Unknown	Unknown
Blocking through command	Blocking through command
Object already selected	Object already selected
Inconsistent parameter(s)	Inconsistent parameter(s)
Blocked by foreign access	Blocked by foreign access
Select time-out	Select time-out
CB not open	Circuit breaker not open
Communication is interrupted	Communication is interrupted
Topology not stable	Topology not stable
FLO in process	Fault locator in processing
Trigger command active	Trigger command active
Close command active	Close command active

Additional Cause	Meaning
Blocked through protection	Blocked through protection
Fault occurred	Fault occurred
CB not closed	Circuit breaker not closed
CB not ready	Circuit breaker not ready
CB not open	Circuit breaker not open
Close command active	Close command active
CB check running	Circuit breaker check running

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 3-2 Log Overview

Log	Logging
Operational log	Operational indications
Fault log	Fault indications
Ground-fault log	Ground-fault indications
Setting-history log	Setting changes
User-defined log	User-defined indication scope
Security log	Access with safety relevence
Device-diagnosis log	Error of the device (software, hardware) and the connection circuits
Communication log	Status of communication interfaces
Motor-startup log	Information on the motor startup

Managing Logs

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 generated via the signal **Fault log 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:
  Project → Device → **Information routing**
- Select the associated routing column in the matrix from:
  Target → Log → **Column ground-fault log**

- The routing of the selected indication is done via right click. Select one of the options in the list box shown:
  - Routed (X)
  - Unrouted

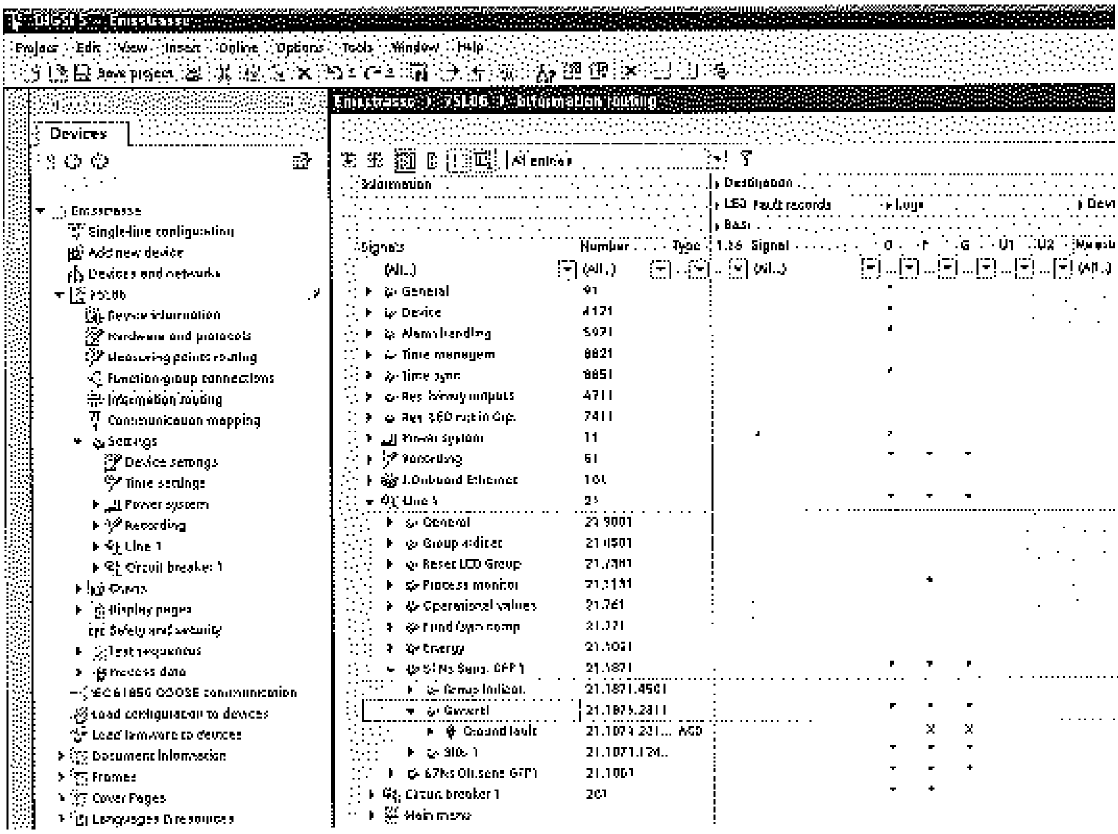


Figure 3-3 Indication Configuration in DIGSI 5 (Example: Ground-Fault Log)

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. Short circuits in the network are indicated as an operational indication **Fault** with sequential fault number. For detailed information about the recording of system incidents, please refer to the description of the fault log (chapter *3.1.5.3 Fault Log*). Up to 2000 indications can be stored in the 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)).

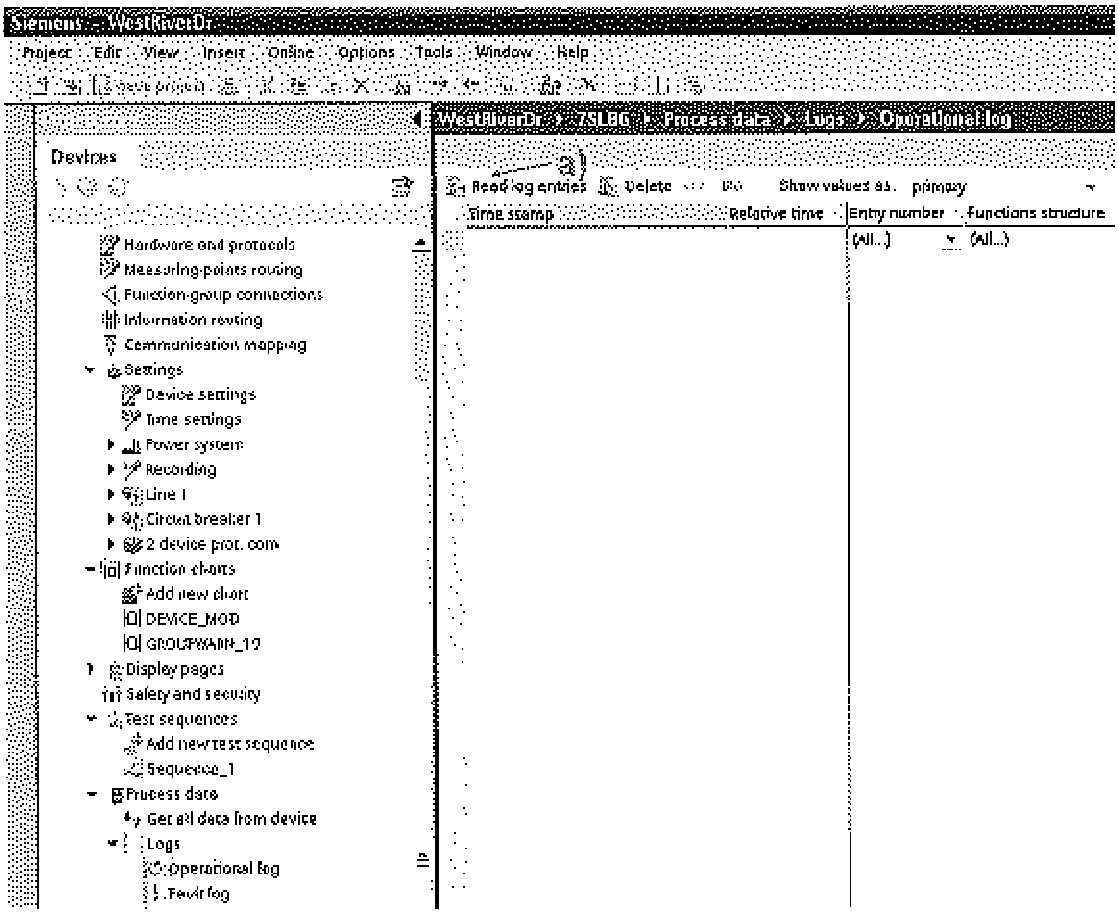


Figure 3-4 Reading the Operational Log with DIGSI 5

Reading on the Device Through 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.

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 Fault Log

Fault indications are events which arise during a fault. They are logged in the fault log with real time stamp and relative-time stamp (reference point: fault occurrence) . Faults are numbered consecutively in rising order. With fault recording engaged, a corresponding fault record with the same number exists for every fault logged in the fault log. A maximum of 128 fault logs can be stored. A maximum of 1000 indications can be recorded in each fault log.

Fault Definition

In general, a fault is started by the raising pickup of a protection function and ends with the cleared pickup after the trip command.

When using an automatic reclosing function, the complete reclosing cycle (successful or unsuccessful) is preferably integrated into the fault. If evolving faults appear within reclosing cycles, the entire clearing process is logged under one fault number even in multiple pickup cycles. Without automatic reclosing function every pickup is also recorded as its own fault.

User-defined configuration of a fault is also possible.

NOTE

The definition of the fault is done through settings of the fault recording (see Device manual). Events are logged in the fault log even when fault recording is switched off.

Apart from the recording of fault indications in the fault log, spontaneous display of fault indications of the last fault on the device display is also done. You will find details about this in chapter *3.1.8 Spontaneous Fault Display on the On-Site Operation Panel*.

Reading from the PC with DIGSI 5

- To reach the fault log of your SIPROTEC 5 device, use the project-tree window.
  Project → Device → Process Data → Log → **Fault logs**

The status of the fault 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.

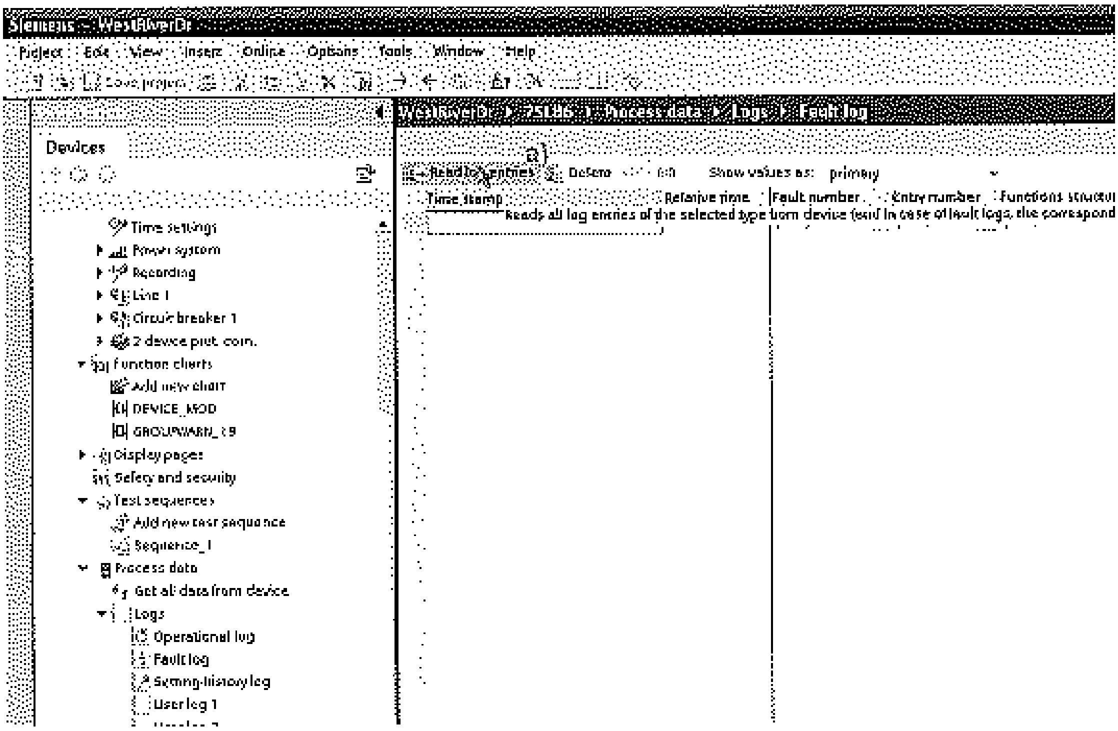


Figure 3-6 Reading the Fault Log with DIGSI 5

Deletability

The fault log of your SIPROTEC 5 device can be deleted. Read about it in chapter 3.1.6 *Saving and Deleting the Logs*.

Reading on the Device through the On-Site Operation Panel

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

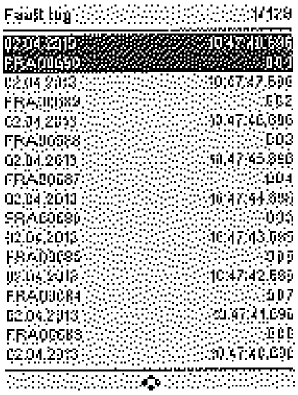


Figure 3-7

Reading the Fault Log on the On-Site Operation Panel of the Device

Configurability

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

Target → Log → **Fault log** column

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

The operational measured values and the measured values of the fundamental components and symmetrical components (see Equipment Manual) are calculated every 9 cycles (at 50 Hz, this is every 180 ms). However, this can mean that the data are not synchronized with the sampled values of the analog channels. The recording of these measured values can be used to analyze the slowly changing processes.

3.1.5.4 Ground-Fault Log

Ground fault indications are events which arise during a ground fault. They are logged in the ground-fault log with real-time stamp and relative-time stamp (reference point: ground-fault occurrence) . Ground faults are numbered consecutively in rising order. A maximum of 10 ground-fault logs are stored and for each ground-fault log, it is guaranteed that at least 100 indications are recorded.

The following functions can start the logging of a ground fault with the raising ground-fault indication:

- **Directional sensitive ground-fault protection for deleted and isolated systems** (67Ns)
- **Sensitive ground current protection with I0** (50Ns/51Ns)
- **Intermittent ground-fault protection**

The logging ends with the going ground-fault indication.

Reading from the PC with DIGSI 5

- To reach the ground-fault log of your SIPROTEC 5 device, use the project-tree window.
  Project → Device → Process data → Logs → **Ground-fault log**

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

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

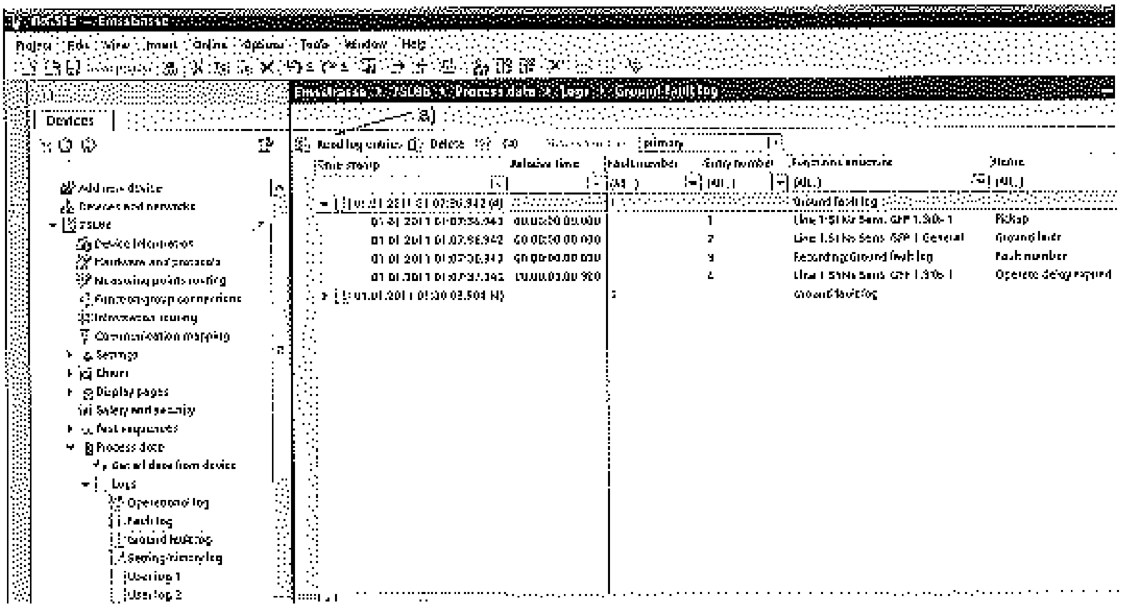


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Figure 3-8 Reading the Ground-Fault Log with DIGSI 5

Reading on the Device through the On-Site Operation Panel

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

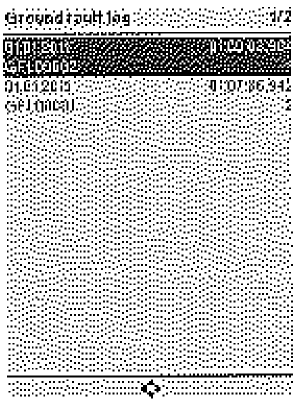


Figure 3-9

Reading the Ground-Fault Log on the On-Site Operation Panel of the Device

Deletability

The ground-fault log of your SIPROTEC 5 device can be deleted. Read about it in chapter 3.1.6 *Saving and Deleting the Logs*.

Configurability

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

Target → Log → Column **Ground-fault log**

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

3.1.5.5 User Log

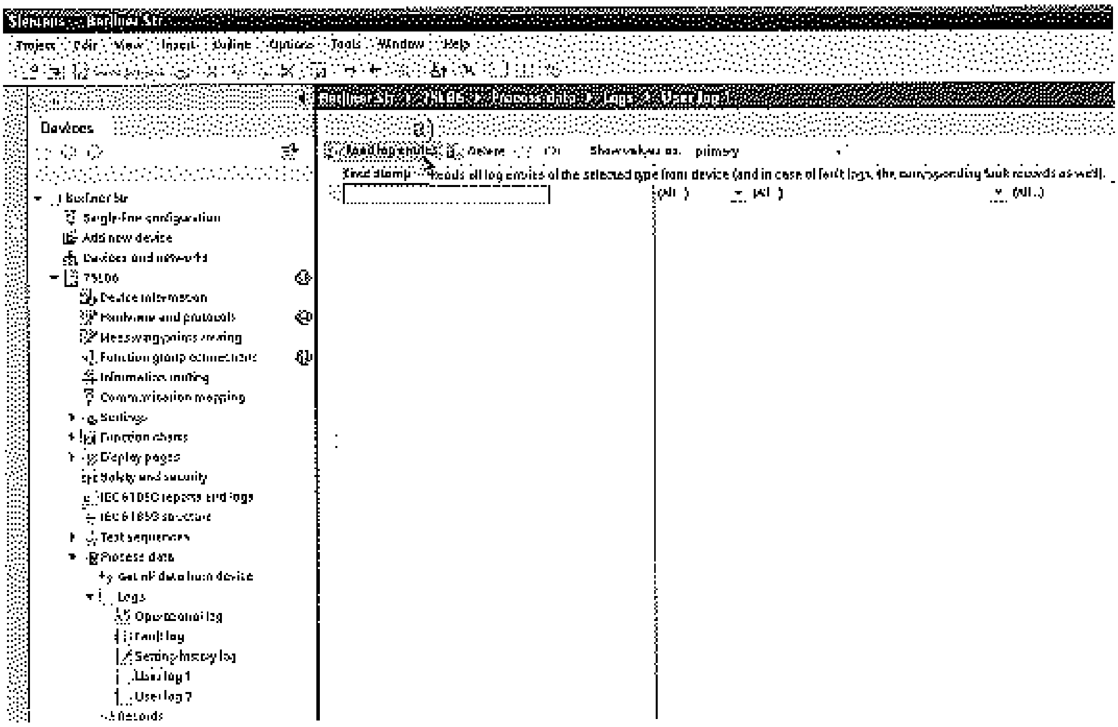
With the user-defined log (up to 2), you have the possibility of individual indication logging parallel to the operational log. This is helpful, for example, in special monitoring tasks but also in the classification into different areas of responsibility of the logs. Up to 200 indications can be stored 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 button **Read log entries** in the headline of the indication list (*Figure 3-10* a)).



[scr_usrlog-150113-01.tif, 1, en_US]

Figure 3-10 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.

Figure 3-11

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. Read about it 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

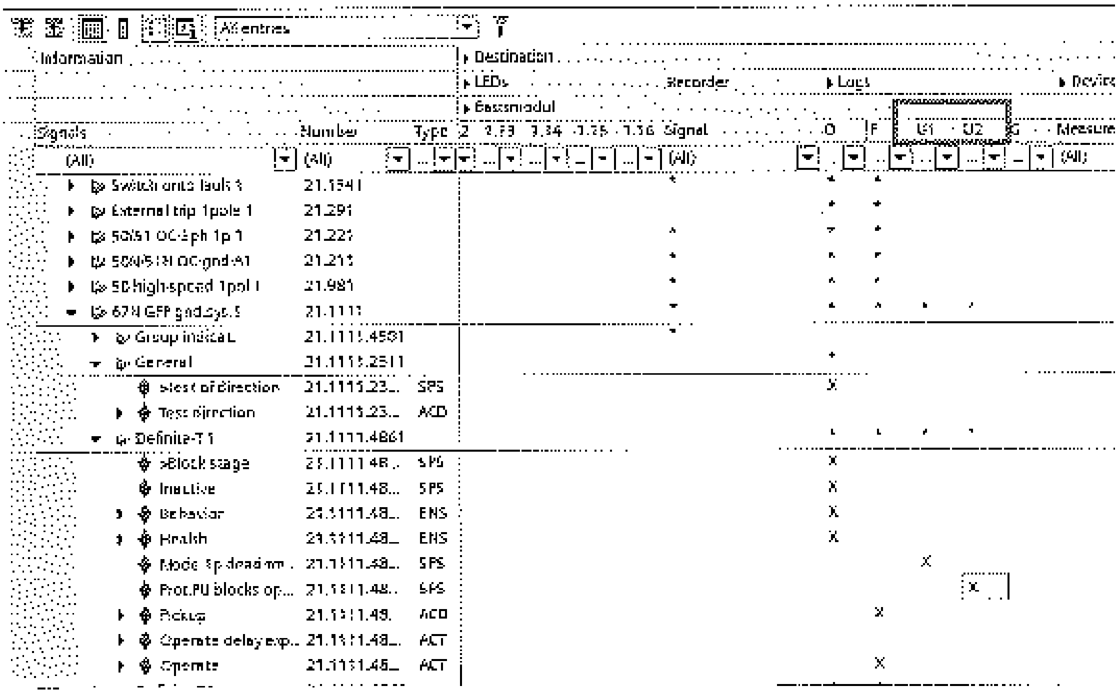


Figure 3-12 Indication Configuration in DIGSI 5 (Example: User-Defined Log U1/2)

3.1.5.6 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 prove 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 3-13*).

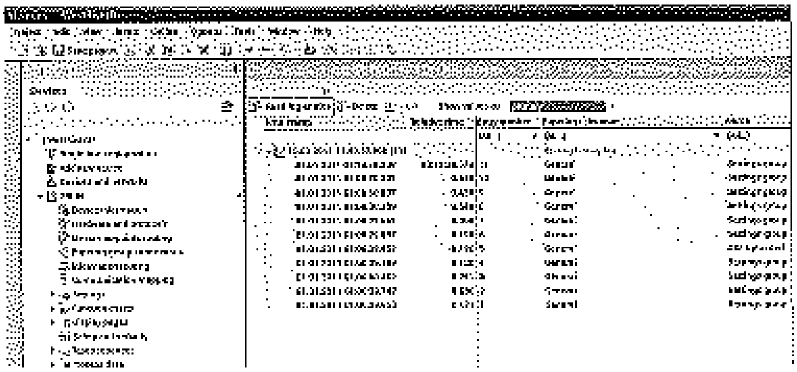


Figure 3-13 Reading the Setting-History Log with DIGSI 5

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.
  Menu → Indications → **Setting changes**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.

Figure 3-14
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 3-3 Overview of Indication Types

Displayed Information	Explanation
Selection editing+	Selection of settings group to be edited
Reject+	Rejection of all changes successful
PG activation+	PG activation via command successful
PG activation-	PG activation via command failed
set+	Parameter value was changed
Acceptance+	Acceptance of change successful
Acceptance-	Acceptance of change failed
DCF loaded	DCF loaded into device
SG 1	Settings group 1
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

Example of Logging in 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.

From top downward:

- In the example at the left, a device has started with the active settings group 1.
- Then the settings group 1 is selected for changes.
- The individual parameter for phase-rotation reversal was changed.
- The changes were successfully accepted.

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 without loss of information, you must regularly read this log.
- You cannot route additional indication objects to the setting history log.

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 → USB → Project → Test suite → Communication module
- Then select:
  J:Onboard Ethernet → **Communication log**

The status of the communication log last loaded from the device is shown to you under the Time stamp item.

- To update (synchronization with the device) click the button **Update** in the headline of the indication list.

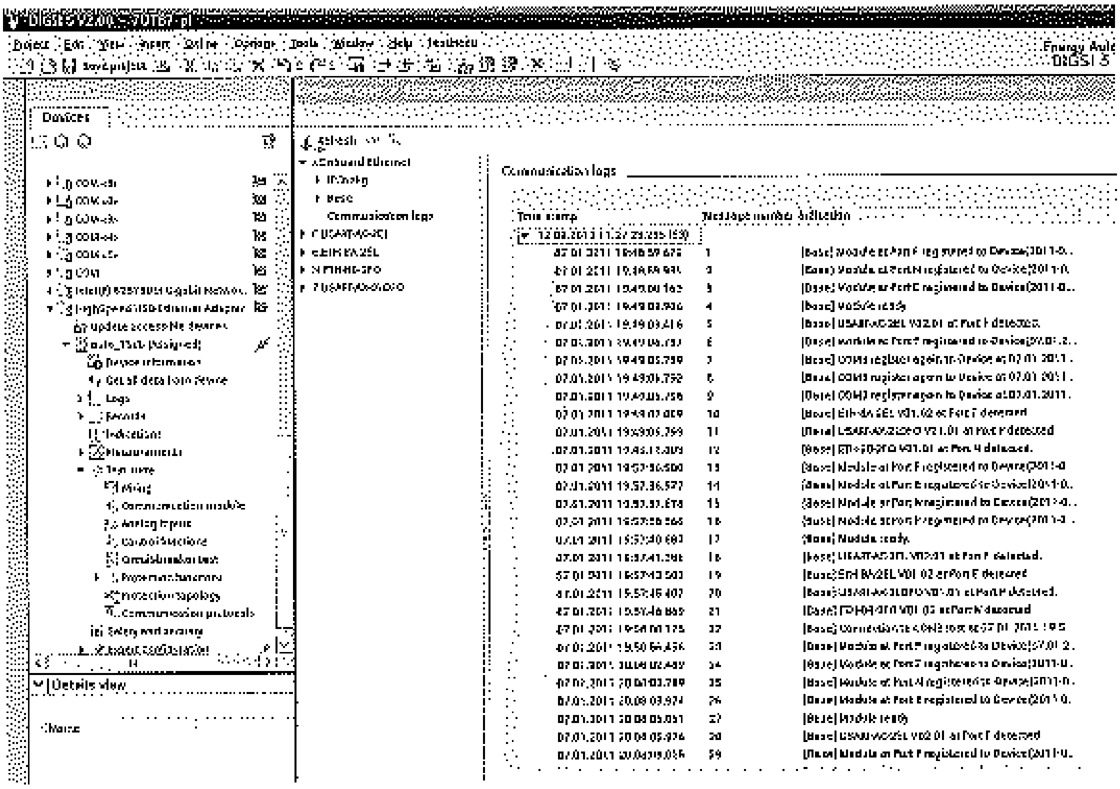


Figure 3-15 Reading the Communication Log with DIGSI 5

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 → Indications → **Communication log**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.

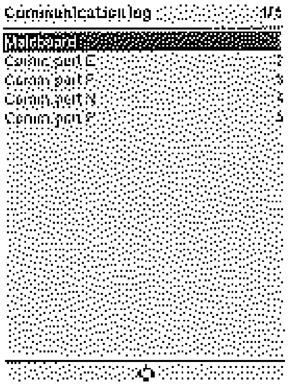


Figure 3-16
Reading the Communication Log on the On-Site Operation Panel of the Device

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 Security Log

Access to areas of the device with restricted access right is recorded in the security log. Unsuccessful and unauthorized access attempts are also recorded. Up to 500 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.
  Project → Device → Device information → Log → **Security log**

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

- To update (synchronization with the device) click the button **Update** in the headline of the indication list.

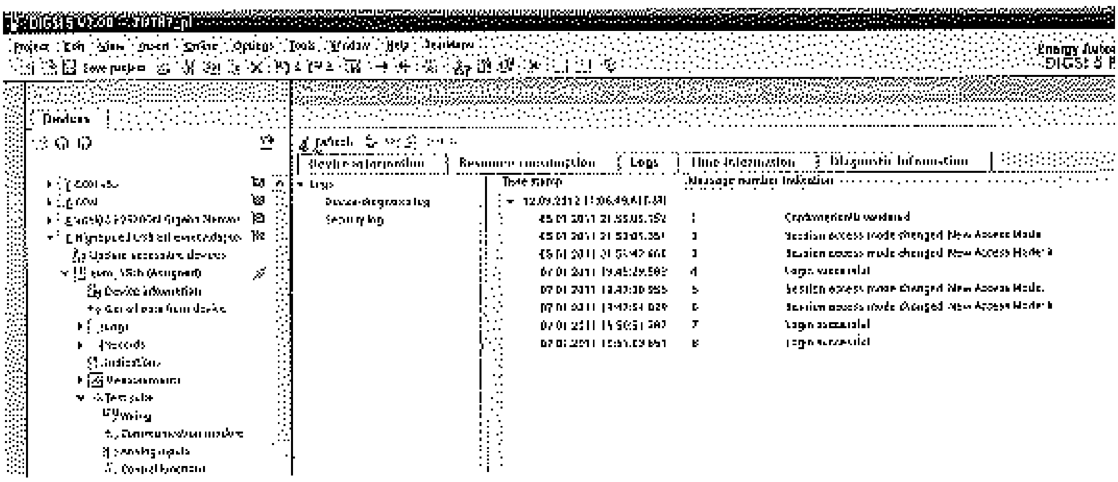


Figure 3-17 Reading the Communication Log with DIGSI 5

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 → Indications → **Security log**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.

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

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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 without loss of information, you must regularly read this log.

3.1.5.9 Device-Diagnosis Log

The logging and the display of concrete instructions are done in the device-diagnosis log during

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

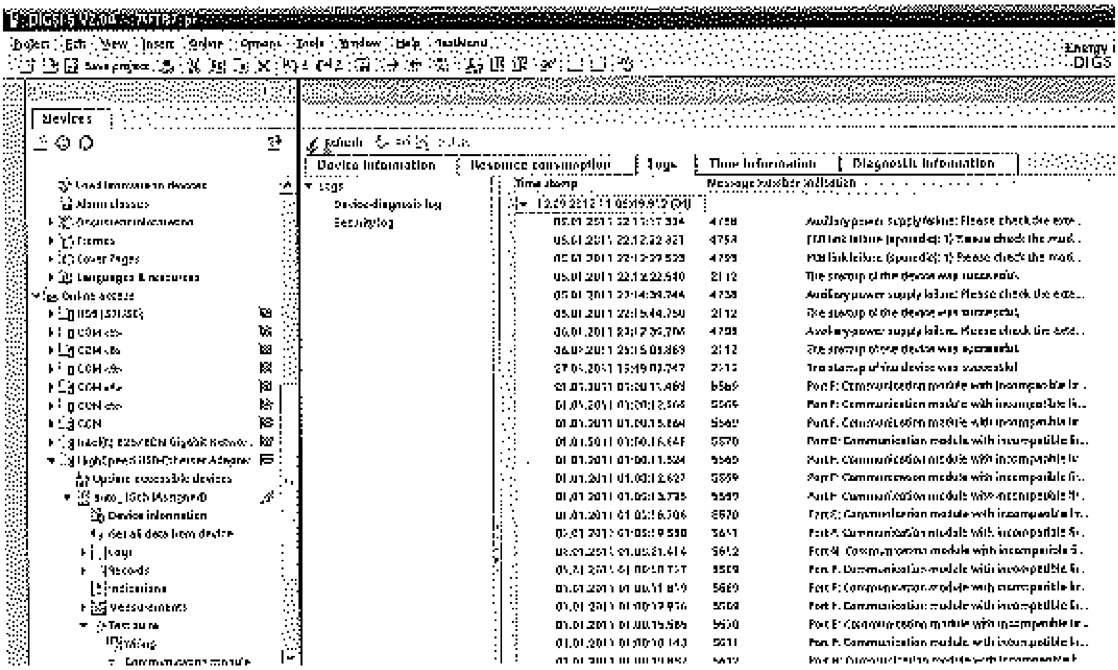
Up to 500 indications can be stored in the device-diagnosis log. In normal operation of the device, it is sufficient for diagnostic purposes to follow the entries of the operational log. This specific significance is assumed by the device-diagnosis log when the device is no longer ready for operation 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 → Device → Device information → Log → **Device-diagnosis log**

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

- To update (synchronization with the device) click the button **Update** in the headline of the indication list.



[scdsdia-140612-01, 1, en_US]

Figure 3-19 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 → Indications → **Device diagnosis**
- You can navigate within the displayed indication list using the navigation keys (up/down) on the on-site operation panel.

Figure 3-20
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!

3.1.6 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 an inspection 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

Upon deletion of the fault log, the associated fault records are also deleted. In addition, the meters for fault number and fault-record number are reset to 0. In contrast, if you delete fault records, the content of the fault log, including the allocated fault numbers, remains.

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
- Fault log
- Ground-fault log
- Setting-history log
- User log
- Motor-startup 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 → Indications → **Operational log**

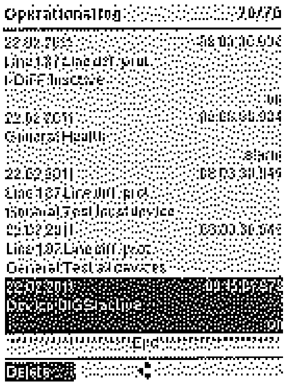


Figure 3-21
Deleting the Operational Log on the On-Site Operation Panel

- 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 prompted, enter the password and confirm with **Enter**.
- After being prompted, confirm the **Deletion of all entries** with **Ok**.

Deleting Logs from the PC with DIGSI 5

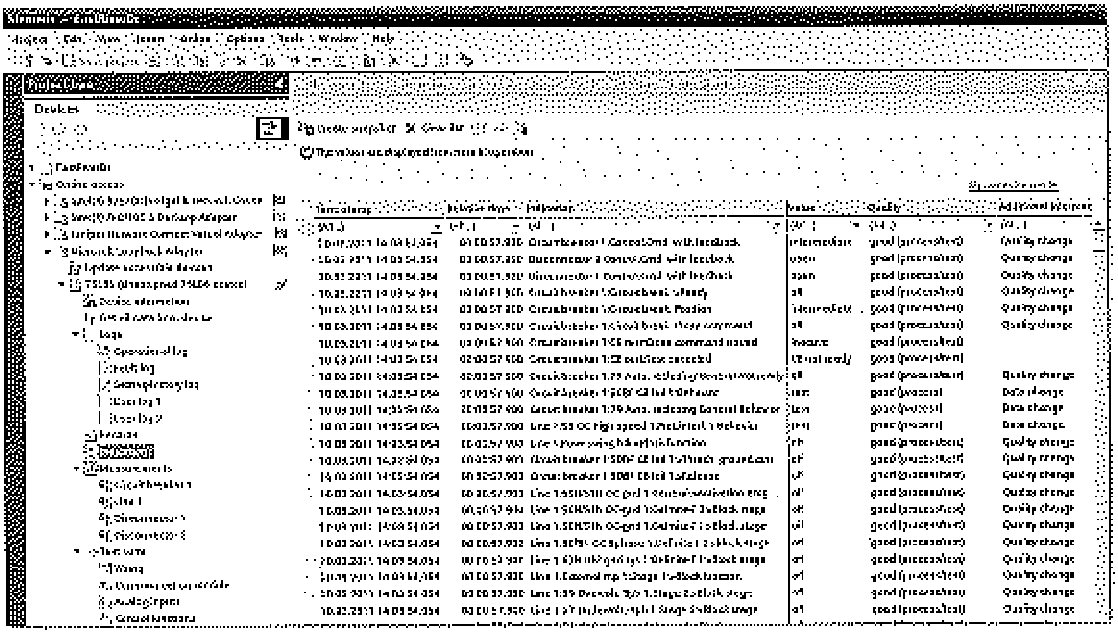
- To reach the selected log of your SIPROTEC 5 device, use the project-tree window (for example, operational log).
  Project → Device → Process data → Logs → **Operational log**

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.



[scsponde-280211-01, 1, en_US]

Figure 3-22 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 reset 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 displayed for each pickup or only pickups with the off command.

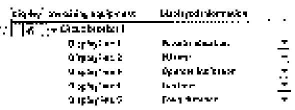


Figure 3-23 Configuration of the Spontaneous Fault Display on the Device

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

Table 3-4 Overview of Display Options

Displayed Information	Explanation
Pickup indication	Display of the first function stage picked up in a fault, as needed with additional 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 additional 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.

Acknowledgement 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 they are manually acknowledged or reset by LED reset.

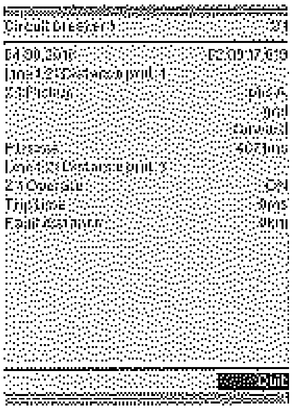


Figure 3-24

Spontaneous Fault Display on the Device

Method 1: Manual acknowledgement

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

Method 2: Acknowledgement 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. For this, go to the project tree.
  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 3-5 Overview of Routing Options

Routing Options		LEDs	BOs	BIs	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, BA) occurs automatically via the binary-signal value.
L	(latched)	X	X		The binary signal is latched when the output (LED) is activated. To reset, a targeted confirmation must occur.
NT	(stored only with tripping)	X			Fault indications are stored when the output (LED) is activated. If the fault is ended via a trip command from the device, the stored state is maintained. In case of dropout of the pickup without trip command from the device (for example, external fault), the state displayed before the fault is restored. **Note:** Observe here the parameter `(_:91:139) Fault-display` with the setting options `with trip` or `with pickup`. For this routing option, select the setting `with trip`.
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.

Acknowledgment of Stored Indications on the On-Site Operation Panel

Acknowledgment via **LED Reset**

Operating the button first causes the activation of all LEDs (LED test) when pressed, and when released the resetting of all stored indications. Stored LEDs, output contacts and spontaneous fault displays are reset.

Acknowledgment via the operating menu

Use the navigation buttons of the on-site operation panel, in order to reach the reset functions from the main menu.

- Select: Main menu → Device functions → **Reset functions**
  You are offered different reset options.
- Open the corresponding submenu.

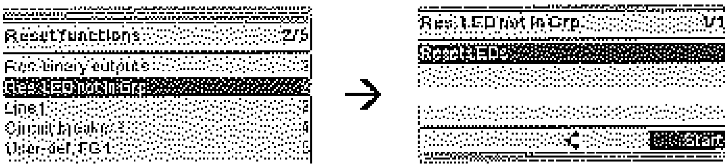


Figure 3-25 Reset Functions on the On-Site Operation Panel

- Use **Res. binary outputs** to reset stored output contacts.
- Actuate the softkey **Start** in the base bar.
- As needed, enter the confirmation ID when requested and then confirm with the softkey **Enter**.
- Use **Reset LEDs not in FG** to reset stored LEDs that are not assigned to a special function group.
- Actuate the softkey **Start** in the base bar.
- As needed, enter the confirmation ID when requested and then confirm with the softkey **Enter**.

Depending on device configuration, the protection function group(s) are displayed to you as submenus for which separately corresponding, stored LEDs can be reset.

- Go to the submenu of the selected function group (example **Line 1**).
- Use **Reset LEDs** to reset stored LEDs in the selected function group.
- Actuate the softkey **Start** in the base bar.
- As needed, enter the confirmation ID when requested and then confirm with the softkey **Enter**.

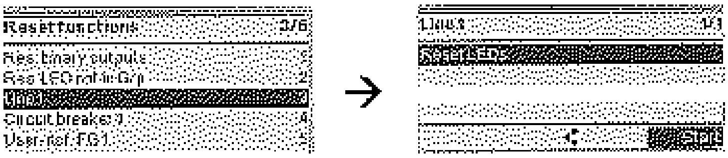


Figure 3-26 Reset Functions on the On-Site Operation Panel (for Example, Line FG)

Acknowledgment of Stored Indications via Binary Inputs

Acknowledgment via entry **>LED Reset**

Acknowledgment via binary input **>LED-Reset** brings about the activation of all LEDs (LED test) and, in case of dropout of signal, the resetting of all stored indications. Stored LEDs, output contacts and spontaneous fault displays are reset.

Acknowledgment of Stored Indications with DIGSI 5

You can acknowledge stored indications via DIGSI 5 in online mode. For this, go to the project tree.

- Select Online access → Interface → Device → **Device information**

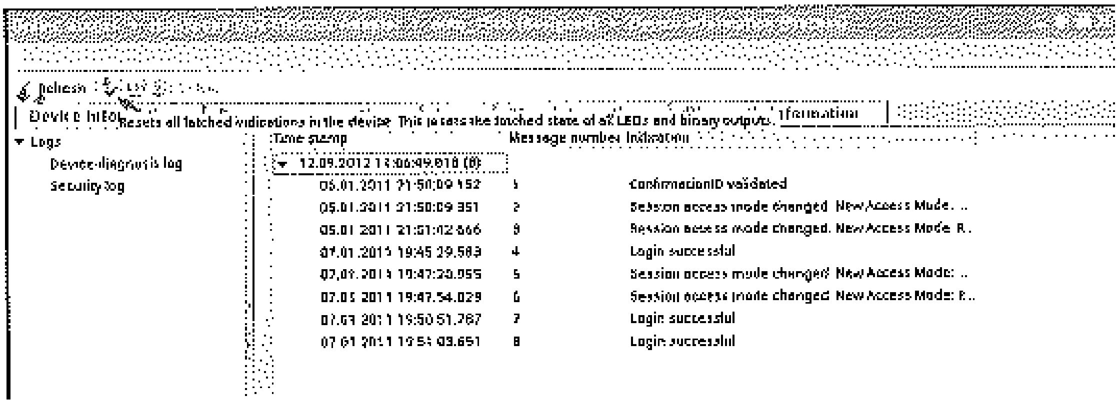


Figure 3-27 LED Reset via DIGSI 5

- Click the LED reset button.
- Enter the confirmation ID.
- Confirm the process with OK.

Stored LEDs, output contacts and spontaneous fault displays are reset on the assigned device.

Acknowledgment of Stored Indications via Log

Initiation of acknowledgment of stored indications can also occur through communication via a connected substation automation technology. This can occur in conformance to standards (IEC 61850, IEC 60870-5-103) or via configuration (mapping) of the LED reset input signal for any protocol. Stored LEDs, output contacts, and spontaneous fault displays are reset.

NOTE

The acknowledgment of **stored** indications then leads to the resetting of configured LEDs and output contacts, as long as these active unstored indications are not present in parallel. That is, indications configured as **unstored** are not affected by the acknowledgment process.

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 Test Mode and Influence of Indications on Substation Automation Technology

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. Necessary reactions in normal operation on the basis of an indication can thus be suppressed.

3.2 Measured-Value Acquisition

Basic Principle

SIPROTEC 5 devices are equipped with a powerful measured-value acquisition function. In addition to a high sampling frequency, they have a high measurand resolution. This ensures a high degree of measuring accuracy across a wide dynamic range. The 24-bit sigma/delta analog-digital converter represents the core of measured-value acquisition. In addition, the oversampling function supports the high measurand resolution. Depending on the requirements of the individual method of measurement, the sampling frequency is reduced (**Downsampling**).

In digital systems, deviations from the rated frequency lead to additional errors. In order to avoid this, 2 algorithm-dependent processes are used in all SIPROTEC 5 devices:

- Sampling-frequency tracking:
  The analog input channels are scanned for valid signals in cycles. The current power frequency is determined and the required sampling frequency is defined by using a **resampling algorithm**. The tracking is effective in the frequency range between 10 Hz and 80 Hz.

- Fixed sampling frequency – correction of the filter coefficients:
  This method operates in a limited frequency range (f_{rated} +/- 5 Hz). The power frequency is determined and, depending on the degree of the frequency deviation, the filter coefficients are corrected.

The following figure shows the basics of dealing with sampled values (SAV) in the measured-value acquisition chain. *Figure 3-28* shows to whom the various sampling frequencies are made available. In order to limit the bandwidth of the input signals, a low pass filter (anti-aliasing filter to maintain the sampling theorem) is installed downstream. After sampling, the current input channels are adjusted. This means the magnitude, phase, as well as the transformer time constant are corrected. The compensation is designed to ensure that the current transformer terminal blocks can be exchanged randomly between the devices.

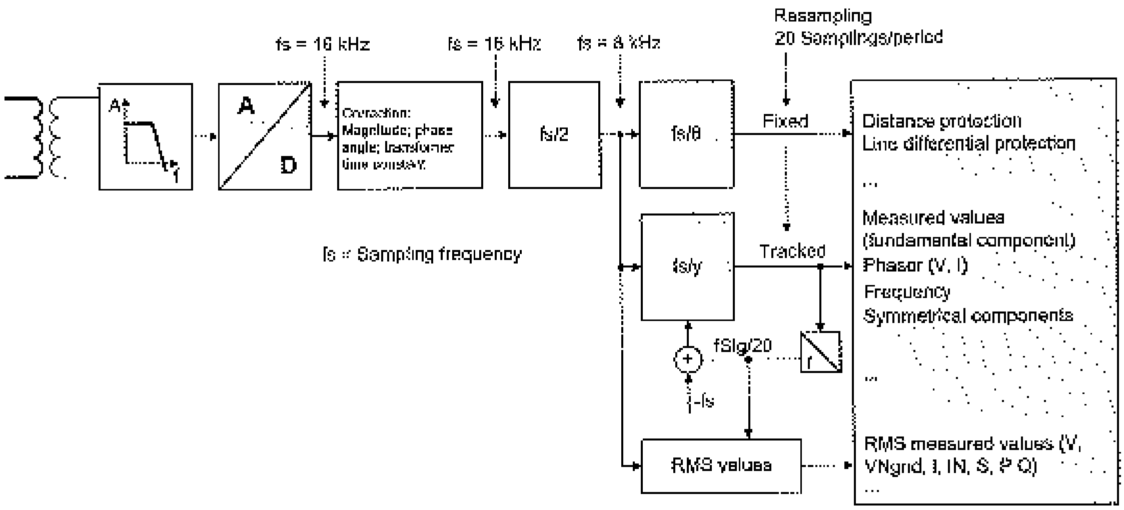


Figure 3-28 Measured Value Acquisition Chain

The internal sampling frequency of the SIPROTEC 5 devices is fixed at 16 kHz (sampling rate: 320 samplings per 50-Hz cycle). All current and voltage inputs are sampled. If the magnitude, phase, and transformer time constant are corrected, the sampling frequency is reduced to 8 kHz (160 samplings per 50-Hz cycle). This is the basic sampling frequency to which various processes, such as fault recording, RMS measured values, refer. For the RMS measurement, the measured value window is adjusted on the basis of the power frequency. For numerous measurement and protection applications , 20 samplings per cycle are sufficient (if f_{rated} = 50 Hz: sampling every 1 ms, at f_{rated} = 60 Hz: sampling every 0.833 ms). This sampling rate is an adequate compromise between accuracy and the parallel processing of the functions (multi functionality).

The 20 samplings per cycle will be made available to the algorithms processed in the function groups, in 2 variants:

- Fixed (not resampled)
- Resampled (frequency range from 10 Hz to 80 Hz)

Depending on the algorithms (see function descriptions), the respective data flow is considered. A higher sampling frequency is used for selected methods of measurement. Detailed information can be found in the corresponding function description.

NOTE

The measuring points for current and voltage are in the **Power-system data** (starting in chapter 6.1 *Power-System Data*). Each measuring point has its own parameters.

3.3 Processing Quality Attributes

3.3.1 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 on the basis of 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.

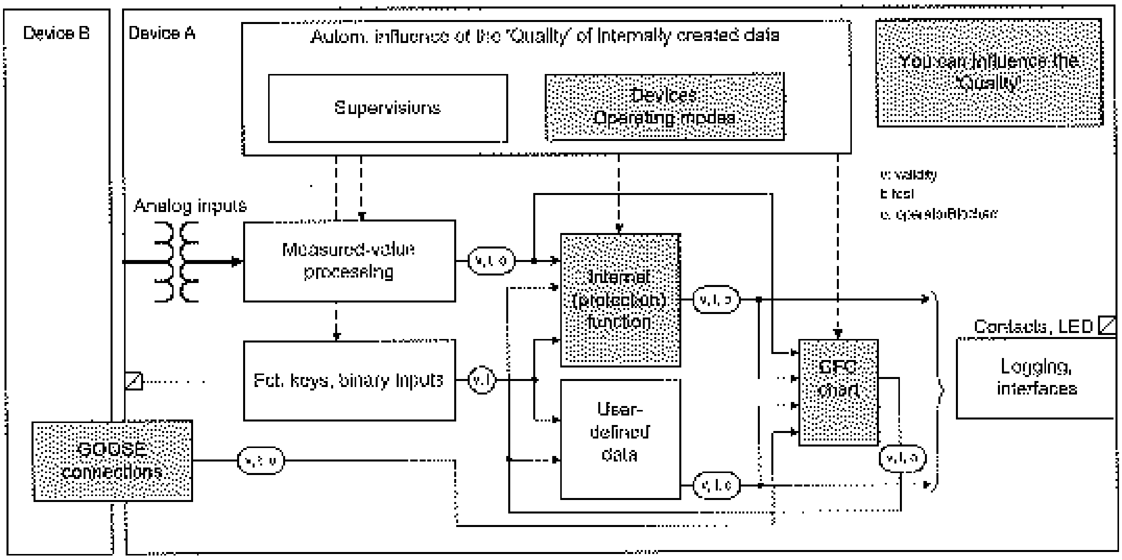


Figure 3-29 Data Flow within a SIPROTEC 5 Device

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 *Figure 3-30*). 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 chapter *3.3.2 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 chapter *3.8.2 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 *3.3.2 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 and measured values) receive the quality attribute **Validity** = *invalid*.

Influencing the Quality through Hardware Supervision

Supervision functions monitor the device hardware (see chapter *9.4 Supervision of the Device Hardware*). If the supervision functions identify failures in the data acquisition of the device, all recorded data will receive the quality attribute **Validity** = *invalid*.

Influencing the Quality through Voltage-Transformer Circuit Breakers

If tripping of the voltage-transformer circuit breaker is detected (see chapter *9.3.4 Voltage-Transformer Circuit Breaker*), 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 of GOOSE connections
- In the CFC chart
- In the **Information routing** editor for binary input signals of device-internal functions

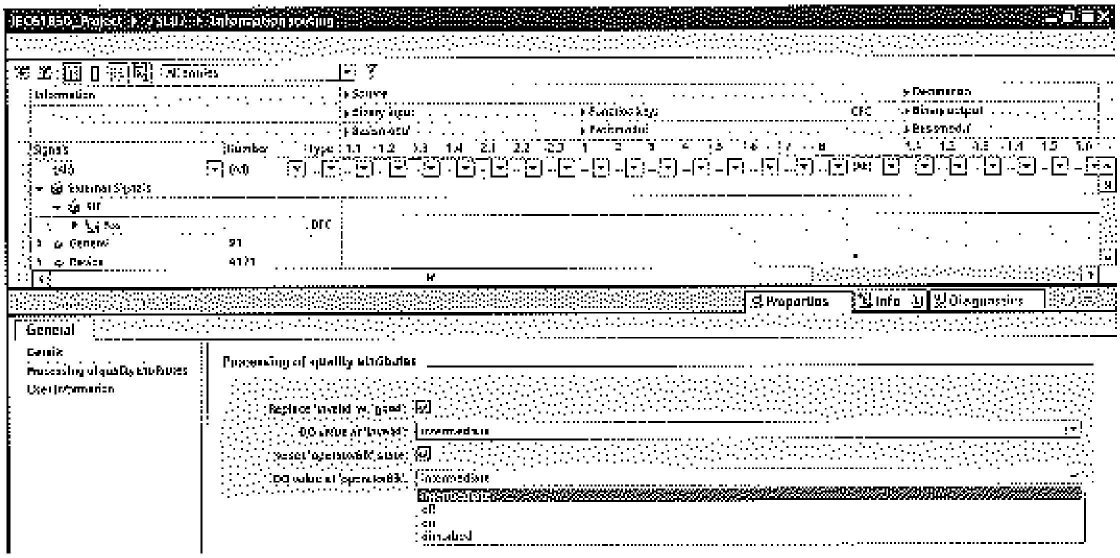
The following chapters describe in more detail the options regarding this influence as well as the automatic quality processing.

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 date 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.

3.3.2 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 an 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 3-30 Influence Option When Linking an DPC Type Data Object

The setting options work for the device receiving the data.

Quality Attribute: Validity	
The validity values *reserved* and *questionable* are replaced at the receiving end by the *invalid* 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 *reserved* and *questionable*).	• The validity attribute is set to *good* 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.

Quality Attribute: OperatorBlocked (opBlk)	
Check box is set and received **OperatorBlocked** = *TRUE*	• The OperatorBlocked attribute is set to *FALSE* 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** = *TRUE*	Regardless of whether the validity check box is set or not, and regardless of the current validity, the validity attribute is set to *good* 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** = *TRUE*	The OperatorBlocked attribute remains set and is forwarded. If the Validity check box is set and the receipt of validity = `invalid` 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 = `invalid` is set, but the quality attribute OperatorBlocked is not yet set.

Data Substitute Values

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

Data Type	Possible Data Substitute Values	
ACD, ACT	general, phsA, phsB, pshC, neut	0 (False), 1 (True)
only ACD	dirGen	0, 1, 2, 3 (Unknown, Forward, Backward, Both)
	dirPhsA, dirPhsB, dirPhsC, dirNeut	0, 1, 2 (Forward, Backward, Both)
BAC, APC	mxVal	$1.401298 \cdot 10^{-45}$ to $7.922 \cdot 10^{28}$
	stSeld	0 (False), 1 (True)
	ctlNum	1 to 255
BCR	actVal, frVal, frTm	0 to 1 073 741 824
CMV	mag, ang	$1.401298 \cdot 10^{-45}$ to $7.922 \cdot 10^{28}$
DPC, DPS	stVal	0, 1, 2, 3 (intermediate-state, off, on, bad-state)
ENUM types (for example, ENS, EN, ENC)	SPS output	0 (False), 1 (True)
	INS output	The qualities of the object of the sending device are taken on.
INC	stVal	0 to 1 073 741 824
	stSeld	0 (False), 1 (True)
ING	setVal	0 to 1 073 741 824
INS	stVal	0 to 1 073 741 824
ISC, BSC	vWTpos	-64 to 64
	vWTInd	0 (False), 1 (True)
SEC	cnt	0 to 1 073 741 824
SPC, SPS	stVal	0 (False), 1 (True)
SPG	setVal	0 (False), 1 (True)

Data Type	Possible Data Substitute Values	
MV	mag	$1.401298 \cdot 10^{-45}$ to $7.922 \cdot 10^{28}$

3.3.3 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** block (see the following figure) under **Device name → Settings → Device settings** in the editor:

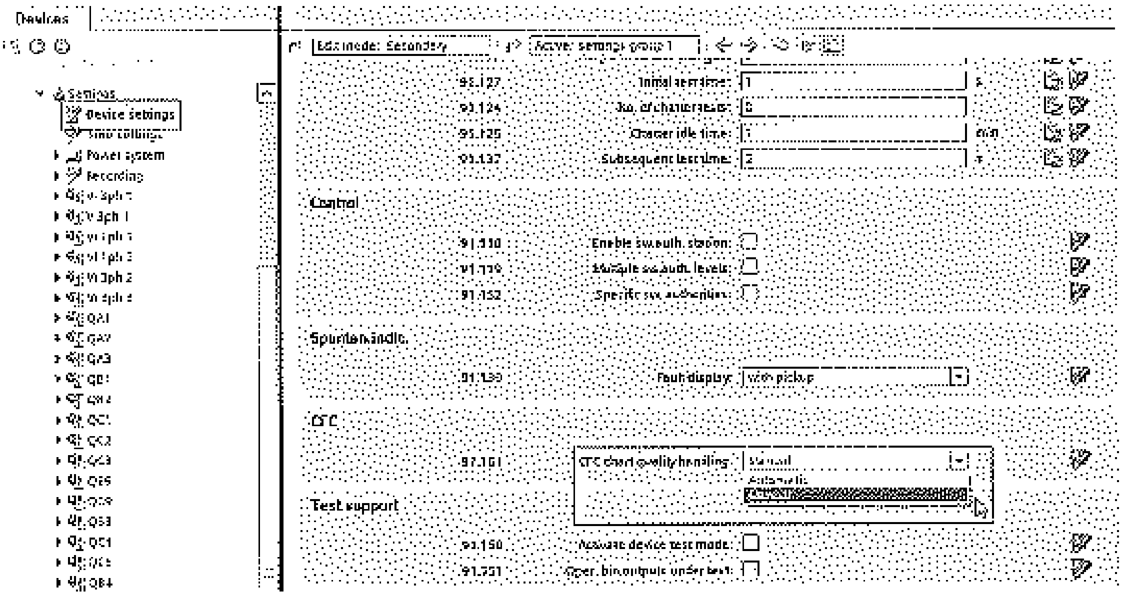


Figure 3-31 Influencing CFC Quality Handling in DIGSI 5

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 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 blocks that are specifically designed for quality processing.

General Processing

Most of the CFC blocks do not have an explicit quality processing. For these 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 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 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 blocks (x_SPS) process the quality automatically according to the stated logic. The other 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 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 *good* (=g) or *invalid* (=i). x = placeholder for the input value and quality attribute **Validity**		
	OR_SPS		
	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
	The output thus has the logical value **1** with **Validity** = *good* as soon as at least 1 input has the logical value 1 with **Validity** = *good*. Otherwise, the inputs are treated according to the OR operation and the INVALID bit is OR-gated for the quality.		
	AND_SPS		
	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
	The output thus has the logical value **0** with **Validity** = *good* as soon as at least 1 input has the logical value **0** with **Validity** = *good*. Otherwise, the inputs are treated according to the AND operation and the INVALID bit is OR-gated for the quality.		
	NEG_SPS		
	A (Value, Attribute)	**Q (Value, Attribute)**	
	0, i	1, i	
	0, g	1, g	
	1, i	0, i	
	1, g	0, g	
SPLIT_SPS **SPLIT_DPS** **SPLI_XMV**	The 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 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 block performs binary separation of the quality into *good*, *bad* (= *invalid*), *test*, *off* and *operatorBlocked*. These 5 attributes can then be processed individually in a binary operation. The block must be connected downstream to a SPLIT_(DO) block.		
BUILD_Q	The building block enters a binary value for *good* and *bad* (= *invalid*) in each quality structure. Thus, with this building block the quality attributes *good* and *bad* (= *invalid*) 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** = *FALSE*. If, for example, the entire CFC chart is in the test state (see Quality Attribute: Test Under General Processing), 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.		

Building Blocks	Description
BUILD_ACD BUILD_ACT BUILD_BSC BUILD_DPS BUILD_ENS BUILD_SPS BUILD_XMV	These blocks merge data value and quality. The block output is generally used as a CFC output. Generally, the BUILD_Q block is connected upstream from these building blocks.

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.

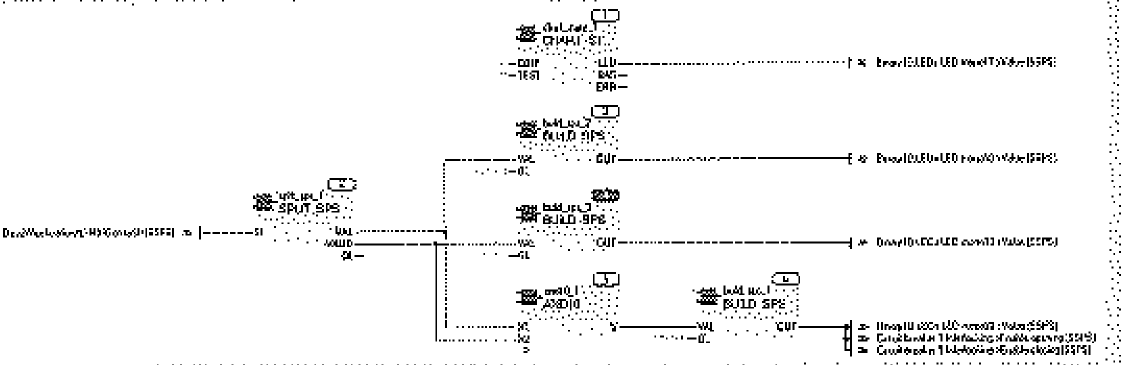
EXAMPLE: Switchgear Interlocking via GOOSE

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.



[scfcrasr-220415-01...1.en_35]

Figure 3-32 CFC Chart with Building Blocks for Quality Processing (Switchgear Interlocking via GOOSE)

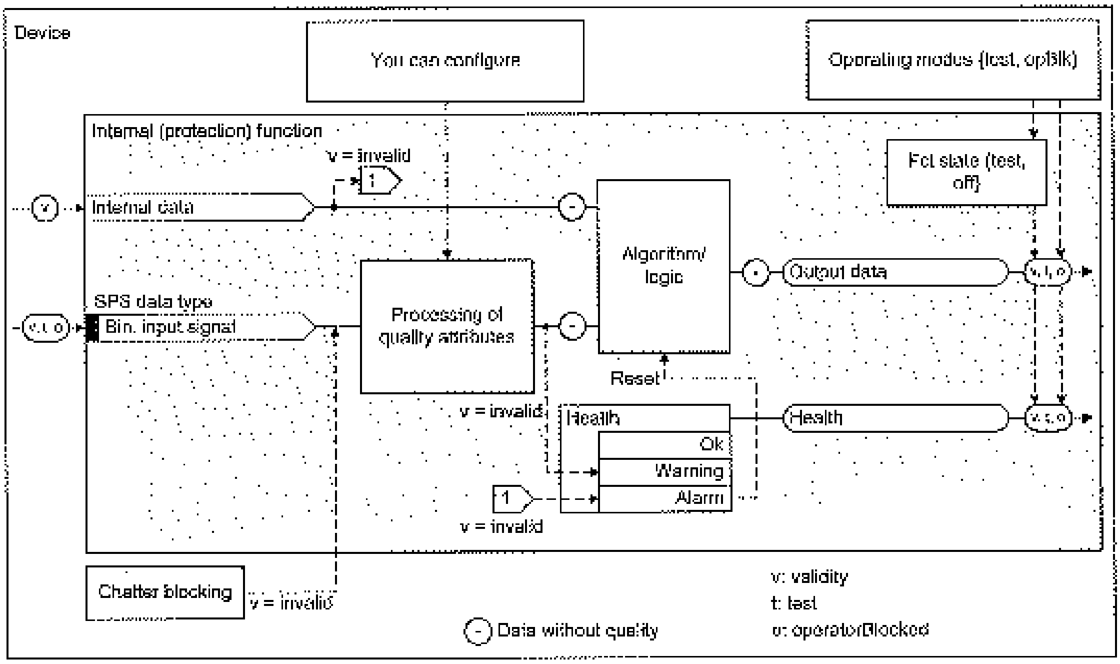
If you do not want to convert the invalid release signal to a valid signal, as described, during the communication interruption, you can also assign a defined data value to the release signal. Proceed as follows: With the SPLIT_SPS building block, split the input signal (data type = SPS) into data value 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.

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

Figure 3-33 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 *3.8.1 Signal Filtering and Chatter Blocking for Input Signals*) sets the corresponding **Validity** attribute to *invalid*.



[dwqua18-100811-01.tif, 2, en_US]

Figure 3-33 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 *invalid* or *good*. • If *invalid*, 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 3-34 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 *3.3.3 Quality Processing/Affected by the User in CFC Charts*
- GOOSE connection: See description in chapter *3.3.2 Quality Processing/Affected by the User for Received GOOSE Values*
- Device hardware: No quality attributes are set and supported.

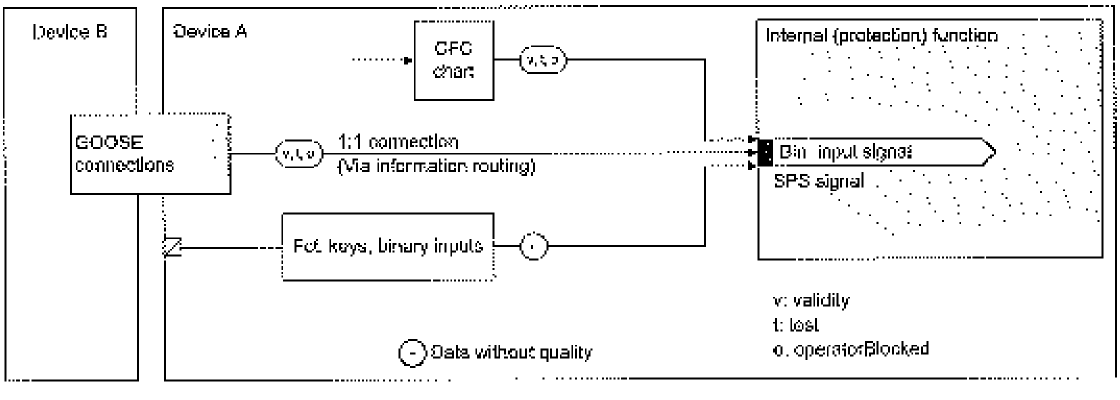
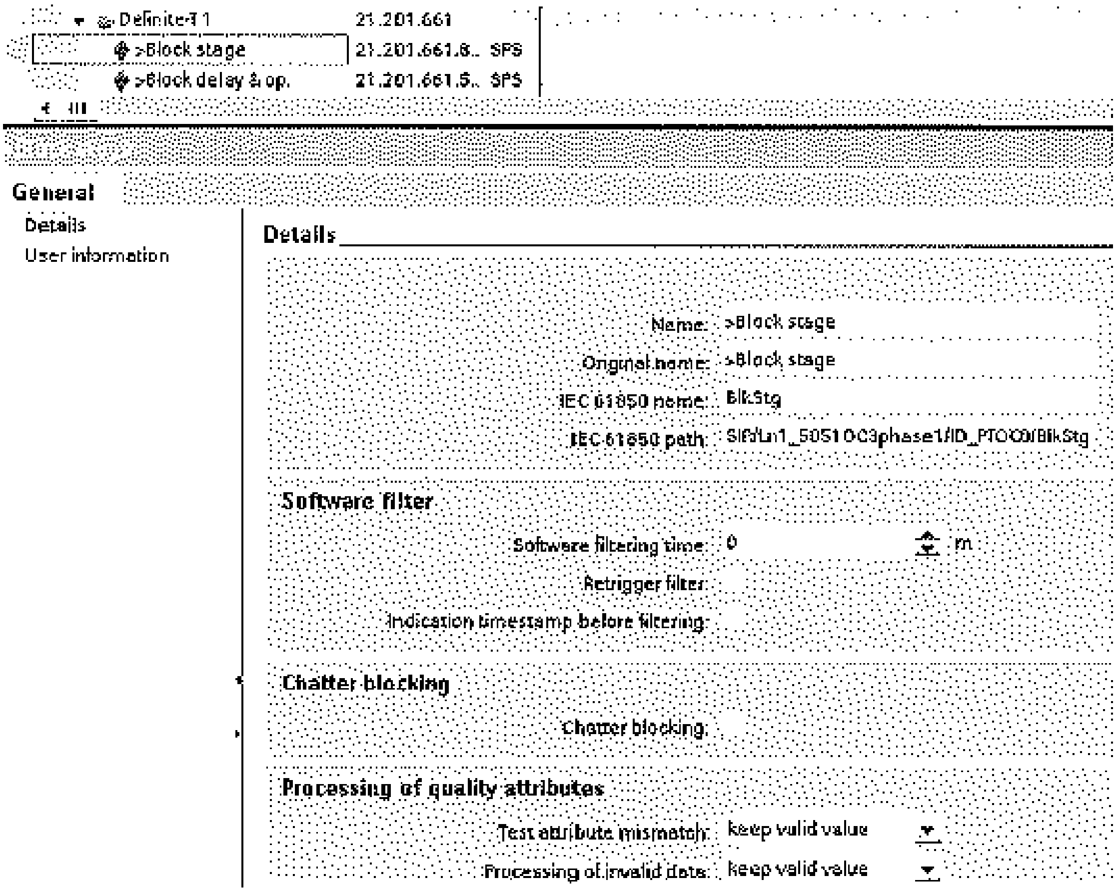


Figure 3-34 Sources for Connecting a Binary Input Signal

For this signal type (SPS), you can influence the processing of the quality, see overview in *Figure 3-33* .

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**.



[scr-fluce-1, en US]

Figure 3-35 Influence Options for a Binary Input Signal (SPS Input Signal)

Quality Attribute: Validity	
The **Validity** attribute can have the values *good* or *invalid* (*reserved* and *questionable* were already replaced at the input end of the device by the value *invalid*).	
The input signal source is *invalid*.	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 *good*.	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.

Quality Attribute: Test	
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 applica tions.

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	DO 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** = *TRUE*	**Test** = *TRUE*
Functional state = **Off** (thus, result of device operating mode = **Off**)	Function-specific, corre- sponding to the definition for switched off	**Validity** = *good*	**Validity** = *invalid*
Function health = **Alarm** (for example, result of invalid receive data)	Function-specific, corre- sponding to the definition for reset	**Validity** = *good*	**Validity** = *invalid*
Device operating mode = **func- tionally logged off**	Unchanged	**Validity** = *good* **OperatorBlocked** = *TRUE*	**Validity** = *good* **detailQual** = *oldData* **OperatorBlocked** = *TRUE*

3.4 Fault Recording

3.4.1 Overview of Functions

All SIPROTEC 5 devices have a fault memory in which fault recordings are kept securely. Fault recording documents operations within the power system and the way in which protection devices respond to them. You can read out fault recordings from the device and analyze them afterwards using evaluation tools such as SIGRA.

A fault record contains the following information:

- Sample values of the analog input channels
- Measured values calculated internally
- Any binary signals (for example, pickup signals and trip signals of protection functions)

You can individually configure the signals to be recorded. Furthermore, you can define the starting condition, the record duration, and the saving criterion of a recording. Fault records saved in the device are also available after a loss of auxiliary voltage.

3.4.2 Structure of the Function

The **Fault recorder** function is a central device function. Both the recording criterion and the measured-value and binary channels to be recorded are functionally preconfigured through the application templates. You are able to individually adapt the configuration in DIGSI 5. The fault recording and the fault log are subject to the same control. This ensures that real time, relative time, and numbering of the fault data are synchronized.

This means that all fault recordings function on the same real-time and relative-time basis.

The data read out via the DIGSI-PC are saved in COMTRADE format. Fault recording data can be transferred to the substation automation technology by request in accordance with the standards via existing communication connections (such as IEC 61850, IEC 60870-5-103). The central device analyzes the data using appropriate programs.

3.4.3 Function Description

The **Fault recorder** function records the sampled values, specific to each device, of all analog inputs, the internally calculated measured values and the binary signals. The configuration, which is predefined for each device via an application template, can be adapted individually.

NOTE

You can find detailed information about selecting and deleting fault records in the Operating Manual (C53000-G5000-C003).

The fault memory of the device is automatically updated with every recording. When the fault memory is filled completely, the oldest records are overwritten automatically. Thus, the most recent recordings are always stored safely. The maximum number of recordings is 128.

Sampling Frequency

The analog measuring channels are sampled at a different sampling rate for fault recording. The `Sampling frequency` parameter is used to set the desired sampling frequency. Possible setting values are 1 kHz, 2 kHz, 4 kHz, and 8 kHz. This setting value applies only to fault recording and does not affect protection functions or calculated measured values.

Record Duration

The overall duration of a single fault recording comprises the total duration of the configurable recording criterion, the `Pre-trigger time` and the `Post-trigger time`. You can set the parameters for these components individually.

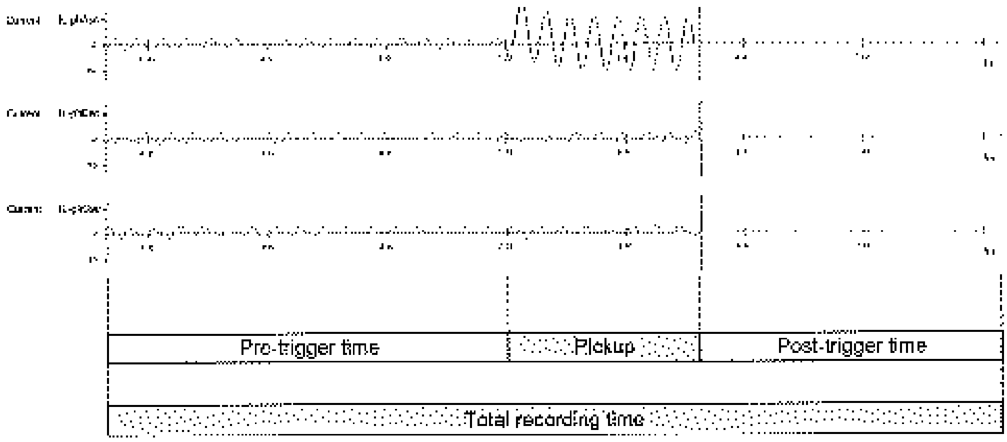


Figure 3-36 Example of a Fault Recording

With the **Fault recording** parameter, you specify the start criterion of the recording.

You can set the following values:

- *with pickup*:

  The fault recording records the complete fault until dropout. The resulting pickup signals of all function groups are taken into account.

- *with pickup & AR cyc.*:

  In connection with an active automatic reclosing function (internal/external), the fault recordings record the fault including the short and long interruptions (automatic reclosing cycles).

- *user-defined*:

  With this setting value, you can individually specify the recording criterion for the fault recording in DIGSI 5. Function-specific recording criteria can be realized in this way.

If a recording criterion reoccurs during the pickup time and post-trigger time, the recording which is currently active is extended to include a new post-trigger time.

For a sampling frequency of 8 kHz and 24 analog channels to be recorded, the duration of one individual fault recording can be up to 20 s.

The maximum record duration can be limited by the **Maximum record time** parameter.

In addition to starting the fault recording via the pickup, the following alternatives are possible:

- Externally via binary input signal *>External start* (for example, from an external protection device without fault recording by an object transferred via a GOOSE message)
- By way of a configurable input signal *>Manual start*, you can start fault records with a configurable length (parameter **Manual record time**).
- With DIGSI 5, you can start test fault records with a fixed length of 1 s.
- With a command from a central device via an existing communication connection (IEC 61850, IEC 60870-5-103)

NOTE

If a pickup signal is present continuously, the fault recording is closed after the **Maximum record time** expires and the fault record cannot be restarted!

Saving the Recording

Not every fault recording that is started actually needs to be saved. With the **Storage** parameter, you specify whether or not you want to save the fault recording that has started. You can also save only fault data for which the pickup of a protection function also caused a tripping. With this setting, faults beyond the self-protection range will not lead to replacing fault recordings that have already been saved.

Configuration of Signals to Be Recorded

All analog inputs of the device that have been configured (currents and voltages) are recorded as sampled channels. Function-specific binary signals (for example, pickup and trip signals) and measured value channels can be configured individually for recording in the DIGSI information-routing matrix. For this purpose, a separate **Content** column is available.

The operational measured values and the measured values of the fundamental components and symmetrical components (see the Device Manual, chapters *10.3 Operational Measured Values* and *10.4 Fundamental and Symmetrical Components*) are calculated every 9 cycles (at 50 Hz, this is every 180 ms). However, this can mean that the data are not synchronized with the sampled values of the analog channels. The recording of these measured values can be used to analyze the slowly changing processes.

Numbering and Time Stamping

All fault recordings saved are automatically numbered in ascending order and assigned a real-time stamp for the start time. The fault recording logs the fault with a relative time. The reference-time point is the start of the recording. Every fault record has a corresponding fault log with the same number. This ensures that the fault recording can be uniquely assigned to the event log.

Fault Memory

The device manages its available fault memory dynamically, so that the maximum recording capacity is always available. When exceeding the limits of the fault memory, the oldest recordings are automatically overwritten. This means that the most recent records are always available. The sampling rate, type, and number of measured value trends to be recorded are the crucial variables when it comes to restricting the length and number of records possible. Parallel to the sampled tracks, up to 50 tracks with function-specific measured values and up to 100 binary tracks can be recorded. The following table provides an overview of the maximum storage capacities, in seconds, for different connection variations of the protection devices.

Table 3-6 Maximum Length of all Stored Records

Connection Examples	Sampling 1 kHz	Sampling 2 kHz	Sampling 4 kHz	Sampling 8 kHz
Feeder: 4I, 6 measured values, 20 binary tracks	1365 s	819 s	455 s	241 s
Feeder: 4I, 4V, 20 binary tracks	1125 s	566 s	284 s	142 s
Feeder: 4I, 4V, 6 measured values, 20 binary tracks	890 s	500 s	266 s	137 s
Feeder 1.5 CB: 8I, 8V, 6 measured values, 20 binary tracks	525 s	281 s	145 s	74 s

Input and Output Signals

The **Fault recorder** function provides several input signals that allow the precise starting , deleting of records. The output signals provide information about the function status.

In the following table, you can find input signals of the **Fault recorder** function:

Name	Type	Description
Control: Start recording	SPC	Start recording via the function key
Control: Reset memory	SPC	Delete all recording via the function key. The error numbers are reset.
Control: Delete memory	SPC	Delete all recording via the function key. The error numbers remain as is.

Name	Type	Description
Control: >External start	SPS	Start recording by an external binary signal, for example, by the trip command of an external protection device without separate recording. The set pre and post-trigger time are taken into account.
Control: >Manual start	SPS	Start a recording of fixed duration (parameter `Manual record time`) by way of an external binary signal, for example, manually via the function key or by an external binary signal.

In the following table, you can find output signals of the **Fault recorder** function:

Name	Type	Description
General: Mode	ENC	Status feedback of the fault recording according to chapter 2.3 *Function Control*
General: State	ENS	
General: Standby	ENS	
Control: Error number	INS	The indication of the current error number allows a unique allocation of entries in the message buffers for the recorded fault records.
Control: Recording started	SPS	Fault recording running

3.4.4 Application and Setting Notes

Parameter: Fault recording

- Recommended setting value (_:2761:130) `Fault recording` = *with pickup*

With the `Fault recording` parameter, you define the time interval at which faults are recorded. The total record duration is defined as the duration of the fault plus the total of the parameters `Pre-trigger time`, `Post-trigger time` and is limited by the maximum record duration.

Parameter Value	Description
with pickup	The fault recording time is determined by the total number of all protection pickups. The resulting pickup signals of all function groups are taken into account. Note: When the post-trigger time has expired, the indications of an automatic reclosing function are not recorded. Evolving faults after expiry of the post-trigger time can result in the opening of a new fault with its own recording.
with pickup & AR cyc.	The fault recording time is determined by the total number of all protection pickups including short and long interruptions (automatic reclosing cycles). It includes the resulting pickup signals of all function groups and the runtimes of initiated automatic reclosing cycles for all active automatic reclosing functions.
user-defined	The fault recording time is defined user-specific. Note: You must specify all signals for individual definition of the fault recording time in the DIGSI 5 information routing matrix. In the information routing matrix in the **Fault record** column, the fault recording has for this purpose a separate column **Trigger**. The record duration is calculated from the logical OR operation of all initiated, configured signals.

Parameter: Storage

- Recommended setting value (_:2761:131) `Storage` = *always*

With the `Storage` parameter, you define the storage criterion for a fault recording that has already started.

Parameter Value	Description
always	Each fault recording that has been started is saved.
with trip	If at least one protection function issues an operate indication during the record time, any fault recording that has been started will be saved.

Parameter: Maximum record time

- Default setting (_:2761:111) **Maximum record time** = *5.00 s*

With the **Maximum record time** parameter, you configure the maximum record duration for an individual fault recording. When the time configured expires, an ongoing fault recording is canceled. This parameter merely limits the duration of the fault recording. It does not affect the logging of faults in the fault log.

Parameter: Pre-trigger time

- Recommended setting value (_:2761:112) **Pre-trigger time** = *0.50 s*

With the **Pre-trigger time** parameter, you configure the pre-trigger time for an individual fault recording. The set pre-trigger time is prepended to the actual recording criterion for the fault recording.

Parameter: Post-trigger time

- Recommended setting value (_:2761:113) **Post-trigger time** = *0.50 s*

With the **Post-trigger time** parameter, you configure the post-trigger time for an individual fault recording. The post-trigger time that has been configured is added to the actual recording criterion for the fault recording after the dropout.

Parameter: Sampling frequency

- Recommended setting value (_:2761:140) **Sampling frequency** = *8 kHz*

With the **Sampling frequency** parameter, you define the sampling frequency of the fault recording. Possible setting values are 8 kHz, 4 kHz, 2 kHz, and 1 kHz.

Parameter: Manual record time

- Recommended setting value (_:2761:116) **Manual record time** = *0.50 s*

With the parameter **Manual record time**, you set the duration of a recording if the fault record is activated dynamically (edge-triggered) via a separately configured input signal *>Manual start*.
In this case, pre-trigger and post-trigger times do not take effect.

3.4.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2731:1	General:Mode		• on • test	on
Control				
_:2761:130	Control:Fault recording		• with pickup • with pickup & AR cyc. • user-defined	with pickup
_:2761:131	Control:Storage		• always • with trip	always
_:2761:111	Control:Maximum record time		0.20 s to 20.00 s	5.00 s
_:2761:112	Control:Pre-trigger time		0.05 sto 4.00 s	0.50 s
_:2761:113	Control:Post-trigger time		0.05 sto 0.50 s	0.50 s

Addr.	Parameter	C	Setting Options	Default Setting
_:2761:116	Control:Manual record time		0.20 s to 20.00 s	0.50 s
_:2761:140	Control:Sampling frequency		• 8 kHz • 4 kHz • 2 kHz • 1 kHz	2 kHz

3.4.6 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			
_:2761:300	Control:Start record	SPC	C
_:2761:305	Control:Reset memory	SPC	C
_:2761:306	Control:Clear memory	SPC	C
_:2761:502	Control:>External start	SPS	I
_:2761:503	Control:>Manual start	SPS	I
_:2761:310	Control:Fault number	INS	O
_:2761:311	Control:Recording started	SPS	O
_:2761:314	Control:Record made	SPS	O
_:2761:327	Control:Tmax reduced	SPS	O

3.5 Protection Communication

3.5.1 Overview

Protection communication includes all functionalities required to exchange data via the protection interface (PI). It manages one or a maximum of 2 protection interfaces. The **Protection communication** is generated with the configuration of the channels as a protocol.

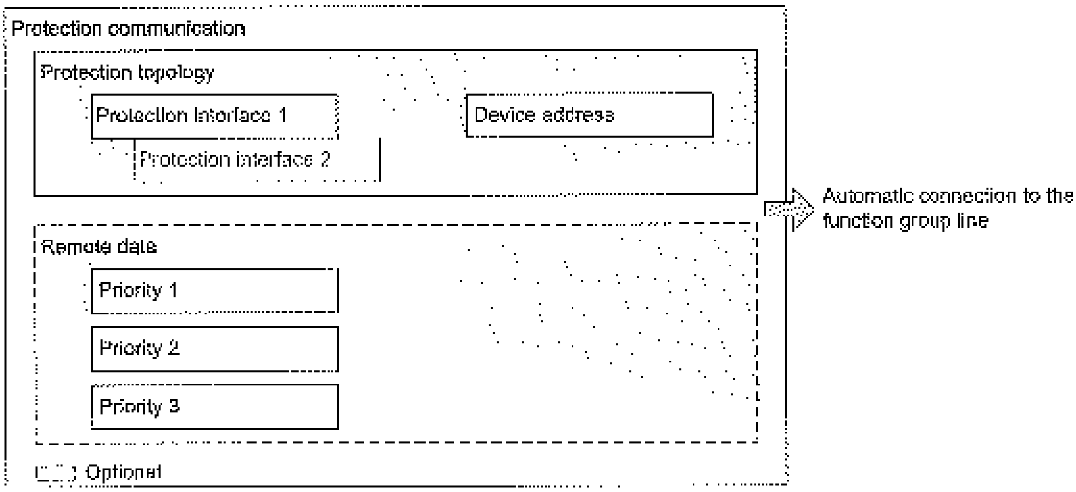
You can find detailed information in the section **Protection interface** in chapter 3.5.3.1 *Overview of Functions*.

3.5.2 Protection-Communication Structure

The following **Protection communication** functions are visible:

- Topology recognition
- Remote data

The following figure shows the structure of **Protection communication**:



[dwpdvs03-171012-01.tif, 1, en_US]

Figure 3-37 Protection-Data Communication Structure

Interface to VI 3-Phase Function Group

Binary signals, measured values, and other data are automatically exchanged between the **Protection-data communication** and the **VI 3-phase** protection function group.

Interface to Motor Function Group

Binary signals, measured values, and other data are automatically exchanged between the **Protection-data communication** and the **Motor** protection function group.

Remote Data

The **Remote data** functionality is applied if you route a specific signal or a measured value to the protection interfaces. The protection interface then attends to the transmitting and receiving of such signals. The maximum amount of remote data is defined by the available bandwidth.

3.5.3 Protection Interface and Protection Topology

3.5.3.1 Overview of Functions

The **Protection topology and protection interface**function enables data exchange between the devices via synchronous serial point-to-point connections from 64 Kbits/s to 2 Mbits/s. These connections can be established directly via optical fibers or via other communication media, for example, via dedicated lines or via communication networks.

A protection topology consists of 2 to 6 devices which communicate via protection interfaces. It can be set up either as a redundant ring or as a chain structure. Within a topology, the protection interfaces can have a different bandwidth. Depending on the bandwidth, a certain amount of binary information and measured values can be transmitted bi-directionally between the devices. The connection with the lowest bandwidth defines this amount (of binary information and measured values).

The following information that is significant for the function of the protection interface is also transferred. You cannot change this information:

- Topology data and values are exchanged for monitoring and testing the connection.
  The results are displayed on the device or with DIGSI 5.
- Protection data, for example, differential protection data or teleprotection scheme binary data, are transferred for distance protection and ground-fault protection.
- The devices can be synchronized in time via the connection, whereby a device of the protection topology assumes the role of the timing master.

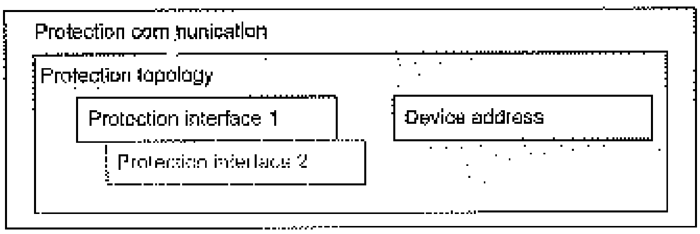
The connection is continuously monitored for data faults and outage, and the time delay of the data is measured.

The protection interfaces are typically used for differential protection and with the teleprotection scheme for distance protection and ground-fault protection. In SIPROTEC 5, you can configure protection interfaces in all devices and then use them for further protection applications. At the same time, any binary information and measured values can be transferred between the devices.

3.5.3.2 Structure of the Function

The protection interfaces of a device are located in the Protection communication function group. A device has 1 or 2 specifically parameterizable protection interfaces.

The **protection topology** is used for administration of that topology data relevant to the respective interfaces and containing data from other devices in the protection topology.



[dwstruct-…]

Figure 3-38 Structure of the Protection Interface in a Device

The protection communication runs physically via a serial optical communication module. This module can have 1 or 2 channels. The protection communication can take place via various modules. This depends on the type of interface and the application. DIGSI 5 is used to configure 1 or 2 channels of a serial optical module as a protection interface. This enables communication with the values set at the **protection interface** via this channel.

3.5.3.3 Function Description

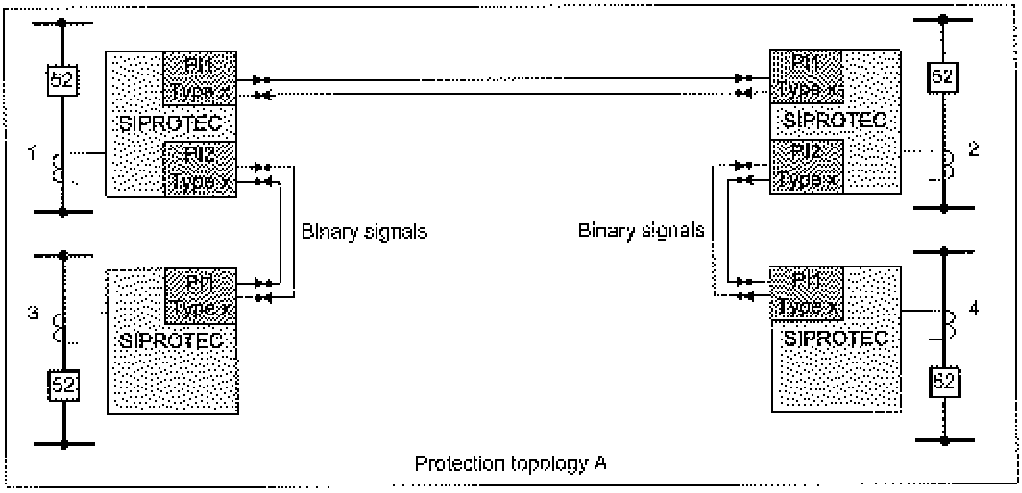
Topology and Type of Protection Communication

The protection interfaces (PI) establish a direct point-to-point connection between devices via different communication media. Data can be transferred within the switchgear or between switchgears.

Devices connected to one another with protection communication form a protection topology. Refer to *Figure 3-39*.

The protection communication in a device can be either type 1 or type 2. In the case of devices with differential protection function (7SD and 7SL), a protection communication of type 1 is automatically created. Type 2 is created for other devices, and is used for other data transmission. A device can contain only the same types of protection communication. Type 1 and type 2 protection communication do not work together in pairs via a protection function.

Types	Description
Type 1 Application using differential protection	With type 1, the differential protection function is the primary application. This application requires the greatest portion of the bandwidth, so that with type 1 the number of signals additionally available is lower. This becomes noticeable with a 64-kbps protection connection via a G703.1 or X21 interface. If a multiple-end differential-protection application is realized, all protection communications must be of type 1. A maximum of 6 line ends is possible. If the **Differential protection** and **Teleprotection scheme** functions are to operate in parallel in the device, the bit rate must not be less than 512 kbps!
Type 2 Application without using differential protection	Type 2 has a significantly higher amount of information that can be transferred as the differential-protection application is not used here. The transmission of protection data and other data, for example, measured values, 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.



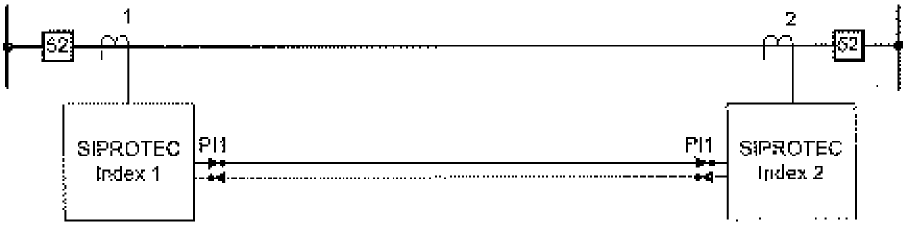
[dw_multi_090211-02.01, 1, en_US]

Figure 3-39 Data Exchange between 4 Devices with Protection Communications of Type 1 or Type 2 in a Protection Topology

2-Device Topology: Simple or Redundant Transfer

In the case of a simple 2-device topology, one protection communication per device is required (see next figure).

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



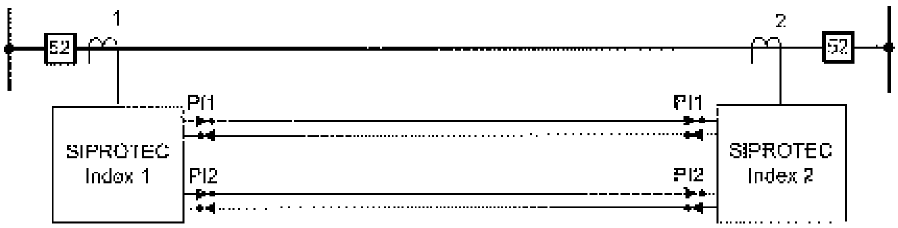
[dw_rrrr-0-0211-0001-1-en_US]

Figure 3-40 Data Exchange for 2 Devices, Each Having Protection Communication

NOTE

The index describes the consecutive numbering of the devices in a protection topology (see parameter `Local device is device`).

A maximum of 2 protection communications can be integrated in one device (see next figure). If 2 protection communications of the same type are connected to one another, 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 connection fails, the system switches over automatically to the 2nd connection until the 1st connection is available again. As the connection with lower bandwidth defines the maximum amount of transferable information, the same information is exchanged via both connections. Both protection communications in the device are then of type 1.



[dwrrrrr-00211-0217-1-en_US]

Figure 3-41 Data Exchange for 2 Devices, Each Having 2 Protection Communications/Redundant Transmission Route

Protection-Interface Information Transfer

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

There are 3 different priorities when transferring protection-interface information:

- **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 a maximum of every 100 ms.

The number of customer-specific signals, indications, and measured values conform with the remaining bandwidth. The remaining bandwidth is lower than with all other protection functions (type 2) when using a differential protection (type 1). 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 the highest transmission rate of 2 Mbps and is immune to failures in the communication route while offering the shortest transmission time. This also enables the transmission of a large amount of additional information on differential protection routes and the remote control of devices at the remote end with DIGSI 5.

The distance to be bridged and the transmission paths 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 Mbps, offers a direct fiber-optic connection to a multiplexer with the corresponding interface.

Table 3-7 to *Table 3-8* 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 with 2 channels, 2 protection interfaces 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 3-7 Plug-In Modules for Applications with the Protection Interface

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[1]	Module Type: USART-AJ-1LDFO[2]	Module Type: USART-AX-2LDFO[3]	Module Type: USART-AY-2LDFO[4]
Physical Connection										
1 x optical serial, 1300 nm, duplex LC plug, 24 km via 9/125 µm singlemode optical fibers, 4 km via 62.5/125 µm multimode optical fibers	●									
2 x optical serial, 1300 nm, duplex LC plug, 24 km via 9/125 µm singlemode optical fibers, 4 km via 62.5/125 µm multimode optical fibers		●								
1 x optical serial, 1300 nm, duplex LC plug, 60 km via 9/125 µm singlemode optical fibers			●							
2 x optical serial, 1300 nm, duplex LC plug, 60 km via 9/125 µm singlemode optical fibers				●						
1 x optical serial, 1550 nm, duplex LC plug, 100 km over 9/125 µm singlemode optical fibers					●					
2 x optical serial, 1550 nm, duplex LC plug, 100 km via 9/125 µm singlemode optical fibers						●				
1 x optical serial, bi-directional via 1 optical fiber, 1300/1550 nm (Tx/Rx), simplex plug LC, 40 km via 9/125 µm singlemode optical fiber							●			

[1] USART-AH-1LDFO only pairs with USART-AJ-1LDFO or USART-AY-2LDFO on the opposite side
[2] USART-AJ-1LDFO only pairs with USART-AH-1LDFO or USART-AX-2LDFO on the opposite side
[3] USART-AX-2LDFO only pairs with USART-AJ-1LDFO or USART-AY-2LDFO on the opposite side
[4] USART-AY-2LDFO only pairs with USART-AH-1LDFO or USART-AX-2LDFO on the opposite side

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[1]	Module Type: USART-AJ-1LDFO[2]	Module Type: USART-AX-2LDFO[3]	Module Type: USART-AY-2LDFO[4]
Physical Connection										
1 x optical serial, bi-directional via 1 optical fiber, 1550/1300 nm (Tx/Rx), simplex plug LC, 40 km via 9/125 µm singlemode optical fiber								●		
2 x optical serial, bi-directional via 1 optical fiber, 1300/1550 nm (Tx/Rx), 2 x simplex LC plug, 40 km via 9/125 µm singlemode optical fiber									●	
2 x optical serial, bi-directional via 1 optical fiber, 1550/1300 nm (Tx/Rx), 2 x simplex LC plug, 40 km via 9/125 µm singlemode optical fiber										●

Table 3-8 Plug-In Modules USART-AD-1FO and USART-AE-2FO

Plug-In module	Plug-In Module USART-AD-1FO	USART-AE-2FO
Physical Connection		
1 x optical serial, 820 nm, ST connector, 1.5 km via 62.5/125 µm multimode optical fibers	●	
2 x optical serial, 820 nm, ST connector, 1.5 km via 62.5/125 µm multimode optical fibers		●
Application		
Protection interface (Sync. HDLC, IEEE C37.94)	X	X

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.

[1] USART-AH-1LDFO only pairs with USART-AJ-1LDFO or USART-AY-2LDFO on the opposite side
[2] USART-AJ-1LDFO only pairs with USART-AH-1LDFO or USART-AX-2LDFO on the opposite side
[3] USART-AX-2LDFO only pairs with USART-AJ-1LDFO or USART-AY-2LDFO on the opposite side
[4] USART-AY-2LDFO only pairs with USART-AH-1LDFO or USART-AX-2LDFO on the opposite side

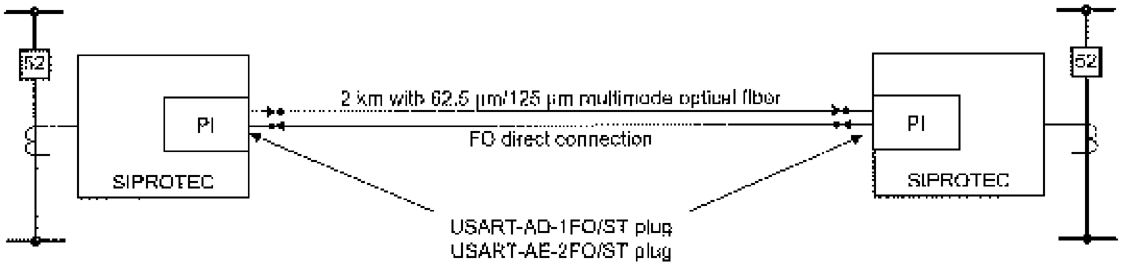


Figure 3-42 Connection over Short Distances, 1.5 km to 2 km via Multimode Optical Fiber

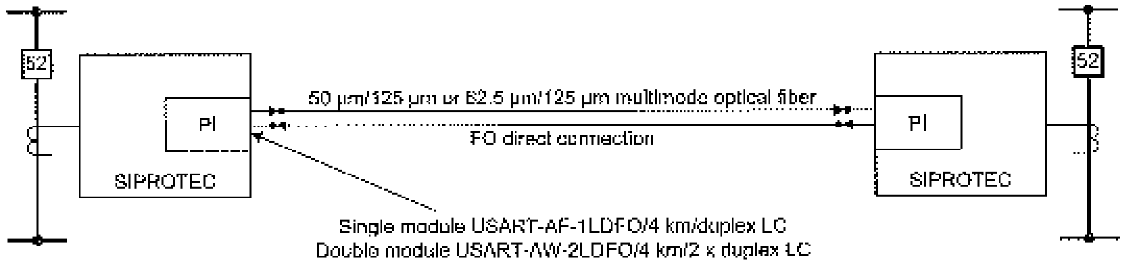


Figure 3-43 Connection over Maximum 4 km via Multimode Optical Fiber

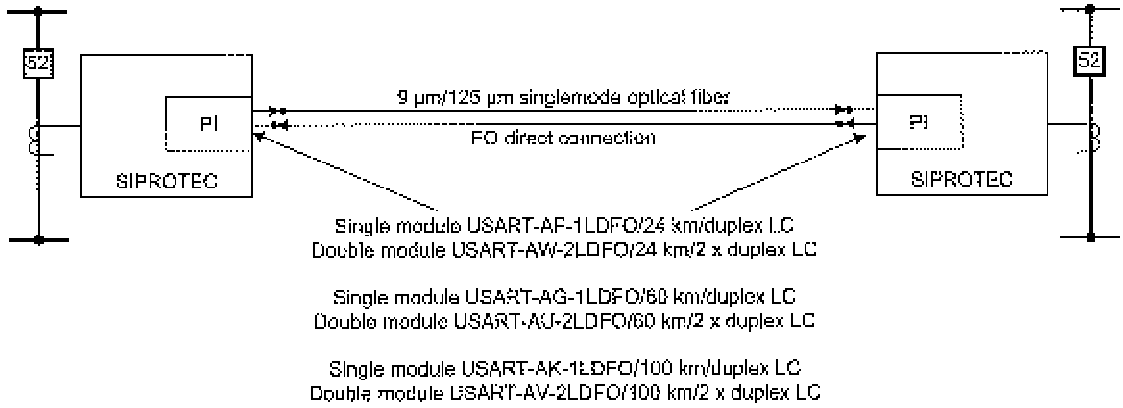


Figure 3-44 Connection via Different Distances via Singlemode Optical Fiber

NOTE

In order to prevent optical overload of the receiver, a 7XV5107-0AA00 attenuator must be used on one side in the fiber-optic modules USART-AF, USART-AG, USART-AU, USART-AK, and USART-AV for distances of less than 25 km/50 km.

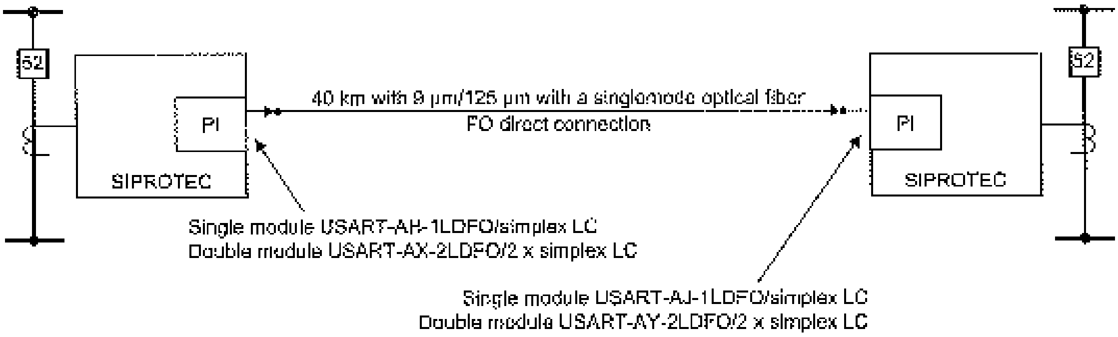


Figure 3-45 Connection via Singlemode Optical Fiber

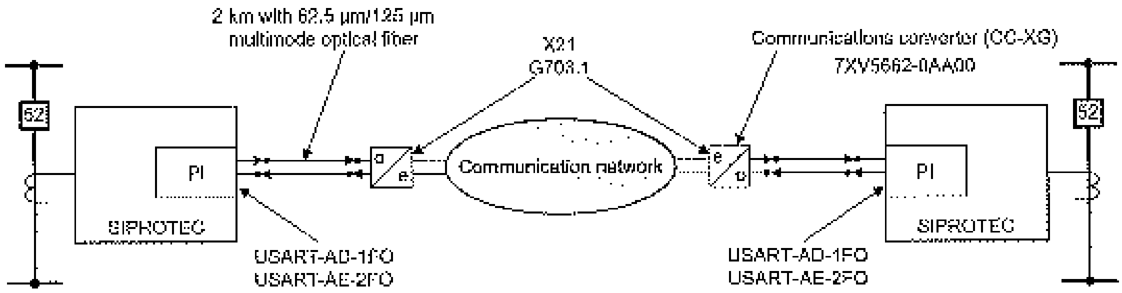


Figure 3-46 Connection via Communication Network with a G703.1 Interface

The connection to the multiplexer is established via a communication converter with a G703.1 interface (64 kbps) or X21 interface (64 kbps to 512 kbps). 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 3-9*.

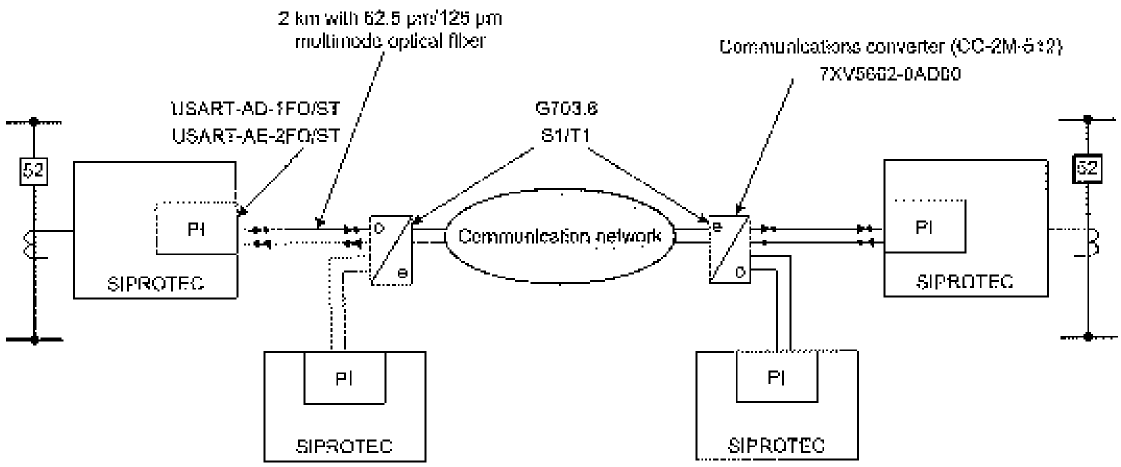
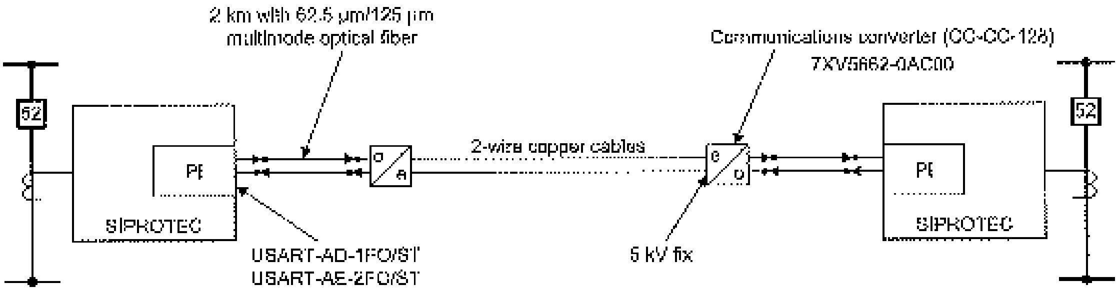


Figure 3-47 Connection via Communication Network with a G703.6 Interface

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

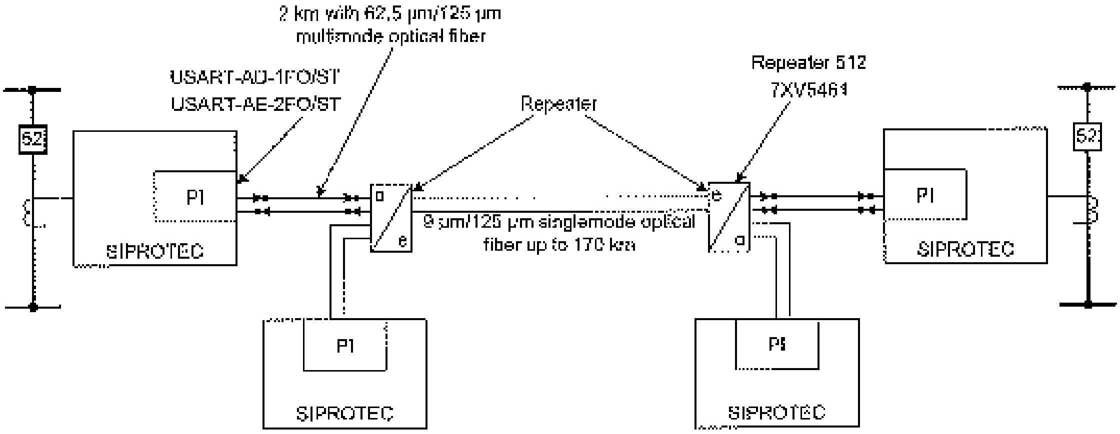
Make the setting for the bit rate with KU-2M-512 with 512 kbps in accordance with *Table 3-9* with the parameter **Connection via**.



[dwku2k07-070611-01.tif, 1, en_US]

Figure 3-48 Connection via 2-Wire Copper Cables

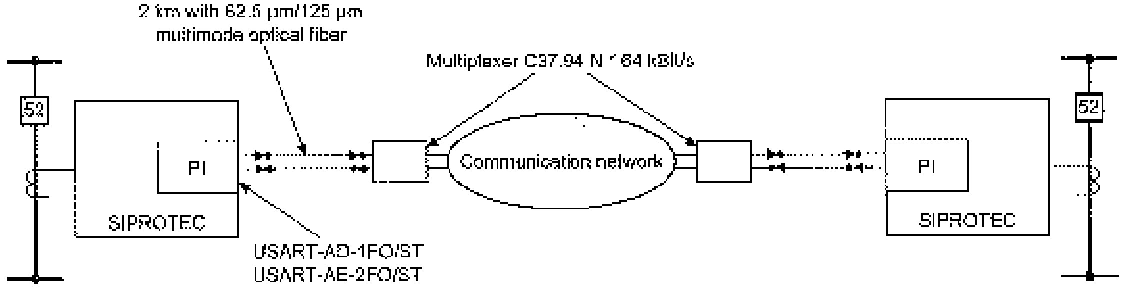
The connection to a communication converter with an integrated 5-kV isolation voltage is established with 128 kbps (KU-KU-128 setting in accordance with *Table 3-9*). A 20 kV isolation of the 2-wire connection is possible via an external 7XR9516 isolating transformer.



[dwrepeat-070611-10.tif, 1, en_US]

Figure 3-49 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 kbps (repeater 512 setting in accordance with *Table 3-9*).



[dwmux6p8-070611-01.tif, 1, en_US]

Figure 3-50 Direct Optical Connection to a Multiplexer with a C37.94 N * 64 kbps 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 communication routes via the same multiplexer board, as no more substitute paths are possible if the board fails.

Supervision of the Communication

The communication is continuously monitored by the devices.

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. 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 communication route exists (as in the ring topology), the protection function operating with the protection interface is not operating and the remote signals are 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

All devices of a topology can be time-synchronized with one another. Synchronization is carried out with millisecond accuracy. The synchronization works independently of the protection function and is exclusively for simultaneous time keeping in the devices of a protection topology.

The device you set in the parameter `Address of device 1` is the device with index 1. This device functions as the timing master in a protection topology. 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 of this topology via the protection interfaces. The time of the timing master is typically synchronized via a substation automation protocol (for example, Ethernet or SNTP) or via IRIG-B. 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 source upon outage of the 1st source in the timing master. This time is communicated with millisecond accuracy to the other devices of the topology.

Set the protection interface as the 1st time source in the other devices of the topology. In this way, all events in the devices of the protection topology are recorded with the same time and are time-synchronized even across different substations. This simplifies fault analysis and the fault records are recorded with the same time in all devices.

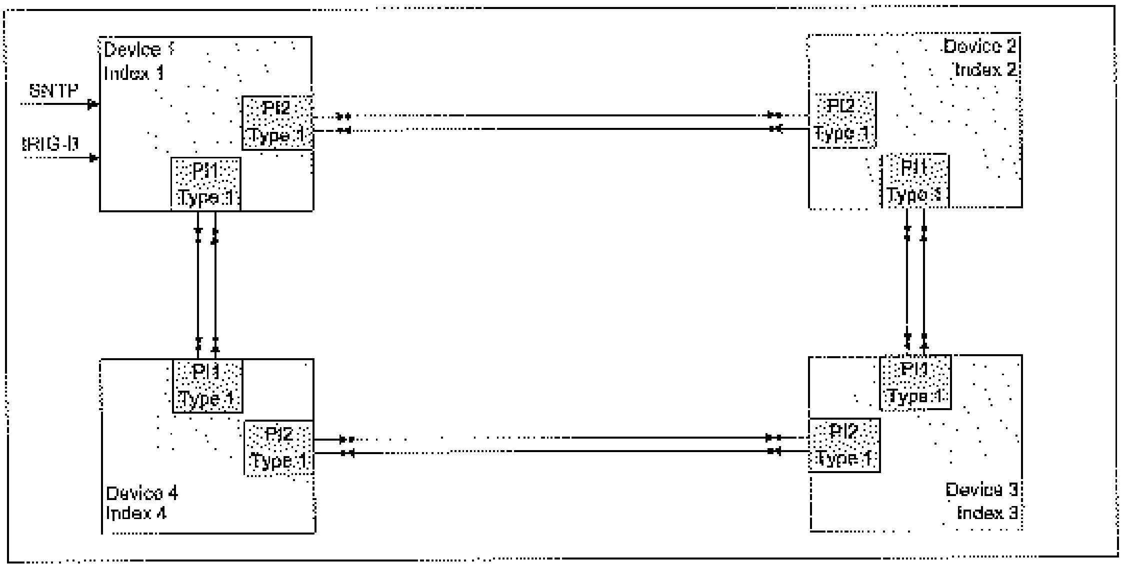


Figure 3-51 Time Synchronization in a Protection Topology

Figure 3-51 shows how device 1 with index 1 is synchronized with the devices 2, 3, and 4 via the protection interface. Device 1 is synchronized externally from 2 sources (IRIG-B and SNTP via Ethernet).

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

The measured values of the line differential protection for the various line ends are synchronized with each other with microsecond accuracy via the mechanisms of the protection interface. The protection interface displays this state with the RAISING indication *Protection interface synchronized*.

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

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.**

Synchronization via GPS Second Pulse

Millisecond-accurate synchronization of the devices (1*10E-06 s), connected via protection interfaces, can take place via a high-precision GPS second pulse at the time-synchronous port G for special differential protection applications or synchrophasor measuring devices. As a result, the transmission time of the communication route can be measured and displayed separately in the forward and reverse directions. This ensures that the maximum responsivity can be obtained during differential protection, even if transmission times are unbalanced in the communication networks. Different transmission times are insignificant for the transmission of protection data with a protection communication of type 2.

Log Off the Device

A device can be logged off for protection function tests, system inspections, or disconnection of a feeder for operational reasons. The device that is logged off no longer participates in the distributed functionality and is therefore no longer a component of the topology. 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 protection topology is not in a transient state and is stable in operation without switchovers.
- The local device is one of the 2 token masters if there is a chain topology. The token masters are the devices at the ends of the chain.
- The circuit breaker must be open and current must not be flowing.

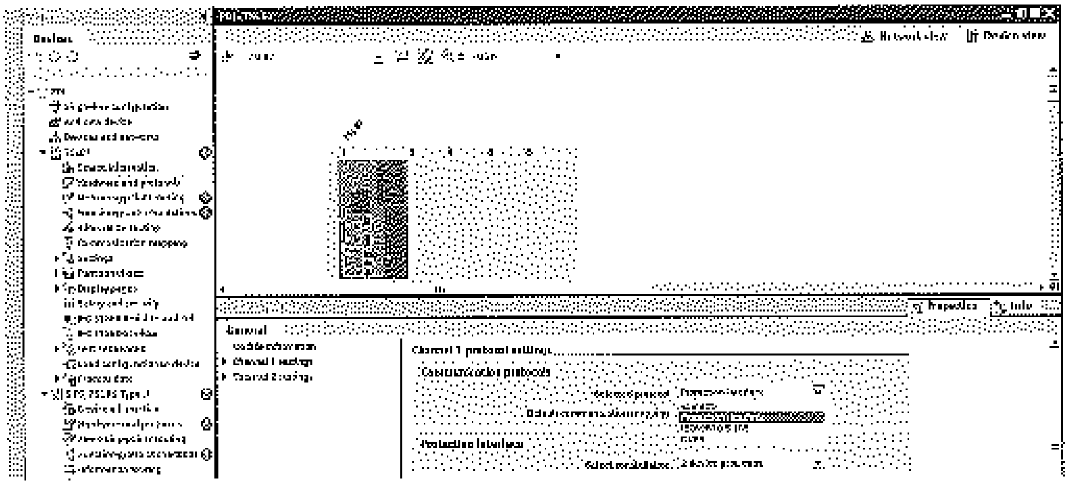
NOTE

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

3.5.3.4 Initialization and Configuration of the Protection Interface in DIGSI 5

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

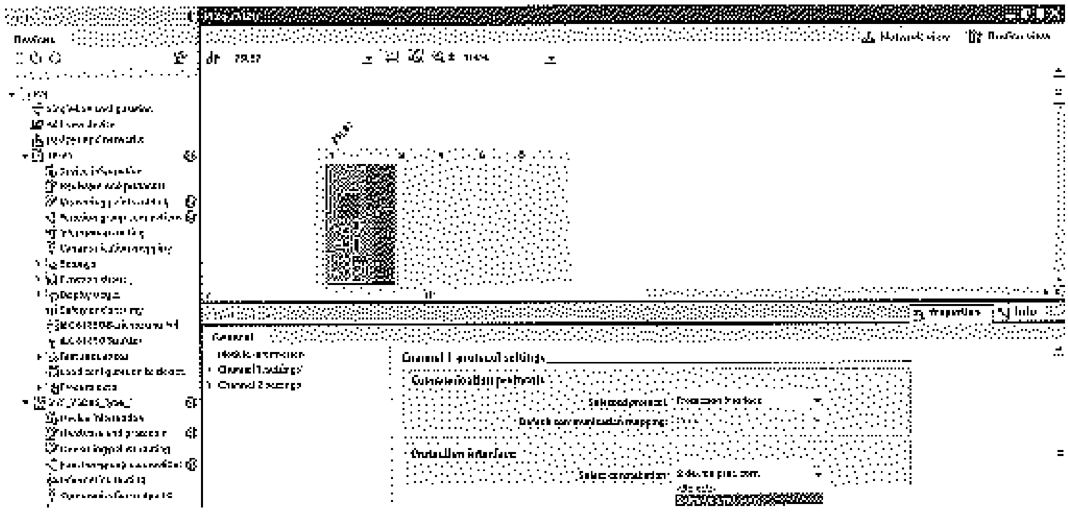
- Select the desired communication module in the rear view of the device.
- Use the **Communication protocols** text box to select the protection interface. A text box entitled **Protection interface** will then appear.



[scr_...-1, en_US]

Figure 3-52 Selection of the Communication Protocol

- Then select the **Select constellation** text box to select the number of devices (see next figure).



[scr_...-1, en_US]

Figure 3-53 Selecting the Constellation

NOTE

You have the option of changing the number of devices (for example **2 protection communication devices**) depending on the product code any way you like via the **Select constellation** text box.

If you change the number of devices via the **Select constellation** text box, all activated constellation settings 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 **Communication protocols** text box to select the protection interface. A text box entitled **Protection interface** will then appear (see *Figure 3-52*).
- Then use the **Select constellation** text box to select the number of devices (for example **2 devices protection com.**) (see *Figure 3-53*).

3.5.3.5 Device-Combination Settings

Make the device-combination settings and the settings for protection communication (see next figure).

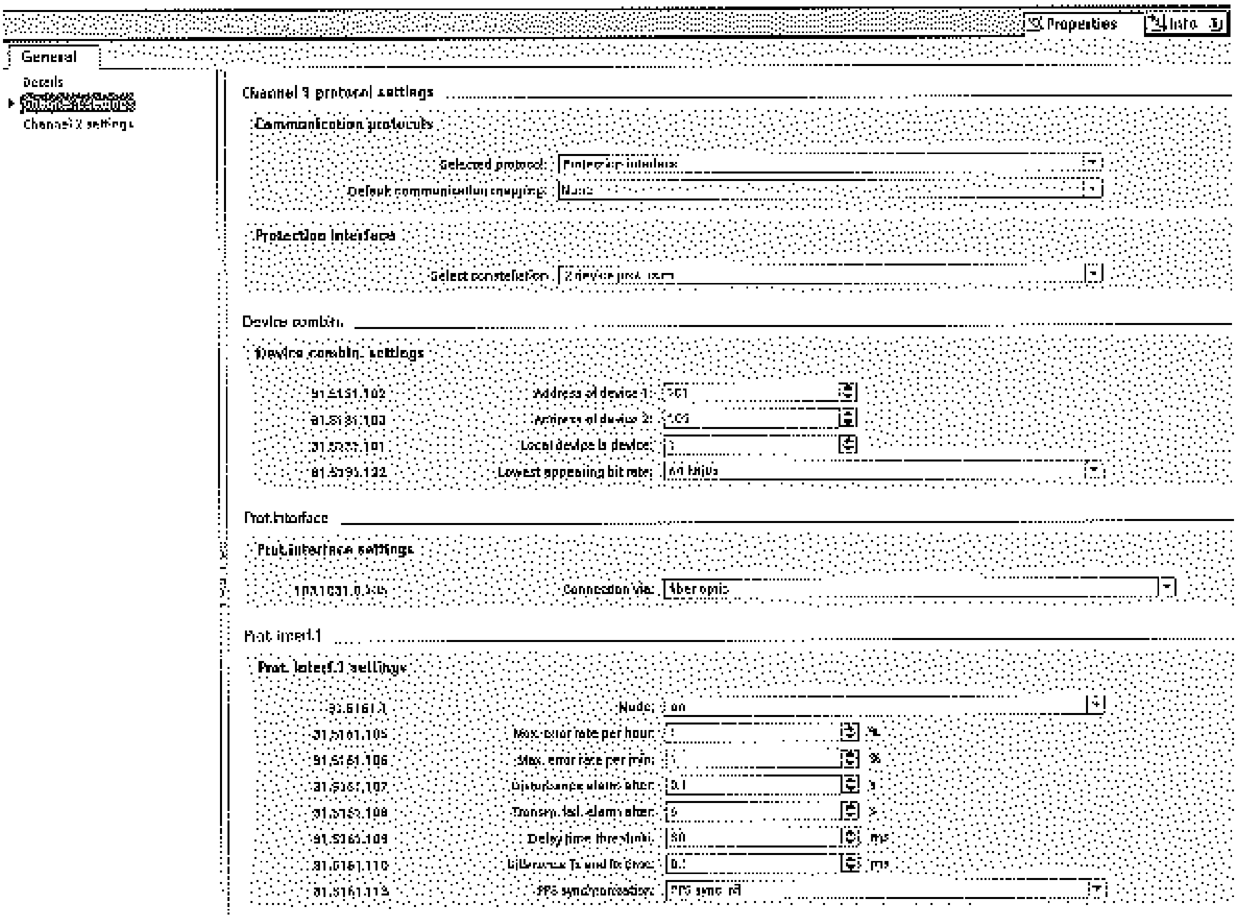


Figure 3-54 Protection Interface Initialization and Configuration

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

Setting Device-Combination Settings

- 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.

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

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

APPLICATION EXAMPLE

You have a topology 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 addresses must be configured identically for all devices involved in the constellation. A functional protection communication requires that you also assign the same index in all devices of a constellation for a device with a unique address.

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

The **Lowest appearing bit rate** parameter is used to set the smallest occurring bit rate in the device group. Set the smallest value in each device with a three-end constellation with 2 fiber-optic connections (2 MBit/s) and a 64-kBit/s connection with the lowest value (64 kBit/s). This value determines the maximum signals and measured values within a constellation.
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 fiber-optic cables for the connection between the devices, set the value to *2048 kBit/s* .

3.5.3.6 Selecting the Connection

- 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 3-9 Means of Communication

Means of Communication	See	Setting Value	Bit Rate
Fiber-optic direct connection	*Figure 3-42* to *Figure 3-45*	*fiber optic*	2 MBit/s
CC-XG-512 communication converter	*Figure 3-46*	*CCXG 512 kBit/s*	512 kBit/s
CC-XG-128 communication converter	*Figure 3-46*	*CCXG 128 kBit/s*	128 kBit/s
CC-XG-64 communication converter	*Figure 3-46*	*CCXG 64 kBit/s*	64 kBit/s

Means of Communication	See	Setting Value	Bit Rate
Repeater 512 communication converter	Figure 3-49	`repeater 512 kBit/s`	512 kBit/s
CC-CC-128 Communication converter	Figure 3-48	`CCPW 128 kBit/s`	128 kBit/s
CC-2M-512 Communication converter	Figure 3-47	`CC2M 512 kBit/s`	512 kBit/s

Multiplexer with C37.94 interface	Figure 3-50	`C37.94 1 * 64 kBit/s`
		`C37.94 2 * 64 kBit/s`
		`C37.94 8 * 64 kBit/s`
			64 kBit/s
			128 kBit/s
			512 kBit/s

Other (freely adjustable bit rates for a direct connection for special applications)		`64 kBit/s`
		`128 kBit/s`
		`512 kBit/s`
		`2048 kBit/s`
			64 kBit/s
			128 kBit/s
			512 kBit/s
			2048 kBit/s

NOTE

Keep in mind that the **Teleprotection schemes** require a minimum bandwidth for communication via a protection interface.

If the **Line differential protection** function is available in the device, the bit rate must not be less than 512 kBit/s!

The minimum bit rate of 512 kBit/s is important for the **Teleprotection with distance protection** and **Teleprotection with ground-fault protection** functions.

3.5.3.7 Setting Notes for the Protection Interface

Parameter: Max. Error Rate/h

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

The `Max. error rate per hour` parameter allows you to receive an error message on the number of faults per hour. An indication is then generated.

Parameter: Max. Error Rate/min

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

The `Max. error rate per min` parameter allows you to receive an error message on the number of faults per minute. An indication is then generated.

Parameter: Disturbance Alarm After

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

The `Disturbance alarm after` parameter determines the time delay after which defective or missing telegrams are signaled as faulty.

Parameter: Transm. Fail. Alarm After

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

The `Transm. fail. alarm after` parameter is used to set the time after which a failure of the communication is signaled.

NOTE

If the setting values of the parameters `Disturbance alarm after` and `Transm. fail. alarm after` are exceeded, then an indication is generated.

Parameter: Delay time threshold

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

For the **Delay time threshold**, the default setting is selected such that it is not exceeded by normal communication networks. If this time delay is exceeded during operation (for example, upon switchover to another transmission route), the indication **Time delay exceeded** is issued.

Parameter: Difference Tx and Rx time

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

The **Difference Tx and Rx time** parameter can be used to set a maximum time-delay difference between the send and receive paths.
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).

NOTE

Only if the **Line differential protection** function is instantiated, the **Difference Tx and Rx time** parameter is displayed.

NOTE

If the user employs 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: PPS Synchronization

- Default setting (_:5161:113) **PPS synchronization** = *PPS sync. off*

If the SIPROTEC device operates with PPS synchronization (PPS: pulse per second), use the **PPS synchronization** parameter to define how the protection is activated after restoration of the communication connection (basic state or after transmission fault).
Refer to *Figure 3-55*.

NOTE

The PPS measurement is used to consider the time delay in the send and receive directions. If PPS fails due to a reception fault or due to a short-term unfavorable satellite position, synchronization via conventional communication media remains active.

The **PPS synchronization** parameter offers 3 different setting options:

Parameter Value	Description
telegr. and PPS	With this setting, the differential protection is only enabled upon renewed establishment of the connection, if the communication section is synchronized via PPS or if symmetrical time delays are signaled by an external operation (binary input). This results in synchronization with the telegram measurement supported by the PPS measurement.
telegr. or PPS	In this setting, the differential protection is enabled immediately upon renewed establishment of connection (data telegrams are received). The conventional method is used up to synchronization. This results in synchronization with the telegram measurement supported by the PPS measurement.

Parameter Value	Description
PPS sync. off	This setting means that no synchronization is performed via PPS at the protection interface. This is typically the case if no time-delay differences are expected. The synchronization only takes place with the telegram measurement.

NOTE

The synchronization mode can be set separately for both protection interfaces.

If no further PPS pulse is received within 2.1 s, the time-out supervision responds. If no new 2nd pulse occurs after the expiry of the supervision time, the indication `PPS pulse loss` is issued.

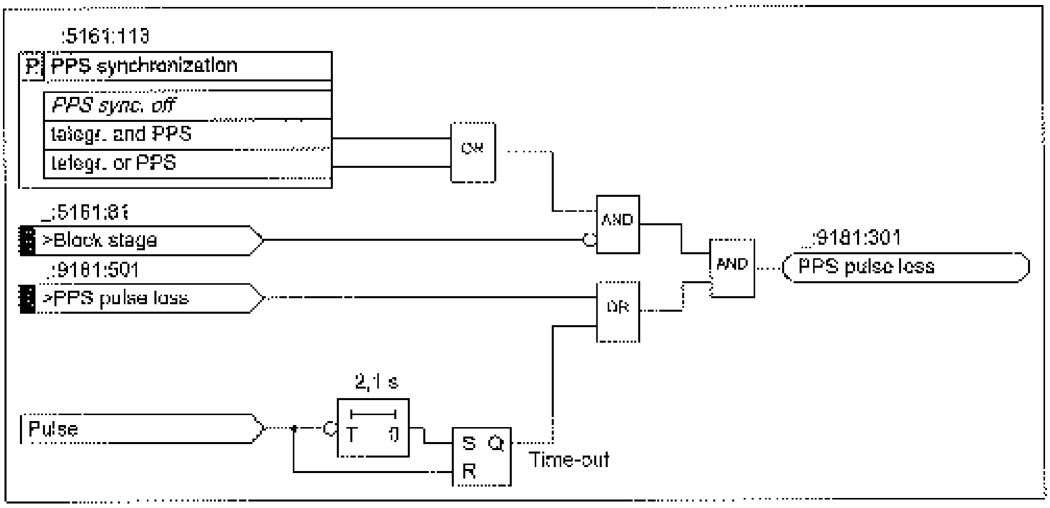


Figure 3-55 Setting the PPS Synchronization

The binary input `>PPS pulse loss` can be used to signal an externally detected failure in the PPS signal (for example, error message from the receiver). Setting this binary input also leads to the indication `PPS pulse loss`.

If you are using a second pulse from a GPS receiver, you must ensure that a loss of reception or reception disturbances do not generate a second pulse. The GPS receivers recommended by Siemens are set by default so that a loss of reception or reception disturbances do not generate a second pulse. In the event of problems, check the setting value for the second pulse.

Siemens recommends the **Meinberg 164** GPS receiver. Check the default setting for the second pulse using the **GPSMON32** program. The program is available in the SIPROTEC *download area*. You can find the setting value under **Outputs** →**Enable Flags**. The second pulse must be set to the value `if Sync`.

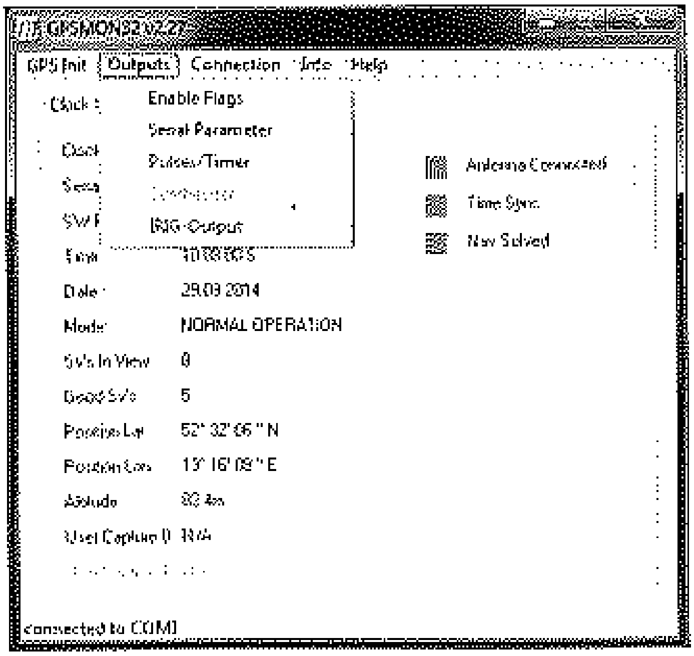


Figure 3-56 Checking the Setting Value for the 2nd Pulse Using the GPSMON32 Program, Step 1

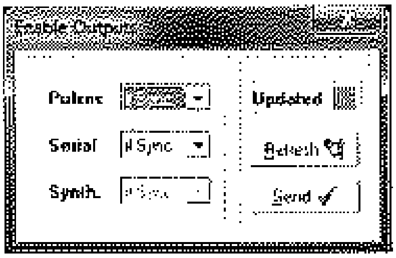


Figure 3-57 Checking the Setting Value for the 2nd Pulse Using the GPSMON32 Program, Step 2

3.5.3.8 Routing Information in DIGSI 5

Protection communications of the same type form a topology.

For more information on this, see chapter *3.5.3.3 Function Description*.

A data bar is exchanged between the devices of a topology connected via protection communication. This can be written into or read from 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.

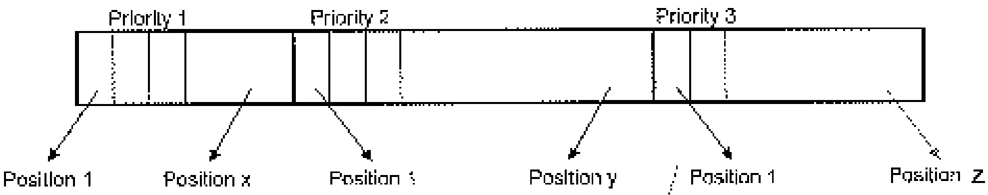


Figure 3-58 Data Bar Exchanged Between Devices

The data bar is divided into 3 priorities, which also have different transmission rates and data volumes.

The following basic principle applies for all messages: 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 secure 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 3-13*).

NOTE

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

Indications 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/s, there are no differences between priority 1 and priority 2.

Priority 3 information is 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.

Indications 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 3-12* .

Table 3-10 and *Table 3-11* show the number of data areas in the data bar in relation to the available baud rate.

NOTE

The **Lowest appearing bit rate** parameter, which has to be set in each device for the protection interfaces of a topology, defines the number of data areas as well as the topology type.

If, for example, in a three-end constellation with a type 2 chain topology two devices are connected via direct optical fibers and 2 devices via the 64-kBit/s weakest line, the 64-kBit/s section is the limiting factor for the entire constellation.

Table 3-10 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 3-11 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 3-12 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

Signal Type	Size in Bits
MW (measured values)[8]	32 Bits
ACT	4 Bits

Table 3-13 Possible Dropout Values

Signal Type	Dropout Values
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 via a 64-kBits channel. This is a type 1 topology. 8 bits are freely available for priority 1. Now, for example, 4 SPS and 2 DPS can be routed:
4 x 1 Bit + 2 x 2 Bits = 8 Bits

NOTE

Measured values are transmitted as primary values.

EXAMPLE

For the rated current display in the receiving device
When I_{rated} = 1000 A in the transmitting device and I_{Load} = 200 A, the number 200 is displayed in the receiving device.

Remote Data Transmission: Routing of the Indications and Measured Values to the Protection Interface

The transmission is organized in the form of a data bar which is continuously exchanged between the devices. For this, see *Figure 3-58* .

A device indication or measured value is allocated to a definite data area of the bar.

Figure 3-59 to *Figure 3-62* show the routing for a communication topology of protection interface type 1.

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 position 1 and 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; they are exchanged between the transmission routes with each telegram. Signals 3 and 4 are double-point indications (DPS), for example, a switch position that is transmitted by a device 1. A double-point indication occupies 2 positions on the data bar. In addition, a measured and metered value are communicated via priority 3.

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

[8] The complex vectors of a measuring point are pre-routed

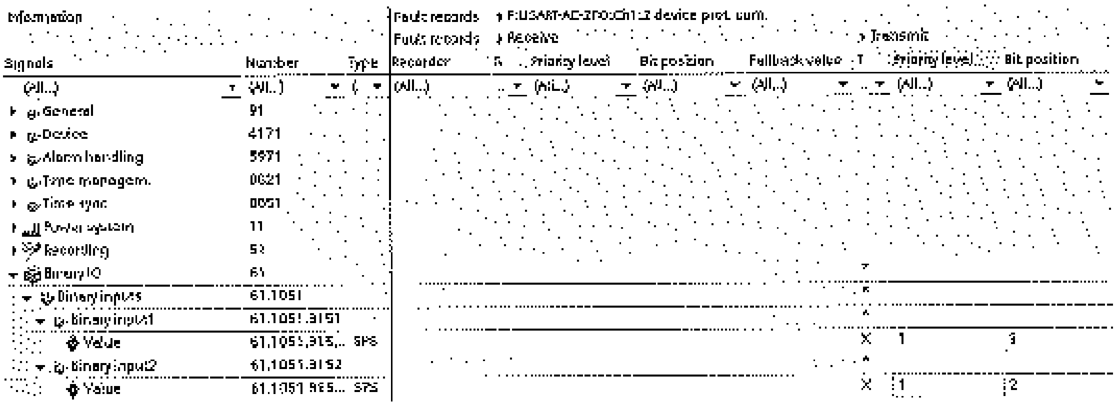


Figure 3-59 Routing of Single-Point Indications to the Protection Interface in Device 1

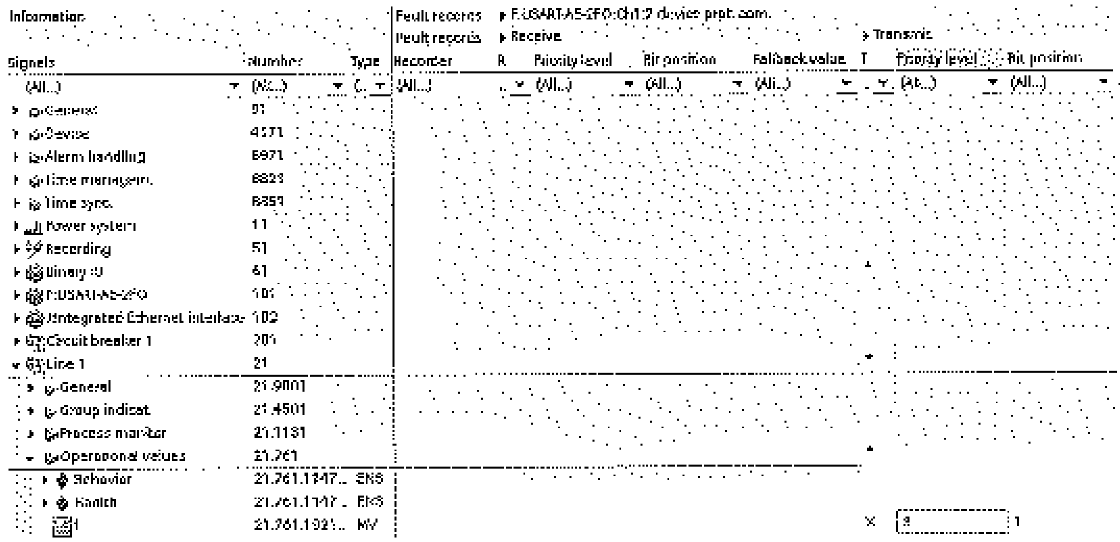
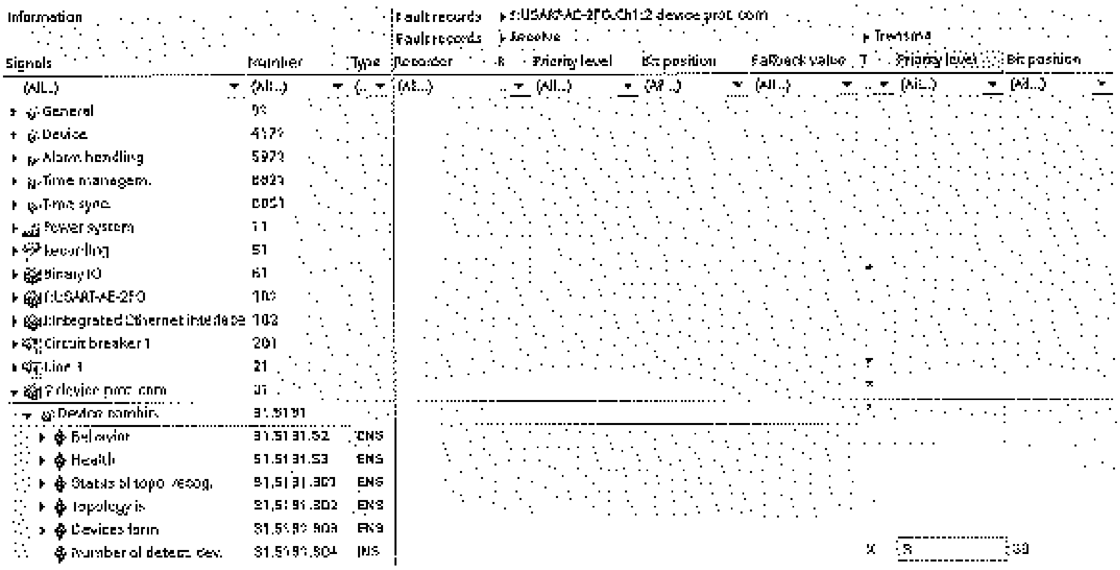


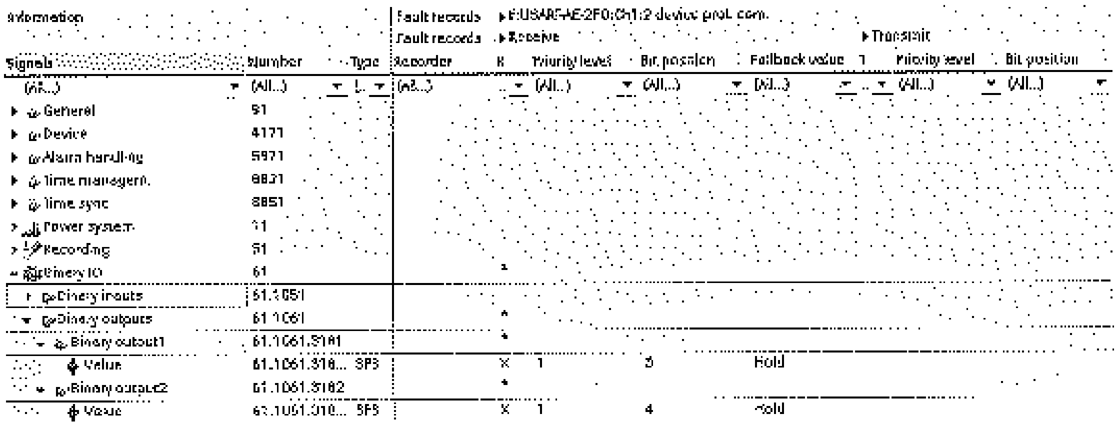
Figure 3-60 Routing of Measured Values to the Protection Interface in Device 1



[scrnspw-021210-01.tif, 1, en_US]

Figure 3-61 Routing of Metered Values to the Protection Interface in Device 1

This device also receives information (in the matrix under **Receive**). This must have been routed as a target for other devices (see next figure). The binary outputs 1 and 2 in device 1 receive their information via the protection interface. This is priority 1 information, which has been routed in another device to position 3 and 4 of the data bar. The secure state is defined in the **Fallback value** column. If the data connection fails, the single point indication is reset to *coming* or **going** or its value is retained (*hold*). For data of the various priorities, you can also set a dropout time after which the resetting (see Figure 3-61) 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 data of one transmission priority and are set as parameters.



[scrnsemp-021210-01.tif, 1, en_US]

Figure 3-62 Routing of Single-Point Indications (Receive) to the Protection Interface in Device 1

The following figure shows the routing in the 2nd device. Binary inputs 1 and 2 are routed with priority 1 to positions 3 and 4 there. In device 1, positions 1 and 2 are already occupied (see Figure 3-59). If you also route the signals to positions 1 and 2, the signals of the devices are then connected to the corresponding 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 that read the data. As a user, you are therefore responsible for the correct routing.

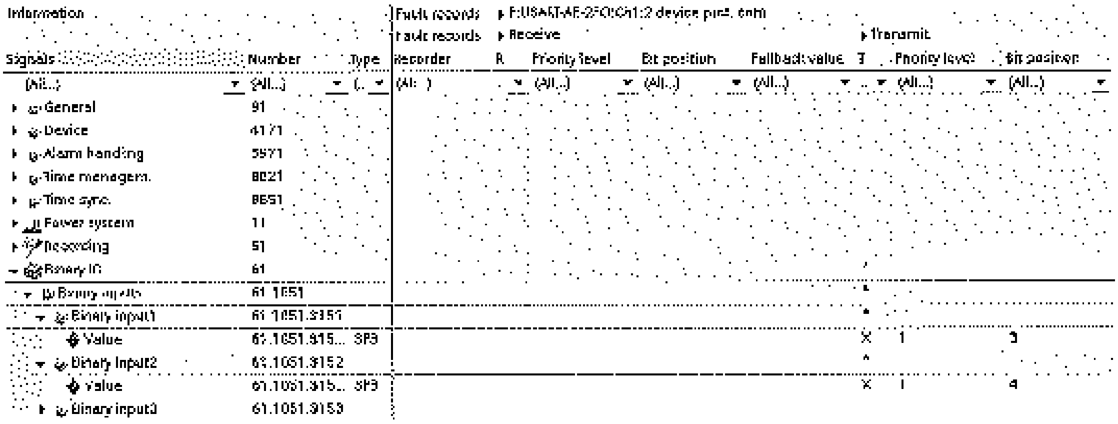


Figure 3-63 Routing of Single-Point Indications to be Sent to the Protection Interface in Device 2

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 indications. Other devices can also read this information and 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. In the case of single point indications, the state is 0 or 1. In the case of double-point indications, the bit combinations 00, 01, 10, or 11 are possible, in order to directly signal a disturbed position upon failure of the data connection, for example.

Hold is used to retain the state.

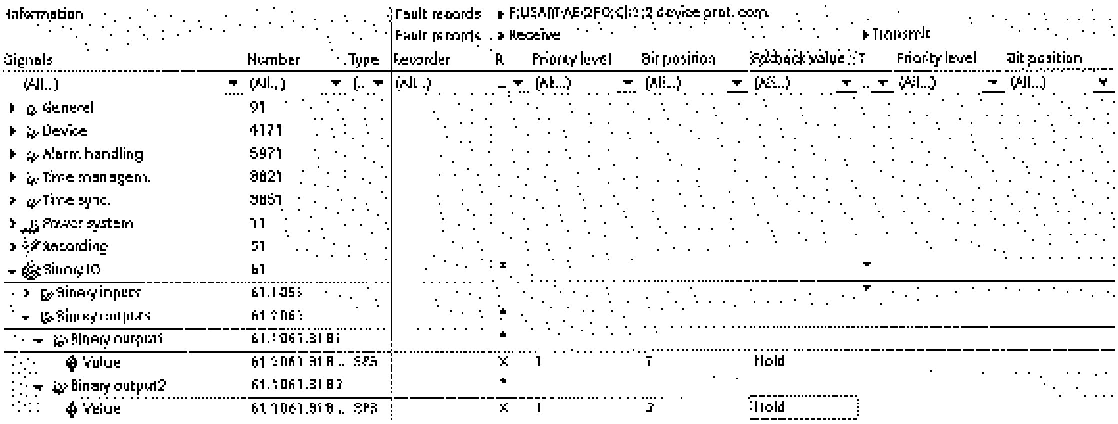


Figure 3-64 Routing of Received Single-Point Indications to the Protection Interface in Device 2

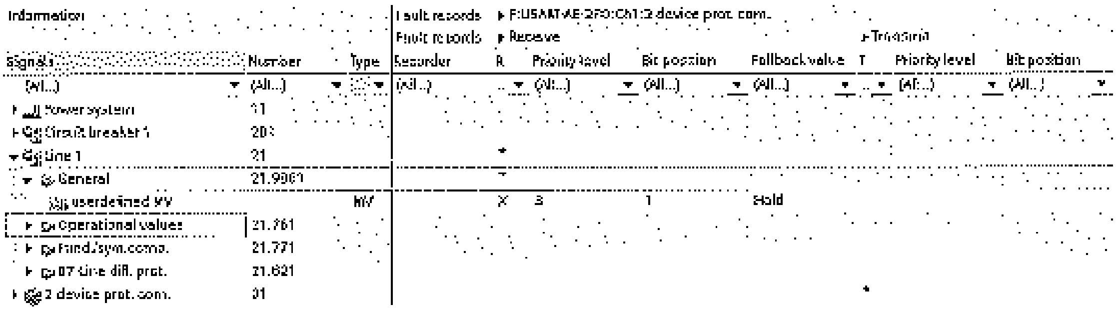


Figure 3-65 Routing of Received Measured Values to the Protection Interface in Device 2

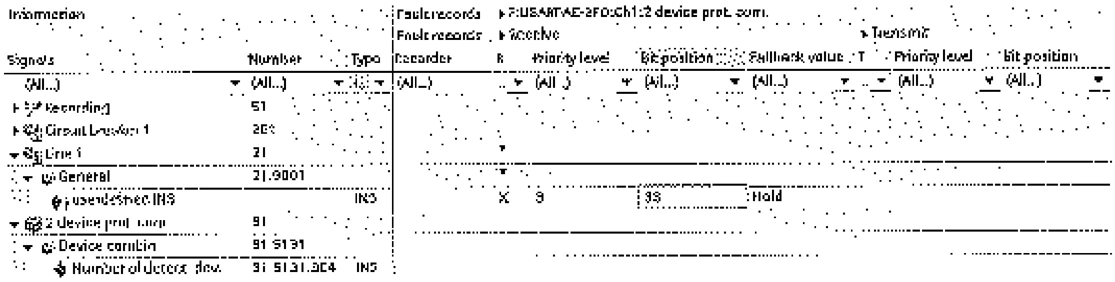


Figure 3-66 Routing of Metered Values to the Protection Interface in Device 2

3.5.3.9 Diagnostic Measured Values of the Protection Interface

The following diagnostic data is provided via the protection interfaces by the devices in the constellation:

- Address of the device in the constellation
- Circuit-breaker switch position (open/closed/undefined) (only for protection interfaces of type 1)
- Availability of protection-interface communication within the last minute, as percentage
  Availability of protection-interface communication within the last hour, as percentage
- Time delay in the send and receive direction of the telegrams between local and neighboring device

You can find this diagnostic data in DIGSI under the following menu structure (see Figure 3-67):

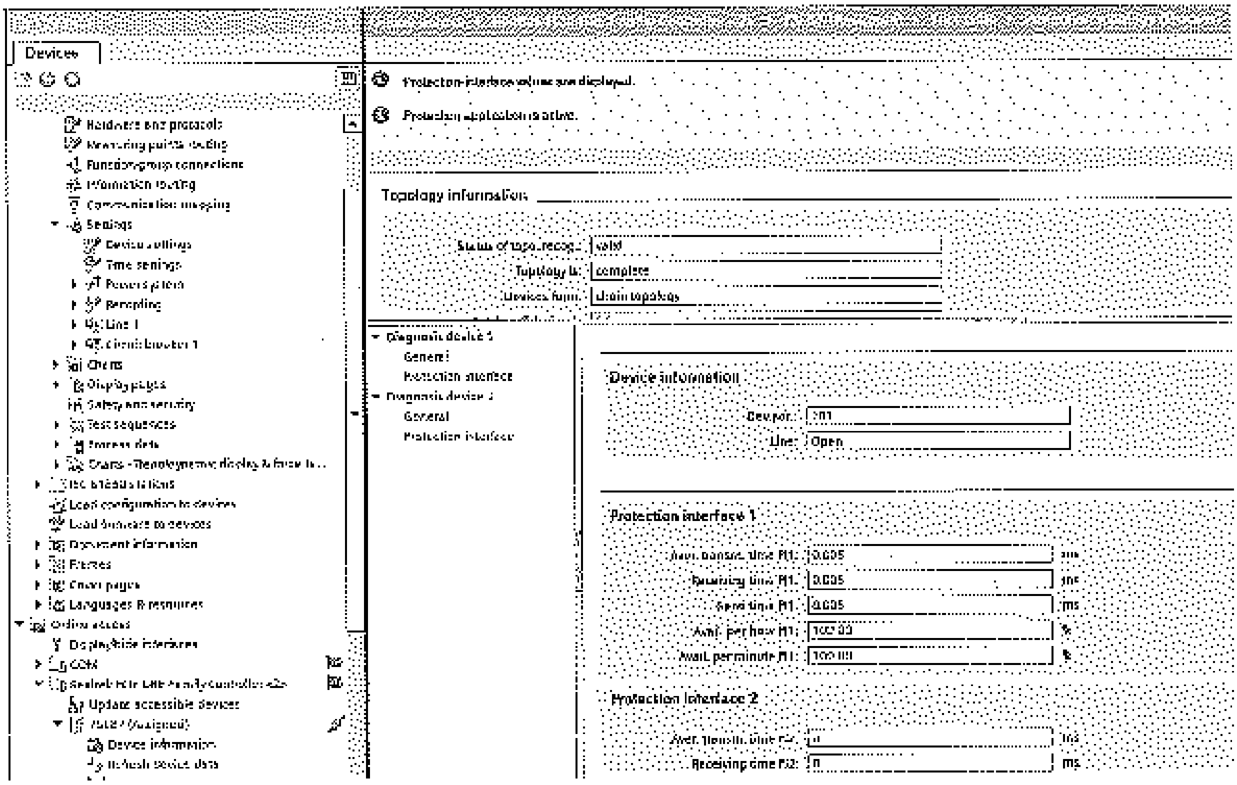


Figure 3-67 Protection-Interface Channel Diagnostic Data – Device Address

NOTE

You can use the following procedure to reset the measured values for the protection interface directly in the device:

Device functions > x Device protection comm. > Protection interface y > Reset measured values.

Output Signals of the Protection Interface

Each individual protection interface provides the following indications for commissioning and diagnosing communication:

Indication	Description
(_:5161:301) Status of lay. 1 and 2	The output signal gives you information about the state of communication layers 1 and 2 (1: Physical Layer, 2: Data Link Layer). The following indications values are possible: • *Initialized*: The protection interface is not connected and is in the initial state. • *Protection interface connected*: The protection interface is connected to the protection interface of a device. • *Protection interface disturbance*: The protection interface has not received any valid telegrams for the time set in parameter **(_:5161:107) Disturbance alarm after**. • *Protection interface failure*: The protection interface has not received any valid telegrams for the time set in parameter **(_:5161:108) Transm. fail. alarm after**. • *not present*: The protection interface has not been assigned to a communication channel.

Indication	Description
(_:5161:302) Status of lay. 3 and 4	The output signal gives you information about the state of communication layers 3 and 4 (3: Network Layer, 4: Transport Layer). The following indications values are possible: • *no error*: The protection interface is operating correctly. • *Software version incompatible*: The firmware versions of the connected devices are incompatible. Update the firmware. • *System mirroring*: The protection interface is receiving its own data. Check the wiring. • *Dev. add. incorrect*: The device address of the partner device is incorrect. Check the settings for parameters **Address of device 1** to **address of device n** (_:5131:102 and following). • *Constell. incorrect*: The constellation settings of the devices are different. Check that the setting for the parameter **Select constellation** is identical in all devices. • *Const. param. incorrect*: Check that the same setting has been made for parameter (_:5131:122) **Lowest appearing bit rate** in all devices. • *Diff. Param. Error*: 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 value of the line (parameter (_:9001:101) **Rated current** and (_:9001:102) **Rated voltage**) must have the identical setting at both ends of the line. If a transformer is installed in the line, both parameters must be set such that the rated apparent power is the same at both ends of the line (parameter (_:9001:103) **Rated apparent power**).

In order to clarify faults, each individual protection interface provides the following binary signals:

Binary Output Signal	Description
(_:5161:303) Connection broken	Signal *Connection broken* indicates that during a parameterized time (parameter (_:5161:107) **Disturbance alarm after**) faulty or missing telegrams were continuously received. If the 'Connection interrupted' indication occurs, the affected protection interface link will be terminated. This can cause the blocking of an active differential protection or a ring topology can change to a chain topology.
(_:5161:316) Error rate / min exc.	Signal *Error rate / min exc.* indicates that the set maximum error rate per minute (Parameter (_:5161:106) **Max. error rate per min**) has been exceeded.
(_:5161:317) Error rate / hour exc.	Signal *Error rate / hour exc.* indicates that the set maximum error rate per hour (Parameter (_:5161:105) **Max. error rate per hour**) has been exceeded.
(_:5161:318) Time delay exceeded	Signal *Time delay exceeded* indicates that the threshold value for the set signal-transit time (Parameter (_:5161:109) **Delay time threshold**) has been exceeded.
(_:5161:319) Time delay different	Signal *Time delay different* indicates that the threshold value for asymmetrical transit times has been exceeded. The setting value results from the setting value of the parameter (_:5161:110) **Difference Tx and Rx time**.
(_:5161:320) Time delay jump	Signal *Time delay jump* indicates that the data transit times changed abruptly. This is caused by switching the communication path in the communication network.

Binary Output Signal	Description
(_:5161:321) *PI synchronized*	Signal *PI synchronized* indicates that the protection-interface connection is synchronized with the opposite end.
(_:5161:340) *Telegram lost*	Signal *Telegram lost* indicates that an expected telegram has failed to arrive or a faulty telegram has been received. If you would like to allocate the communication failures or faults to other events, move the signal *Telegram lost* 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 faults.

Measured Values of the Protection Interface

The protection interface provides the following measured value to diagnose the protection interface communication:

Measured Value	Description
(_:5161:308) *TX tel/h*	Telegrams sent during the last hour
(_:5161:309) *Rx tel/h*	Telegrams received during the last hour
(_:5161:310) *Tx tel/min*	Telegrams sent during the last minute
(_:5161:311) *Rx tel/min*	Telegrams received during the last minute
(_:5161:312) *Tx err/h*	Transmission failure rate during the last hour
(_:5161:313) *Rx err/h*	Reception failure rate during the last hour
(_:5161:314) *Tx err/min*	Transmission failure rate during the last minute
(_:5161:315) *Rx err/min*	Reception failure rate during the last minute
(_:5161:325) *Aver.Δt*	Mean signal-transit time (average value of the transit time in transmission and reception direction divided by 2, without GPS synchronization)
(_:5161:326) *Rec. Δt*	Signal-transit time in reception direction (with GPS synchronization)
(_:5161:327) *Sen. Δt*	Signal-transit time in transmission direction (with GPS synchronization)
(_:5161:334) *Miss.tel/min*	Number of telegram failures within the last minute
(_:5161:335) *Miss.tel/h*	Number of telegram failures within the last hour
(_:5161:336) *Miss.tel/d*	Number of telegram failures within the last day
(_:5161:337) *Miss.tel/w*	Number of telegram failures within the last week
(_:5161:338) *M. loss/d*	Longest lasting telegram failure within the last day
(_:5161:339) *M. loss/w*	Longest lasting telegram failures within the last week

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 > Reset measured values.**

3.5.3.10 Tunneling with DIGSI 5 via Protection Interface

Configuration of the Subnetworks

You can use a PC to access other devices within the constellation via the protection links. DIGSI 5 communication then operates exclusively via the connections and the protection-data communication is turned off. In this way, you operate the remote devices from the local device via DIGSI 5.

Remote control with DIGSI 5 is only possible if you are online with the local device and connected there with the integrated Ethernet interface RJ45

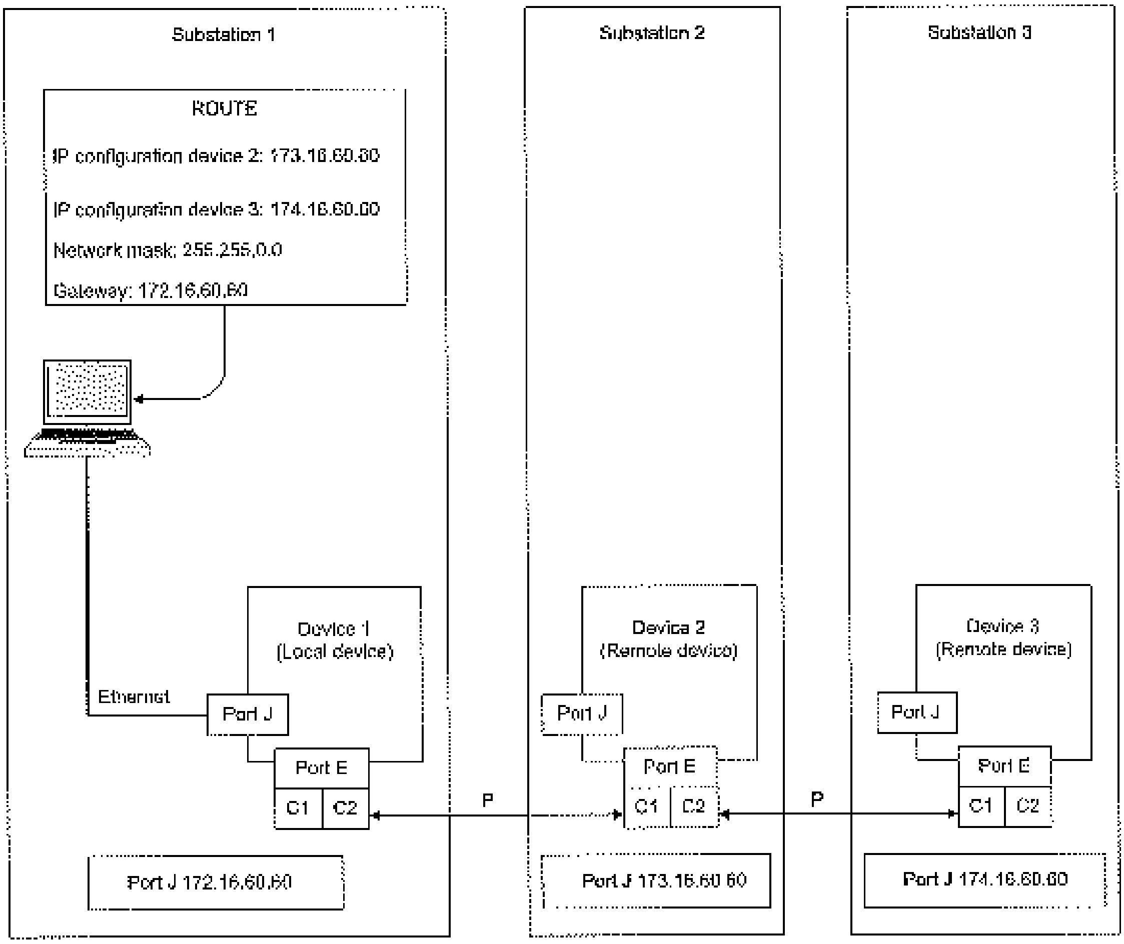
NOTE

All remote devices need an IP configuration for port J (integrated Ethernet interface) in all cases. The IP addresses of slots J of a protection topology must be in different subnetworks.

NOTE

If reparameterization requires a restart of the remote device, then the corresponding route is not available until after approx. 2 min. following a complete restart.

The following figure shows a configuration with 3 devices as an example.



C1 Channel 1
C2 Channel 2
P Protection connection

[dwremote 050211-01.tif, 1, en_US]

Figure 3-68 Sample Configuration of a Remote Control with 3 Devices

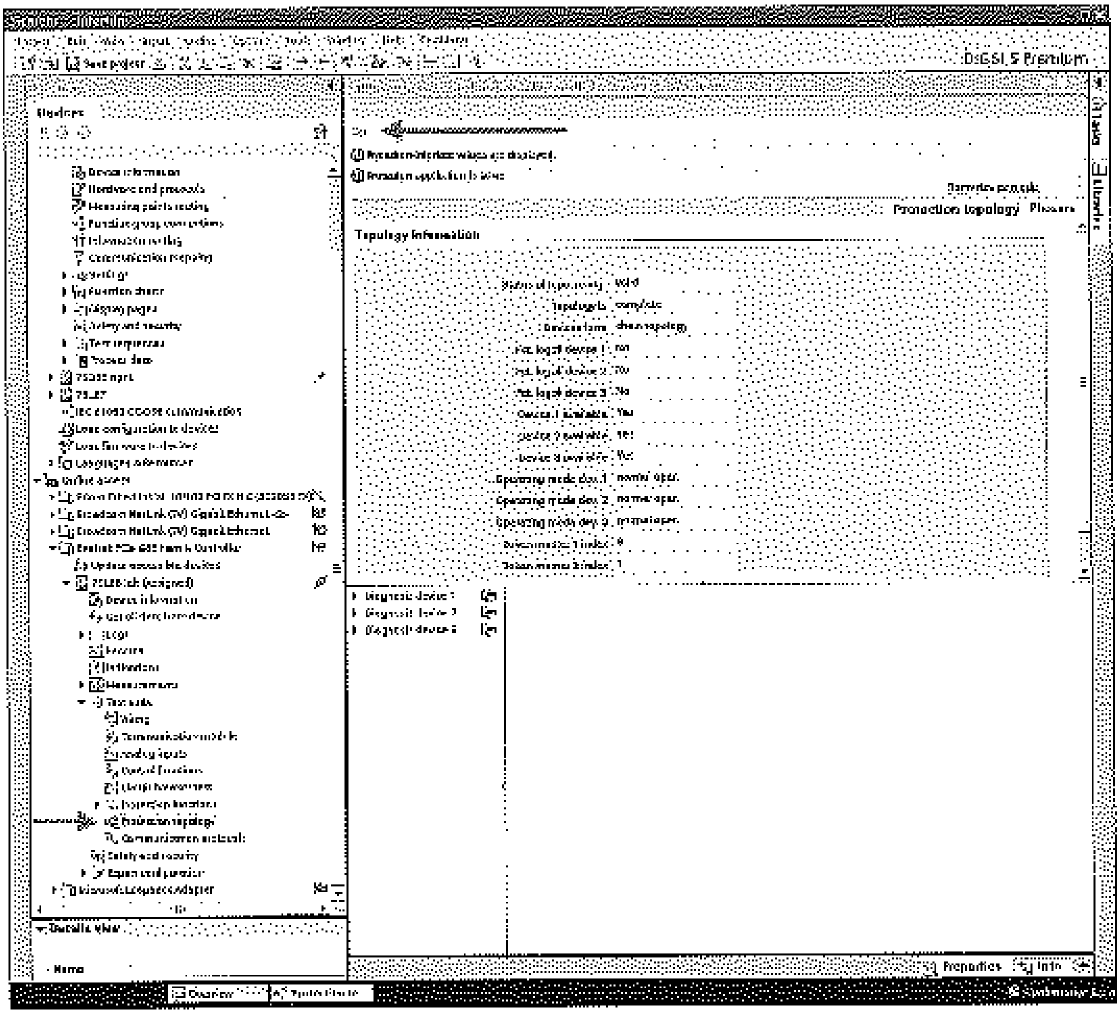
Tunneling with DIGSI 5 via Protection Interface: Procedure

If you want to perform tunneling (remote control)[6] via DIGSI 5, proceed as follows:

- You make a connection between DIGSI 5 and the device through the Ethernet RJ45.
- Open the device concerned in **Online access**.
- Go to **Test suite/Protection topology**.
- Open **Protection topology**. In the next window, press the button at top left (see arrow in the following figure). The dialog for deactivating the protection communication then opens.

  If you confirm the query, protection communication is interrupted and the communication channels are used exclusively for DIGSI 5. Note that the protection functions that use protection data communications (e.g. differential protection) are deactivated and no remote data can be updated in the constellation. Then, the remote signals fall back to the secure state the user has defined earlier.

[6] This function is not yet implemented and will first be activated with a later firmware version.



[illegible]

Figure 3-69 Tunneling with DIGSI 5

NOTE

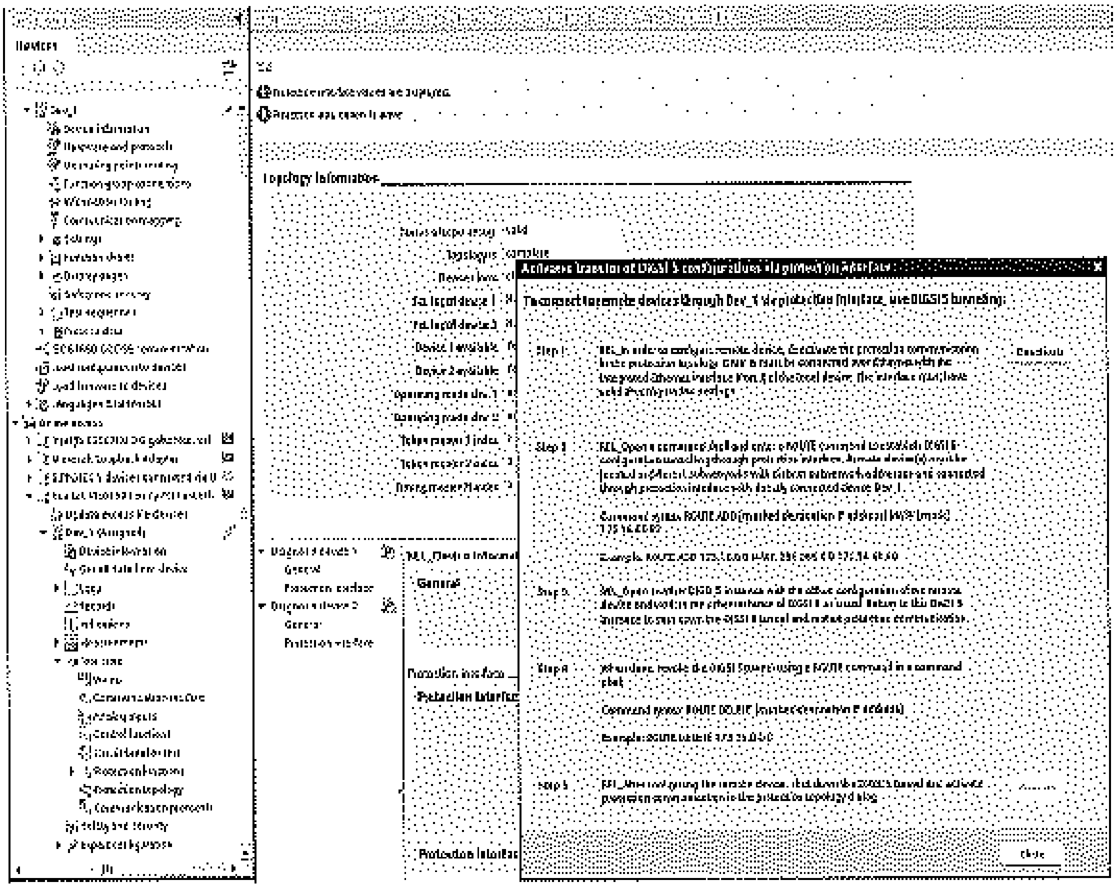
The protection communication remains interrupted until either the user reactivates it manually, or a maximum deactivation duration of 12 hours has been exceeded. After this, the connection reactivates itself. This ensures that the protection communication and protection function working with it are reactivated.

NOTE

Ensure that DIGSI 5 is connected via Ethernet to RJ45 of the local device. The local device must be configured with valid IP addresses.

Figure 3-70 to Figure 3-71 show the steps for the deactivation of protection communication.

In the next step, a window appears in DIGSI 5 containing the instructions for deactivating the protection data communication (see next figure).



[scdsacIq 06/210 01.dt. 1. en_05]

Figure 3-70 Steps for the Deactivation of Protection Communication

In order to be able to deactivate the protection data communication, you must enter your confirmation ID if a security query is activated (see next figure). The default confirmation ID is **222222**.

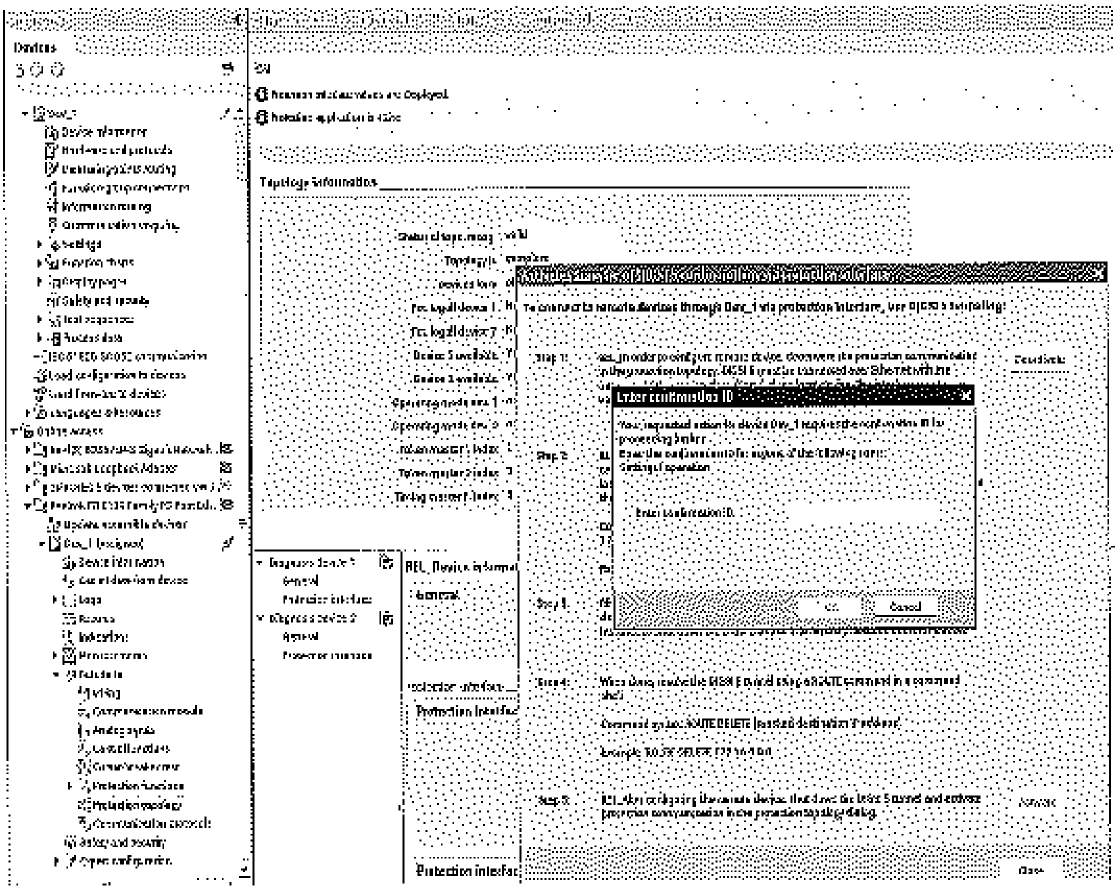


Figure 3-71 Entering the Confirmation ID for the Deactivation of Protection Communication

- Under **Start ---> Run In Windows**, open an input window by entering **CMD**.

  Use the DOS box to enter a command line to set a route (see next figure). This is the prerequisite that DIGSI 5 can be routed further via the protection interface.

Figure 3-72 Setting of the Route in the DOS Box

NOTE

To set the route, you must have administrator rights for the DIGSI PC.

- The following routing command is necessary to connect from device 1 to device 2 in the example shown (see *Figure 5-68*):
  - Route add 173.16.60.60 Mask 255.255.0.0 172.16.60.60
  - Route <Command> Destination (= Device 2) Mask (Routing Device) Local Device

  Remote devices must be available in different subnetworks and provided with unique IP addresses. For this, RJ45 of the relevant devices must already be configured so that these devices can now be accessed remotely.
- Now, select your DIGSI 5 project for substation 2 and connect this to the device. Although you are physically connected to the local device, this device now establishes a connection with the remote device. You can now fully operate the remote device with DIGSI 5.
  After completing the process, the protection communication must be reactivated. For this, end the connection with the remote device in DIGSI 5 at the local device for the protection interface.
  If this communication is not terminated properly, the protection-data communication then switches on again automatically after about 12 hours.
- Delete the route again by entering the following in the DOS box:
  - Route Delete 173.16.60.60
- If you wish to access device 3 via the protection interface, proceed in the same way. In this case, the DIGSI 5 communication is routed to device 3 via device 2 and you are connected from device 1 to device 3.
- To establish a connection with device 3, the following route is necessary:
  - Route add 174.16.60.60 Mask 255.255.0.0 172.16.60.60

NOTE

If there is no connection between the local device and DIGSI 5 for longer than an hour, the connection automatically resets to protection communication.

3.5.3.11 Diagnostic Data for the Protection Interface

Diagnostic Data of the Channel in DIGSI 5

Different diagnostic data can be read with DIGSI 5.

For this, connect with the device via DIGSI 5 and query the device information. Diagnostic data for a module whose channel is configured with the protection interface can be received by selecting the module slots (for example, F) and the corresponding channel (1 or 2). The following figures show the extensive diagnostic data for the protection interface. It is particularly helpful if data failures occur or other irregularities in a communication connection (for example, transmission time fluctuations).

NOTE

The diagnostic data can also be read via the device control on the display of the device. The overview of DIGSI 5 does not offer this option, however.

The following table describes the displays.

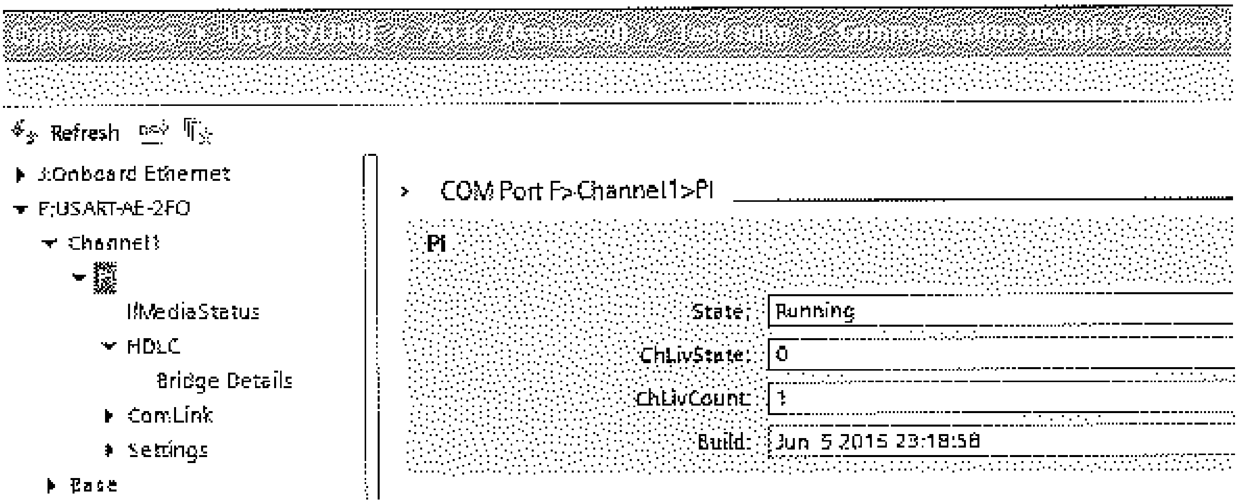


Figure 3-73 Diagnostic Data of a Channel Configured with the Protection Interface

Table 3-14 Description of the Diagnostic Data under Protection Interface

Channel Type	Name	Values	Description - Diagnostic Information for Log PI
Protection interfaces - log	Status	Initial, Running, Error	Runtime status of the log
Protection interfaces - log	Build	Date/time	Date and time of the log version

Diagnostic Data of the Protection-Interface Log in DIGSI 5

The following figures and tables describe the displays of the protection-interface log.

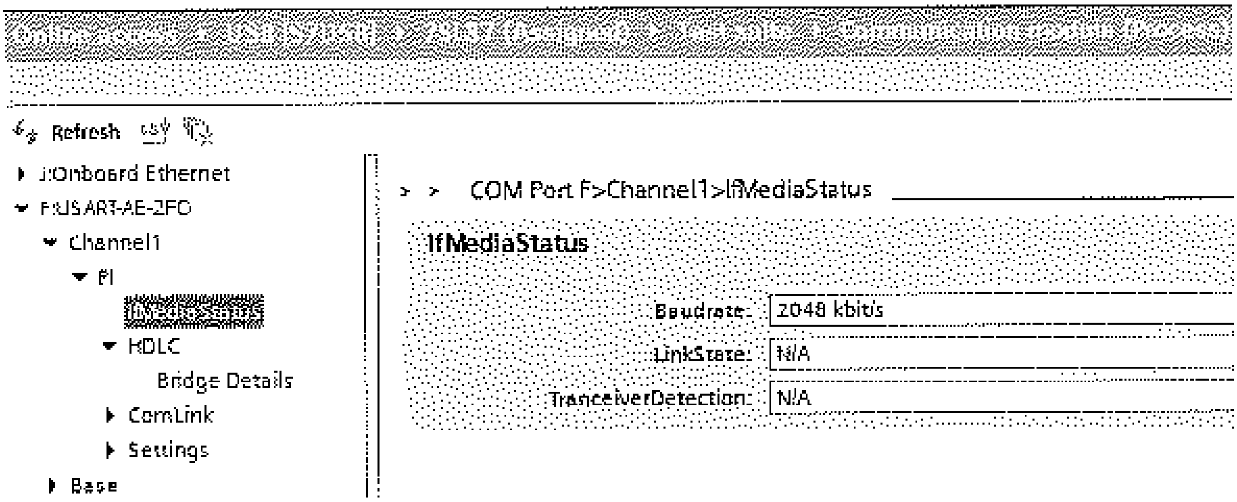


Figure 3-74 Diagnostic Data of the Protection-Interface Log - Media Status

Table 3-15 Description of Diagnostic Data under Media Status

Protection Interfaces - Log Type	Name	Values	Description - Media Status Interface (in Direction of Outside Interface)
Media Status	Baud rate	64 kBit/s; 128 kBit/s; 512 kBit/s; 2048 kBit/s; 30 MBit/s; <unknown>	HDLC baud rate: FO: 64 kBit/s to 2048 kBit/s for 820-Nm USART modules LDFO: 30 MBit/s for 1300/1500-Nm long-distance modules Error case: <unknown>
Media Status	LinkState	N/A, UP, DOWN	FO: N/A (always display N/A)
Media Status	TransceiverDetection	N/A, NO Transceiver detected, Transceiver detected	FO: N/A (always N/A) (NO Transceiver detected, Transceiver detected), Error case: N/A

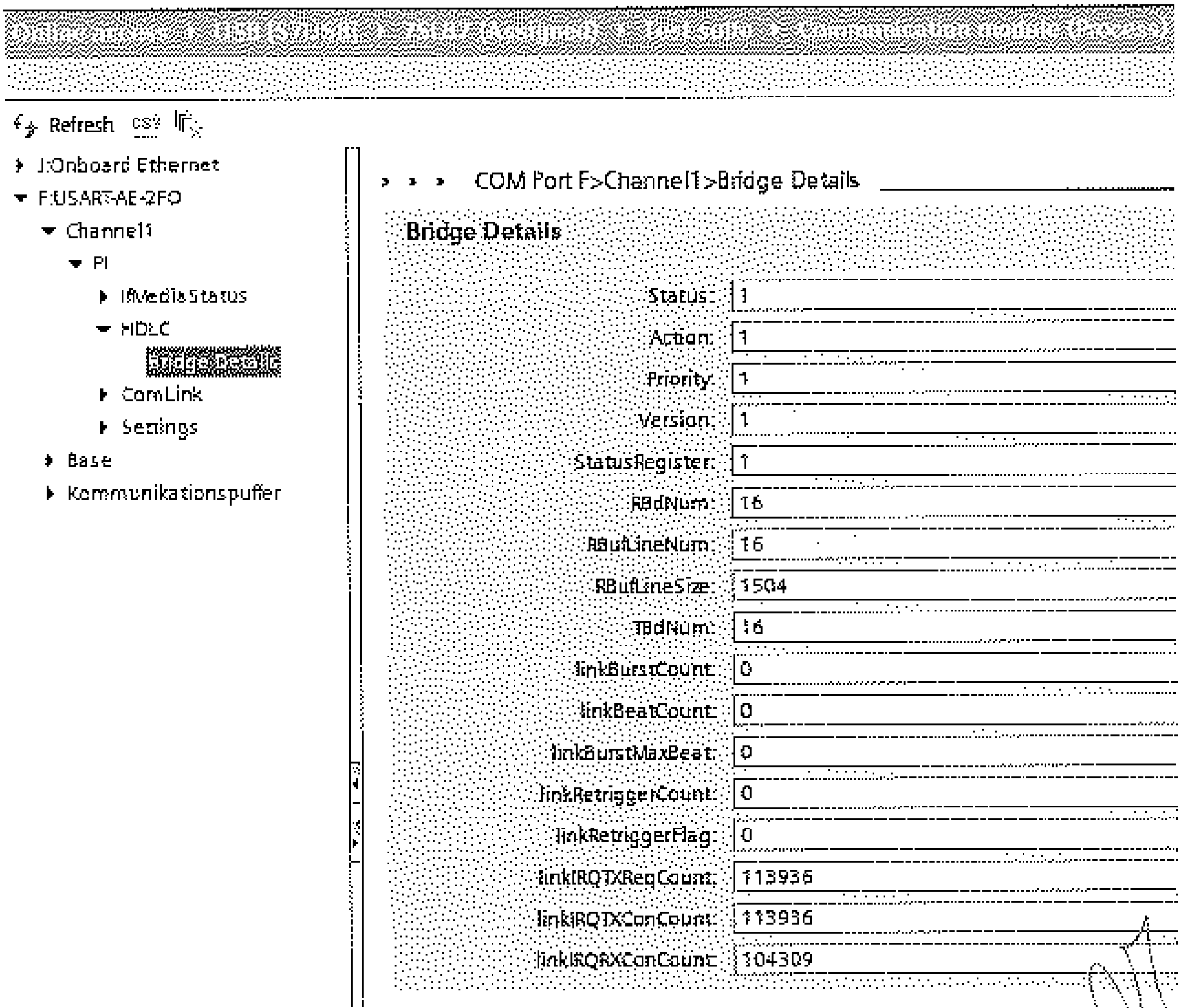


Figure 3-75 Diagnostic Data of the Protection-Interface Log - HDLC (Log - Layer)

Table 3-16 Description of Diagnostic Data of the Protection-Interface Log - HDLC (Log - Layer)

Protection Interfaces - Log Type	Name	Values	Description - HDLC Link Layer Diagnostic Information (in Direction of Outside Interface)
HDLC	RXHPFramesOK	Number of corresponding frames (16 bit counter)	Incoming telegrams, high priority, OK
HDLC	RXLPFramesOK	Number of corresponding frames (16 bit counter)	Incoming telegrams, low priority, OK
HDLC	RXHPFramesERR	Number of corresponding frames (16 bit counter)	Incoming telegrams, high priority, faulty
HDLC	RXLPFramesERR	Number of corresponding frames (16 bit counter)	Incoming telegrams, low priority, faulty
HDLC	TXHPFramesOK	Number of corresponding frames (16 bit counter)	Sending telegrams, high priority, OK
HDLC	TXLPFramesOK	Number of corresponding frames (16 bit counter)	Sending telegrams, low priority, OK
HDLC	TXHPFramesERR	Number of corresponding frames (16 bit counter)	Sending telegrams, high priority, faulty
HDLC	TXLPFramesERR	Number of corresponding frames (16 bit counter)	Sending telegrams, low priority, faulty
HDLC	Bridge Details Sub-nodes	Sub-nodes	Siemens-internal special diagnostic for fault search

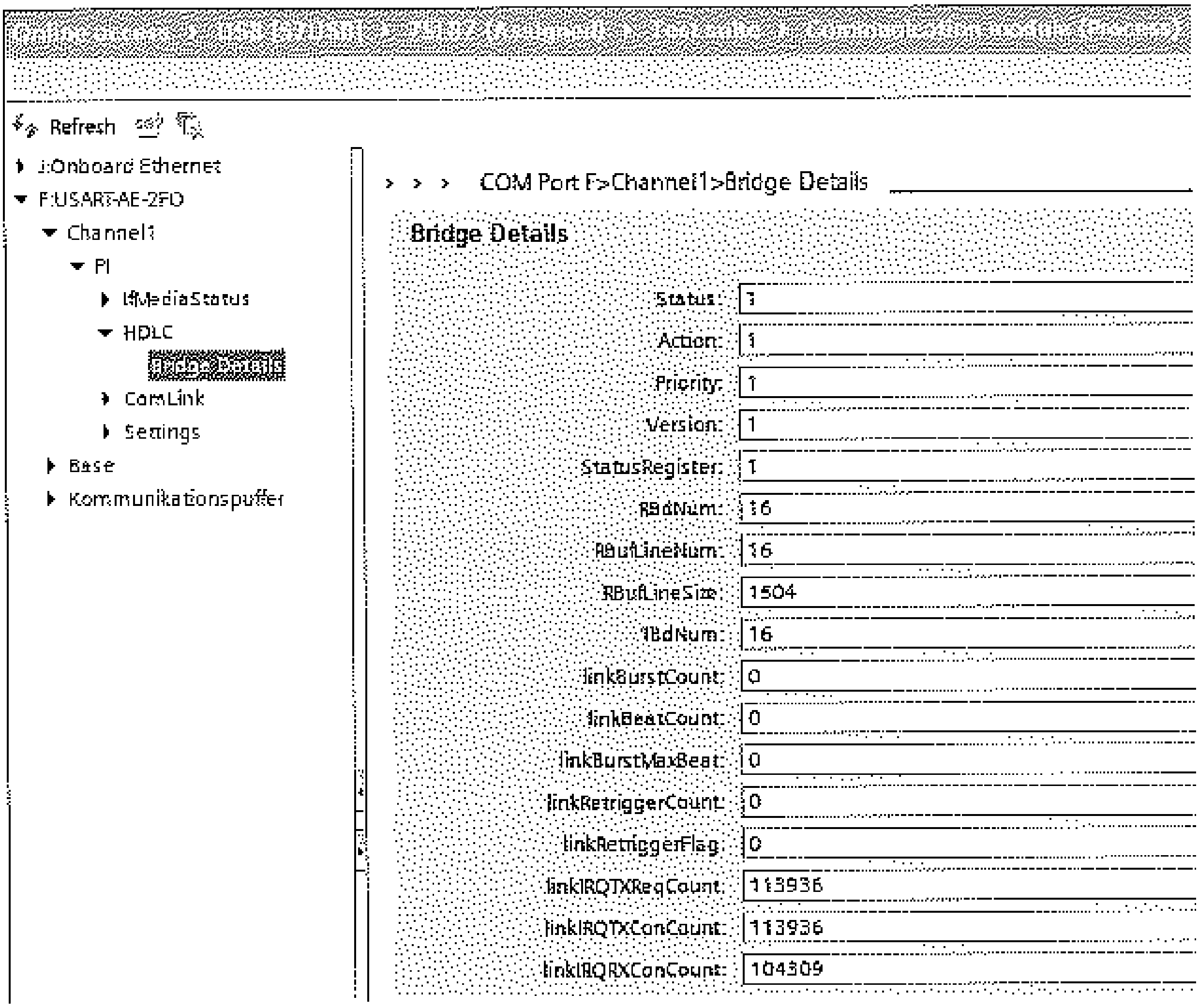


Figure 3-76 Diagnostic Data of the Protection-Interface Log - COM Interface (Internal COM Link Interface Between Module and Mainboard)

Table 3-17 Description of Diagnostic Data of the COM Interface (Internal COM Link Interface Between Module and Mainboard)

Protection Interfaces - Log Type	Name	Values	Description - COM Interface Layer Diagnostic Information (Internal COM Link Interface in Mainboard Direction)
COM interface	RXHPFramesOK	Number of corresponding frames (16 bit counter)	Incoming telegrams, high priority, OK
COM interface	RXLPFramesOK	Number of corresponding frames (16 bit counter)	Incoming telegrams, low priority, OK
COM interface	RXHPFramesERR	Number of corresponding frames (16 bit counter)	Incoming telegrams, high priority, faulty
COM interface	RXLPFramesERR	Number of corresponding frames (16 bit counter)	Incoming telegrams, low priority, faulty

Protection Interfaces - Log Type	Name	Values	Description - COM Interface Layer Diagnostic Information (Internal COM Link Interface in Mainboard Direction)
COM interface	TXHPFramesOK	Number of corresponding frames (16 bit counter)	Sending telegrams, high priority, OK
COM interface	TXLPFramesOK	Number of corresponding frames (16 bit counter)	Sending telegrams, low priority, OK
COM interface	TXHPFramesERR	Number of corresponding frames (16 bit counter)	Sending telegrams, high priority, faulty
COM interface	TXLPFramesERR	Number of corresponding frames (16 bit counter)	Sending telegrams, low priority, faulty
COM interface	Bridge Details Sub-nodes	Sub-nodes	Siemens-internal special diagnostic for fault search

Table 3-18 Description of Diagnostic Data of some Setting Values of the Protection Interface

Protection Interfaces - Log Type	Name	Values	Description - Protection Interface Setting Values
Settings	`Connection via`	Integer number - display of the internal coding of the settings variant	Protection interface is `Connection via`
Settings	`PDI bandwidth`	Bit-rate display	Bit rate (bit/s) for protection telegrams based on the parameter `Connection via`
Settings	`PDI Telegram.Overhead`	Display of bits	Overhead for every protection telegram in bit.

3.5.3.12 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
_: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

Addr.	Parameter	C	Setting Options	Default Setting
Prot. interface				
_:105	Prot.interface:Connection via		• fiber optic • CCXG 512 kBit/s • CCXG 128 kBit/s • CCXG 64 kBit/s • repeater 512 kBit/s • CCPW 128 kBit/s • CC2M 512 kBit/s • C37.94 1 * 64 kBit/s • C37.94 2 * 64 kBit/s • C37.94 8 * 64 kBit/s • 64 kBit/s • 128 kBit/s • 512 kBit/s • 2048 kBit/s	fiber optic
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:PPS synchronization		• telegr. and PPS • telegr. or PPS • PPS sync. off	PPS sync. off

3.5.3.13 Information List

No.	Information	Data Class (Type)	Type
Channel 1			
_:307	Prot.interface:Health	ENS	O
_:304	Prot.interface:Channel Live	SPS	O
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. logoff device 1	SPS	O
_:5131:306	Device combin.:Fct. logoff device 2	SPS	O
_:5131:307	Device combin.:Fct. logoff device 3	SPS	O
_:5131:309	Device combin.:Fct. logoff device 4	SPS	O

No.	Information	Data Class (Type)	Type
_:5131:310	Device combin.:Fct. logoff device 5	SPS	O
_:5131:311	Device combin.:Fct. logoff 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

No.	Information	Data Class (Type)	Type
Ext. Synchron.			
_:9181:500	Ext. Synchron.:>Block stage	SPS	I
_:9181:501	Ext. Synchron.:>PPS pulse loss	SPS	I
_:9181:301	Ext. Synchron.:PPS pulse loss	SPS	O
_:9181:302	Ext. Synchron.:PPS 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:Line	ENS	O
_:1351:6811:302	Meas.val.dev.1:Vph	WYE	O
_:1351:6811:303	Meas.val.dev.1:Iph	WYE	O
Meas.val.dev.2			
_:1351:6841:300	Meas.val.dev.2:Dev.adr.	INS	O
_:1351:6841:301	Meas.val.dev.2:Line	ENS	O
_:1351:6841:302	Meas.val.dev.2:Vph	WYE	O
_:1351:6841:303	Meas.val.dev.2:Iph	WYE	O
Meas.val.dev.3			
_:1351:6871:300	Meas.val.dev.3:Dev.adr.	INS	O
_:1351:6871:301	Meas.val.dev.3:Line	ENS	O
_:1351:6871:302	Meas.val.dev.3:Vph	WYE	O
_:1351:6871:303	Meas.val.dev.3:Iph	WYE	O
Meas.val.dev.4			
_:1351:6901:300	Meas.val.dev.4:Dev.adr.	INS	O
_:1351:6901:301	Meas.val.dev.4:Line	ENS	O
_:1351:6901:302	Meas.val.dev.4:Vph	WYE	O
_:1351:6901:303	Meas.val.dev.4:Iph	WYE	O
Meas.val.dev.5			
_:1351:6931:300	Meas.val.dev.5:Dev.adr.	INS	O
_:1351:6931:301	Meas.val.dev.5:Line	ENS	O
_:1351:6931:302	Meas.val.dev.5:Vph	WYE	O
_:1351:6931:303	Meas.val.dev.5:Iph	WYE	O
Meas.val.dev.6			
_:1351:6961:300	Meas.val.dev.6:Dev.adr.	INS	O
_:1351:6961:301	Meas.val.dev.6:Line	ENS	O
_:1351:6961:302	Meas.val.dev.6:Vph	WYE	O
_:1351:6961:303	Meas.val.dev.6:Iph	WYE	O

3.6 Date and Time Synchronization

3.6.1 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.

3.6.2 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.**

3.6.3 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 start-up 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.

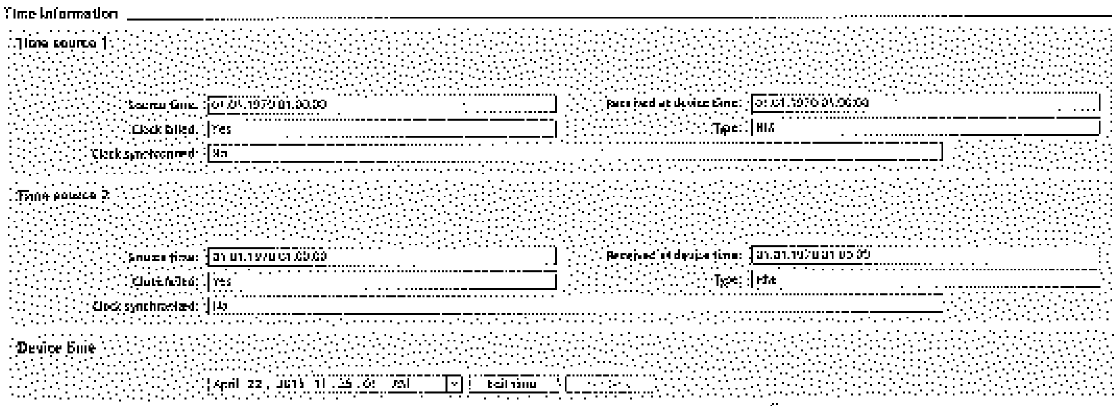
Indication	Description
Device: *Clock fail*	This indication signals a high difference between the internally managed time and the time of the clock module that is not permissible. The triggering of the indication can point to a defect in the clock module or to an unacceptable high drift of the system quartz crystal. The time maintained internally is marked as invalid.
Time management: *Daylight saving time*	This indication signals whether daylight saving time has been enabled.
Time management: *Clock set manually*	This indication signals that the device time has been set manually via the on-site operation panel or via DIGSI 5.
Time synchronization: *Status time source 1* *Status time source 2*	These 2 indications signal whether the active time sources are recognized as valid and active from the device point of view. When the indications get triggered, 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: *Time sync. error*	This indication signals after the parameterized time **Fault indication after** that synchronization using an external time source has failed.
Time synchronization: *High accuracy*	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**



[scdevde 220415, 1, en_US]

Figure 3-77 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 infeed 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).

3.6.4 Application and Setting Notes

Parameter: Date Format

- Default setting `Date format` = *YYYY-MM-DD*

With the `Date format` parameter, you define the local customary format of the date display.

Parameter Value	Description
YYYY-MM-DD	Day.Month.Year: Typical European display Example: 24.12.2010
YYYY-MM-DD	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 `Time zone time source 1` and `Time zone time source 2` parameters, you define the handling of time zones of the external timer.

Parameter Value	Description
local	Local time zone and daylight saving time are considered as time zone offsets to GMT.
UTC	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 `Time source 1` and `Time source 2` parameters, 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
none	The time source is not configured.

Parameter Value	Description
IRIG-B	Time synchronization by an external GPS receiver: SIPROTEC 5 devices support several protocol variants of the IRIG-B standards: • **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 or in the case of local time, specifies the appropriate offset to UTC in each set time telegram.
DCF77	Time synchronization by an external DCF 77 receiver `Time zone time source 1` or `Time zone time source 2` = `local` Please note: There are also clocks that generate a DCF 77 signal representing UTC. In this case, UTC must be set.
PI	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 of a SIPROTEC 5 master, receives its system time kept in UTC.
SNTP	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, ClockFailure, 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`
IEC 60870-5-103	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.

Parameter Value	Description
DNP3	The time is synchronized via telegram with the appropriately configured communication interface in accordance with the DNP3 protocol. Two 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.
IEEE 1588	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 **Fault indication after** parameter 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 radio buttons or check box.

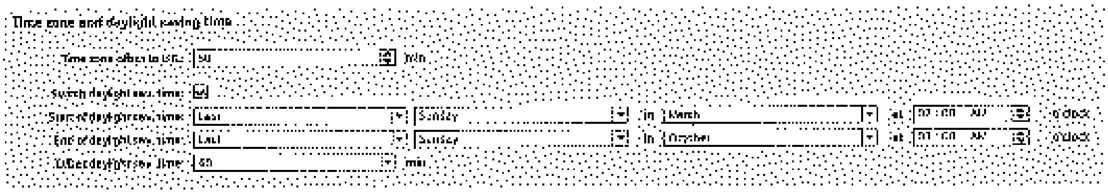


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Figure 3-78 Settings for Time Zone and Daylight Saving Time in DIGSI

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

3.6.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Time sync.				
_:102	Time sync.:Time source 1		• none • PPM • IRIG-B • DCF77 • Syncbox • 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 • PPM • IRIG-B • DCF77 • Syncbox • 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

3.6.6 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

3.7 User-Defined Objects

3.7.1 Overview

Within a **User-defined function group**, you can use the **User-defined function block** and the **User-defined function block [Control]** to group user-defined objects that you find in the DIGSI 5 library under **User-defined functions**.

With user-defined function groups and user-defined functions, a grouping of user-defined objects, for example, user-defined function blocks, can be performed. 2 user-defined function blocks are available (see following figure).

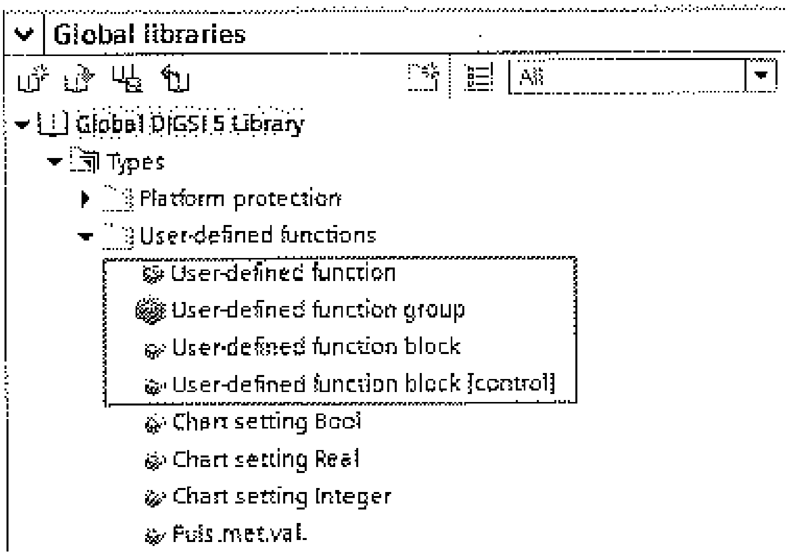


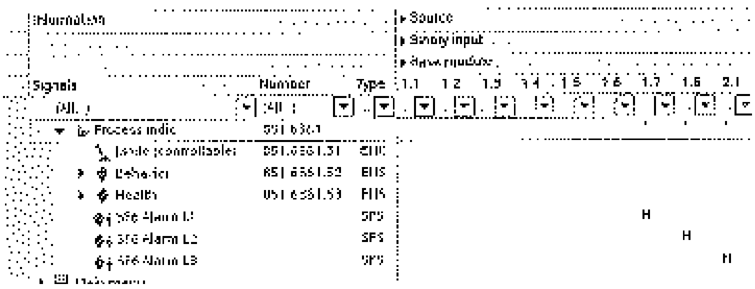
Figure 3-79 User-Defined Objects in the DIGSI 5 Library

You can insert single-point indications, pickup and operate indications (ACD, ACT), single or double commands, commands with a controllable whole number as well as measured values in the **User-defined function block** (see following figure). You can assign a superordinate name to the grouping (for example, **Process indications**, for a group of single-point indications that are read in via binary inputs). This function can be deactivated via the mode. Readiness is also evaluated and represented.

The user-defined function can be instantiated both at the highest level (in parallel to other function groups) and within the function groups and functions.

A **User-defined function block [control]** is also available. In addition to the mentioned option of a general **User-defined function block**, this block offers additional tests for user-defined control signals, for example, SPC or DP.

You can find more information in chapter *8.6.1 Overview of Functions*.



[scrnshot_2009-12-07.01, 1, en_US]

Figure 3-80 Information Routing Through Use of Added User-Defined Function Block: Process Indications and Single-Point Indications

3.7.2 Basic Data Types

The following data types are available for user-defined objects in the DIGSI 5 library under the heading **User-defined signals**.

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`.

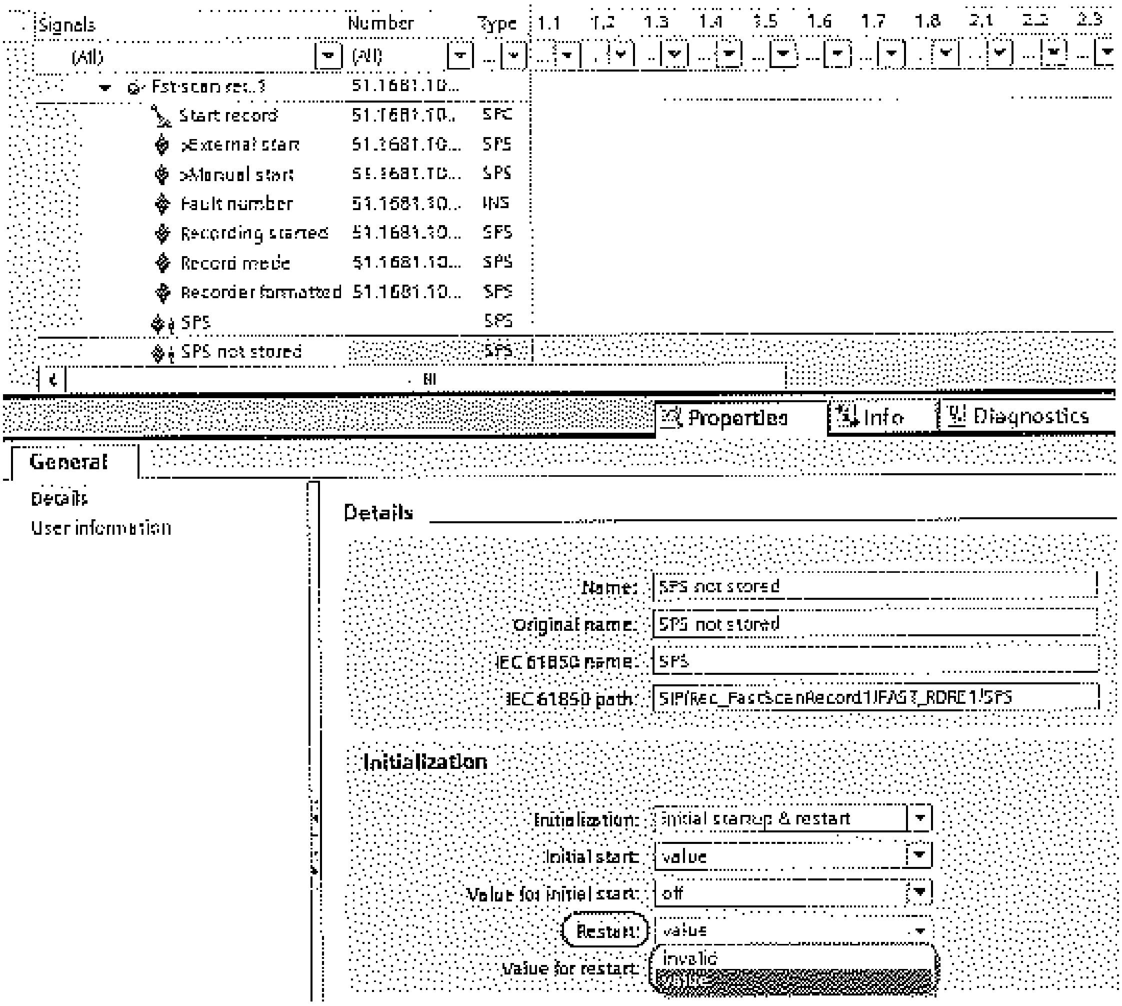


Figure 3-81 Single-Point Indication SPS Unsaved (Example: 7KE85 Fault Recorder)

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).

State of a Whole Number (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 instance.

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**.

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.

3.7.3 Pulse- and Energy- Metered Values , Transformer Taps

Pulse-Metered Values

Pulse-metered values are available as data types **BCR** (Binary Counter Reading) in the DIGSI library under **User-defined Functions**.

The functionality and the settings of the pulse-metered values can be found in chapter *10.8.1 Pulse-Metered Values Function Description* .

Transformer Taps

Transformer taps are contained in the **Transformer tap changers** switching element. When the **Transformer tap changer** switching element is created in the device, the transformer tap position is available as a data object of type **BSC** (binary controlled tap changer with tap-position information).

You can find detailed information in *8.8.1 Function Description* .

Energy-Metered Values

Energy metered values no longer need to be created by the user separately. They are available as active and reactive power in each **Line** function group for reference and output direction. The calculation is based on the current and voltage transformers associated with the protected object.

You can find more detailed information in chapter *10.7.1 Function Description of Energy Values* .

3.7.4 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 tap changer with tap-position information).

3.8 Other Functions

3.8.1 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

For the circuit breaker or the disconnector, the settings of the software filter for spontaneous position changes are available only in the **Control/Command with feedback** function block. These settings are not available in the **Circuit breaker** or **Disconnector** function blocks since these function blocks contain the actual unfiltered position of the switch in the bay.

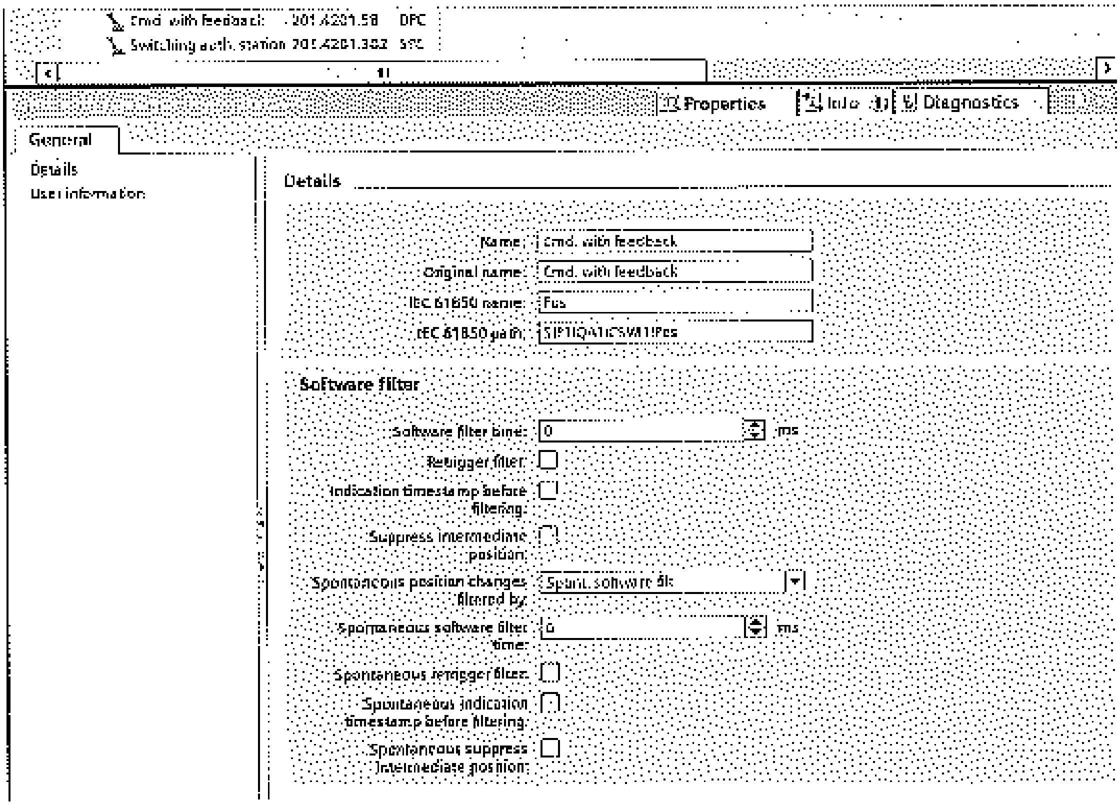


Figure 3-82 Settings for Circuit-Breaker Switch Position

The setting range for the `Software filtering time` parameter ranges from 0 ms to 86 400 000 ms (1 day) in ms increments. The `Retrigger filter` check box can be used to select whether the software filter should be restarted by a change from 1 to 0 and back. When activated, the `Indication timestamp before filtering` check box back dates the time stamp by the set software filtering time and the fixed hardware 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 filter time.

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 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. The settings for spontaneous position changes can then not 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 a parameter of the position in the **Circuit breaker** or **Disconnector** function block.

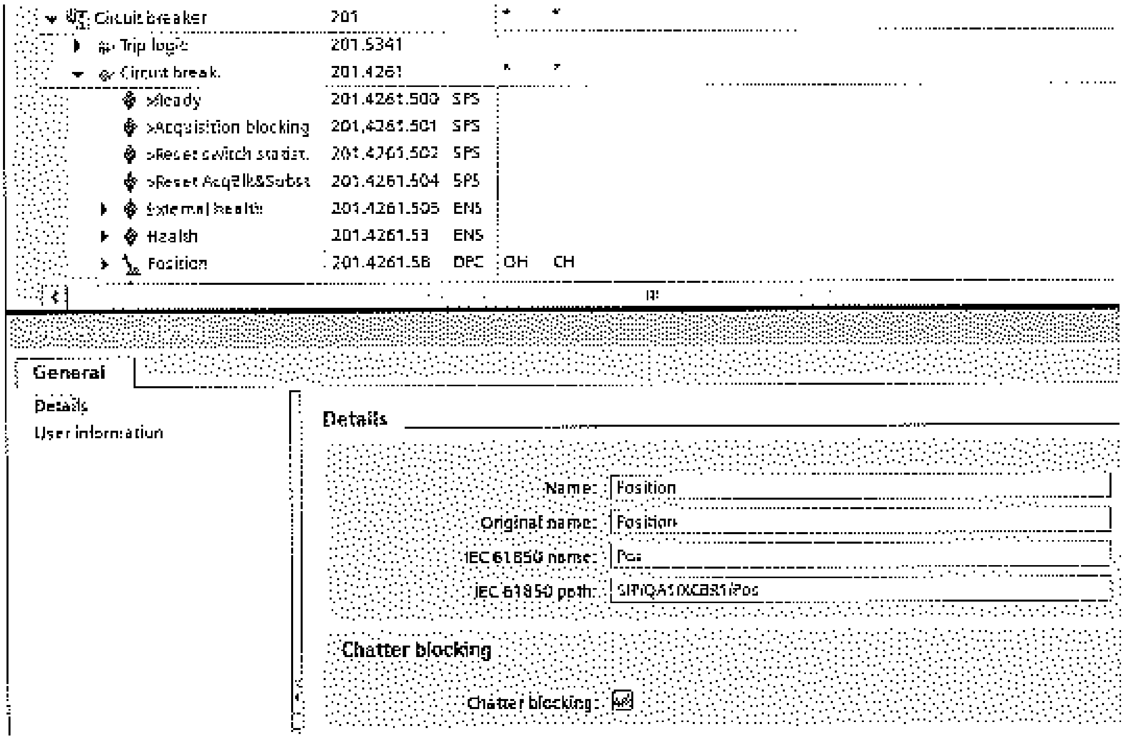
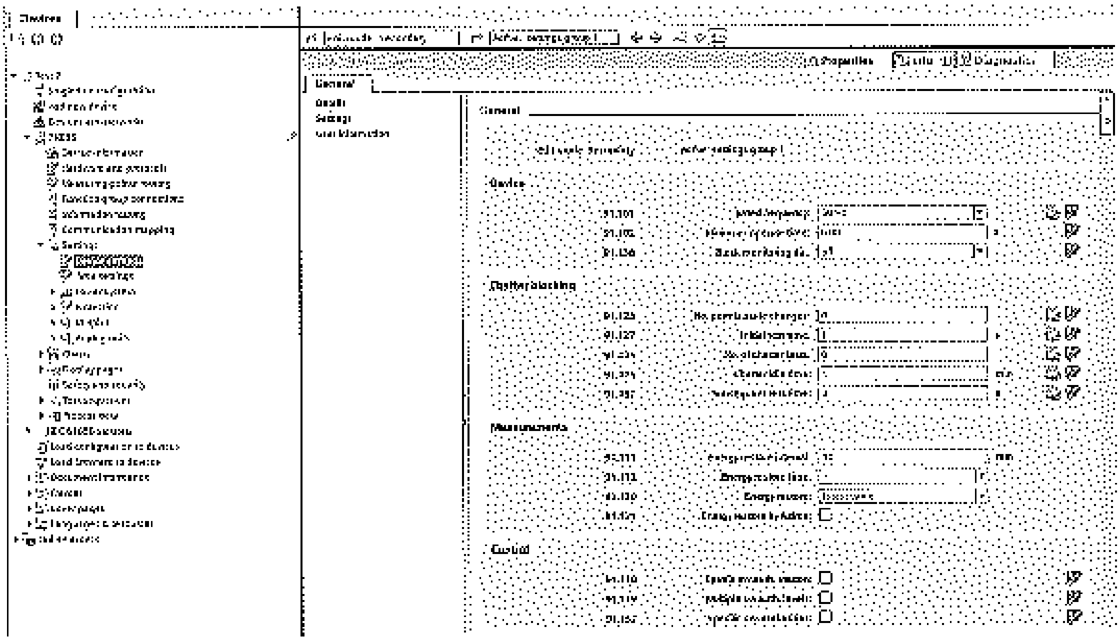


Figure 3-83 Setting Chatter Blocking

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).



[scpcrall 20110 01 6f, 2 en, US]

Figure 3-84 Chatter-Blocking Settings

The chatter-blocking settings have the following meaning (see also Figure 3-85 and Figure 3-86 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 state changes is exceeded during the initial test time, the signal is temporarily blocked and the indication *Chatter blocking* is set.

  Enter a number between 1 and 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 state changes 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) are 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 between 1 and 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 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 between 2 and 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.

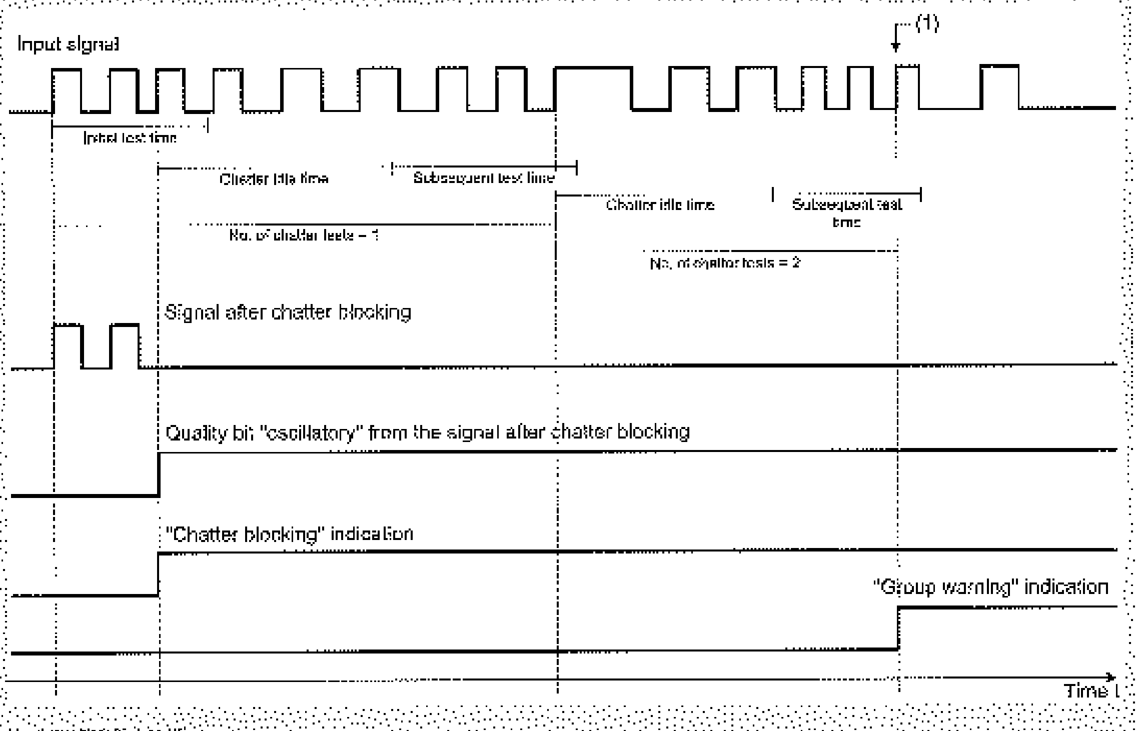
Example 1: Permanent Blocking

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 state 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 3-85 Signal Change during Chatter Blocking with too Important Number of Signal State Changes During 2nd Subsequent Test Time

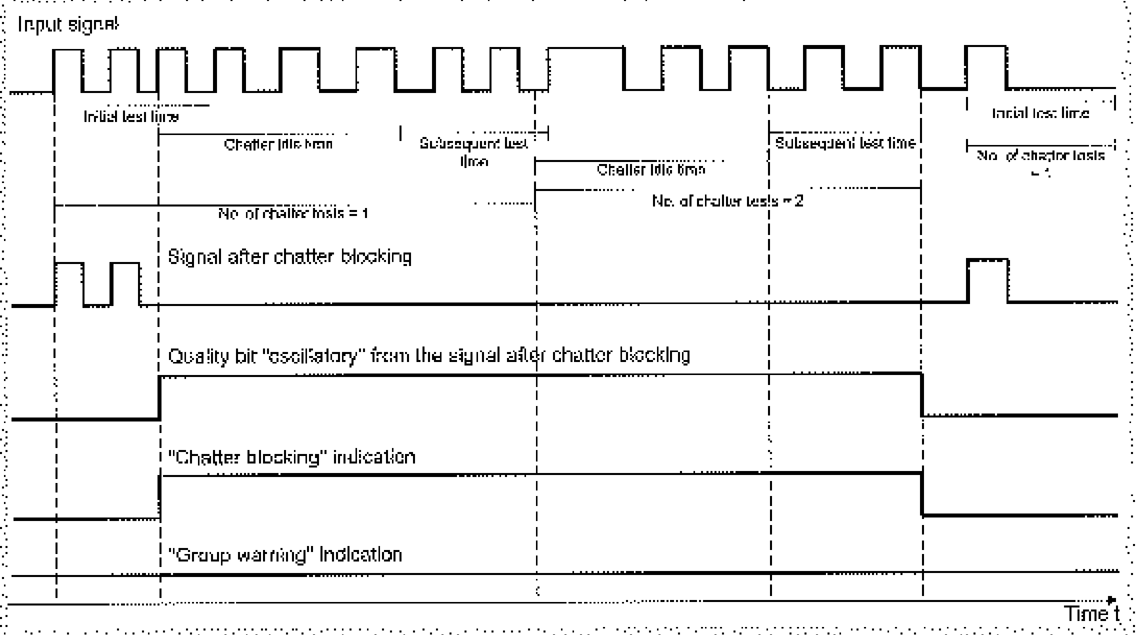
(1) The input signal is permanently blocked starting from this point in time.

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-blocking, 1, en_US]

Figure 3-86 Signal Change during Chatter Blocking with Permissible Number of Signal State Changes During 2nd Subsequent Test Time

3.8.2 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.

Set the Acquisition blocking function in the menu of the device display **Commands > Equipment >Aq.blk man. update**. If several switching devices are available, select the appropriate switching device. When pressing the **Change** key, the confirmation ID will be queried. After entering the confirmation ID, the acquisition blocking function is switched on when **OK** is pressed.

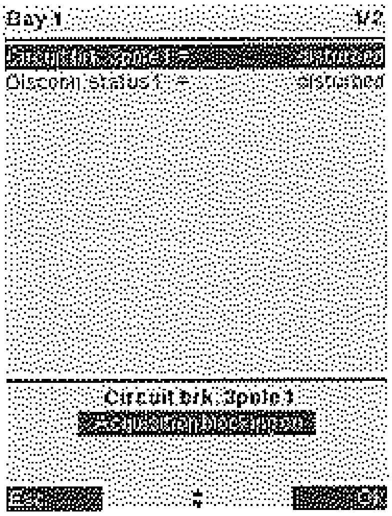


Figure 3-87 Activating the Acquisition Blocking

Manual updating of the switching device is possible from within the same menu. Use the menu item **Change** to select the **Manual updating** function. Subsequently, select the updating setting of the switching device manually and acknowledge the selection by pressing **OK**. The manually updated position of the switching device will be displayed.

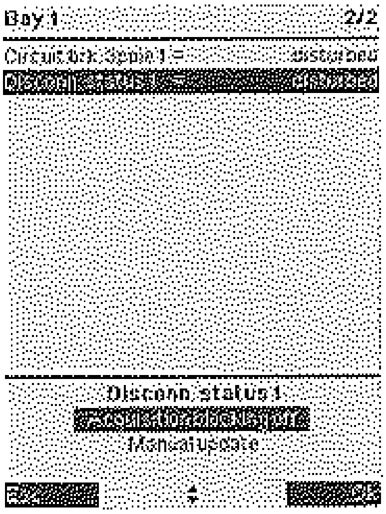


Figure 3-88 Activate Manual Updating

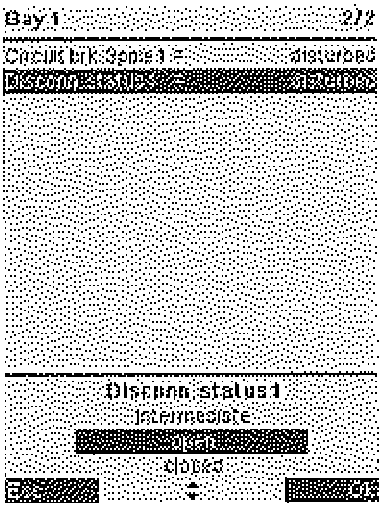


Figure 3-89 Selecting Position

NOTE

For safety 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.

Acquisition blocking can also be set via a binary input. This way, acquisition blocking can be set for an individual or several switching devices in a feeder simultaneously with an external toggle switch in order to disable the feeder. 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.

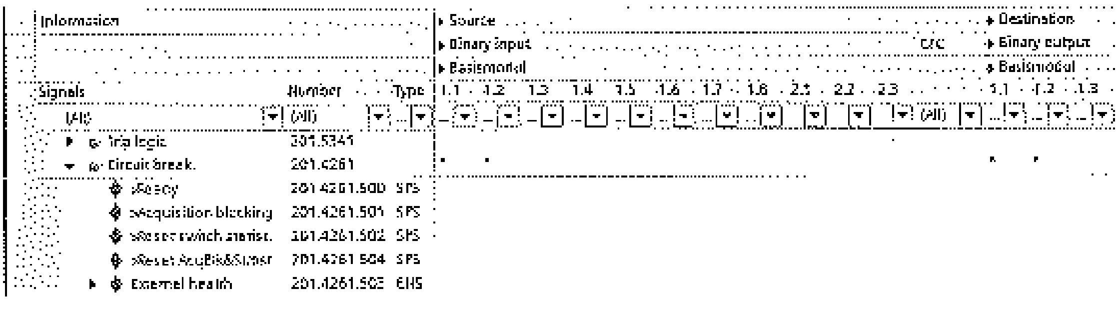


Figure 3-90 Input signals *>Acquisition Block* and *>Release Acquisition Block & Manual Updating* on the Switching Device

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

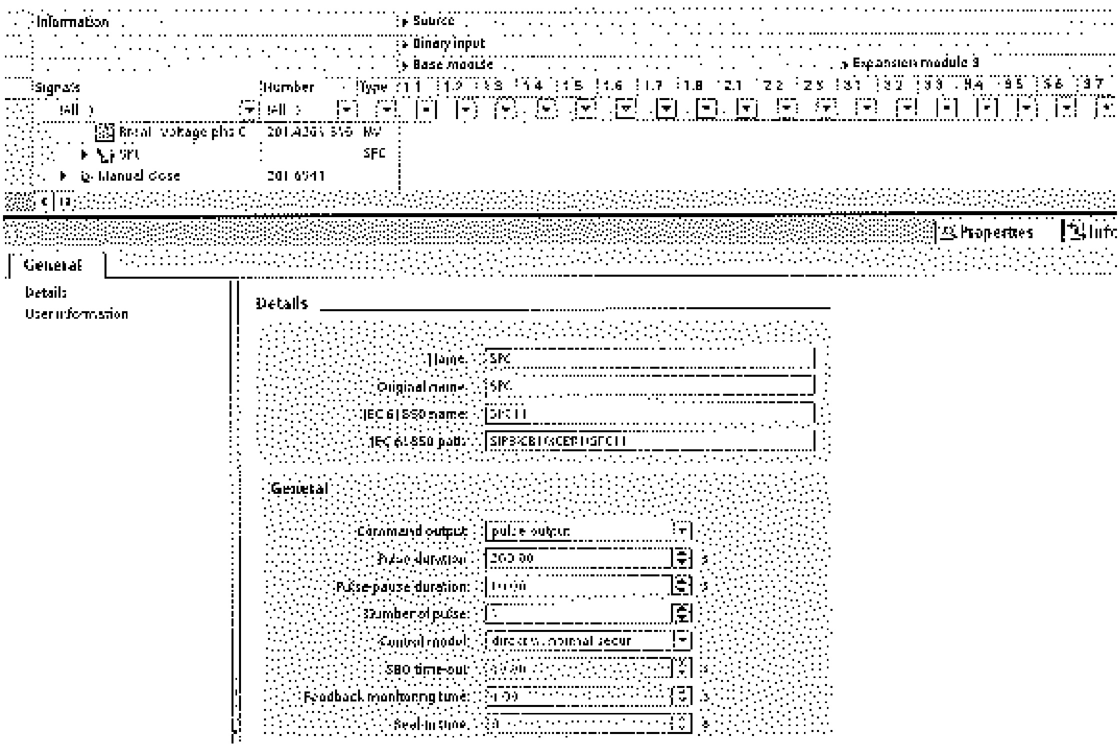
When the acquisition blocking is activated or the switching device updated manually while the entire device or the switching device is in test mode, these states are not saved. The acquisition blocking and the manual updating are not retained after a restart.

Acquisition blocking and 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.

3.8.3 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.



[scdetcmd-260912-01.tif, 1, en_US]

Figure 3-91 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.

3.9 General Notes for Setting the Threshold Value of Protection Functions

3.9.1 Overview

You can set the threshold values of protection functions directly on the device or by using DIGSI 5.

An innovative design was implemented for the protection settings.

You can switchover the edit mode between the following setting views:

- Primary
- Secondary
- Percent

If you change settings in a setting view, DIGSI 5 calculates the settings of the 2 inactive views in the background. If you wish to save, for example, conversion to secondary values, then select the primary view. Configure all the settings and switchover to the secondary view.

Edit Mode: Primary

The parameters are set as primary values and thus refer directly to the primary system. The manual conversion on the secondary circuit omitted.

Edit Mode: Secondary

The settings refer to the secondary circuit of the transformer. This means that the settings must be converted. The secondary setting is the customary setting view. For secondary tests, the pickup values can be read directly.

Edit Mode: Percent

This setting type is beneficial for electric machines (generators, transformers, motors, and busbars). The setting values can be standardized regardless of the machine size. The reference values for the percentage settings are the rated values of the function groups, for example, rated voltage and rated current or rated apparent power . The setting values are, thus, related exclusively to the primary settings. If other reference values are used, then this is documented for the respective protection function in the application and setting notes.

If parameters are selected it may happen that they are set only in percent in all 3 setting views.

Recommendation for Setting Sequence

When setting the protection function, Siemens recommends the following procedure:

- First set the transformation ratios of the transformers. You can find these under **Power-system data**.
- In addition, set the reference parameters for the percent setting. You will find these parameters in function group .
- Next, set the parameter of the protection functions.
  If the transformer data have changed after completing the protection setting, remain in the setting sheet (for example, primary setting) and change the transformer data. In the background, DIGSI 5 obtains the new settings in the inactive setting views (for example, new secondary values).

The following section explains, by way of an example, how to modify the transformer ratios in DIGSI 5 using the corresponding alternatives.

3.9.2 Modifying the Transformer Ratios in DIGSI 5

In the delivery setting, DIGSI 5 is set to the **Secondary** edit mode.

The following setting example shows how you can change the transformer ratio in DIGSI 5, and what impact this has on the settings in the setting views **Primary** and **Secondary**. The protection setting is observed in the example of the **Overcurrent protection** function.

The following output data are assumed:

Current transformer:	1000 A/1 A
Protection pickup value:	1.5 A

The following figure shows the protection setting of the **Overcurrent protection** function in the secondary view. The threshold value of the stage is set to 1.5 A.

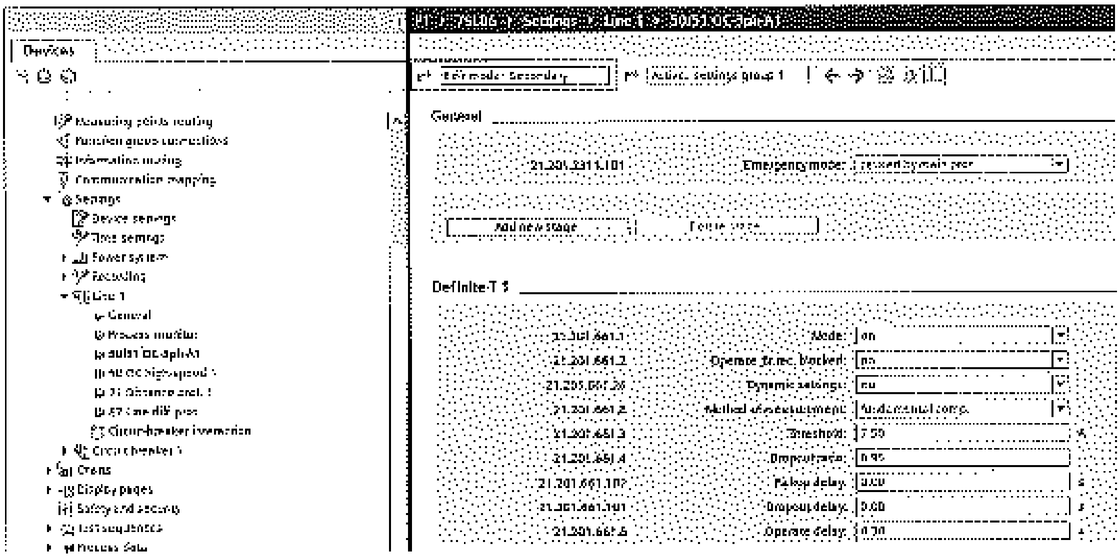


Figure 3-92 Protection Setting, Display of the Active Setting Sheet

When you click the green arrow in the setting sheet at the upper left, you get to the window for switching over to the setting view (see the following figure). Select the setting view you prefer.

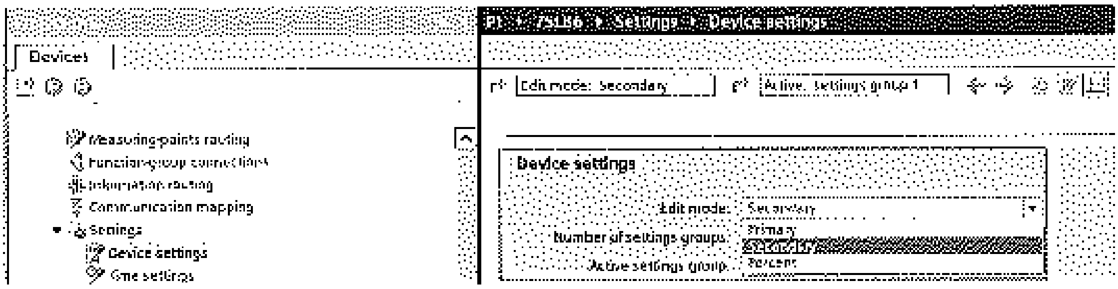


Figure 3-93 Switchover to the Desired Setting View

The following figures show the setting sequence in the **Primary** edit mode. Set the transformer data. In the example, the current transformer has a transformation ratio of 1000 A/1 A.

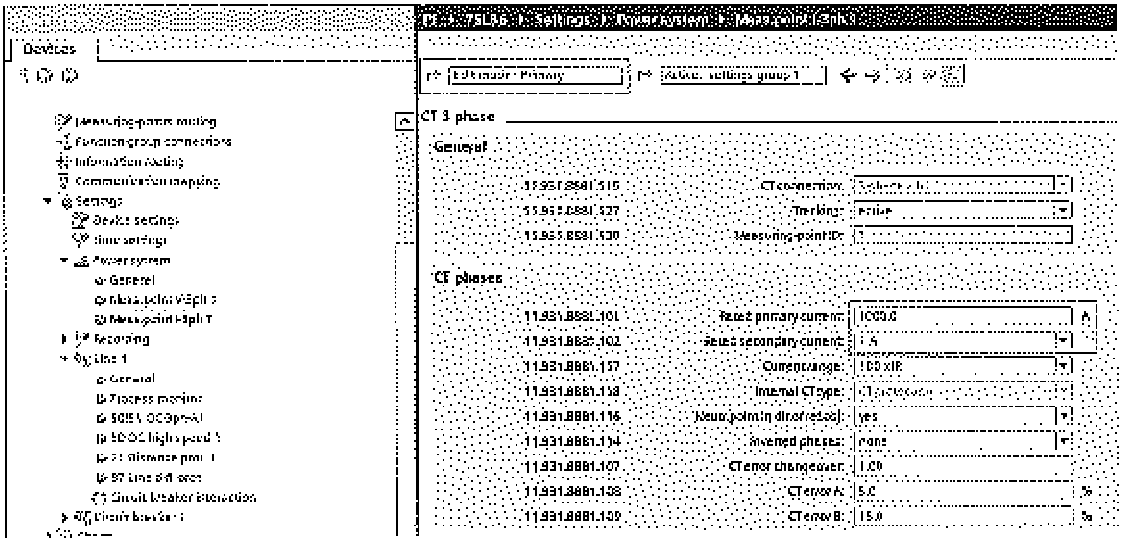


Figure 3-94 Setting Sheet: Transformer Data

In the **Voltage/current 3-phase** function group, you set the rated current and rated voltage (see the following figure). Rated current, rated voltage are the reference variables for the percent setting.

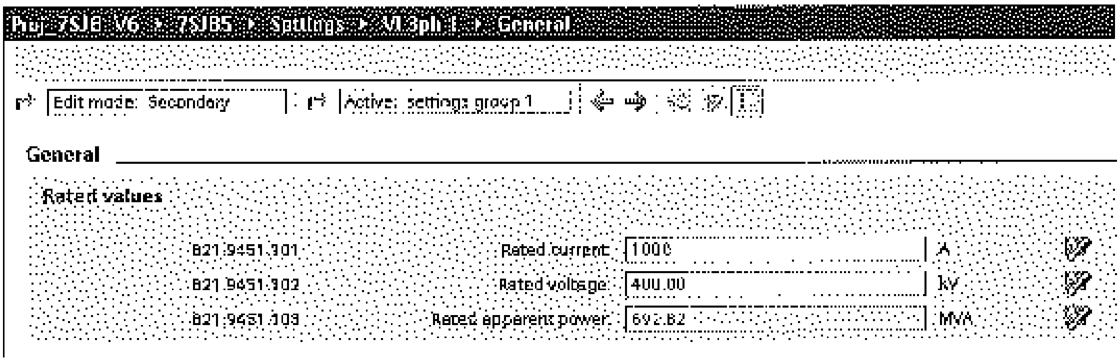
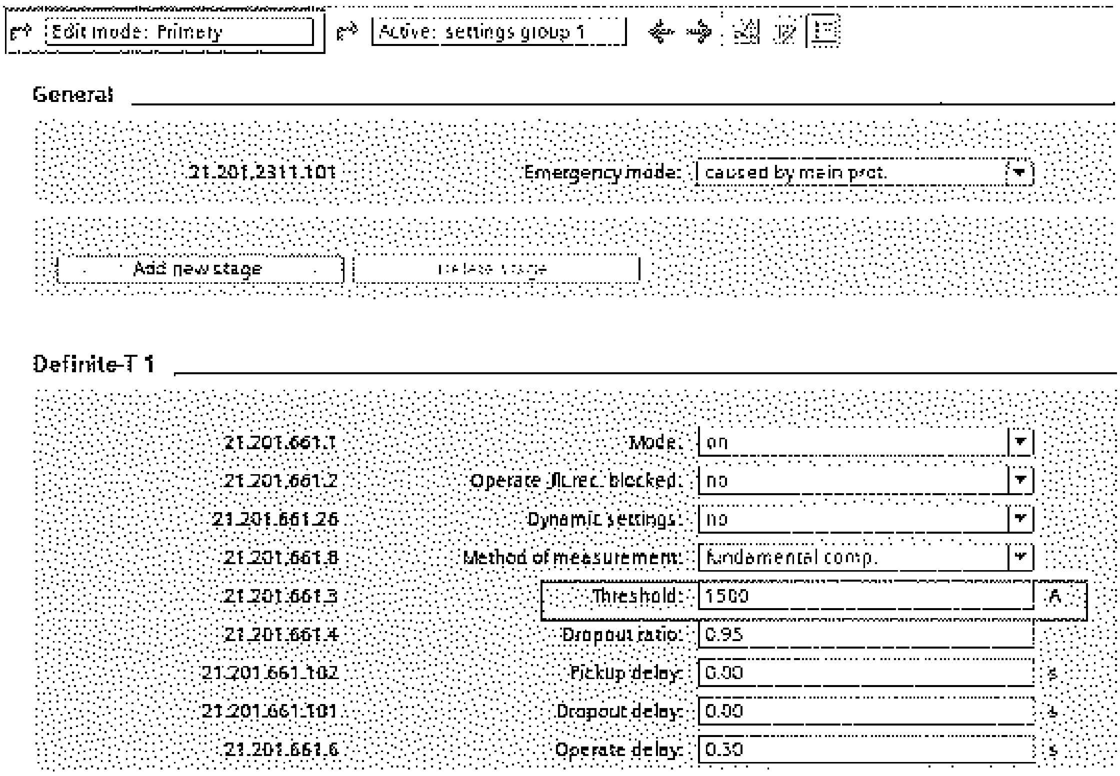


Figure 3-95 Reference Data for Percentage Settings

The following figure shows the threshold value of the **Overcurrent protection** function in the primary view at 1500 A.



[scrmpri_3, 1, en_US]

Figure 3-96 Example of the Threshold Value of the Definite Time-Overcurrent Protection (Edit Mode: Primary)

When switching over to the percent view, the result should be the following value:

1500 A/1000 A · 100 % = 150 %

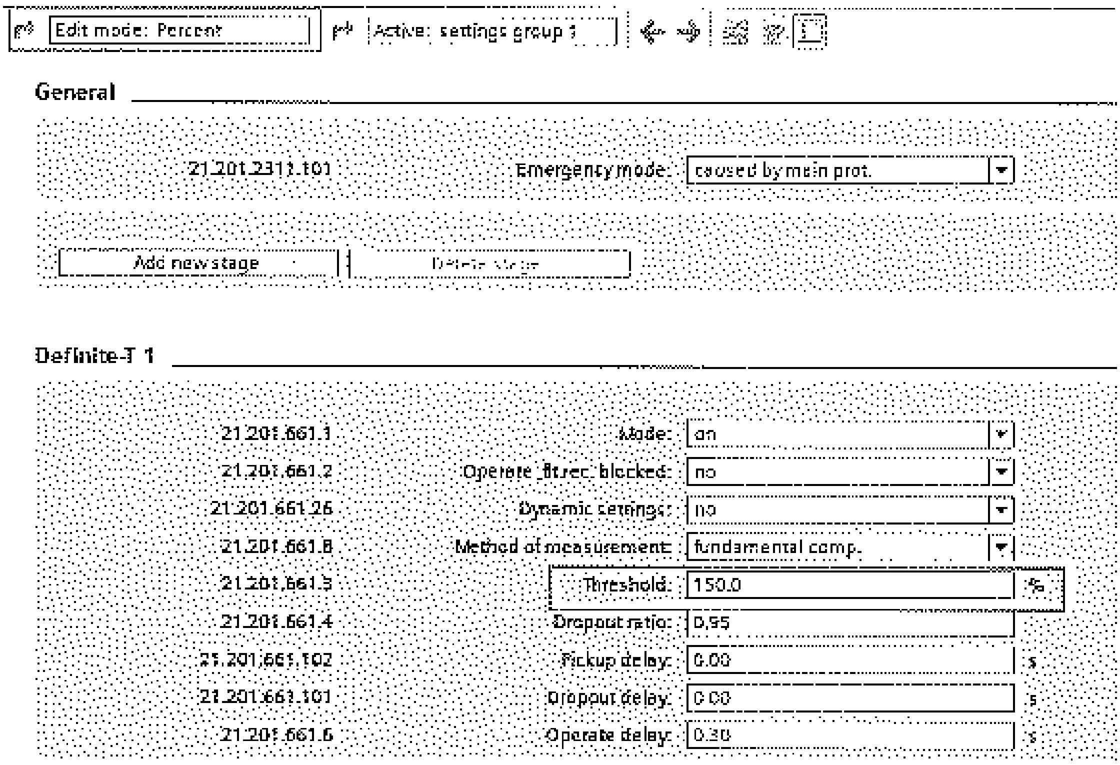


Figure 3-97 Example of the Threshold Value of the Definite Time-Overcurrent Protection (Edit Mode: Percent)

When switching over to the secondary view, the result should be the following value:

1500 A/(1000 A/1 A) = 1.5 A