SIEMENS

SIPROTEC 5
IEC 61850

V3.00 or higher

Manual

Preface

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C53000-G5040-C007-4

NOTE

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

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Preface

Purpose of the Manual

This manual contains information about:

- Communication within the SIPROTEC 5 family of devices and to higher-level control centers
- Installation of the modules
- Setting parameters in DIGSI 5
- Information on commissioning

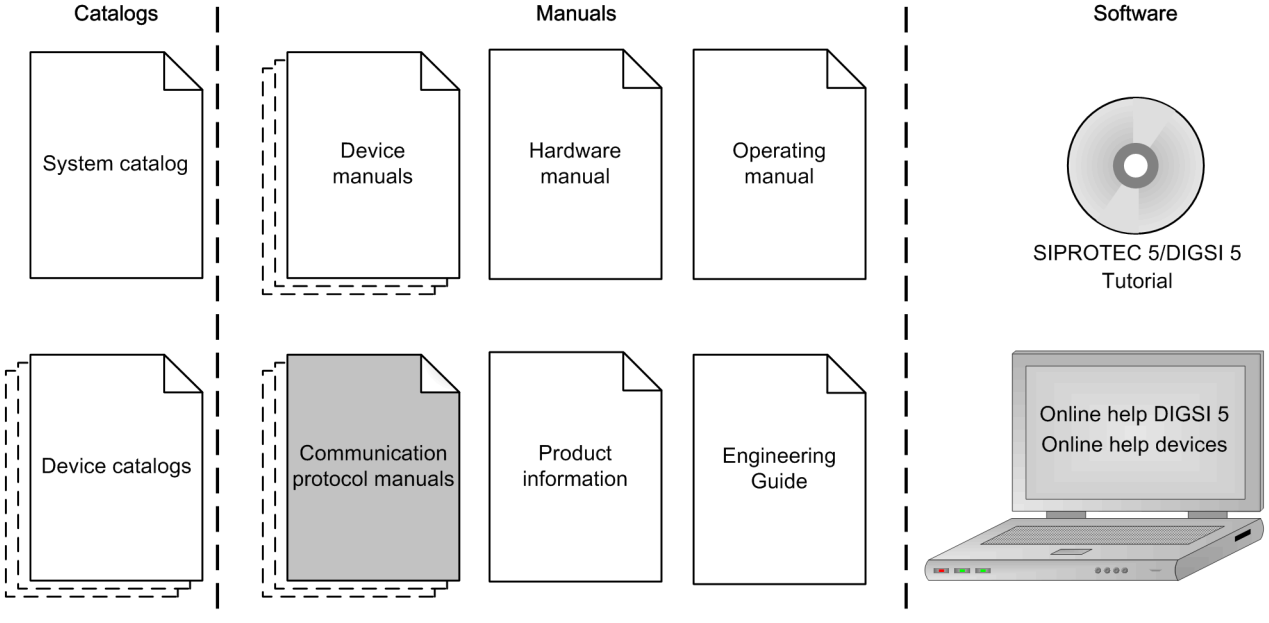
Target Audience

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



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- Device manuals

  Device manuals describe the functions and applications of a specific SIPROTEC 5 device. The printed manual and the device's online help have the same informational structure.

- Hardware manual

  The Hardware manual describes the hardware components and device combinations of the SIPROTEC 5 range.

- Operating manual

  The Operating manual describes the basic principles and procedures for operating and assembling the devices of the SIPROTEC 5 range.

- Communication protocol manuals

  The Communication protocol manuals include a description of specific protocols for communication within the SIPROTEC 5 family and to higher-level control centers.

- Product information

  The Product information includes general information about device installation, technical data, limit values for input and output modules, and conditions when preparing for operation. This document is delivered 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 components 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.

- System catalog

  The system catalog describes the SIPROTEC 5 system features.

- Device catalogs

  The device catalogs describe device-specific features such as functional scope, hardware and applications.

Indication of Conformity

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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 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low Voltage Directive 2006/95/EC).
This conformity has been proved by tests performed according to the Council Directive in accordance with the generic standards EN 61000-6-2 and EN 61000-6-4 (for EMC directive) and with the 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.

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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.

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Internet: http://www.siemens.com/poweracademy

Safety Information

This manual is not a complete index of all safety measures required for operation of the equipment (module, device). However, it comprises important information that must be noted for purposes of personal safety, as well as in order 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 medium-severe or slight injuries.

NOTICE

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

✧ Comply with all instructions, in order to avoid material 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.

Use as Prescribed

The equipment (device, module) may only be used 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 material 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).
- Equipment with exposed current-transformer circuits must not be operated. Before disconnecting the equipment, ensure that the current-transformer circuits are short-circuited.
- The limit values stated in the document may not be exceeded. This must also be considered during testing and commissioning.

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1 Introduction

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1.1 Use in SIPROTEC 5 Devices

The IEC 61850 protocol is implemented on an Ethernet module. This Ethernet module can be inserted into module slots E, F, N, and P. In contrast to SIPROTEC 4, several Ethernet modules can be accommodated in one SIPROTEC 5 device. This permits communication between the client and the server for substation automation via the IEC 61850 MMS protocol (MMS – Manufacturing Message Specification) in one module. Cross communication between devices takes place on a second module via GOOSE messages (GOOSE – Generic Object-Oriented Substation Event). As an option, different networks can be used for communication.

NOTE

You can also use a network like for SIPROTEC 4.

The Ethernet modules come with 2 RJ45 connectors or with 2 duplex-LC interfaces for a 1300-nm fiber-optic connection. The physical interface is always duplicated to permit redundant networks.

The interfaces have different operating modes:

- **Line** operating mode

  One of the 2 interfaces is always active in this operating mode. The other interface is monitored passively. If the active interface experiences a problem, the module switches to the other interface automatically within milliseconds.
- **Switch** operating mode

  In this operating mode, an integrated switch can be activated in an electrical and optical module. Operation with an integrated switch permits the creation of redundant ring structures. Both interfaces are active in this operating mode.

You can find more detailed information on ring structures in chapter *2.1 Network Structures*.

You can use DIGSI 5 to set the IEC 61850 protocol for the Ethernet module. DIGSI 5 is also used to make all necessary network settings. Various editors are available for the different protocol services listed in the IEC 61850 Standard. The IEC 61850 object image of a device can be configured flexibly to meet your requirements.

SIPROTEC 5 devices support the Editions 1 and 2 of IEC 61850. For substation automation compatibility with existing Edition 1 devices, you can use DIGSI 5 to switch the IEC 61850 server of the device to the Edition 1 mode. The IEC 61850 server then operates together with Edition 1 clients and exchanges GOOSE messages with Edition 1 devices.

Edition 2 offers the following benefits, among others:

- Correction and clarity in the event of misunderstandings and interoperability problems that are documented in the **Tissue** database.
- Functional extensions in the engineering process, especially when exchanging configuration data between system configuration tools
- Stronger test of SCL files during import

  This test is implemented using another special SCL scheme.
- Extension of test equipment capabilities (data tracking and monitoring functions), device models, character strings
- Extension of the data model in terms of statistics data, power quality, conditional monitoring, hydropower, distributed energy resources, wind power, and communication between substations
- More standardized data classes (logical-node classes, CDC)

  These data classes may not be used in an Edition 1 project in this manner.

If you would like to use the benefits of Edition 2, the devices can be operated in the Edition 2 mode.

Additional Ethernet-based protocols such as DNP3 can also be activated on another Ethernet module.

■

2 Network Topology

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2.1 Network Structures

The Ethernet communication modules and interface are available in both electrical and optical versions. Both module types are provided with an integrated switch functionality and a function called **Dual Homing**. **Dual Homing** designates the simultaneous use of both interfaces on a module. This makes it possible to integrate the IEC 61850 devices into almost all network structures together with third-party components.

The interfaces on the devices can be used in different operating modes. A distinction is drawn between the 2 operating modes **Dual Homing** and **Switch**.

Superordinate Network Structures

SIPROTEC devices are always incorporated into superordinate network structures. This is not the case for connections with only a single partner.

The basic element of superordinate structures is always a so-called switch. Switches have several ports. The connections between these ports and the ports of other network switches form the superordinate network. The redundancy protocol RSTP (Rapid Spanning Tree Protocol) can be activated individually for each port of a switch.

RSTP is defined in standard IEEE 802.1D-2004. Siemens supports this standard.

Today, superordinate network structures are formed from structures based on switches that operate using RSTP. This always means that the higher level network forms a ring or a network of such network switches. This results in a variety of possible circuits. A superordinate network is always included in the following figures of structures.

It can be seen that a network structure always consists of a higher level network structure and the connection to a device.

NOTE

With RSTP, you must recall that, in the event of an error, this structure and the superordinate network structure determine the time behavior. With Dual Homing, only the device-connection line that switches very quickly is protected. Errors in the higher level network are always subject to the time behavior of the network.

In the following explanations, the superordinate network structure is always shown as a simple ring. Such a ring may conceal a structure with several superimposed rings.

Dual Homing Interface Operating Mode

If you have not set a redundancy protocol, the **Dual Homing** operating mode will be active. In this operating mode, both ports of the SIPROTEC device behave like an independent port. The 1st port that detects a connection to another power-system component accepts it as active and handles the entire data transmission via that connection.

The 2nd port on the device operates on standby, that is, only the link status is monitored. If the active port fails, the device switches to the 2nd port within a few milliseconds.

NOTE

Keep in mind that the device or the network connection has only one MAC address, that is, only one of the connected lines is active at any moment.

In the **Dual Homing** operating mode, redundant star structures (as viewed from the device) can be formed if both device ports are connected with different ports of a network switch or with one port on each of 2 different network switches.

If only one port is connected with a network port, then this connection has no redundancy and has only a single connection, just like the network connection on a PC.

The following connections are possible:

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Figure 2-1 Single Connection

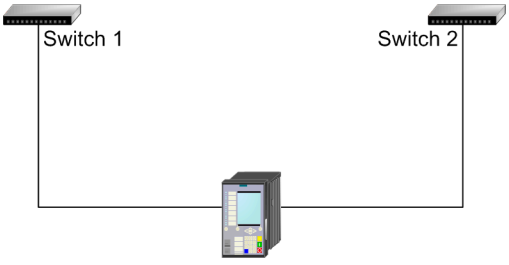

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Figure 2-2 Dual Homing with 2 Switches

Redundancy Protocol Interface Operating Mode

Currently, RSTP is available as a redundancy protocol. In accordance with IEEE 802.1D-2004, RSTP is then set as the redundancy protocol.

The Switch function in the device itself establishes interconnection of the components to one another as a ring and to the superordinate switches. This ensures that all telegrams intended for the device reach it. Telegrams sent from the device are incorporated into the data stream on the ring.

The **Redundancy Protocol** interface operating mode uses both ports on the device, which must be connected with 2 ports of a network switch or with one port each on 2 different network switches. The actual connection is similar to that of **Dual Homing**. In any case, the ports of the network switches support RSTP and are linked in the network. Only activation of RSTP at the device interfaces permits incorporation of SIPROTEC devices into ring or mesh structures.

Switch Function (Internal Switch)

The Switch function in the device itself establishes interconnection of components to one another as a ring and to the superordinate switches. This ensures that only telegrams intended for the device reach it. Telegrams transmitted from the device are incorporated into the data stream on the ring. The following figures show the connections. The connections of the 2 network switches show their location in the network.

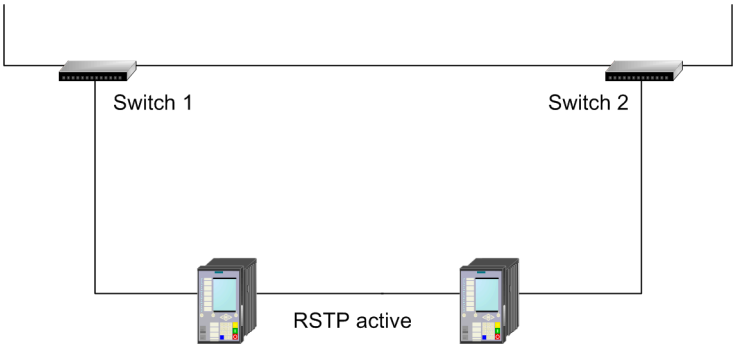

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Figure 2-3 Redundant Connection with Different Network Switches

This figure shows the general use of the Switch function and the possibilities for connecting a device. The redundant connection ensures connection in the event of failure of the link or of a switch. Usually, several devices are arranged in a ring.

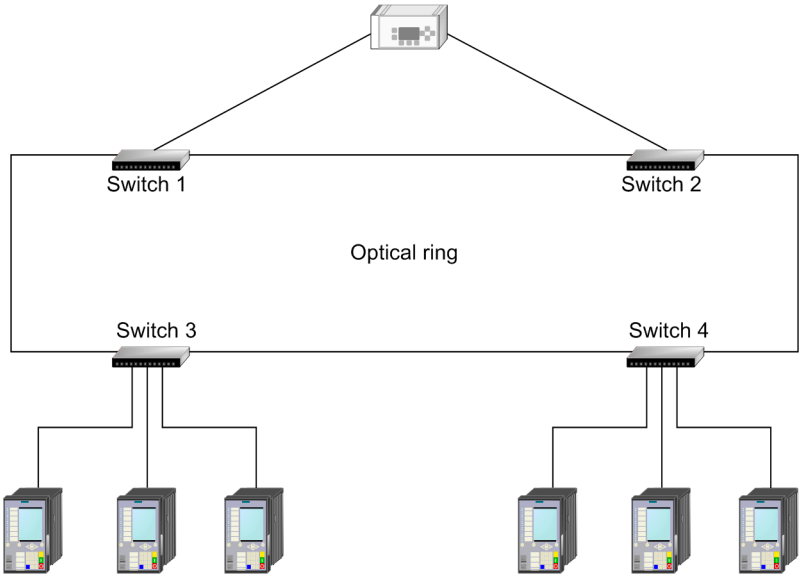
Interface Versions on the Modules

The interfaces of the Ethernet modules in the devices come in different versions for optical or electrical connections. Siemens recommends using an optical fiber for longer connections (> 20 m (787.4 in). For physical reasons, the length of the connection between 2 switches or between a device and a switch is always limited. The length can be increased by using several switches. For shorter connections, you can also select electrical connections if the actual EMC is taken into account.

Single Structure

In a single structure, a ring consisting of network switches with electrical or optical connections forms the superordinate network structure. In this case, the SIPROTEC devices are connected to the ports of the network switch with a star connection. RSTP is not activated in the SIPROTEC devices.

The star-shaped arrangement of the connections yields a very simple structure which, however, provides no redundancy for the connection between the device and network switch.



[DwOpRing-170311-enUS-01.tif]

Figure 2-4 Single Optical Ring

Redundant Star Structure (Dual Homing)

In contrast to a single structure, the devices in a redundant star structure are connected with the network via both ports, in this case, with the ports of 2 different network switches.

In the **Dual Homing** operating mode, RSTP in the SIPROTEC devices is not activated/parameterized, but there is a redundant connection between network switches and the SIPROTEC device. The redundancy of the superordinate network is assured by the RSTP functionality there, but this does not affect the interface function of the devices. Another redundancy procedure may also be active in the superordinate network. The superordinate network may also be of a star shape.

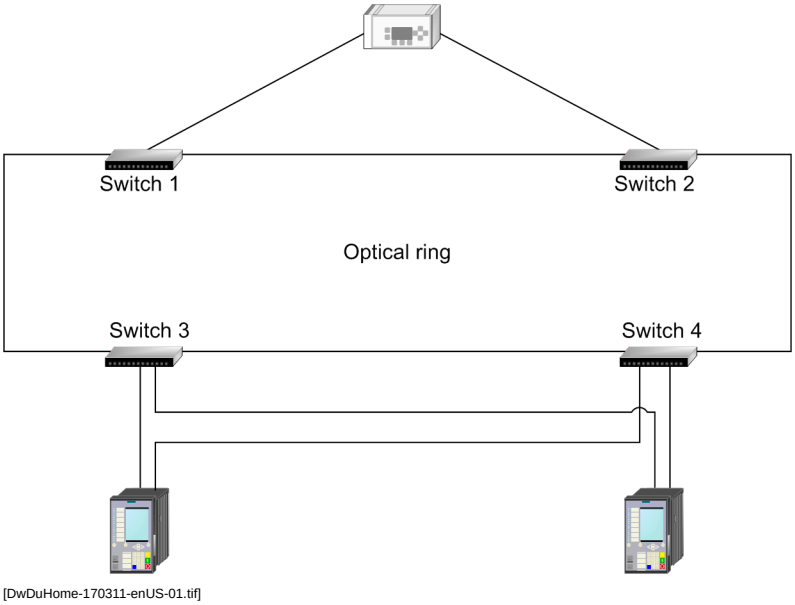


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Figure 2-5 Dual Homing Structure

Ring Structure

Ring structures are structures in which SIPROTEC devices are interconnected with devices from other manufacturers in a ring. The devices are incorporated into the ring structure via both ports. This yields rings consisting of devices and network switches 3 and 4. These network switches have at least 4 ports that support RSTP. Network switches 1 and 2 are connected with the SICAM PAS.

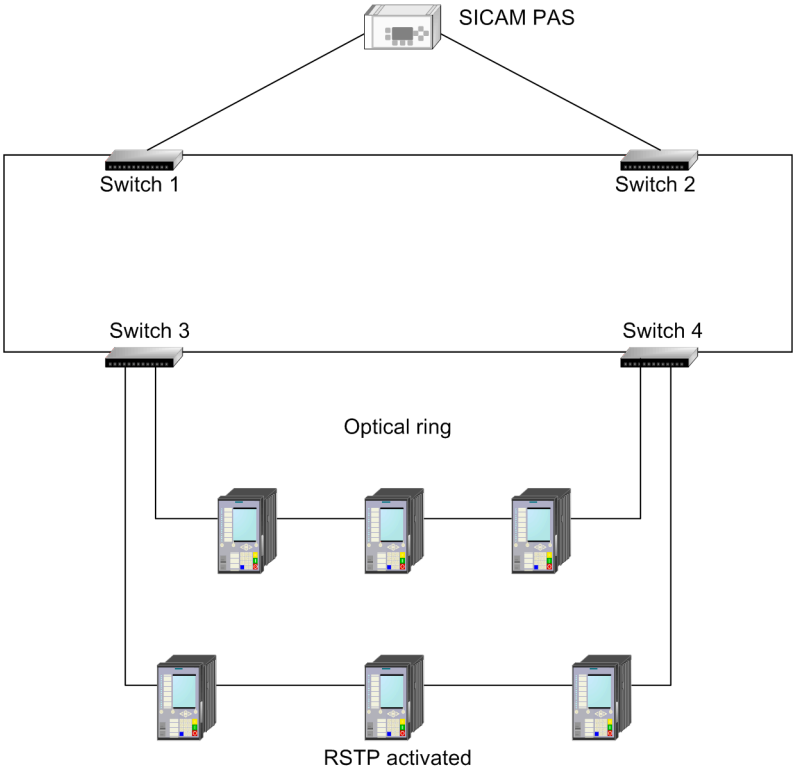

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Figure 2-6 Ring Structure

Information is routed from participant to participant in the ring until it reaches its intended destination. If the ring structure shown is cut at a point, a line results. Communication continues to function almost without interruption, because network control with RSTP initiates a reconfiguration. A second fault in the line or in one of the participants, however, cannot be overcome. Depending on the structure, keeping additional faults under control is becoming less secure.

You must set the RSTP parameter **Bridge Priority**. This requires that you set one of the 2 switches connected with the SICAM PAS to priority 0. As a result, the switch with priority 0 is then specified as the root switch. You must set the other switch connected with the SICAM PAS to a lower priority. A higher numerical value means a lower priority. Siemens recommends setting this switch to 4096. This switch serves as the backup root switch in the event that the root switch fails.

Network switches 3 and 4 always have the next-lowest priority, that is, the priority value must be set higher. The priority for both can be the same, however.

Siemens recommends using this topology for compact systems.

Multiple-Ring Structure

Multiple-ring structures may occur in succession in larger systems.

To create a multiple-ring structure, activate and set the settings for RSTP in the devices.

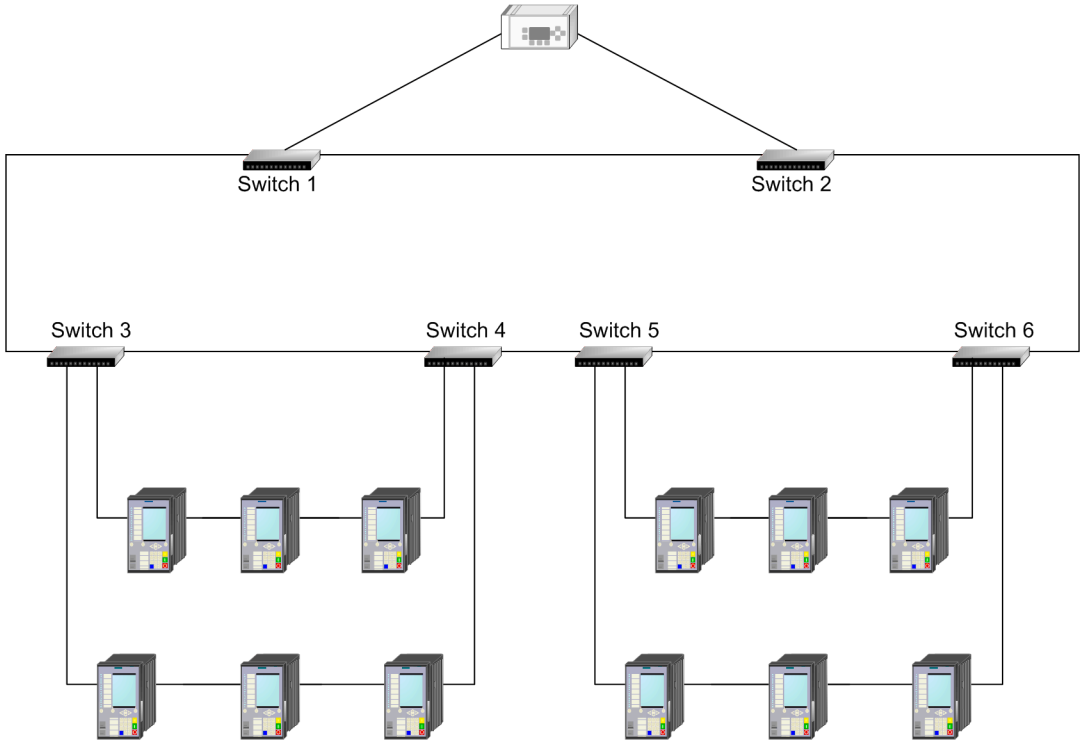

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Figure 2-7 Dual-Ring Structure

The figure shows the possible arrangement in such a structure. Each ring may contain several switches. Even the SICAM PAS is incorporated via its own switches.

The structure shown represents a **Garland structure**: The SIPROTEC devices are connected in a line. At its ends, this line is connected with the switches. The line of devices is called a garland. The garland structure occurs several times in succession here.

Detailed information on the special aspects of setting the parameters for such a structure can be found in the following chapter.

Optical and Electrical Module Interfaces

In contrast to SIPROTEC 4 devices, there is no difference between modules with an optical interface and modules with an electrical interface in SIPROTEC 5 devices.

NOTE

When setting parameters, note the following:

You can select between the Line, RSTP, PRP, and HSR structures.

The PRP and HSR protocols have no additional setting values.

The PRP and HSR protocols are supported as by devices of version V3.00 and higher and by DIGSI 5 (delivery deployment in May 2013). If your devices, Ethernet modules, and DIGSI 5 are at a lower version, upgrade the components to V3.00.

PRP Structure

The PRP structure (Parallel Redundancy Protocol according to IEC 62439-3:2012) provides communication over 2 independent networks (LAN A and LAN B) simultaneously. As shown in the following figure, the 2 networks may not be connected to one another. Siemens recommends building both networks identically. Connect LAN A to channel 1 and LAN B to channel 2.

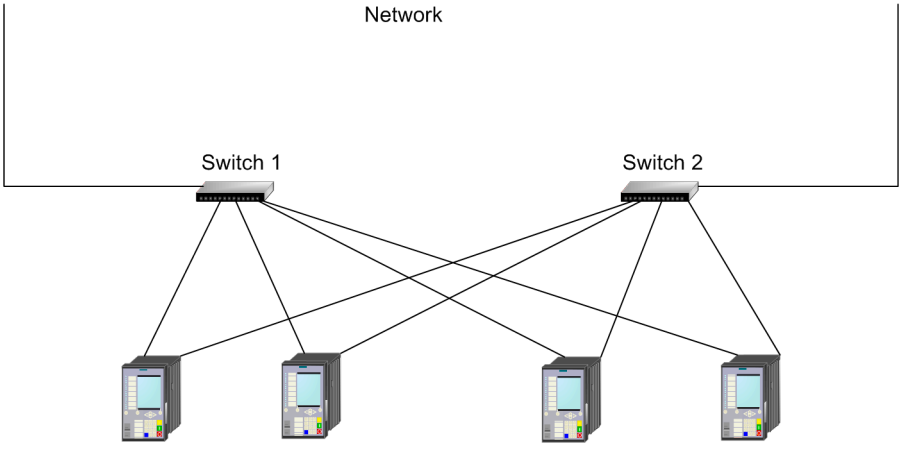

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Figure 2-8 SIPROTEC Devices Connected via 2 Independent Networks (LAN A and LAN B)

If there is an interruption in communication on network A or network B, the data exchange continues without problems on the other network. This means that there is no interruption.

HSR Structure

The devices are arranged in rings in the the HSR structure (High Availability Seamless Redundancy Protocol according to IEC 62439-3:2012) shown in the following figure. The procedure does not have its own parameters.

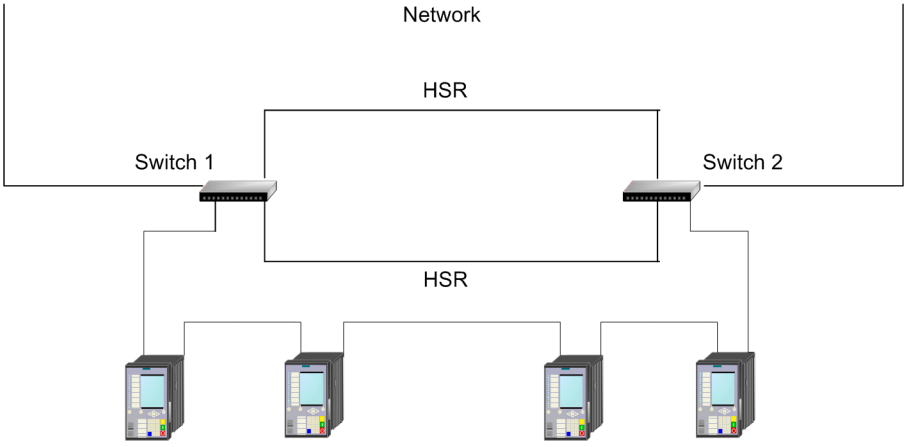

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Figure 2-9 SIPROTEC Devices Arranged in Rings

If an interruption in communication occurs in a network, a seamless switchover takes place. All components in the HSR rings must support HSR.

If you want to connect non-HSR-capable devices, apply HSR RedBoxes or HSR-capable switches. For example, if communication via Ethernet with a PC with devices in the HSR ring is to take place, the connection must be established using a RedBox.

2.2 Network Structure-Dependent Parameters

RSTP needs the settings that are listed and described in the table under *7.6.2 Parameter Settings for Networks* in order to operate.

Detection of the Correct RSTP Settings

The RSTP diagnostics values can be displayed on the HMI (Human-Machine Interface) of the device and with DIGSI 5.

Correct settings can be identified from several diagnostics values. The following diagnostics values are assigned to bridge data:

- NumOfTC

  Number of topology changes

  This value must remain constant during operation. When it remains constant, there has been no topology change in the network.

- TimeSinceTC

  This diagnostics value shows the time elapsed since the last topology change. It must be incremented continually.

Also check the role of the ports.

Determining the Location of the Alternate Port

There must always be an alternate port in a ring, since such a port in a ring forms a logical cut that is necessary to prevent continually circulating telegrams.

If the alternate port does not exist, it may still be possible to reach all devices, but there will no longer be any redundancy. That means a line break has occurred that was already handled prior by RSTP. A break in the line always leads to a reconfiguration and loss of the alternate port, since the alternate port must switch through in order to bridge the break caused by an error.

The alternate port in a configuration can always be determined by querying the port roles. This is possible with the aid of SNMP (Simple Network Management Protocol) or, with more effort, by means of the display of the device. Establishing the location of the alternate port depends on the number of switches in the range.

In the simple ring structure in *Figure 2-6*, the situation is as follows: :

- If Switch 1 is the root switch, then there are 3 rings:
  - One ring consisting of Switches 1 to 4
  - Two 3-device lines of SIPROTEC devices
- If Switch 1 is the root switch, the ring consisting of 4 network switches contains the ring from Switch 1 to Switch 3 and Switch 2 and from there to Switch 4. If the priority of Switch 2 is lower than that of Switch 3, then the alternate port is set to the right port of Switch 4.
- If Switch 1 is the root switch, you obtain a 2nd ring: Switch 1 – Switch 3/Switch 2 – S11/Switch 4 – S12/S13. This establishes the alternate port on the tie line S12/S13. If S13 has a lower priority, then the alternate port is set to the right port of S12.
- The same holds for the 2nd ring of. SIPROTEC devices.

NOTE

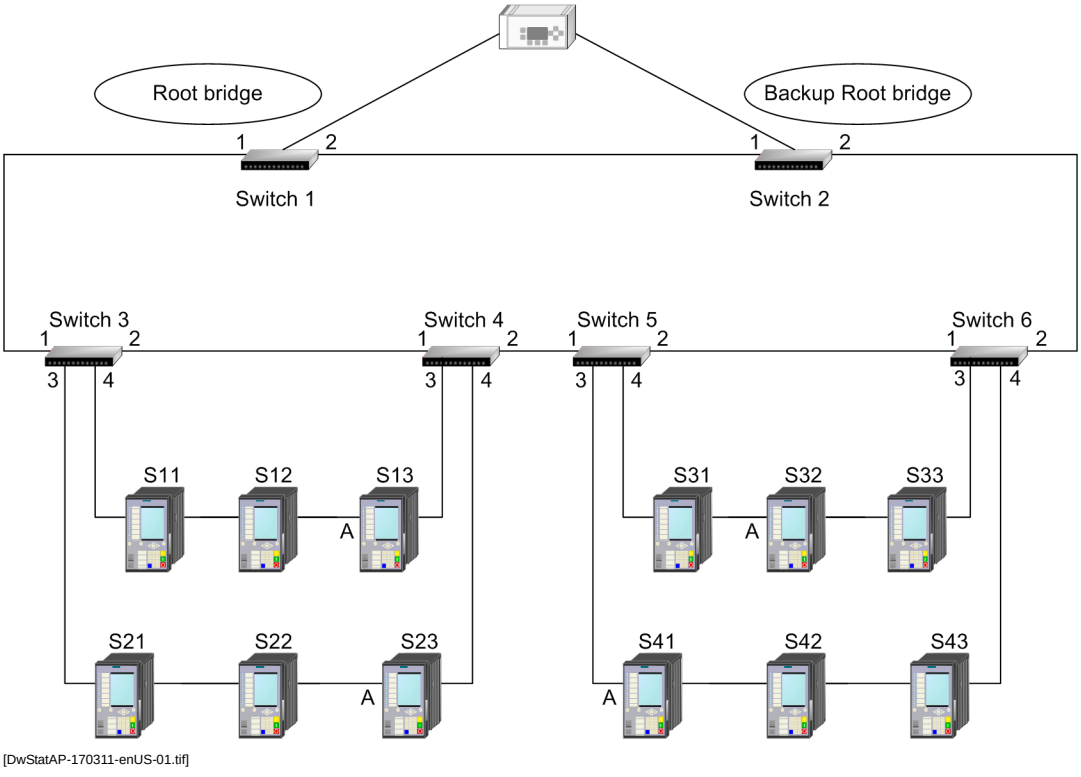
Keep in mind that the MAC address is linked to the priority. If the switches are set to the same priorities, then the MAC address is the determining factor.

In the dual-ring structure and when the alternate port is stationary, the situation is somewhat more complex:

- The primary ring is now Switch 1 – Switch 3/Switch 2 – Switch 4/Switch 6 – Switch 5/Switch 5. If Switch 4 has a lower priority than Switch 6, then the alternate port is set to the left port on Switch 5.
- The ring with the S1x switches is slightly different. The root switch (Switch 1) has a connection to Switch 3. This is where the subring Switch 3 – S11/Switch 4 – S12/S13 begins. In this case, the alternate port is set to one port of the connection between S12/S13. If S13 has a lower priority[1] than S12, then the left port on S13 is established as the alternate port.
- The ring with S4x is an additional example. The left port on Switch 5 is the alternate port in the primary ring. As a result, the connection to the root bridge runs through the right port on Switch 6, yielding: Switch 6 – Switch 5/S43 – S41/S42. The alternate port is established on the ports used for the connection S41-S42. If S41 has a lower valence than S42, then the right port on S41 is established as the alternate port.

Using this procedure, it is possible to determine the alternate ports for all structures and check them in the real system.

These settings are shown in the following figure.



[DwStatAP-170311-enUS-01.tif]

Figure 2-10 Structure with Alternate Ports

Setting the MaxAge Parameter

The **MaxAge** parameter is preset to 20. This setting is listed as the default setting in the Standard IEEE Std 802.1D™ – 2004 and can be increased up to 40. The primary function of this parameter is to discard telegrams with a greater or identical age. Aging itself is established by the number of switches passed.

The **MaxAge** parameter must be defined such that all switches can reach the root switch when taking this definition into account, particularly in the case of a break in the line or device failure.

1. The priority consists of several components including, among others, the MAC address.

The alternate ports indicate the break points. If you consider the connections to the root switch, for example, S23 – S22 – S21 – Switch 3 – Switch 1, then a value of 4 suffices for the **MaxAge** setting.

NOTE

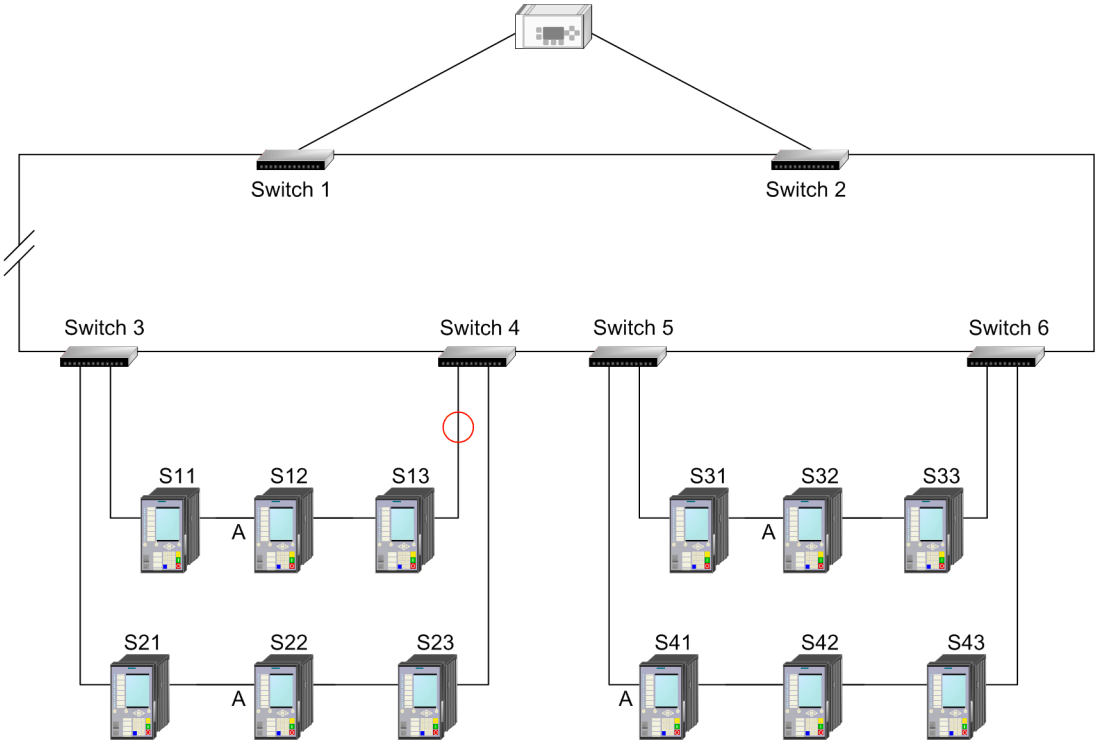
The alternate port is included in the count!

If the entire network is considered, then you must set the **MaxAge** parameter to 5 (Switch 1 – Switch 2 – Switch 6 – S43 – S42 – S41). This, however, represents the steady state.

Such a state must first be established. It must be possible to reach the root switch in all interruption scenarios. If the line from the left port on Switch 1 to the left port on Switch 2 breaks, then the alternate ports shift.

NOTE

Switching on a device can also cause such reconfiguration effects, for example, the shifting of alternate ports.



[DwUBPort-170311-enUS-01.tif]

Figure 2-11 Broken Connection with Shifting of the Alternate Ports

The worst case is when the connection from the right port on S13 to Switch 4 breaks as well. In this case, the maximum setting is 8 (Switch 1 – Switch 2 – Switch 6 – Switch 5 – Switch 4 – Switch 3 – S11 – S12 – S13).

NOTE

The telegram age that results is 7, but since it must always be less than the **MaxAge** parameter, a setting of 8 is mandatory.

You can find more information on telegram age in chapter *7.6.2 Parameter Settings for Networks*.

The optimum situation is thus a setting of 8.

NOTE

It is also possible to set 20, but in the event of a root failure, RSTP telegrams can remain in the network until they disappear because of their age. These telegrams can cause temporary interruptions.

For this reason, you should not set the **MaxAge** parameter any higher than necessary.

Setting the HelloTime Parameter

You can set the **HelloTime** parameter to 1 s or 2 s. This value sets the interval between cyclically sent RSTP telegrams.

If you wish to achieve a fast response, set 1 s. In this way, root failure is handled quickly.

Setting Priorities

Priority settings in a network establish the location of the root bridge. Establish the location of the root bridge such that all switches, including the SIPROTEC devices, can reach the root bridge over almost identically long paths. Using this approach, you also achieve a minimum setting of the **MaxAge** parameter, as described in the section that discusses setting of the **MaxAge** parameter. Normally, SIPROTEC devices should not form the root bridge.

Once the root bridge has been established, also specify a 2nd bridge as a backup root bridge in the event of failure of the primary root bridge when the network is similar to that shown in *Figure 2-10*. For the **MaxAge** parameter setting not to be increased unnecessarily, the backup root bridge should be in the immediate vicinity of the primary root bridge. This results in the following: for Switch 1, a priority setting of 0; Switch 2 is set to 4096; Switches 3 to 6 are higher, and the devices are all set to 32 768.

NOTE

The port priorities are changed only in special cases.

■

3 Communication Modules

3.1	Ethernet Modules	30

3.1 Ethernet Modules

3.1.1 Operation of Ethernet Modules

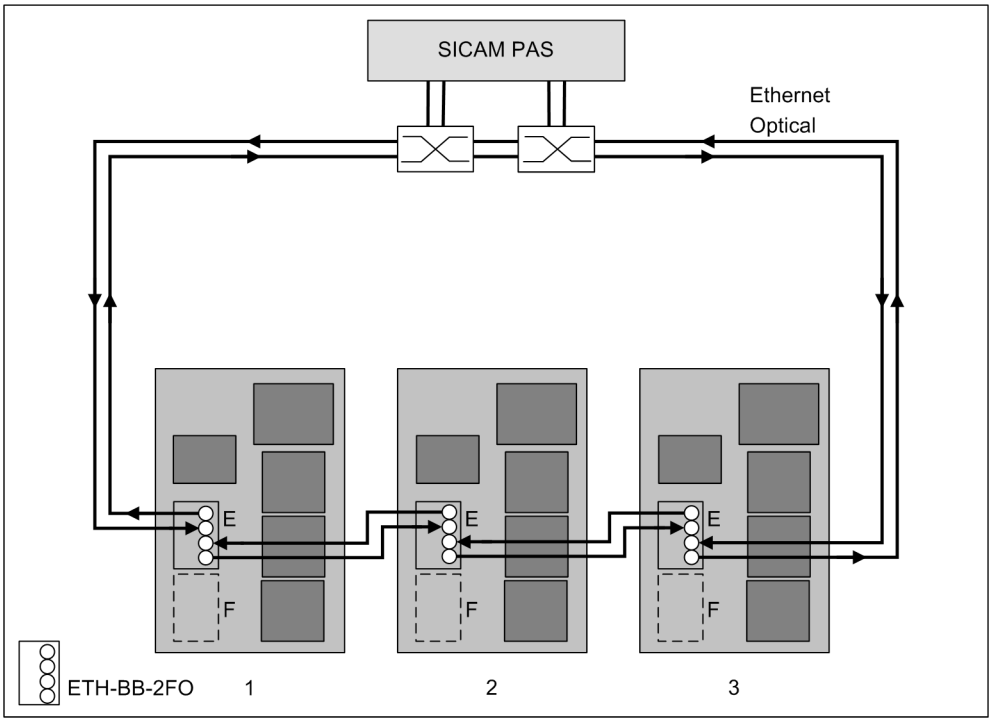
The Ethernet modules of the SIPROTEC 5 series can be operated optionally with or without integrated switch function. This applies for the electrical as well as for the optical module. The function can be selected via the parameterization. It is not necessary to make any indication in the order. The optical Ethernet modules are compatible with the EN100 modules of the SIPROTEC 4 series. If the RSTP protocol is active the optical modules of the SIPROTEC 4 series and the SIPROTEC 5 series can be operated in a ring.

When using SIPROTEC 4 devices with module firmware ≤ V4.0.5 and SIPROTEC 5 devices, the maximum allowable number of participants is 30 devices. When using SIPROTEC 4 devices with module firmware ≥ V4.0.7 and SIPROTEC 5 devices, the maximum allowable number of participants is 40 devices. When using SIPROTEC 5 devices, the maximum allowable number of participants is 40 devices.

Figure 3-1 shows operation of the Ethernet modules with integrated switch function. All devices of a station which are connected to one another with optical fibers are shown. The devices form optical rings. In addition, 2 switches are used on the substation controller for the SICAM PAS. The 2 switches take the requirements for the redundancy into account.

Additional participants with electrical interfaces can also be connected to the SICAM PAS (for example, the DIGSI 5 control PC). An external switch is sufficient. Optical communication modules are primarily used for this topology, as there can be substantial distances between the devices.

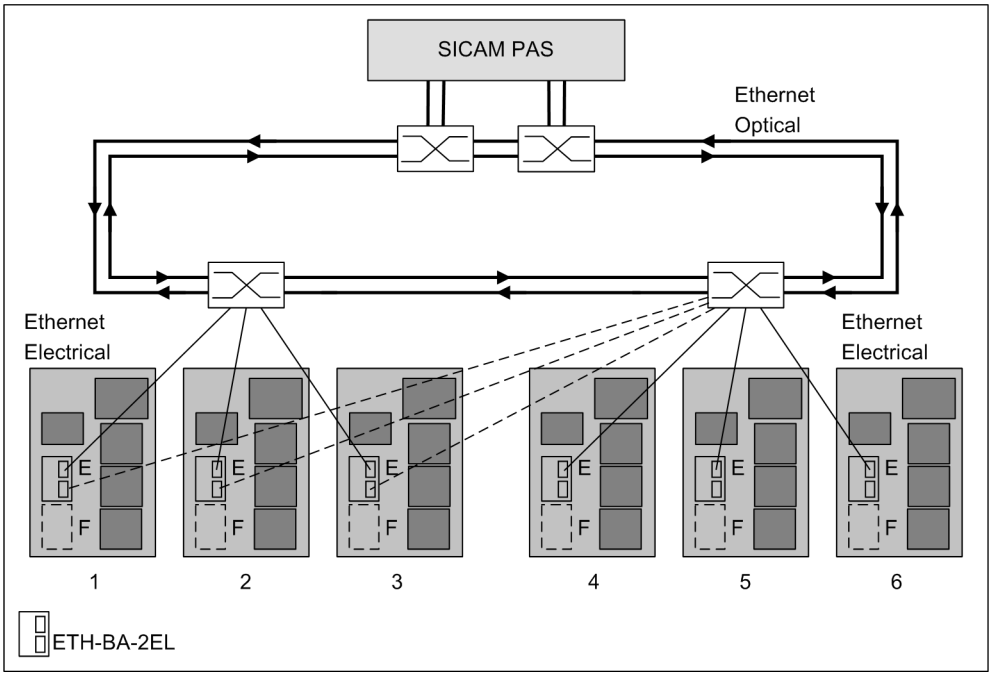
If the Ethernet modules are installed in expansion modules with a CB202 PCB assembly, the power supply can be provided with an independent battery. The integrated switch can maintain the function when the device is switched off. The data are transmitted in optical and electric rings. This prevents opening of the ring. The ring continues to operate when 1 or more devices are switched off.



[DwETH1Sw-030211-enUS-01.tif]

Figure 3-1 Operation of Ethernet Modules with an Integrated Switch Function

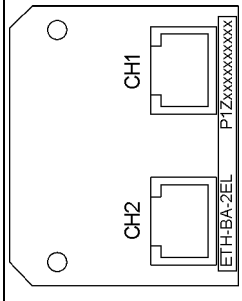
Figure 3-2 shows the operating mode without integrated switch function. Optionally, the 2nd connection can be connected to the 2nd switch. This connection is shown with a dashed line in *Figure 3-2*. The IP communication is established using the 1st connection here. If this connection fails, the system changes over to the 2nd connection within a few milliseconds. The IP connection is retained practically without interruption using the 2nd switch. This hot-standby connection redundancy increases the availability in such configurations, as shown in the above figure. The information on failure of the protection connection is transmitted to the substation automation technology.



[DwETHSwi-030211-enUS-01.tif]

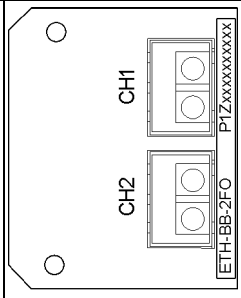
Figure 3-2 Operation of Ethernet Modules Without Integrated Switch Function with Single or Redundant Connection to the Switch

3.1.2 ETH-BA-2EL

Description	Communication module for the transmission of Ethernet protocols via 2 electrical interfaces
Product code	P1Zxxxxxxxxx
Figure	 [DwETHBA2-040211-xxXX-01.tif]
Connector type	2 x RJ45
Baud rate	10 Mbit/s or 100 Mbit/s

Protocol	DIGSI 5 protocol (secure Web service protocol) IEC 61850 (MMS and GOOSE) DNP3 Synchrophasor protocol You can switch on and off other network services like SNMP, RSTP, and SNTP.
Max. line length	20 m with Ethernet patch cable CAT 5

3.1.3 ETH-BB-2FO

Description	Communication module for the transmission of Ethernet protocols via 2 optical interfaces
Product code	P1Zxxxxxxxxx
Figure	 [DwETHBB2-040211-xxXX-01.tif]
Connector type	2 x LC Duplex
Wavelength	λ = 1300 nm
Baud rate	100 Mbit/s
Protocol	DIGSI 5 protocol (secure Web service protocol) IEC 61850 (MMS and GOOSE) DNP3 Synchrophasor protocol You can switch on and off other network services like SNMP, RSTP, SNTP.
Max. line length	3 km for 62.5 µm/125 µm optical fibers

Transmit Power	**Minimum**	**Typical**	**Maximum**
50 µm/125 µm, NA[1] = 0.2 peak	-19.8 dBm	-15.8 dBm	-12.8 dBm
62.5 µm/125 µm, NA[1] = 0.275 peak	-16.0 dBm	-12.0 dBm	-9.0 dBm

Receiver sensitivity Optical power for high Optical power for low	 Maximum -24 dBm Minimum -40 dBm
Optical budget	Minimum 4.2 dB for 50 µm/125 µm, NA[1] = 0.2 peak Minimum 8.0 dB for 62.5 µm/125 µm, NA[1] = 0.275 peak
Path attenuation	In the case of multimode optical fibers, you can expect a path attenuation of 1 dB/km
Laser class 1 as per EN 60825-1/-2	When using fiber-optic cables 62.5 µm/125 µm and 50 µm/125 µm
Comment: [1] Numerical aperture (NA = sin θ (launch angle))	

■

4 Setting Parameters in DIGSI 5

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4.1 Selecting the IEC 61850 Edition

To begin the project engineering of SIPROTEC 5 systems with IEC 61850, create a project and specify which edition of the IEC 61850 Standard is to be used.

NOTE

Edition 2 is the default setting.

If the edition is not set manually, you will be queried about which edition to use when creating the 1st device with IEC 61850 functionality.

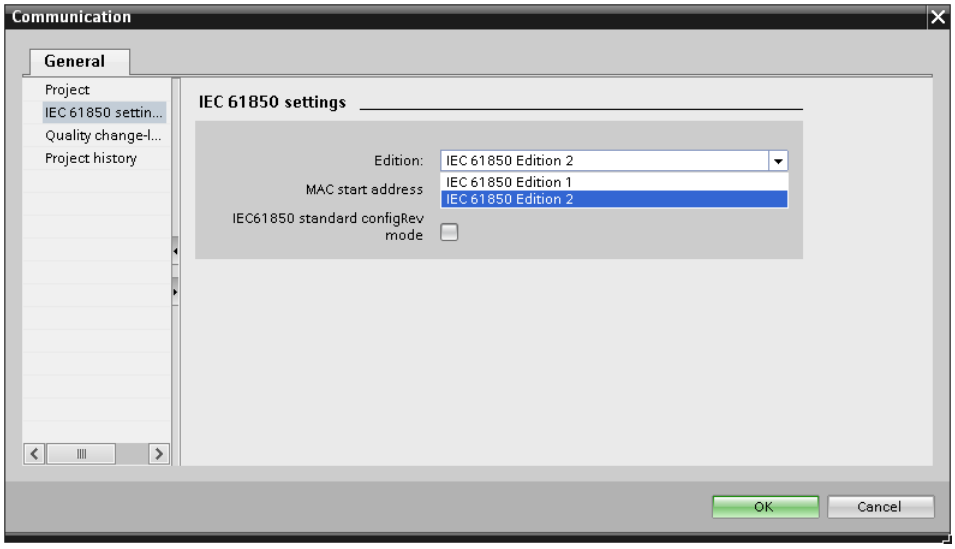
If you have selected Edition 1, you can upgrade to Edition 2. Switching from Edition 2 to Edition 1 is not possible however, because functionality would be lost.

If you export project or device configuration data, they are exported in the determined edition.

- ✧ Create a project in DIGSI.

  Additional information can be found in DIGSI Online Help in the **Creating a project** chapter.
- ✧ Right-click on the project names in **Project tree**.
- ✧ Select the **Properties...** context menu.
- ✧ Select the **IEC 61850 settings** section.

  This is where you specify the IEC 61850 edition.



[ScIECEdt-150113-enUS-01.tif]

Figure 4-1 Setting the IEC 61850 Edition

4.2 Selecting the Communication Module

If a product code was used to select the devices, they will be delivered with assembled communication modules. You can install and replace additional communication modules afterwards.

NOTE

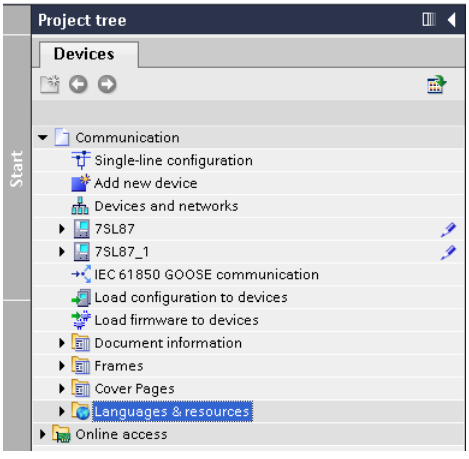
When doing so, you must ensure that both the protocol firmware as well as the parameterization of the protocol are first transferred by DIGSI.

✧ Select the communication modules from the library in the **Hardware Editor** working area in DIGSI.

NOTE

The type of communication protocols to be used is the deciding factor when selecting the communication module. The IEC 61850 protocol operates on Ethernet modules. Ethernet modules have 2 interfaces.

✧ In the **Project tree**, select the **Devices and networks** area.



[ScProjtr-140113-enUS-01.tif]

Figure 4-2 Selection in the Project Tree

You have 2 possibilities to select the communication module and pull it to the plug-in module position:

✧ Move the communication module by drag and drop from the hardware catalog to the plug-in module position of the device.

-- or --

✧ Open the communication module by double-clicking in the hardware catalog.

4.3 Configuring Communication Interfaces

The following communication interfaces are available:

- Integrated Ethernet interface

  The interface can be found at port J of the device.
- Interface on the communication module

Integrated Ethernet Interface

✧ Select the integrated Ethernet interface (Port J).

✧ Select the IEC 61850 protocol from the **Properties** window.

GOOSE is not possible for this interface.

NOTE

The IEC 61850 protocol is an option that can be ordered for Port J (integrated Ethernet interface). This protocol is displayed only if the corresponding product feature was purchased.

In the lower Editor section of the **Properties** tab, the sections **Ethernet addresses**, **Details**, and **Ethernet interface settings** appear under **General**.

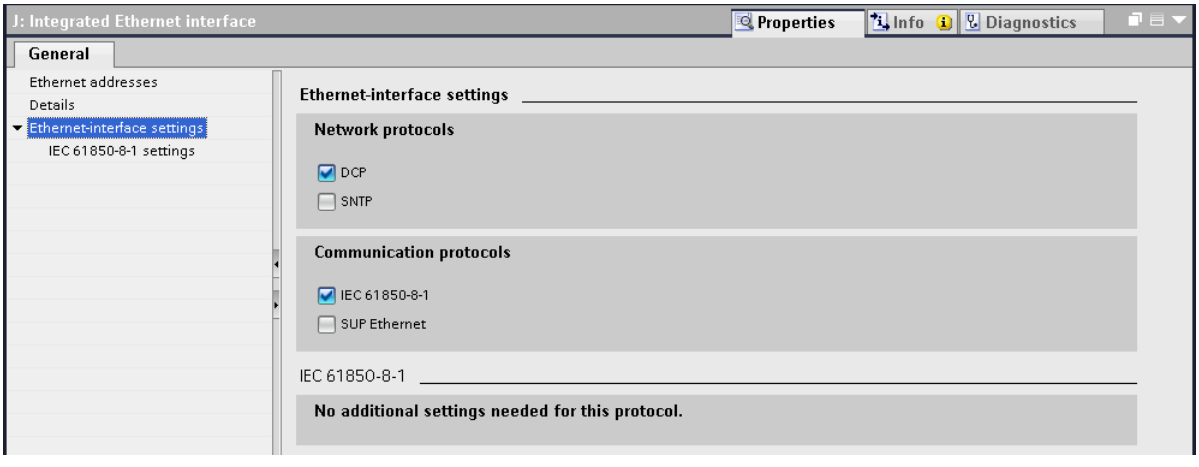
✧ Once you have opened the device in the Device View, click on Port J (integrated Ethernet interface).

The address settings for the integrated Ethernet interface appear in the lower section of the **Properties** tab.

✧ Select **Ethernet interface settings**.

The protocols that are supposed to run simultaneously on the interface are selected in the Ethernet interface settings.

Additional information can be found in the section **Setting network protocols**.



[ScParPtJ-140113-enUS-01.tif]

Figure 4-3 Setting Port J

NOTE

Client-server communication can take place via Port J (integrated Ethernet interface), for example, reports can be transmitted. This interface does not support the GOOSE message of the IEC 61850 standard. An Ethernet module that is configured with IEC 61850 is needed for GOOSE communication.

Interfaces on the Communication Module

After placement on the plug-in module position, set the communication protocol used for the communication module ETH-BB-2FO or ETH-BA-2EL:

✧ Highlight the channel to be configured in the Device view.

The protocol types are listed in the operating range window that opens. These can be routed on the highlighted channel.

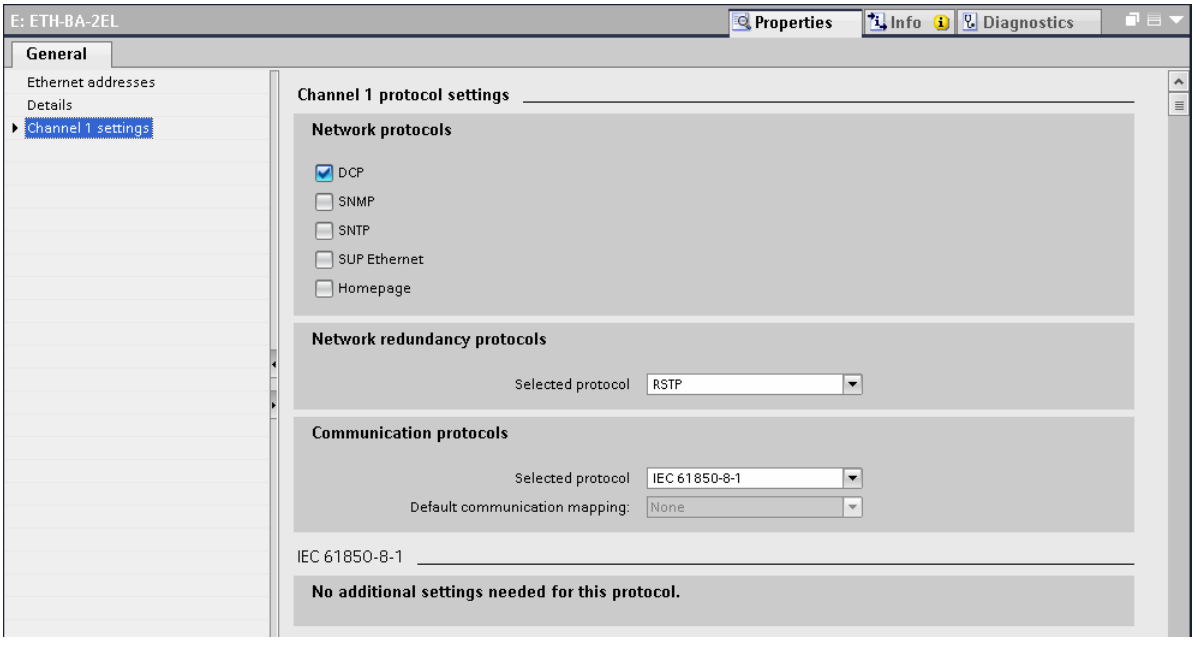
For each channel, you may route one or several network protocols and one communication protocol.

✧ Set the IEC 61850 protocol in the **Properties** tab.

✧ In the lower Editor section under **General**, select the option **Channel 1 settings**.

✧ Under **Communication protocols**, select the IEC 61850-8-1 protocol.

GOOSE is possible with this variant.



[ScProtMd-140113-enUS-01.tif]

Figure 4-4 Setting the IEC 61850 Protocol in the Ethernet Communication Module

The IEC 61850 protocol is set.

Setting Network Protocols

Except for DCP, all network protocols are deactivated in the default setting for safety reasons. If necessary, you may select the following network protocols:

- DCP

  Activates Discovery and Basic Configuration Protocol (DCP) for the Ethernet module. This protocol allows DIGSI to find a SIPROTEC 5 device in the local network without an IP address.

- SNMP

  Simple Network Management Protocol (SNMP). Provides monitoring information about the device to the network management system.

- SNTP

  Activates Simple Network Time Protocol (SNTP) for the Ethernet module. This protocol is needed for the time synchronization over an Ethernet network.

- RSTP

  Activates Rapid Spanning Tree Protocol (RSTP) for the Ethernet module. This protocol will be needed for redundant ring structures in the Ethernet networks.

✧ You can select one or more of these network protocols.

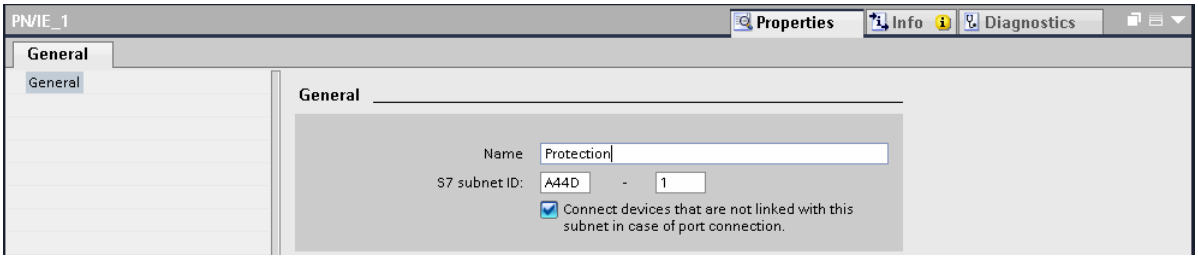
Creating a Subnetwork

✧ If no subnetwork exists, click the **Add new subnetwork** button under **Interface connected with** in the **General** section of the **Properties** tab.

-- or --

✧ Highlight the communication module of a device in the **Network view**.

✧ While holding the left mouse button down, drag the cursor to the desired communication module of another device.



[ScSubnet-140113-enUS-01.tif]

Figure 4-5 Creating a subnetwork

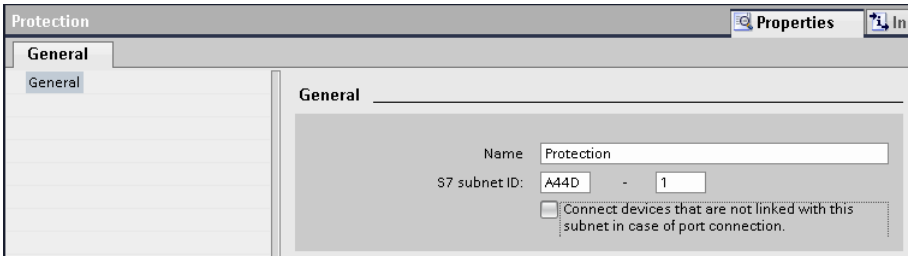
NOTE

When using SIPROTEC 5 devices with the IEC 61850 protocol, 2 communication modules configured with IEC 61850 must not be placed in the same subnetwork.

To establish an IEC 61850-GOOSE connection, modules must be in the same subnetwork.

Renaming a Subnetwork

- ✧ In the **Project tree**, click in the **Devices and networks** area.
- ✧ Click on the subnetwork that you wish to rename.
- ✧ Change the name of the subnetwork in the lower section.



[ScRenSub-140113-enUS-01.tif]

Figure 4-6 Renaming a subnetwork

NOTE

You may only rename the subnetwork in the Network view.

4.4 GOOSE Application

4.4.1 GOOSE Communication

For GOOSE communication, you must specify the subnetwork for each communication module on the devices. This determines the subnetwork over which the communication modules are connected to one another.

More detailed information can be found in chapter *4.3 Configuring Communication Interfaces* section **Creating a subnetwork**.

Creating the GOOSE Communication

The following conditions have to be fulfilled to meet the GOOSE communication requirements:

- ✧ Install Ethernet modules.

  These modules are designed for IEC 61850-GOOSE.

- ✧ Communication modules of devices participating in GOOSE must be part of the same subnetwork.

  Additional information can be found in section **Creating a subnetwork**.

This meets the network requirements of the GOOSE communication.

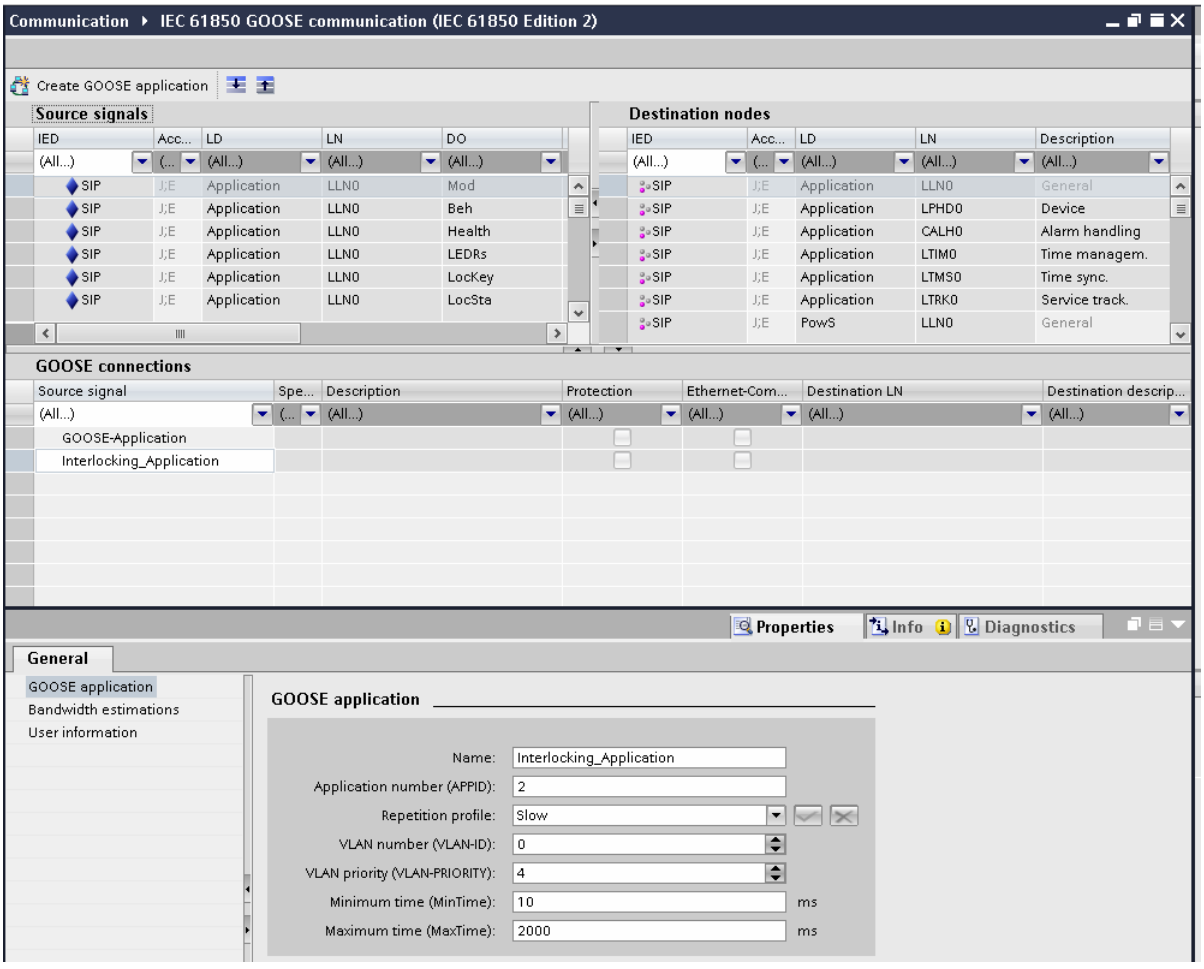
In order to ensure proper data exchange, GOOSE applications must now be created in the devices.

4.4.2 Creating a GOOSE Application

Creating a GOOSE Application with the IEC 61850 GOOSE Communication Editor

The GOOSE configuration can be set up flexibly and in great detail in the IEC 61850 GOOSE communication editor.

- ✧ To open the IEC 61850 GOOSE communication editor, double-click on **IEC 61850 GOOSE Communication** in **Project tree**.



[ScGOOEdr-140113-enUS-01.tif]

Figure 4-7 IEC 61850 GOOSE Communication Editor

- ✧ To create a GOOSE application, right-click on **GOOSE Application** in the **GOOSE Links** section.
- ✧ In the context menu select **Create the GOOSE application**.

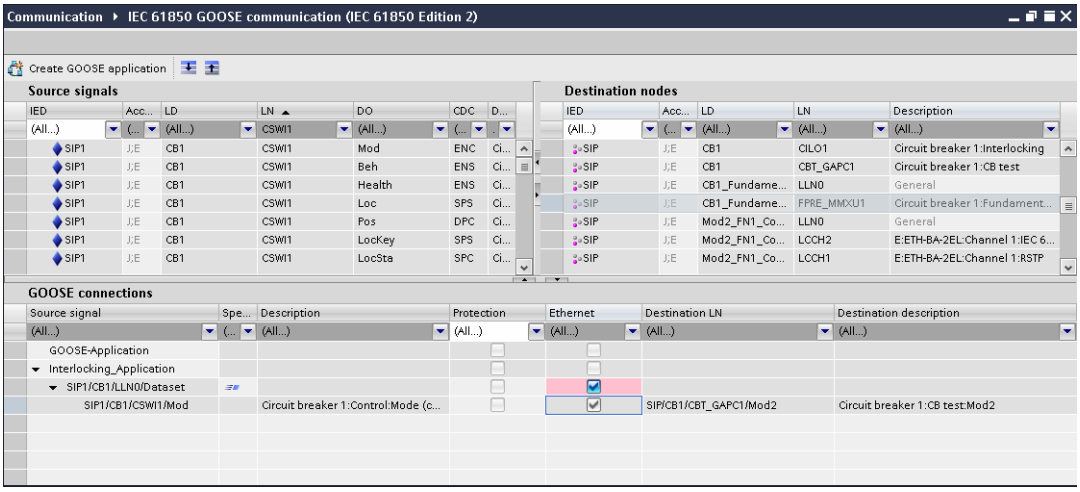
A new GOOSE application is created.

You can create up to 16 GOOSE applications per device. The number of signals depends on the object type, for example, 30 signals per dataset are possible for single-point indications.

This new GOOSE application has its own name and an application number (APPID).

Although the APPID will be set as a whole number from 1 to 65 535, these values will be saved as a hexadecimal number (0000h-FFFFh) in the IEC 61850 description file.

Set the parameters for the transmission characteristics of this GOOSE application in the lower Editor section on the **Properties** tab. Please observe the following rule: The lower the value is set for Minimum Time and Maximum Time, the higher the load generated by the receiver, since all receiving messages can only be processed sequentially.



[ScGOOApp-140113-enUS-01.tif]

Figure 4-8 IEC 61850 GOOSE communication editor with GOOSE application and datasets

At least one dataset with information that is to be communicated is assigned specifically to each IED (Intelligent Electronic Device) included in the GOOSE application.

- ✧ You can change the name and hierarchical path (storage location of the corresponding LLN0 in the object tree) in the property window of the datasets.
- ✧ You may generate a dataset by dragging the signal that needs to be sent from the **Source signal catalog** into the **GOOSE connections** section.

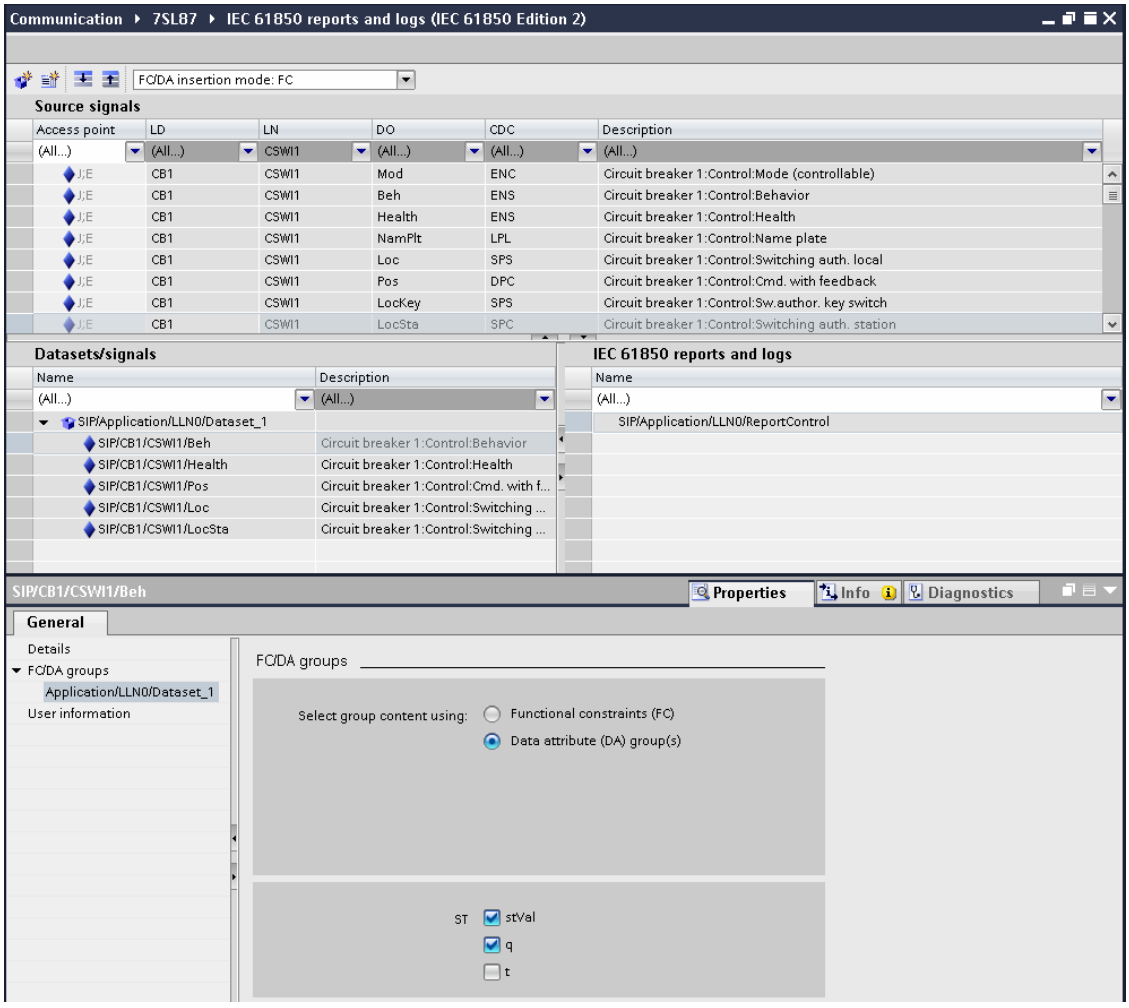
  If you select signals from different devices, another dataset is generated automatically for each device.

  You set the name (GoCB) and the configuration version of the GSE Control Block (confRev) as well as the GOOSE number (appId in GoCB) and the multicast address in the **GSE Control** section.

  The standard recommends the optional ranges of the multicast address (01-0C-CD-01-00-00 to 01-0C-CD-01-01-FF).
- ✧ Properties that are displayed in the properties window are assigned to each individual data object in the dataset list.

  Among other things, these properties determine which data attributes will be transmitted by GOOSE, as well as the processing of this information by the receiver.

  The CDC types DEL, SEQ, WYE and SEC will be transmitted as x CMVs, where x is the number of the CMVs contained in the respective type. For example, a DEL will be displayed on 3 CMVs. A separate source within the receiver has to be defined for each one.



[ScRpDset-140113-enUS-01.tif]

Figure 4-9 Settings in the Dataset List

NOTE

The transmission of **t** is not advised.

NOTE

The default selection of the data attributes is as follows:

- stVal + q
- magf + q

Siemens recommends changing these preset values only if the device of a different manufacturer cannot receive these values, for example,, quality (q).

Although GOOSE communication is a multicast transmission[1] and therefore a destination address is not required, the IEC 61850 protocol provides a configuration of the receive data object in a Subscriber IED. This enables a 1:1 assignment to be configured between the source in the Publisher IED and the target in the Subscriber IED. This assignment may also be used for additional parameterization of the application, for example, in the CFC Editor.

- ✧ To configure the RxD object, select a logical node under **IED** in the **Destination Node Catalog**.
- ✧ Drag the selected logical node out of the **Destination node catalog** and into the **Destination LN** column in the **GOOSE connections** section.

  If several destinations are to be configured, the source objects appear several times, but are not entered several times in the real dataset.

  The subnetwork over which the communication modules are connected is identified by a check mark.
- ✧ If more than one receiver should receive GOOSE, drag the 2nd receiver over the 1st destination.

A message appears asking whether the existing connection should be overwritten.

- ✧ Click **No**.

This assigns the 2nd receiver.

NOTE

If you want to connect an object from an initiating device with an object from the receiver, you may use the options described below for the creation of GOOSE connections in other editors. The thereby created GOOSE application can be found in the GOOSE Editor. Here, you may set additional properties or verify the GOOSE application.

To ensure that the GOOSE connection works, Siemens recommends always creating GOOSE connections in the GOOSE Editor.

1. Multicast: Transmission of a message to a selected group of receivers.

4.5 Signals to the Communication Modules

Description of the Signals to the Communication Modules

There are different signals for each communication module:

- **Channel Live**

  The signal **Channel Live** displays the data flow. Therefore, the signal indicates that the communication service is transmitting and receiving data on the module.

  Consider that multiple services can run in parallel on one Ethernet module. The representation is defined in the standard IEC 61850, Edition 2.

- **Module ready**

  The signal **Module ready** indicates that the module has started and the protocol applications are started. You can reallocate this signal, for example, LED, log, or message. Then you can recognize whether the IEC 61850 services, for example, GOOSE, are started on the Ethernet module and are working correctly.

NOTE

Starting the module can take some time.

- **Health**

  The signal **Health** indicates the state of the module. The following 3 states can occur in this case:

  - **Okay**

    Module OK indicates, that the module is working.

  - **Warning**

    This state is not used.

  - **Alarm**

    The state **Alarm** is set when there is a failure of the module.

Each protocol application has a **Health** node. If a protocol has problems at startup, for example, missing parameters, no mapping, no hardware support, the status is set to **Alarm**. An alarm in a protocol causes an alarm of the module.

4.6 Report Application

4.6.1 Creating a Report Application

In the report application, determine which information will be sent to an IEC 61850 client, for example, a SICAM PAS.

A report application can be created in compliance with the IEC 61850 standard with the aid of statically or dynamically generated reports. Dynamic in this sense means that devices provide the client with the ability to create, modify, and delete datasets for reports while the device is in operation. For this, it is not necessary to reload the devices; they are always available. During the configuration of a device or system, a report is created and settings are created statically using the Report Editor. Report applications are described and in the SCD file and configured in DIGSI 5.

A report application is configured in the Report Editor. In the Report Editor, you can create datasets or report control locks with the aid of 2 symbols.

NOTE

You can only create static reports in the Report Editor.

Dynamic reports are created by a client during operation of the system.

- ✧ To create a report control block or a dataset, click the corresponding icon in the upper left corner of the Report Editor.

A new object is generated in the report control block (right list) or in the datasets (left list).

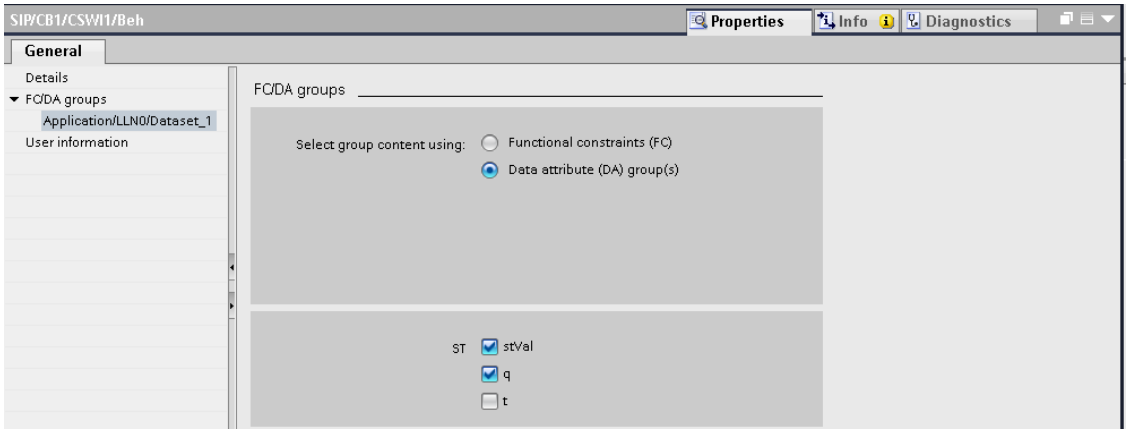
4.6.2 Configuring the Dataset

One dataset is required for each report control block. It is possible to use 1 dataset for several Report Control Blocks.

Configuring a dataset is similar to configuring a GOOSE application.

- ✧ Create a new dataset in the list of datasets.
- ✧ Drag & drop the source-signal data objects into the list of datasets.

  You can configure the properties of the individual elements with regard to the FC/DA groups.



[ScFCDADs-140113-enUS-01.tif]

Figure 4-10 Settings for FC/DA Groups

✧ Drag and drop the dataset into a report control block.

NOTE

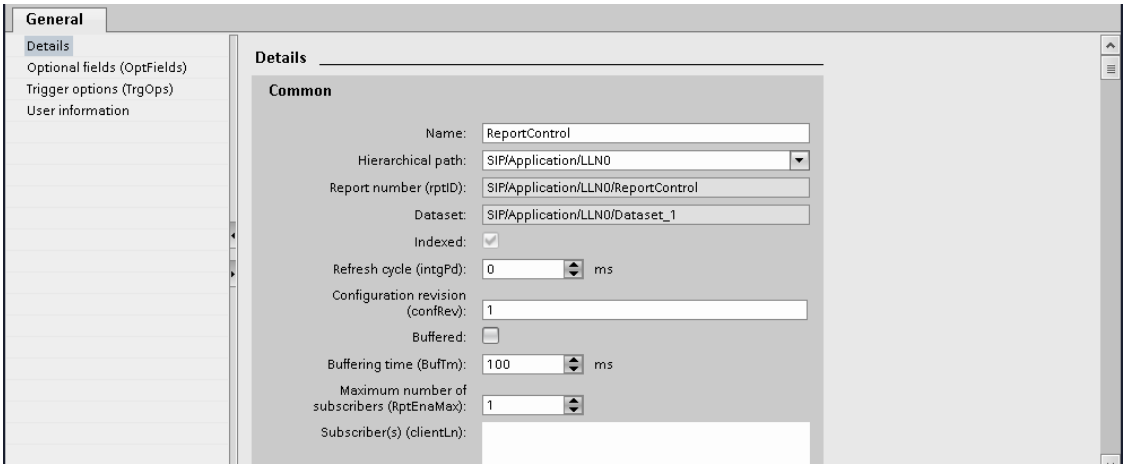
If the report control block already contains a dataset, any dataset which is added to this report control block will overwrite the existing dataset.

4.6.3 Report Control Blocks

Properties

You will find the following elements on the **Properties** tab of the report control block:

- Hierarchical path
  Storage location of the report control block in the object tree
- Report Number (rptID)
  Text for identifying the report application
- Different configuration settings
  For example, buffer time (BufTm) for creating reports



[ScFeaRCB-140113-enUS-01.tif]

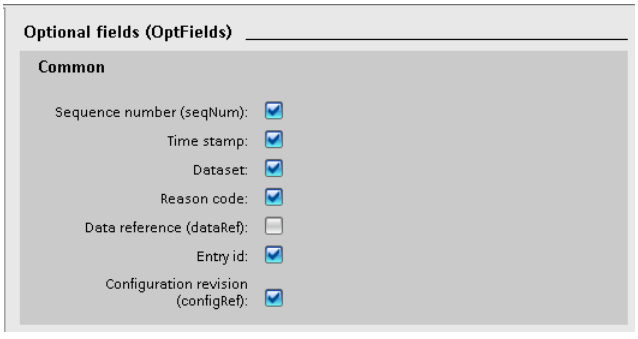
Figure 4-11 Properties of a Report Control Block

NOTE

The Report number (rptID) must be unambiguous in the station.

Optional Fields (OptFields)

In the **Optional fields (OptFields)** section, you may set up optional field elements that are to be transmitted with a report, for example, sequence (seqNum), time stamp, dataset.



[ScOptFld-140113-enUS-01.tif]

Figure 4-12 Settings for Optional Fields

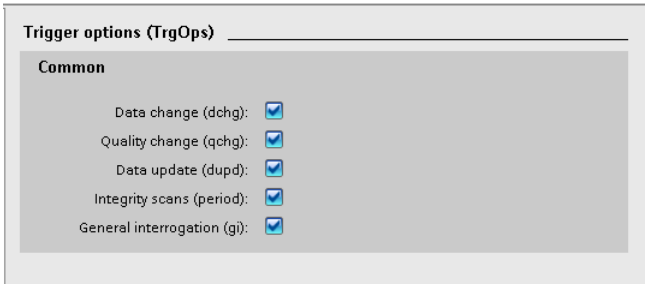
Trigger options (TrgOps)

In the **Trigger options (TrgOps)** section, you set up the triggering conditions. You use these triggering conditions to specify when a report is to be generated and transmitted.

The trigger option dchg (= data change) specifies that a report to a client be updated automatically after a change of the indication, for example, as a result of protection pickup. A quality change (qchg) can also trigger a report. This is the case if, for instance, the test mode for indication transmission has been activated in the device by DIGSI 5 and indications to the client have been given a test bit.

NOTE

Siemens recommends not changing the default settings of the trigger options.



[ScTrgOps-140113-enUS-01.tif]

Figure 4-13 Trigger Option Settings

4.7 Time Synchronization

4.7.1 Time Synchronization through SNTP

Time Synchronization

In order to allow the correct time recording of events synchronously, SIPROTEC 5 devices need a time synchronization.

The SNTP protocol is used for time synchronization in IEC 61850 networks.

SNTP enables a time resolution of 1 ms. When considering similar runtimes, SNTP can determine the average runtime of a synchronization telegram between the client and the server in the Ethernet network. This transmission time can be taken into account in the terminal device and improves synchronization of terminal devices.

As default, SNTP is deactivated. If SNTP is to be used for time synchronization, activate the SNTP check box of the Ethernet communication module or for the integrated Ethernet interface.

Additional information for setting SNTP in DIGSI 5 can be found in the *6.8 Time Synchronization through SNTP* chapter.

Time Server in the Network

For time synchronization via Ethernet according to SNTP, a time server must be present in the network. 1 or 2 time servers are supported. This time server must also be able to address the different time requirements of the devices as defined in the SNTP. Time servers can be reached through an IP address.

The following SNTP settings can be configured:

Parameter name	Settings	Default setting
Time source 1	IP address of the SNTP server	10.16.60.1
Time source 2	IP address of the redundant SNTP server If a 2nd SNTP server is not available, you can leave the standard setting for the time source 2 without making any changes.	10.16.60.2
Time interval	SNTP server inquiry time interval Time interval: 15 s to 60 s	15 s

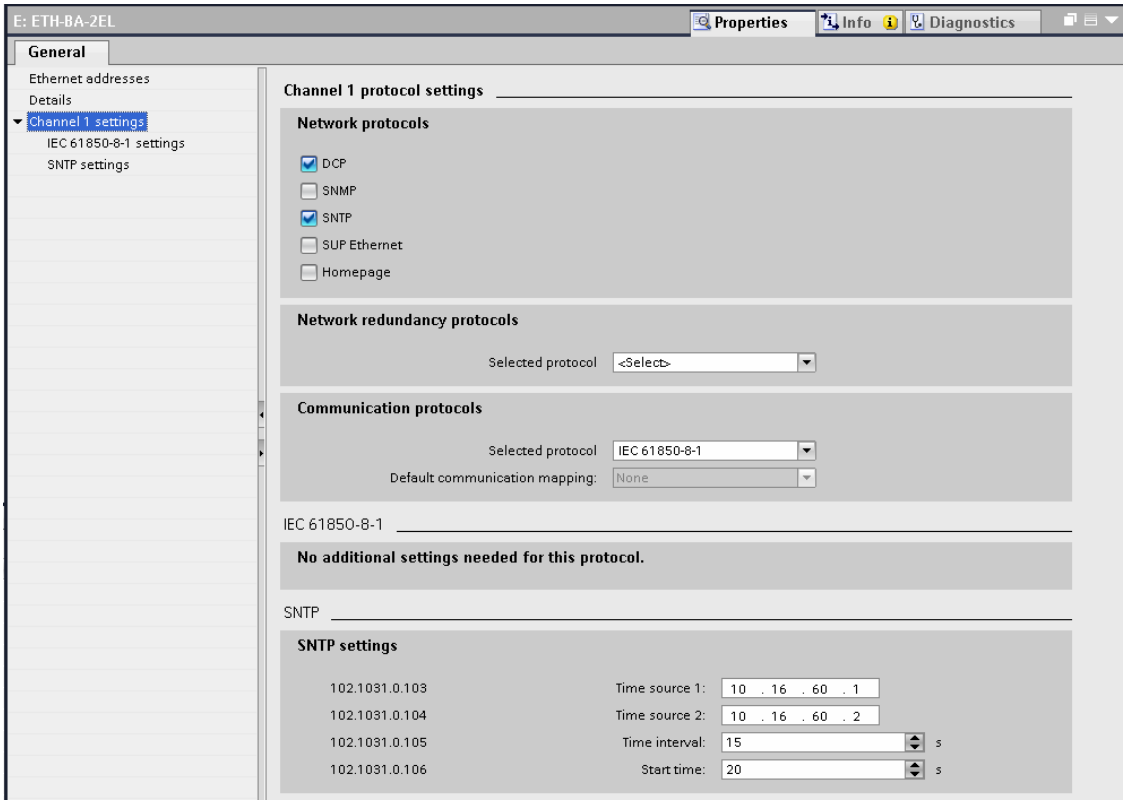
If the 1st SNTP time server configured in the network cannot be reached, the 2nd SNTP server is automatically queried. If the 2nd SNTP time server also cannot be reached, there is no synchronization via SNTP. The device reports a time-synchronization failure.

4.7.2 Setting the Parameters for Time Synchronization

For the purpose of time synchronization, activate SNTP on the Ethernet communication module or on the integrated Ethernet interface.

- ✧ To activate SNTP on the Ethernet module, select the Ethernet communication module in the Device view.
- ✧ Select the IEC 61850-8-1 protocol under **Channel 1 settings**.
- ✧ Place a check mark at SNTP in the **Network protocols** section.
- ✧ To access the **SNTP settings** section, click **Channel 1 settings**.

  You can make the SNTP settings in this section.



[ScTmSync-140113-enUS-01.tif]

Figure 4-14 SNTP Settings

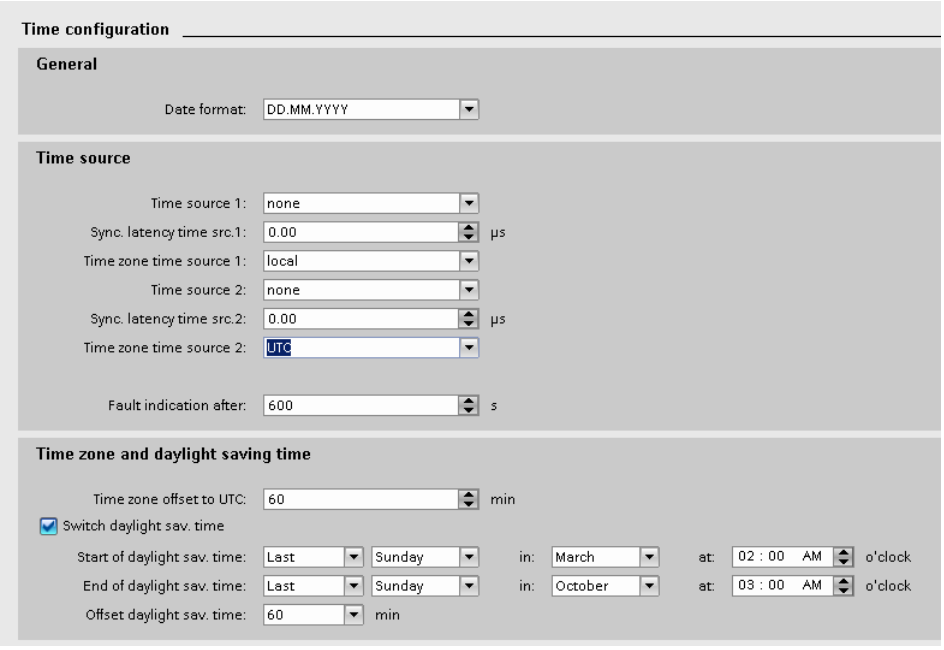
NOTE

If there is no 2nd SNTP server, set the value **0.0.0.0** for **Time Source 2**. Setting another value can result in error messages.

- ✧ Select a device in **Project tree**.
- ✧ Under **Settings**, select the **Time settings** section.

  Here, you can select SNTP as the time source under **Time source 1**.

  The hardware catalog contains an IEC 61850 time server in the **Devices and networks** section. If you create the IEC 61850 time server, you can select this time server as the time source for time synchronization.



[ScTmsyn2-140113-enUS-01.tif]

Figure 4-15 Setting the Time Source

NOTE

Redundant SNTP time servers are supported. The device obtains the time information from both time servers.

4.8 Engineering Concept

The **Functional naming and flexible product naming** engineering concept describes the interchangeability of devices at the communication level.

The communication interfaces of the devices are configured such that the scope of information transmitted and the address scheme (naming) between devices of different versions and manufacturers appear the same.

Function-Related Address Scheme

The function-related address scheme (functional naming) is specified in the Substation view of the IEC 61850 configuration. This involves configuring the SCL element **LNode** at all elements such as function/subfunction and equipment/subequipment. These elements are used to select the data structures and their formats that are to be communicated over the IEC 61850 interface.

Product-Related Address Scheme

The product-related address scheme (product naming) describes the actual configuration of the IEC 61850 address scheme and the object-tree structure of the IEC 61850 data model (logical device – logical node – data object – data attribute). The telegrams are generated based on this address scheme and sent over the IEC 61850 interface.

The object-tree structure can be modified when using the flexible address scheme (flexible naming). Based on the flexible address scheme, a device exhibits the following attributes:

- Flexibility of the data models implemented for the device

  The ability of the user to specify structures of logical devices (LD – Logical Device).

  This provides the option to create and use user LDs.
- Random designation of the IEDName, LDinst, prefix, and suffix
- Free creation of standards-compliant logical nodes (LN – Logical Node)

  The ability to use all important data classes listed in IEC 61850 (LN, Do) to the full extent.
- Random naming of the LD with an LDname attribute.

  The attribute LDname will be used instead of the combination IEDname+LDinst (combination of the name of the IED and the instance of the LD) as part of the address in a GOOSE or Report communication.
- The controllable data objects must be identical. This means that the location in the data model must be the same. The mapping-specific structure of these objects must also be identical. The control model should be the same. The behavior during the switching sequence must be identical as well, for example, use of addCauses.

The concept of the flexible address scheme offers the following benefits, among others:

- Device interchangeability at the communication level
- Typical device configuration, regardless of the device manufacturer
- Longevity of the configuration data generated

4.9 IEC 61850 Structure

4.9.1 IEC 61850 Structure

The IEC 61850 structure shows the object tree of the IEC 61850 data model of the device.

This object-tree structure illustrates the following elements:

- Logical Devices (LD)
- Logical Nodes (LN)
- Data Objects (DO)

By using the filter function, objects (LD, LN, DO) can be searched and displayed.

4.9.2 Adjusting a Data Model

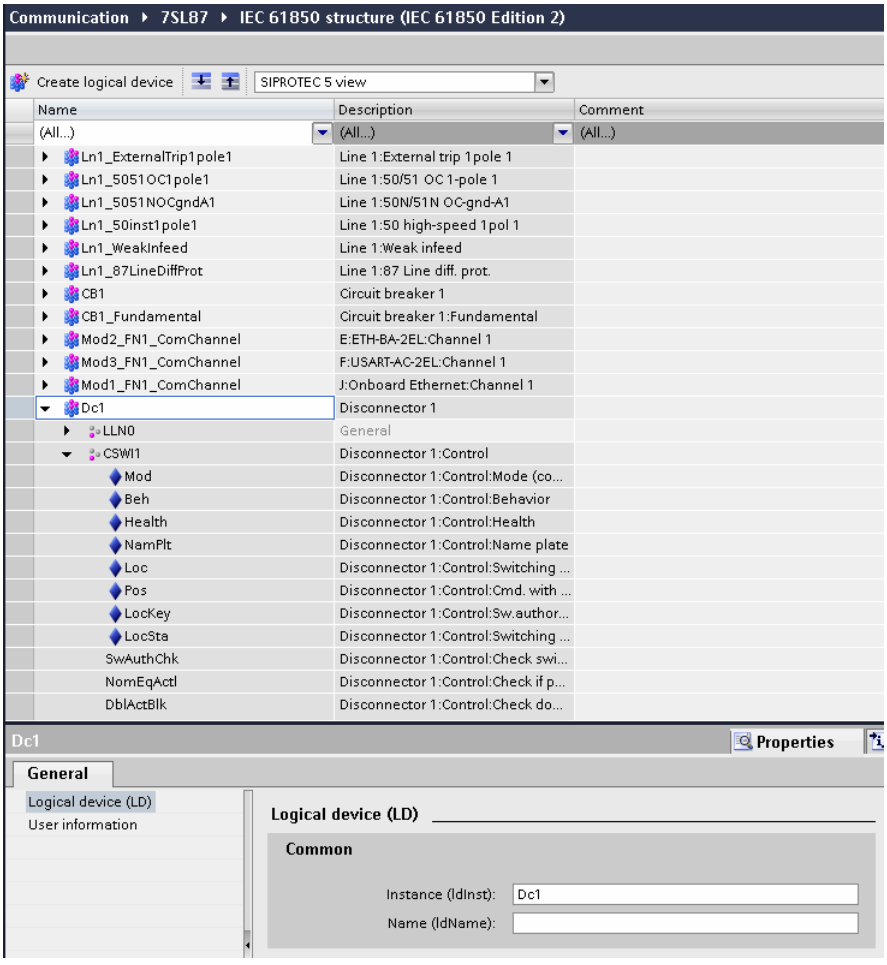
In order to adjust a data model of the device to a desired interface configuration, you may implement the following modifications:

- You can rename the existing Logical Devices, for example, CB1 to QA1.
- You can add an ldName (Logical Device name). This LDname will then be used in the communication address instead of the IEDname (device name) and the Logical Instance ID (LDinst).

NOTE

You may not use the LDname twice within the entire Ethernet subnetwork.

- You can configure an LN Prefix and the LN Instance number.
- You can create new Logical Devices.
- You can create new Logical Nodes, your LN Prefixes, and your LN Instance number.
- You can create data objects (DO).
- You can add data objects to new LNs.
- You can expand the data volume of a LN by one or several DOs.
- You can shift a Logical Node from one LD to another LD, as well as into an LD that you created yourself.



[ScIECStr-140113-enUS-01.tif]

Figure 4-16 IEC 61850 Structure

Examples of How to Adjust a Data Model

In a function-related system specification according to IEC 61346, you have assigned a group of LNs with DOs to an equipment circuit breaker.

These data objects are to be transmitted during the communication with the following function-related addresses:

- Switchgear (Station): Sample system
- Voltage level E1
- Bay name: Q3
- Equipment circuit breakers QA1
- Phase (Subequipment): A
- Logical Nodes:
  - XCBR
  - CSWI
  - CILO
  - RSYN

In order to illustrate this address structure in a product-related address scheme, configure a logical device with the following LDname:

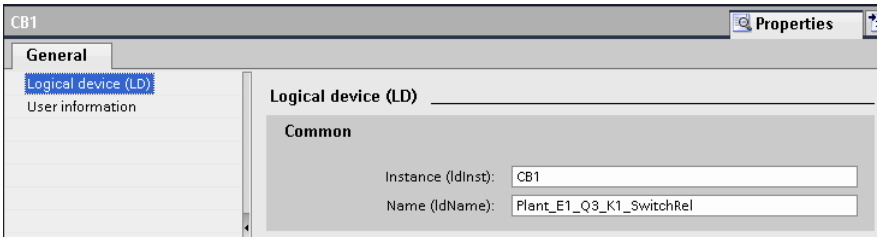
Sample system_E1_Q3_K1_SwitchRel

K1 means electronic control unit 1 and **SwitchRel-** refers to information related to the switching device.

LN instances will be set with the prefix **QA1A**.

Implement the following changes in the IEC 61850 structure:

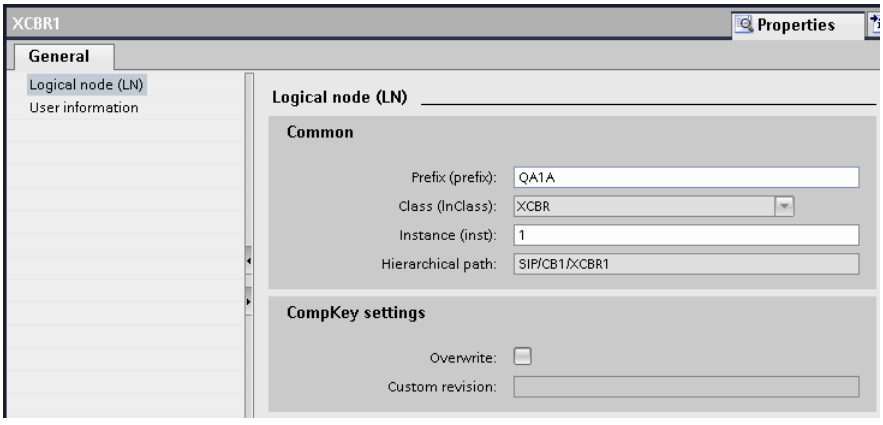
✧ Enter **Sample system_E1_Q3_K1_SwitchRel** into the **Name(IdName)** field.



[ScIECSt2-150113-enUS-01.tif]

Figure 4-17 Changing the LD Name

✧ Enter **QA1** into the field **prefix** LN XCBR0, XCBR1, XCBR2, XCBR3, CSWI0, CILO0.

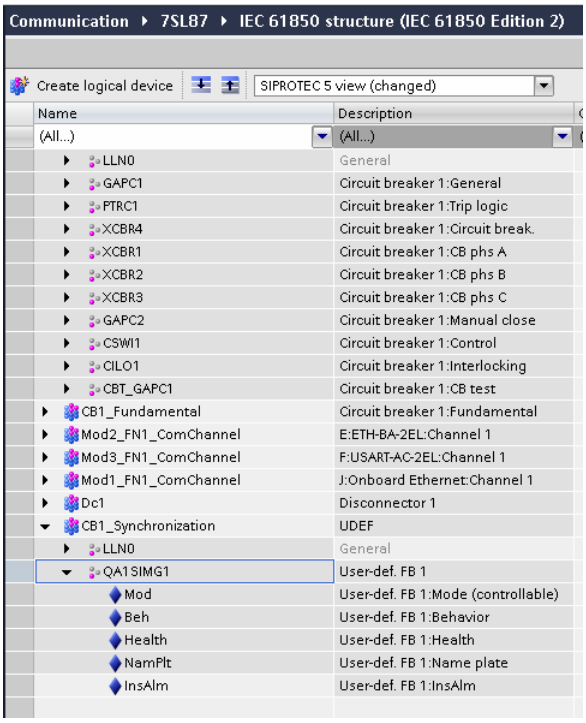


[ScIECSt3-150113-enUS-01.tif]

Figure 4-18 Entering the Prefix

✧ Move the LN from the LD CB1_Synchronization into LD CB1.

If data objects are missing from the standard content of the IED, you can simply copy the user-defined function (LN) and a user-defined signal (DO) from the library into the respective device.



[ScCopLNs-140113-enUS-01.tif]

Figure 4-19 Adding a User-Defined Object to LN

4.10 Exporting

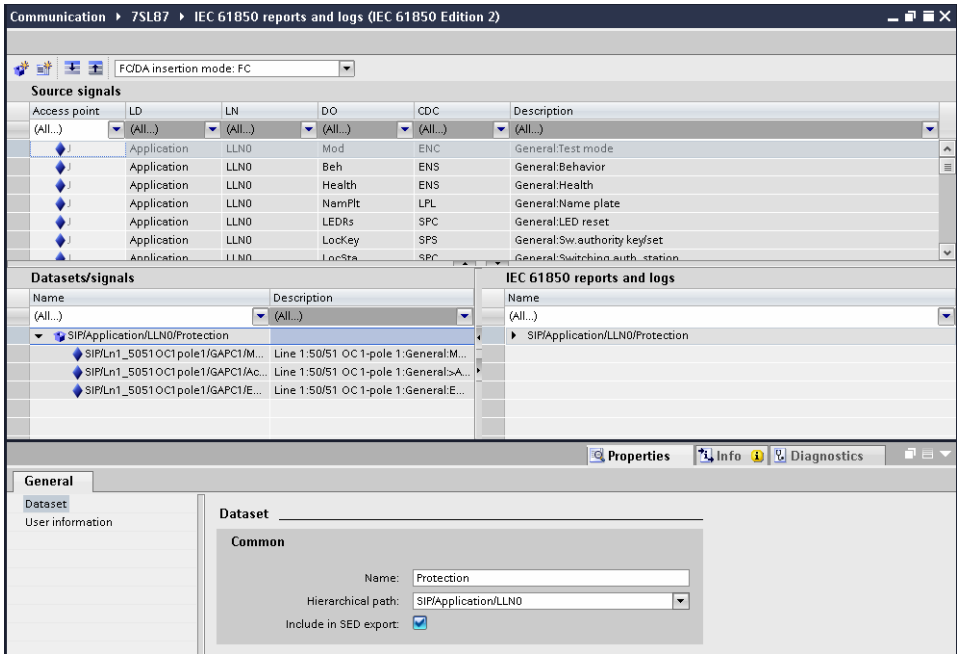
4.10.1 Export Formats in DIGSI 5

Export files permit interoperable data exchange of IEC 61850 data between the configuration tools of various manufacturers. They can be used for documentation purposes or in other IEC 61850 configurators, for example, DIGSI 4.

Export of IEC 61850-compliant SCL files is possible with DIGSI 5. This export occurs on the project level for the SCD file and SED file.

- SED (System Exchange Description)

  To be able to select this file type, mark the option **Include in SED export** in the properties of the dataset.



[ScSEDExp-140113-enUS-01.tif]

Figure 4-20 Include the Dataset in the SED Export

The following export formats are available at the device level to export device-specific IEC 61850 data:

- ICD (IED Capability Description)
- IID (Instantiated IED Description)
- CID (Configured IED Description
- MICS (Model Implementation Conformance Statement)

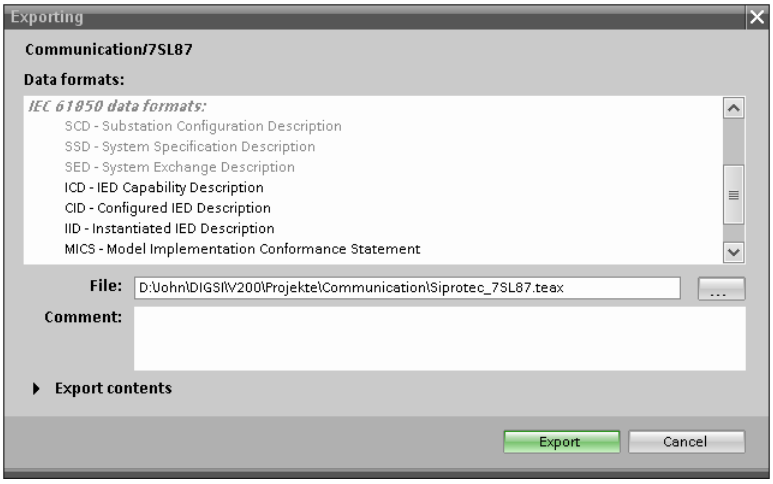
  This file is the XML description of the device data model.

  With this export format, 3 files are exported: 1 XML description and 2 formatting files.

  Both formatting files must be in the same directory as the XML file so that the XML files can be displayed correctly in the browser. If this is not the case, the XML file is displayed in an unformatted way.

ICD and IID files may also be imported from third-party configurators. They permit working with third-party devices in the IEC 61850 device configuration in DIGSI 5. The result can then be exported as the SCD file of the project.

SCL files are exported according to Edition 1 (SCL Scheme V1.4) or Edition 2 (SCL Scheme V3) of the IEC 61850 protocol. The edition is set in the project properties.



[ScIECExF-140113-enUS-01.tif]

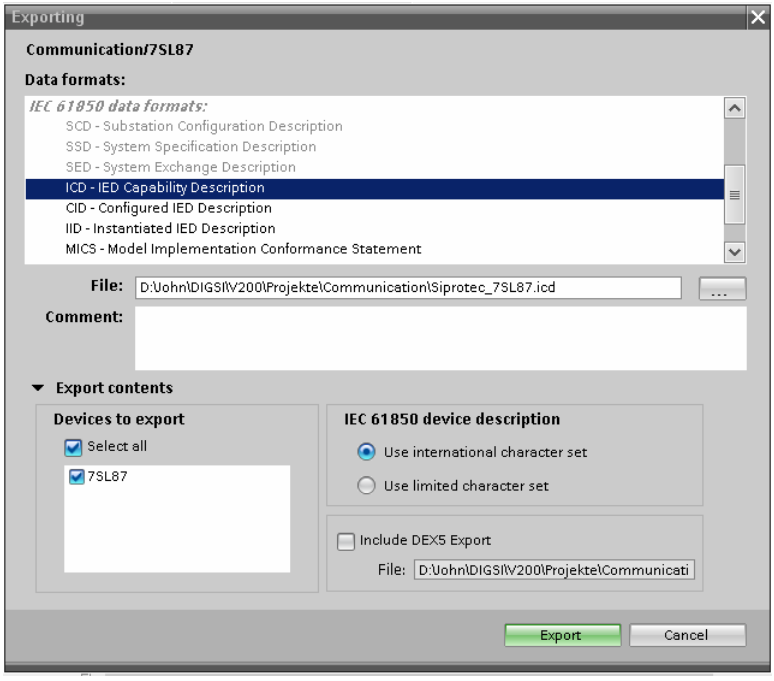
Figure 4-21 Export Formats on the Device Level

4.10.2 Exporting IEC 61850 Description Files

IEC 61850 description files include, for instance, ICD, CID, and IID. They include descriptions of the performance properties of an IED.

- ✧ In order to export IEC 61850 description files, highlight the device in the project tree.
- ✧ Select the **Export** function from the menu.

The export dialog appears. You can select from among various data formats.



[ScExpMap-140113-enUS-01.tif]

Figure 4-22 Export Content

A system configurator or a substation automation system configuration software program can directly import these files. These files are used for the IEC 61850 engineering process.

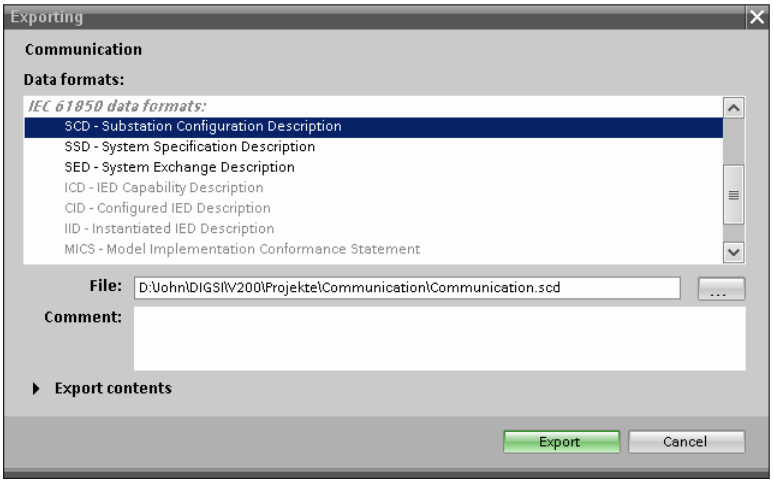
4.10.3 Exporting SCD/SED Files

- ✧ In order to export SCD or SED files, select the project in the project tree.
- ✧ Select the **Export** function from the **Project** menu.

-- or --

- ✧ Right-click the project and select **Export** in the context menu.

The export dialog appears. You can select from various data formats.



[ScSCDExp-150113-enUS-01.tif]

Figure 4-23 Export the SCD File

✧ Click **Export**.

■

5 Commissioning and Diagnostics

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5.1 Commissioning Instructions

5.1.1 Requirement

NOTE

In this chapter, the commissioning procedure is presented in compressed form. Note that one part deals with the RSTP settings.

All components must be installed and operating properly.

Creating a List of Addresses

NOTE

With the aid of an address list, you can obtain an overview of the network topology. This list contains all important information about the devices. In this way, you can find any errors quickly.

Siemens thus recommends that you first create a list of component addresses immediately.

The list must contain the following information at a minimum:

- Device type
- Product code
- Serial number
- Firmware version in the device
- Firmware version in the module
- IP address

  IP settings can be read only after the devices have been initialized, that is, the parameter sets have been loaded into the devices.
- Subnet mask
- Standard gateway
- MAC address

  The MAC addresses can be read directly on the display of the device (Menu 5-5 Enter).
- IED name under IEC 61850 for each device

It makes sense to also obtain the above-mentioned information for third-party devices, for example, switches.

Supplement this list with a description of the network topology. This topology description explains how the devices are connected to one another.

To obtain information about devices from the competition, follow the procedure in the Manuals.

Once the list is complete, check whether any IP addresses appear twice. MAC addresses do not appear twice when power-system components are identified unambiguously.

Additional commissioning information is available at http://siemens.siprotec.de/download_neu/index_e.htm.

Commissioning a Ring Structure

Prior to commissioning, check whether the system has been installed correctly.

Start up proceeds in the following sequence:

- Break the ring structure at one point.

  Siemens strongly recommends this action in order to create a stable ring structure.
- Switch on the switches

  Siemens recommends that you wait about 20 s after switching on the power.
- Switch on the devices

  Siemens recommends that you switch on the devices in succession in accordance with their location in the ring. After switching on power, wait until the device has started up before you switch on the next device.

  In principle, the sequence and waiting period do not play any role. Time-outs can delay connection establishment in the case of RSTP.
- Close the ring

  Breaking the ring can accelerate commissioning, as effects like the one above could otherwise occur.

Check Accessibility

After commissioning the network, use DIGSI 5 to check the accessibility of the components in the ring.

NOTE

Keep in mind that modules with an optical interface can operate in both the Line and Switch mode. The homepages thus differ accordingly. You use DIGSI 5 to set the operating mode.

Upon completion of these preliminaries, a ring structure will be an operation. Additional settings are now possible.

5.1.2 Additional Tests

Check Accessibility

After settings have been made and parameters loaded, all components must be accessible via their IP address. This must be possible regardless of whether the ring is open or closed.

If a device cannot be reached, the following reasons can be the cause:

- A SIPROTEC 5 device connected to a switch via a Line connection is switched off.
- A SIPROTEC 5 device incorporated into an optical ring is switched off.
- A ring structure is cut at more than one point. As a result, some of the devices are no longer accessible.

  The following reasons can be the cause of the break:
  - Switched-off devices
  - Broken connections

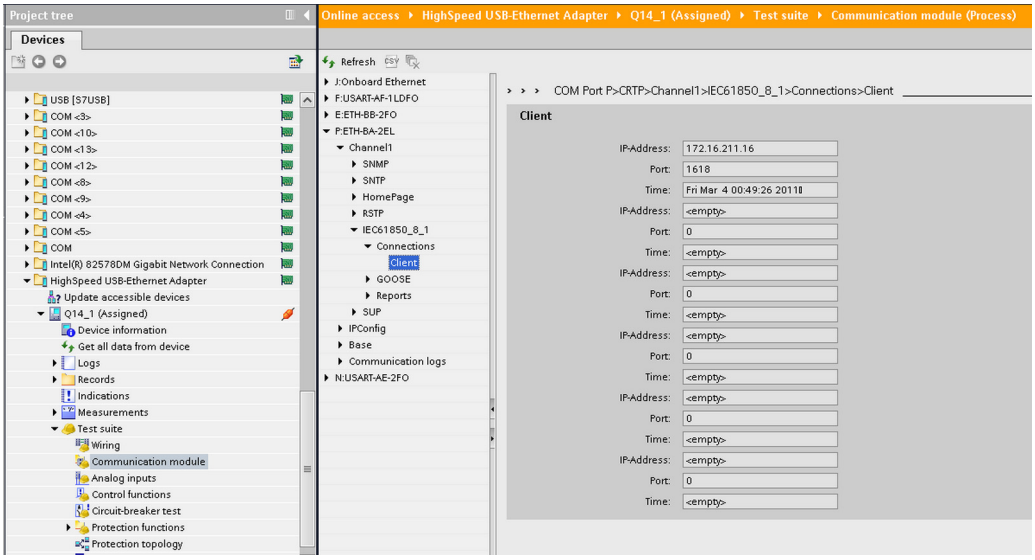
5.2 Diagnostic Pages in DIGSI 5

The services and protocols configured on the Ethernet module are diagnosed exclusively by DIGSI 5 over secure connections.

You can use the following elements to access via DIGSI 5:

- USB Interface
- Integrated Ethernet interface (Port J)
- Ethernet module

The diagnostic pages and the communication log provide assistance during commissioning or when performing diagnoses during operation by providing important data online.



[ScDgClnt-280111-enUS-01.tif]

Figure 5-1 Diagnostic Pages - Connections for the Client

Diagnostic indications regarding communication are displayed in a communication log. The communication log displays, for instance, whether a module has started up successfully and communication services have been initiated. The communication log can be retrieved from the device as an indication list by DIGSI 5.

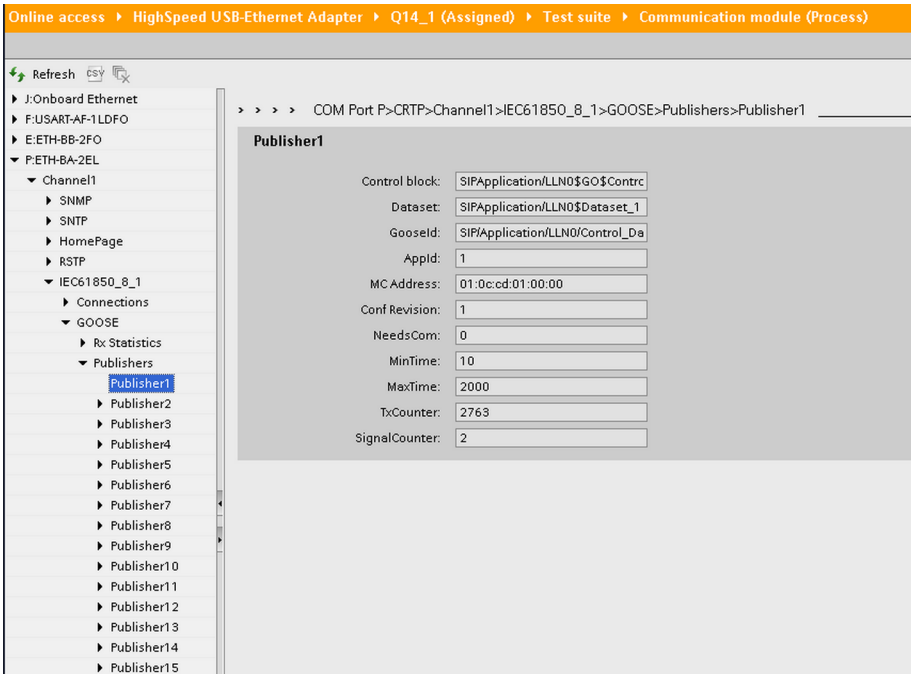
GOOSE Control Blocks and Reports Generated

You can find the following information in the IEC 61850 protocol:

- Generated reports and GOOSE datasets that have been transmitted by the device are displayed.
- Once a connection has been established between the servers, objects that have been received via GOOSE messages from other devices are displayed.

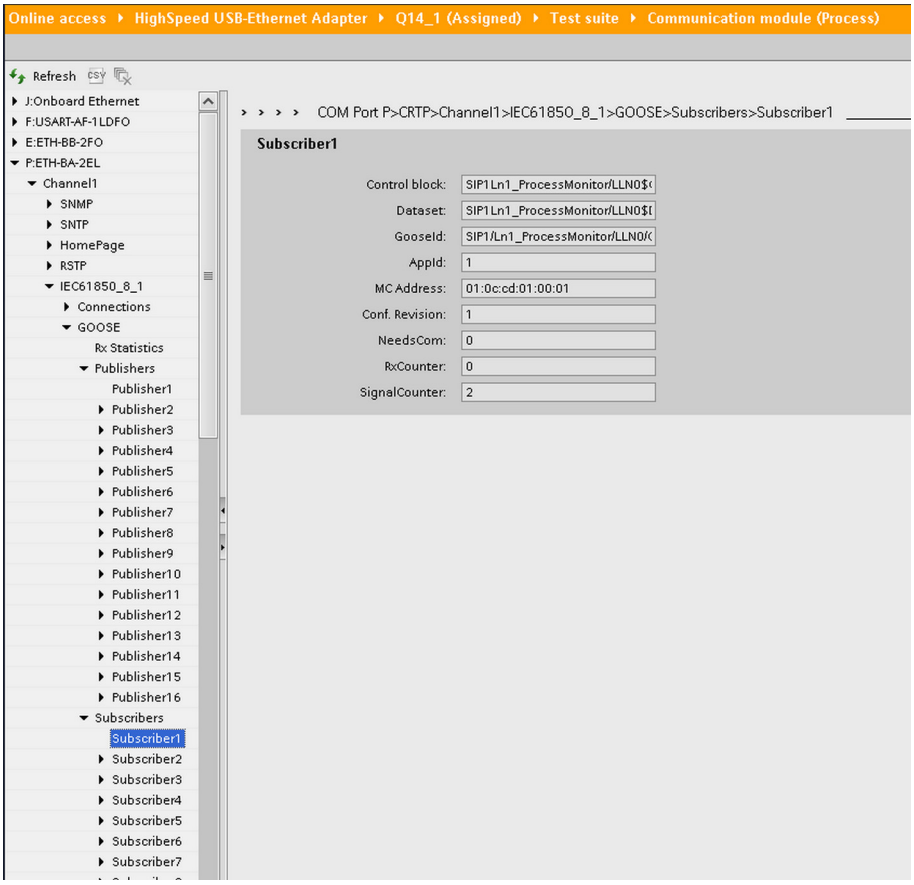
  This allows you to recognize, for instance, whether configured GOOSE connections in DIGSI 5 are also communicating successfully.
- Transmitted and received GOOSE messages are counted.
- Faulty telegrams are displayed.

The diagnostic pages are available for the GOOSE (Publisher, Subscriber) and Reports sections.



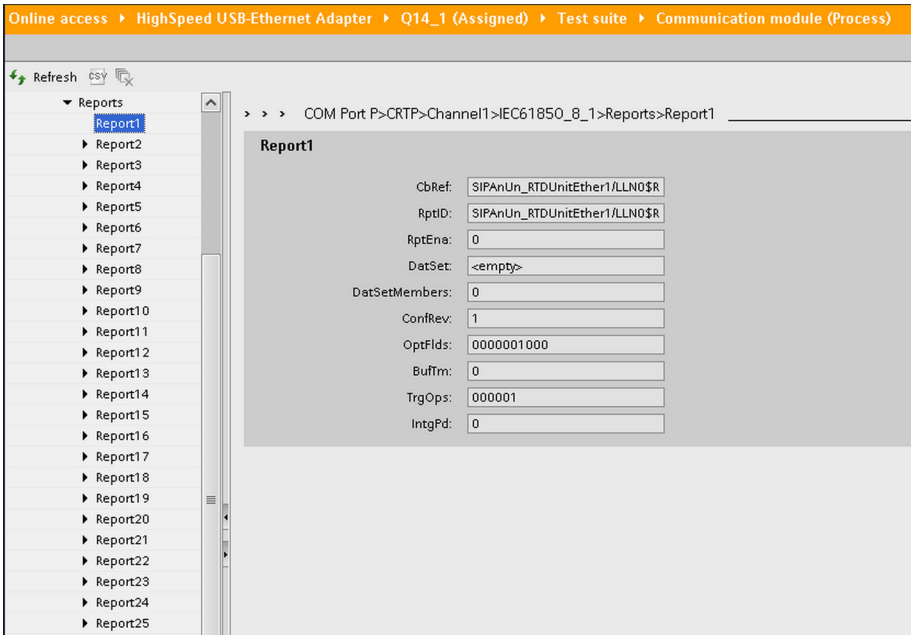
[ScDgPubl-280111-enUS-01.tif]

Figure 5-2 Diagnostic Pages for GOOSE - Publisher



[ScDgSubs-280111-enUS-01.tif]

Figure 5-3 Diagnostic Pages for GOOSE - Subscriber



[ScDgRept-280111-enUS-01.tif]

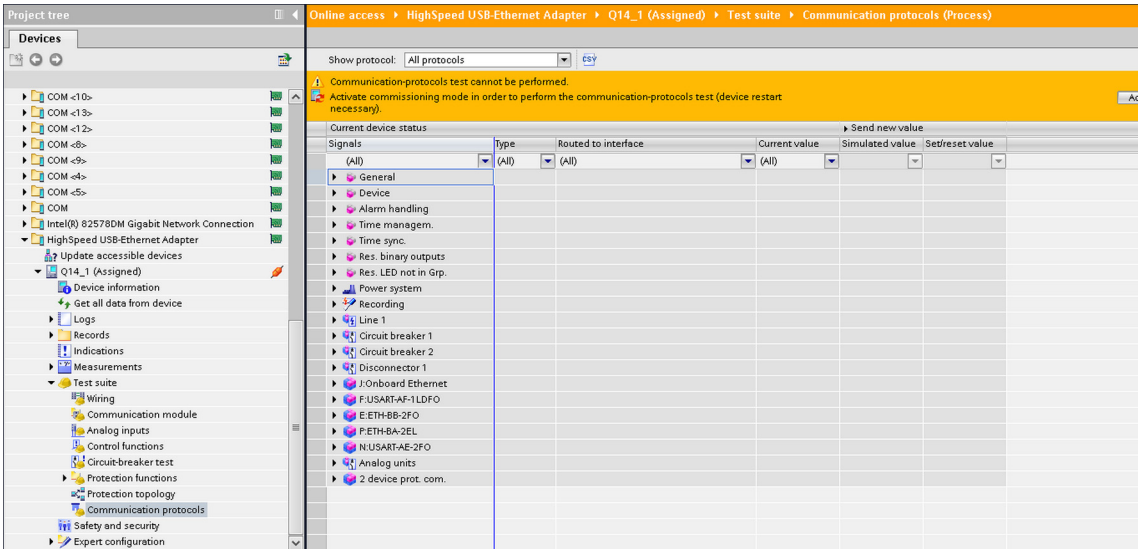
Figure 5-4 Diagnostic Pages for Reports

Diagnostic data can also be retrieved online for the configured SNTP time servers. This allows you to check successful time synchronization of the device.

5.3 Test Editor

For the protocol test, DIGSI 5 is used to set and reset specific values for objects that are routed through communication interfaces. The object will always be transmitted using a test bit. If the objects are to be designed with receivers, then the receivers must also be placed into the test state. A Test Editor is provided in DIGSI 5 for this purpose.

You can set objects for IEC 61850. If this object is configured in a dataset that is to be transmitted as a GOOSE message or report, then the object can be received spontaneously by a client or other server. In this way, you can change states and test their response via the IEC 61850 communication.



[ScTestEd-280113-enUS-01.tif]

Figure 5-5 DIGSI 5 Communication Protocol Test Editor

5.4 Switching off GOOSE Messages

Using an IEC 61850 client, you can switch off GOOSE messages in a device.

Controlling GOOSE Messages

A GOOSE message is controlled by a GOOSE control block. It is located in the LLN0 of the logical device in which the GOOSE message was created. All relevant data for the GOOSE message can be found there.

The variable **GoEna** is needed to switch off GOOSE messages. The variable **GoEna** controls the transmission of the GOOSE message. If a client sets this variable from 1 to 0, the device stops the transmission this GOOSE message and the objects it contains. You can now check the receivers of GOOSE messages to see whether an interruption of data reception is detected reliably. An object that is not received is set to the value **Invalid** or its state can be updated manually at the receiver.

Name	Type(Len[arr])	Value
Name		Control_DataSet1
Type		Data Object
Path		IEDSJ64gCTRL/LLN0GOControl_DataSet1
TypeID		3
	{ (0[11])	
GoEna	Bool (1[1])	0
GoID	VisString (66[-65	0
DatSet	VisString (69[-65	IEDSJ64gCTRL/LLN0$DataSet1
ConfRev	UInteger (4[4])	2
NdsCom	Bool (2[1])	0
DstAddress	{ (0[4])	
DstAddress$Addr	OctetStr (6[6])	010ccd010004
DstAddress$PRIORITY	UInteger (2[1])	4
DstAddress$VID	UInteger (2[2])	0
DstAddress$APPID	UInteger (2[2])	0
DstAddress	} (2[4])	
	} (0[11])	

[ScGoEnab-081210-enUS-01.TIF]

Figure 5-6 Variable GoEna with Value 0

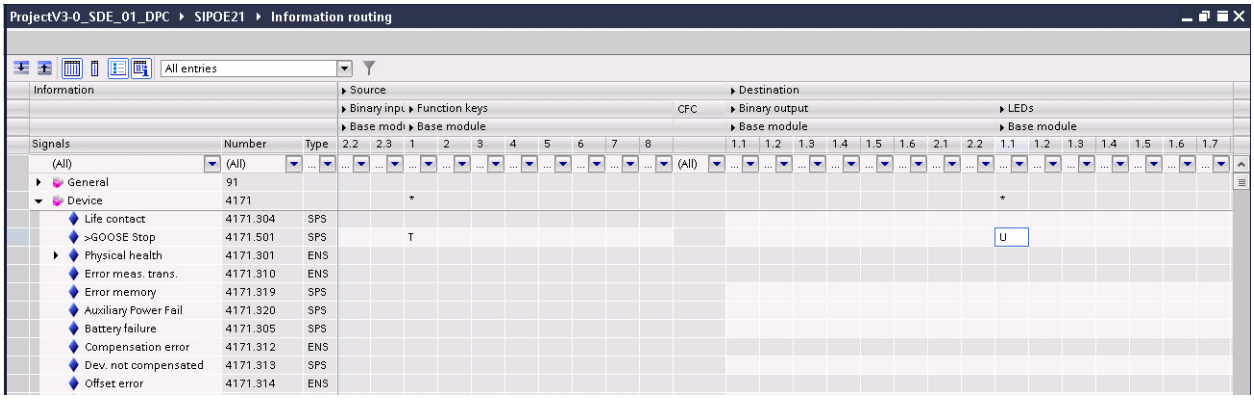
If a device transmits several GOOSE messages, then you must set all **GoEna** variables to 0 to switch off the GOOSE messages completely.

The GOOSE messages are switched on by setting the value of the variable **GoEna** to 1.

For testing purposes, you can use the IEC 61850 Browser, as it displays and can set GOOSE control blocks and variables.

Switching off GOOSE Messages in Information Routing

You can switch off GOOSE messages in the information routing by routing the **>GOOSE Stop** signal to a binary input or function key. You cannot route this signal to a binary input and a function key simultaneously.



[ScGoStop-110113-enUS-01.tif]

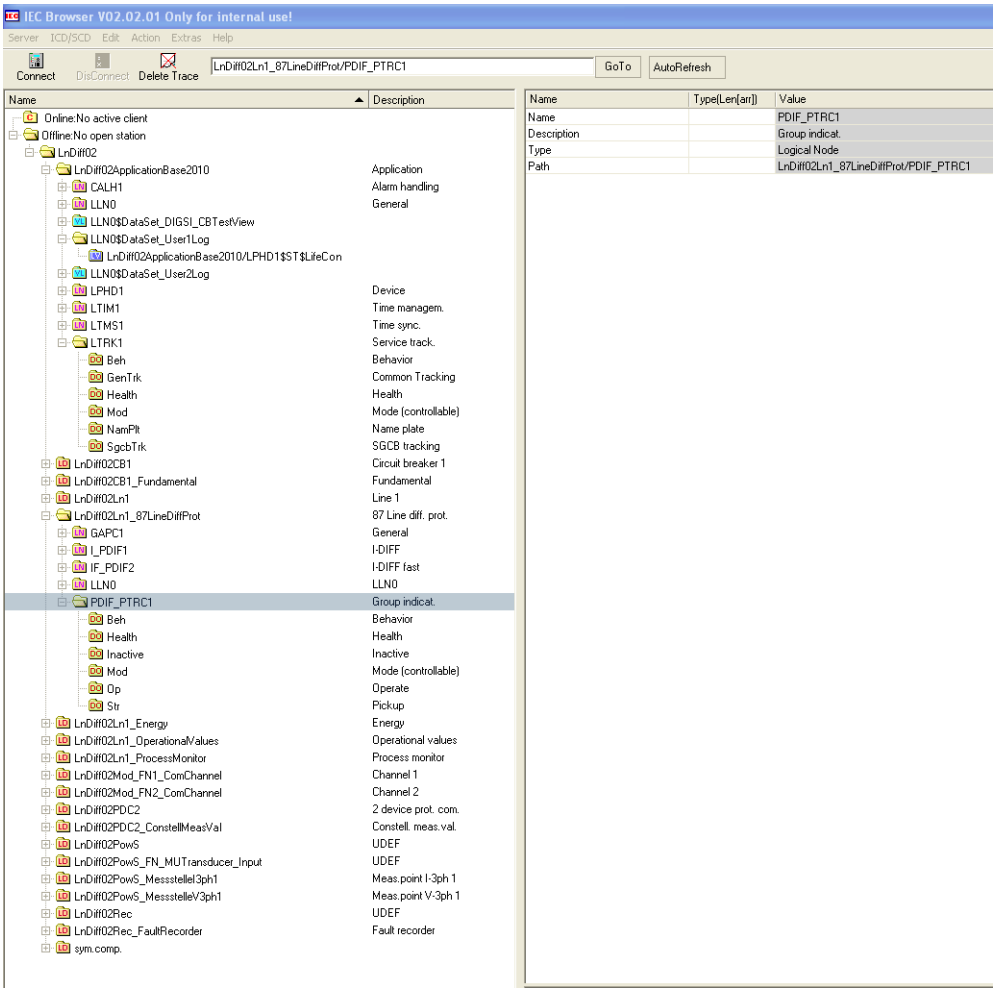
Figure 5-7 Routing the >GOOSE Stop Signal

5.5 Working in the IEC 61850 Browser

5.5.1 IEC 61850 Browser

The IEC 61850 Browser is a PC program that allows the IEC 61850 structure of a device to be displayed online. It is supplied as a debugger together with DIGSI 5 and provides valuable information about the IEC 61850 structure of a device during commissioning. The IEC 61850 Browser displays datasets configured in the device, for example, for static reports or GOOSE messages, as well as the data objects they contain.

The Browser behaves like an IEC 61850 client and can, for instance, receive reports from a device.



[ScIECBrw-081210-enUS-01.TIF]

Figure 5-8 IEC 61850 Browser

To display the IEC 61850 structure of a device, connect to the IP address of the device over the network. The IEC 61850 Browser reads the entire IEC 61850 structure of a device online and displays it in a tree structure with logical devices, logical nodes, and data objects. For test purposes, you now have read and write access to the device.

If you have used DIGSI 5 to export data as ICD or SCD files, then you can import these files into the IEC 61850 Browser and in this way transfer the data in the IEC 61850 Browser. In this case, the Browser displays the IEC 61850 structure of the device offline. In this offline display, you can also recognize the descriptions of the IEC 61850 objects. They are incorporated from the ICD or SCD files and improve reading of the IEC 61850 structure noticeably. In the SCD file, you can see all devices and the IP addresses configured. You can now connect to a device and browse through the IEC 61850 structure of this device.

More information on the IEC 61850 Browser can be found in the Help system of the program.

■

6 Protocol Properties and Implementation

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6.1 IEC 61850 Structure of a SIPROTEC 5 Device

There are 2 possible structures:

- The SIPROTEC 5 view
- The SIPROTEC 4 similar view

NOTE

Select the basic structure at the beginning. If you subsequently change the structure, all report and GOOSE configurations are lost.

SIPROTEC 5 View

A SIPROTEC 5 device is organized into function groups and functions. The protection functions are located in a function group, for example, Line. Breaker, for instance, is an additional function group that contains breaker-related functions.

The SIPROTEC 5 view contains the following components:

- Protection functions/protection functions

  The protection functions/functions consist of one or several tripping stages and a superordinate stage that controls the stages below it. In DIGSI 5, this view corresponds to, for example, information routing. A generic conversion into the IEC 61850 protocol structure takes place.

- Logical device

  The function group and function form the logical device. The following figure shows this, using the differential-protection function as an example. Ln1 Is the function group Line1 that contains the **87 Line diff.prot.** protection function and additional protection functions.

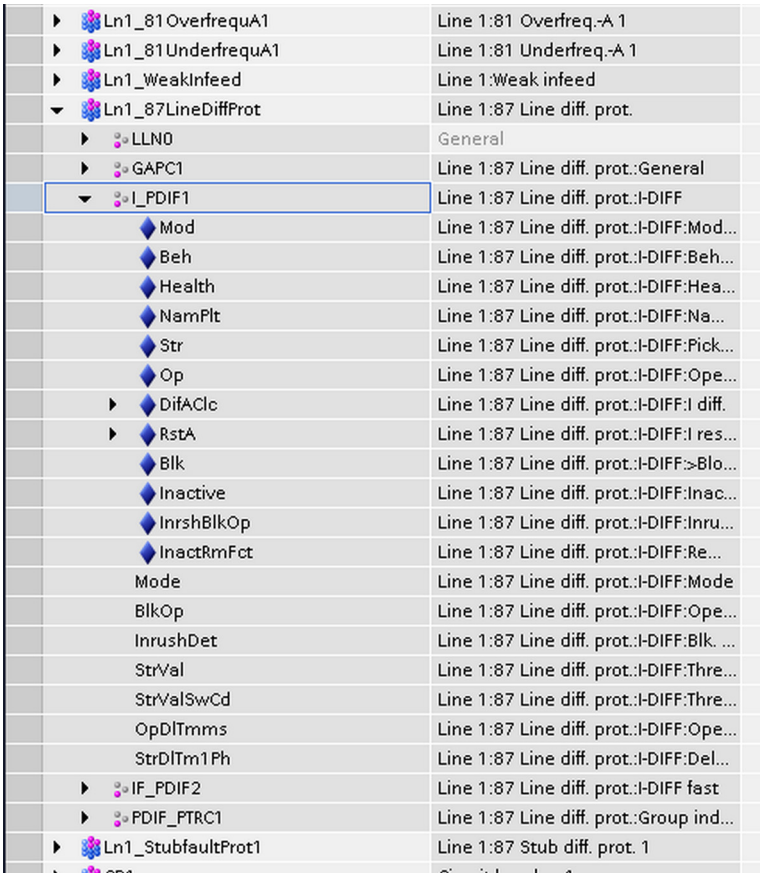
  The text of the logical device **Ln1_87LineDiffProt** consists of an abbreviation for the function group Line1 and the protection function. In the column at the right in the following figure, you can see the corresponding DIGSI 5 text that is used, for instance, in information routing. In information routing, but also in the GOOSE Editor, the IEC 61850 descriptions and the DIGSI 5 texts will always be displayed in table format. This will enable you to always find the IEC 61850 object assigned to the DIGSI 5 objects.

- Logical nodes

  The differential-protection stages appear as logical nodes (called PDIF per the Standard). These are the logical nodes **I_PDIF1** and **IF_PDIF2**. The prefix and suffix of the logical node are specified by Siemens. However, you can change them at any time.

  The logical nodes **GAPC1** and **PDIF_PTRC1** contain parameters that control the tripping stages as well as superordinate indications, for example, group indications. If you open up the logical nodes, you will see the information objects and settings contained.

This IEC 61850 structure is what appears when you select the **SIPROTEC 5 view** in the IEC 61850 structure editor. It is also the default for devices in the Edition 2 mode of IEC 61850.



[ScIEC5St-280113-enUS-01.tif]

Figure 6-1 IEC 61850 Structure of a SIPROTEC 5 Device (SIPROTEC 5 View), Using the First Tripping Stage of Differential Protection as an Example

SIPROTEC 4 Similar View

The **SIPROTEC 4 similar view** is an additional IEC 61850 structure. It is used in the Edition 1 mode.

The logical devices are given with the following designations, for instance:

- PROT
- CTRL
- MEAS
- DR

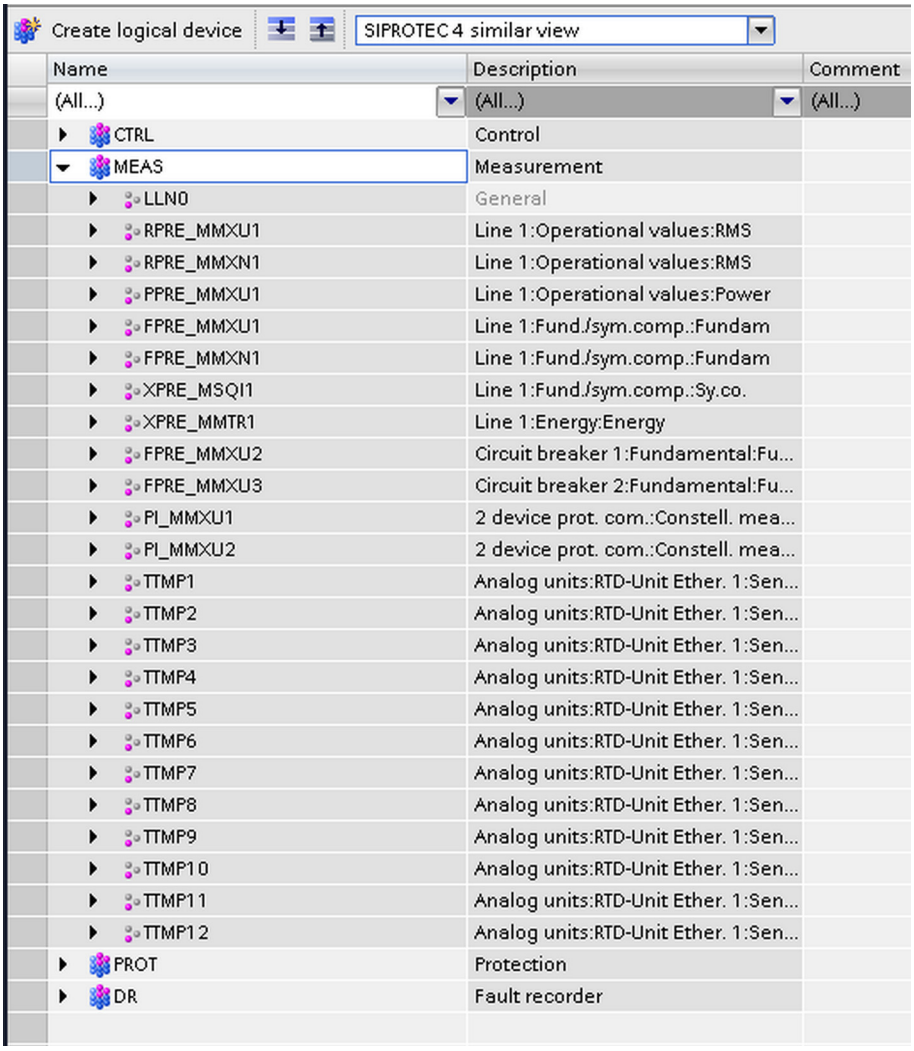
NOTE

The logical device EXT (Extended) is not available as default. However, you may create this logical device.

The logical devices exhibit a great deal of similarity to the LD structure of SIPROTEC 4 devices.

The logical devices contain the tripping stages, for example, protection function stages, and the superordinate stages that control them as logical nodes.

A generic assignment of function groups and functions to the IEC 61850 structure is no longer available in this view. Logical nodes and the superordinate controlling nodes are, however, displayed in the correct sequence. In addition, the DIGSI 5 text for an object or a parameter is always visible. You can also change this view in the Structure Editor at any time.



[ScIEC4St-280113-enUS-01.tif]

Figure 6-2 IEC 61850 Structure of a SIPROTEC 5 Device (SIPROTEC 4 Similar View)

NOTE

If you wish to change the IEC 61850 structure, you can begin with the SIPROTEC 5 view or the SIPROTEC 4 similar view and incorporate your changes via the IEC 61850 structure editor.

6.2 IEC 61850 Services

SIPROTEC 5 devices support the following IEC 61850 services:

GOOSE Messages

Datasets are created in the device by GOOSE applications. This takes place in the logical node **LLN0** (logical device zero 0) of a logical device. You can specify where these datasets are created.

The first object configured in a GOOSE message from a logical device creates a dataset for a GOOSE message in LLN0. Further objects are configured in this dataset and added to this dataset, even if they originated in other LDs. Alternatively, if you wish to send objects in different datasets, you can also create a new GOOSE application and thus a new dataset.

NOTE

Sending objects in different datasets generates unnecessary data traffic, since each dataset created is transmitted via its own GOOSE message.

The dataset is sent as a GOOSE message and distributed to all network participants in the form of multicast telegrams. If participants wish to receive specific objects in a GOOSE message, the participants can select these objects via the system configuration and receive them later online.

GOOSE messages are transmitted with high priority and repeated at an interval of a few milliseconds in the event of a spontaneous change of the data object. You set the repetition time in the GOOSE Editor.

You can find more information on GOOSE parameterization in chapter *4.4.2 Creating a GOOSE Application*.

Control Commands

You can control an object in a device with control commands. By using the control model **Select before operate**, you can actuate a circuit breaker reliably, for instance. Commands without feedback can be executed in the device as well, for example, resetting the LEDs (LED Reset) by the client.

Additional information on the configuration and control of switching objects can be found in the chapter *6.6 Control via IEC 61850*.

Settings are changed by using the Setting Services function.

You can find more information in chapter *5.5.1 IEC 61850 Browser*.

6.3 Reporting

6.3.1 Reports

6.3.1.1 What Is a Report?

When using IEC 61850 in switchgear as well, you must test communication between protection devices and the substation automation technology just as you do with the previous protocols. This requires, among other things, the knowledge of the power system protection technician who generates the signals sent to the substation control system. Testing these connections is a basic part of commissioning.

The IEC 61850 Standard defines various types of communication. For time-critical data such as triggering events and converter values, real-time transmission via GOOSE or sampled values is employed.

For **classic** communication, for example, between the substation control system and a bay unit, the Standard describes various services based on the data model:

- **Control** for controlling
- **Log** for event lists
- **Report** for transmission of indications and measured values

There are static and dynamic reports. You can find more detailed information on this in chapter *6.3.2 Static Reporting*.

The following sections describe reports involving data exchange between a protection or bay unit (server) and the substation automation technology (client) and its tests. Reports are transmitted over Ethernet connections via TCP/IP (Transmission Control Protocol/Internet Protocol).

Data objects (indications) of a device are summarized as a list in a report. For instance, indication changes, e.g caused by a raising and cleared protection tripping event, are transmitted spontaneously from server to client. Therefore, the client does not have to query the server cyclically, as is the case with serial protocols, but automatically receives a notification of the event, for example, an indication change or a change of the measured value.

If the server permits, it is also possible to have cyclic transmission of data and general interrogation. The event control of data transmission is a property that is contained in the attributes of each report. You can affect these properties by using the Report Editor settings in DIGSI 5.

Buffered and Unbuffered Reports

The Standard distinguishes between **Buffered reports** and **Unbuffered reports**.

The **Buffered report** is used most frequently today.

Buffered Report

In the case of an Buffered Report Control Block (BRCB), internal events trigger immediate transmission of reports. If the connection between the server and client is interrupted, indication changes in the protection device are stored. As soon as the connection has been reestablished, these indications are transmitted to the substation control system with a time stamp and the attribute **Historic**. To enable saving to a practicable limit – as recommended in the standard – the server must have adequate storage capacity. If an uninterrupted connection exists between the client and server, for example, in the case of controlled operation in a switchgear, then the behavior of both procedures appear identical from the user's view of the substation control system.

Client LNs can be set. ICD files from the client are imported. Here, you will find the IP address. With this, you can assign the report to the client. This ensures that only this client will receive the report.

Unbuffered Report

In the case of an **Unbuffered Report Control Block** (URCB), internal events trigger immediate transmission of reports. If there is no connection or if the transport data flow is not fast enough, events can be lost.

Datasets are needed for reports.

6.3.1.2 Datasets

Static and Dynamic Datasets

Every IEC 61850 service relies on data from the data model. This requires **Datasets** that reference actual values in the model.

There are report datasets with data for this report, for example, indication of the positions of the disconnector switch and circuit breaker in the feeder. These datasets can be created statically or dynamically.

Static datasets

In the case of a static dataset, the number of indications and measured values is specified in the Report Editor. Once these configuration data are loaded into the server, the client can no longer change the contents of the configuration data. A fixed report that the client can retrieve is stored in the server. Changing the number/scope of the indications requires new parameterization in the Report Editor, followed by loading to the server.

The benefit is that the data provided by a server are stored in an SCD configuration file (Station Configuration Description). The drawback is that the settings in the server must be changed if the number/scope of indications is changed.

Dynamic datasets

In the case of dynamic datasets, the settings in the server do not need to be changed when the number/scope of indications changes. The client has 2 opportunities to read all data points that the server can potentially make available:

- Offline with a configuration file (ICD or SCD file)
- Online by connection establishment to the server

The client specifies the information that a report from a device should contain. Thus, the content of a report is not fixed, but rather can be changed while the system is operating. The parameters set in the server do not have to be changed.

In this way, the client can be set to watch for special indications or measured values, for instance, for only a specific period. It can then create a report in the server, retrieve this report in order to obtain the information and then delete the report. No classic protocol offers this flexibility.

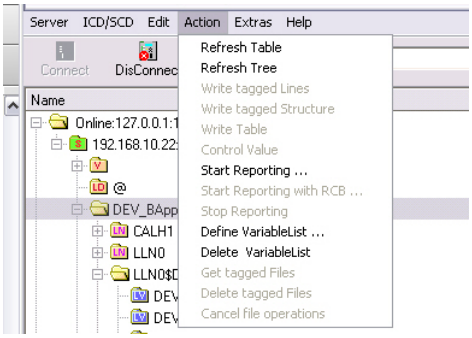
NOTE

Siemens supports this concept.

Creating Dynamic Datasets

The IEC Browser supports creation of dynamic reports as well. At the moment, this function is supported by only a few servers and clients. SIPROTEC devices support this function, which may allow the temporary creation of datasets. To do this, it is not necessary to create a dataset in the system configurator. In the following example, a new dataset is created for protection indications.

✧ Select the **Action** menu, then click the **Define VariableList ...** context menu.

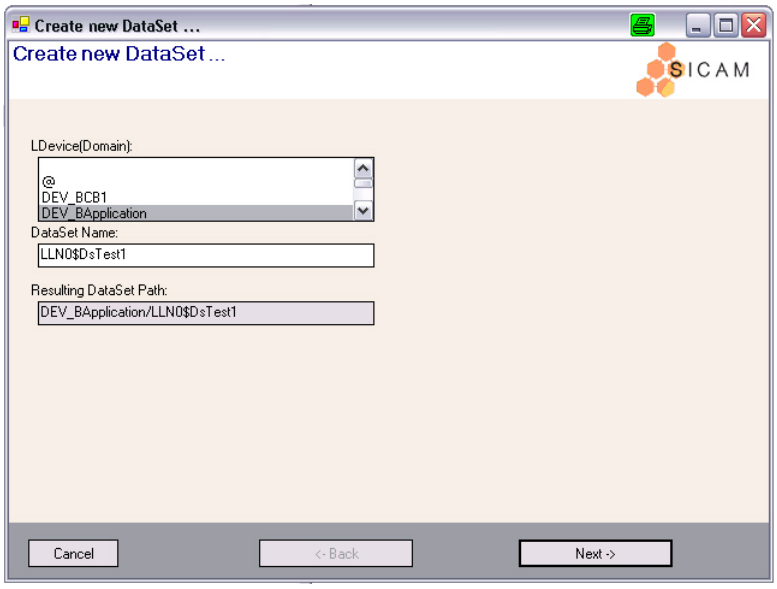


[ScDfDats-240311-xxXX-01.TIF]

Figure 6-3 Creating a Dataset

A dialog with all logical devices contained in the server appears.

- ✧ Select the logical device in which the new dataset is to be created.
- ✧ Enter the name of the dataset.



[ScNwDats-240311-xxXX-01.TIF]

Figure 6-4 Entering the Name of the Dataset

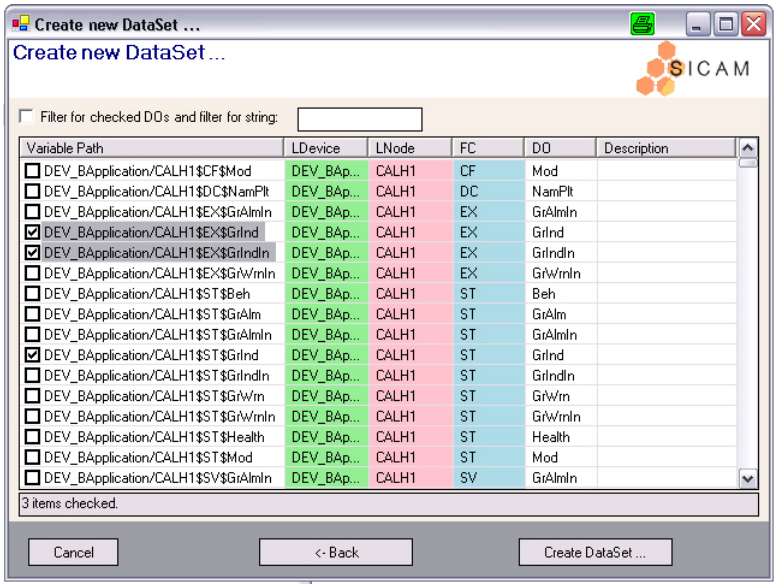
In this example, the dataset has been given the name **LLN0$DsTest1**.

NOTE

Only change the part of the name following the **$** symbol.

- ✧ Click **Next**.

A list with all available signals will be displayed.

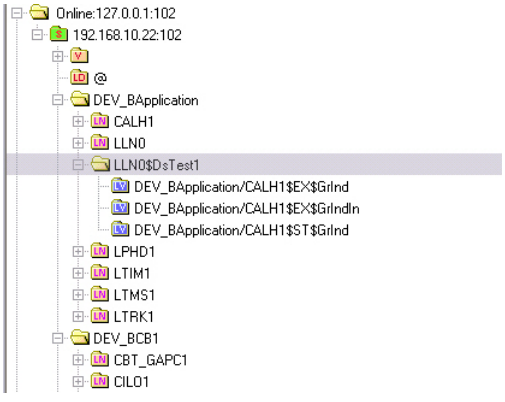


[ScSglist-240311-xxXX-01.TIF]

Figure 6-5 Signal List

- ✧ From this signal list, select the signals applicable for the dataset.
- ✧ Click **Create DataSet**.

The dataset is created in the server and the data objects set to the current status.

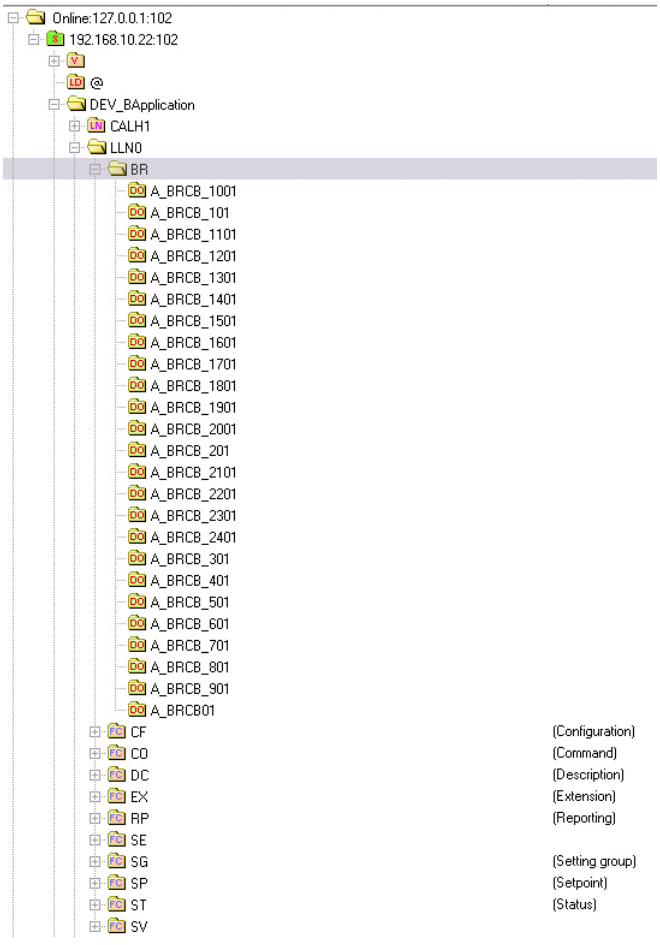


[ScCrDats-240311-xxXX-01.TIF]

Figure 6-6 Dataset LLN0$DsTest1

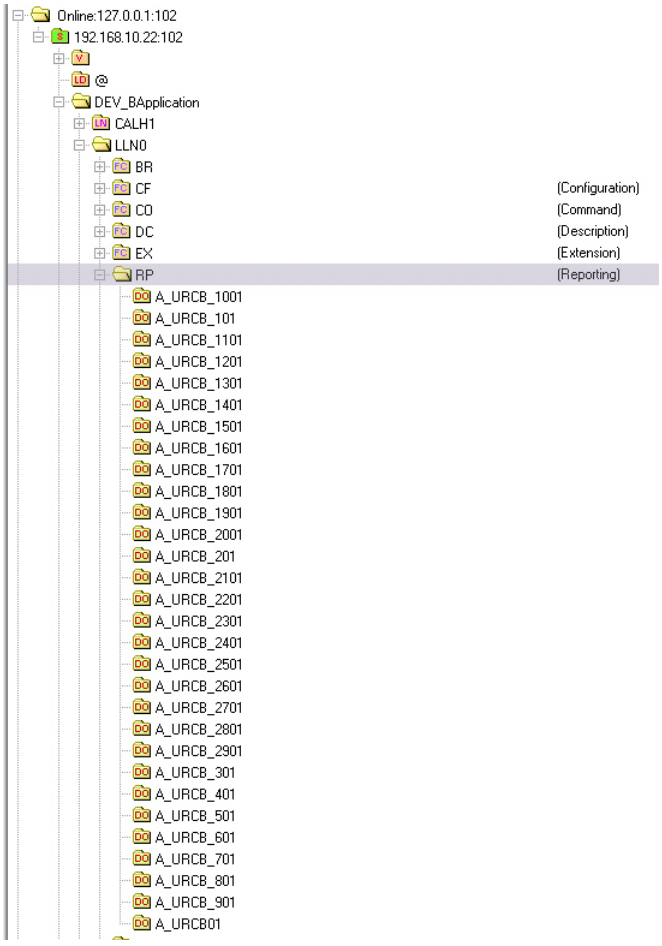
Reviewing Dynamic Datasets

In order to test a dataset, you must create a report control block. The buffered reports can be found in the **BR** folder, the unbuffered reports are located in the **RP** folder.



[ScBufRCB-240311-xxXX-01.TIF]

Figure 6-7 Buffered Reports



[ScUnbRCB-240311-xxXX-01.TIF]

Figure 6-8 Unbuffered Reports

- ✧ In order to connect the control block with the dataset, copy the path of the dataset into the **DatSet** field.
- ✧ From the **Options** menu select the option **Enable write**.
- ✧ Enter the password **000000**.
- ✧ In order to activate the report, set the variable **RptEna** (Enable Report) to **1**.

If a signal changes, a report is being generated.

- ✧ In the right column **Write**, insert a check mark for all fields you have changed.
- ✧ From the **Action** menu, select the option **Write tagged Lines**.
- ✧ Click the **Auto Refresh** button.

-- or --

- ✧ Click the **Auto Refresh** button in the IEC client.

  The signals will be reread. If any signals have been changed on the device, these changes will be visible.

  This alternative has the advantage that reports must not be configured in order to test datasets.

6.3.2 Static Reporting

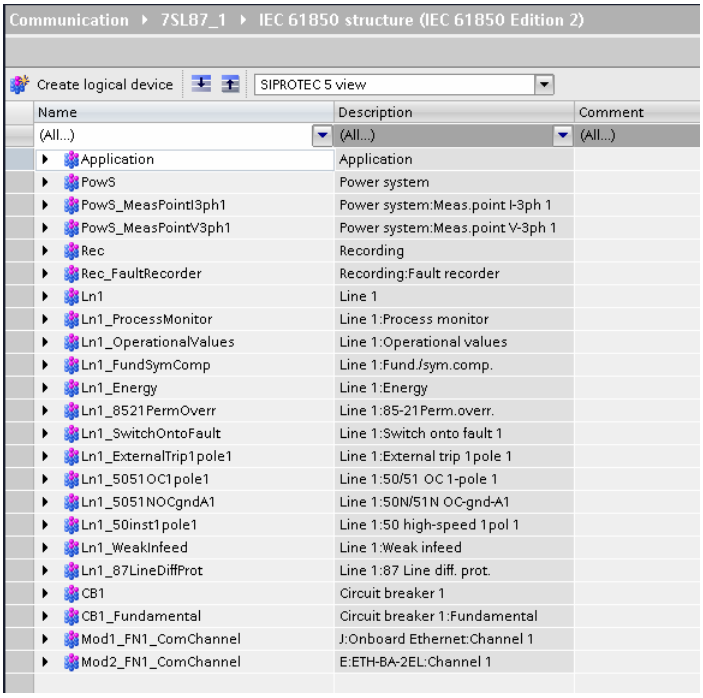
What Is a Static Report?

In a static report, the datasets are generated by the configuration in the Report Editor in DIGSI 5. Such a dataset contains the data objects that are to be transmitted to an IEC 61850 client. You specify the content of the dataset with the configuration setup in DIGSI 5. This dataset is associated with a report. There are numerous possible configurations for a report.

IEC 61850 View in the System Configurator

The protection devices and bay units (server) provide a system configurator with all of the information that can be transmitted to a client (substation control system) or between servers in the form of an ICD file. In the case of protection functions, the manufacturer specifies the number/scope of the indications. For control functions, you establish the number/scope of indications with the configuration tool of the server (for SIPROTEC devices from Siemens, by means of DIGSI 5). The IEC 61850 Standard defines how this information is displayed in a separate XML scheme called SCL (Substation Configuration Language).

The DIGSI 5 system configurator displays the indication texts (**Description** column) together with the IEC 61850 texts (**Name** column).



[ScSysCon-140113-enUS-01.tif]

Figure 6-9 DIGSI 5 Structure Editor

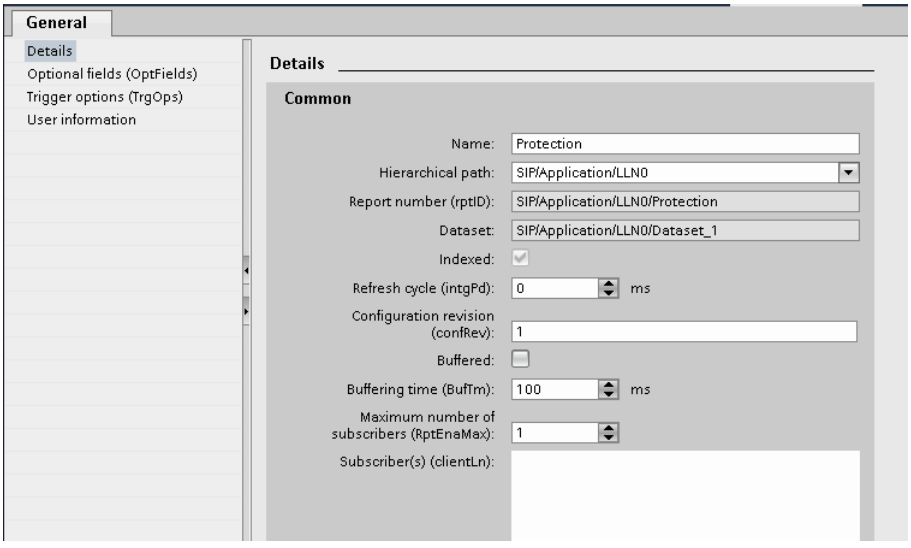
Only names (designations) from the data model (**IEC texts**) are transmitted between client and server. In this way, only the IEC texts can be seen in the case of eavesdropping of the Ethernet by a network sniffer.

Indications and measured values from the server of an IEC 61850 station are configured in a static report. For this purpose, the devices are displayed as information sources in terms of their IEC 61850 structure.

Configuration of a Static Report in the System Configurator

Device View

Select only information from the Device view that you wish to configure in the report. For this, create a report application. You describe the application via a properties dialog (here: protection). You also select between a **Buffered report** and an **Unbuffered report**.



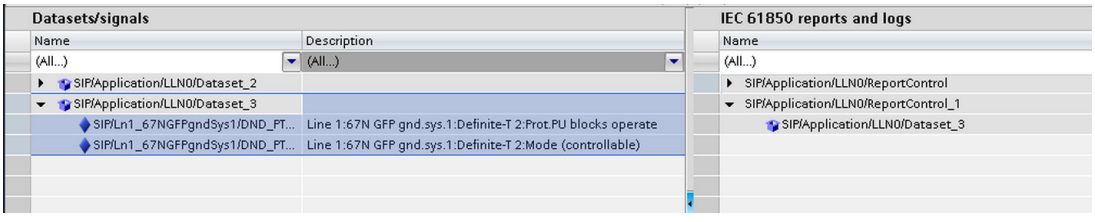
[ScPropDI-140113-enUS-01.tif]

Figure 6-10 Properties of a Static Report

More detailed information pertaining to the Optional Fields (OptFields) and the trigger options (TrgOps) can be found in chapter *4.6.3 Report Control Blocks*.

The server specifies these properties for the report and they cannot be changed. Under **Report number** you can see the report ID (rptID). You can find the dataset under this ID to review.

All protection indications that are to be transmitted to the client are added to the dataset with the name **Protection**.



[ScRpPtIn-280113-enUS-01.tif]

Figure 6-11 Static Report with Protection Device Indications from the Overcurrent Protection

NOTE

You can create additional reports for information regarding command control or for measured values. A SIPROTEC device has a maximum of 11 buffered reports.

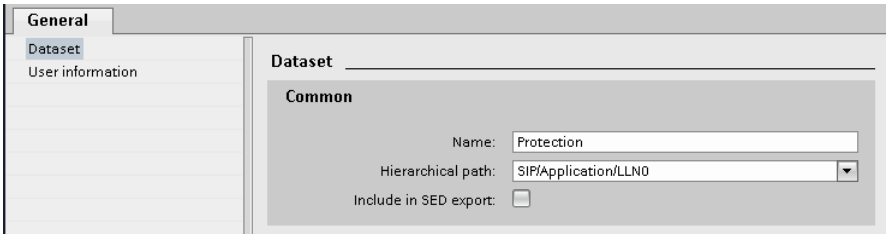
Server

The buffers in which the indications are located are specified in the server on a manufacturer-specific basis.

The properties of the report (dataset, trigger conditions…) are saved in so-called **Report Control Blocks (RCB)**.

You can also change the dataset names that the system suggests (dataset + number) in the properties dialog of the dataset.

To make it easier to find the data during the subsequent review, Siemens recommends that you change the dataset name. In the example, the name of the dataset is changed to **Protection**.



[ScPrDset-140113-enUS-01.tif]

Figure 6-12 Properties Dialog for a Dataset with Protection Device Indications

Test mode

All data objects can be identified with a test flag. If the function block to which the data object belongs is in **Test** mode, then the test flag for a date object has been set.

The **Test** mode of a function block can be simulated by the following actions:

- The function block has been placed in test mode by the parameter **Mode** or by the controllable **Mod**.
- The entire device has been placed in the application test mode (HMI: Device functions/Operating modes/test).

If the reports have been configured, the data are written to an SCD file (Substation Configuration Description File) after the export. This file is important for loading the data in the device that is simultaneously the IEC 61850 server. For SIPROTEC devices, data are loaded with DIGSI 5. To import indication lists into the client, use the SCD file. In this way, the client knows the scope of the reports and the datasets that contain the information. This standardized data exchange is a great benefit compared to previous substation control protocols in which manufacturer-specific indication lists are exchanged in proprietary file formats or manually. The SCD file can be exported from the DIGSI device manager and is available as an input to the test program.

6.3.3 Subscribing to Reports

In order to subscribe to the report, the datasets must be defined. To do this, the datasets must be connected to the report control block. Subscribing is described here using the example of the IEC61850 Browser.

- ✧ Click the respective datasets.
- ✧ Copy the path.
- ✧ Select the report control block.
- ✧ Click the **Auto Refresh** button.

-- or --

- ✧ Select the **Start Reporting** menu and click the report control block with the right mouse button.
- ✧ Add the path.
- ✧ In order to activate the report, set the variable **RptEna** to **1**.
- ✧ Activate the option **Write tagged Lines** for **RptEna** and the dataset
- ✧ Insert a check mark in the right column **Write**.

You have now subscribed to the report.

NOTE

You may subscribe to static as well as dynamic reports.

For static reports, all datasets are predefined, in dynamic reports, signal lists are always newly generated.

6.3.4 Testing Protection Indications

Using Reports to Test Protection Indications

- ✧ Create a report for the protection indication and connect the dynamic dataset with the control block.
- ✧ Pick up the protection indication by using a tool that is capable of changing the signal inside the device.

-- or --

- ✧ Use binary inputs that trigger the protection application in order to pick up the protection indication.

Protection indication on the IEC browser

- ✧ Select the **Reporting** field.

-- or --

- ✧ Click the **Auto Refresh** button in the IEC client.
- ✧ Pick up the protection indication.

This will enable you to detect changes on the device via the client.

6.4 File Transfer

File transfer is used to transmit fault records from a server to a client. The fault records are stored in the server together with the configuration file (.cfg) and data file (binary format.dat). A client reads both files and can then display the fault record with analog and binary traces. This requires special analysis programs, for example, SIGRA.

MMS file transfer is used for transmitting fault records.

The configuration file contains, among other information,:

- All analog and binary traces contained in the fault record
- Names of the traces
- Sampling rate

The raw data for these traces are contained in the data file, which is stored as a binary COMTRADE in the device.

An IEC 61850 client can retrieve a directory of the fault record from the device. It can later transmit the records from the device with MMS file transfer.

NOTE

Fault records can also be read from the device by DIGSI 5. They are available there at a sampling rate of max. 8 kHz. Transmission to DIGSI 5 does not use the IEC 61850 protocol, but instead employs a compressed and encrypted format that an IEC 61850 client does not understand.

6.5 Setting Parameters via IEC 61850

Settings in the device can be read and changed via the IEC 61850 protocol. This requires an IEC 61850 client, for example, the IEC Browser provided on the DIGSI 5 DVD. All settings displayed in logical nodes can be read and can be changed partially using the protocol. Consequently, an IEC 61850 client can change settings in the device independently of DIGSI 5 or the HMI (Human-Machine Interface) .

The IEC 61850 Standard defines a SETTING-GROUP-CONTROL-BLOCK model (SGCB). This model allows an item to have several values that can be used individually. It provides mechanisms for switching between several values of one or more data objects. Related values form the settings group (PG).

The device supports up to 8 different settings groups that can be configured with DIGSI 5.

The only SGCB model for a SIPROTEC 5 device is found in the logical node LLN0 of the logical device (LD) **PROT** in the **SIPROTEC 4 similar view** or the logical device **Application** in the **SIPROTEC 5 view**.

The following structure is defined for the SGCB model:

SGCB class			
Attribute name	**Type of attribute**	**Read and write access (read (r)/write (w))**	**Description**
NumOfSG	INT8U	r	The attribute **NumOfSG** identifies the total number of available settings groups. n = NumOfSG
ActSG	INT8U	r	The attribute **ActSG** identifies the values of the settings group that are in the active buffer. Admissible range: 1 to n
EditSG	INT8U	w	In order to edit a setting in a specific settings group, the attribute **EditSG** must be set to the appropriate value. Admissible range: 0 to n
CnfEdit	BOOLEAN	w	Siemens recommends that the attribute **CnfEdit** be used to confirm the edit process.
LactTm	TimeStamp	r	The attribute **LActTm** designates the time at which the **SelectActiveSG** service was edited.
Services SelectActiveSG SelectEditSG SetSGValue ConfirmEditSGValue GetSGValue GetSGCBValue			

The following settings are supported and can be changed:

- Single-point setting (SPG)
- Integer status setting (ING)
- CDC ENS setting (ENG)
- Time settings group (TS)
- Analog setting (ASG)

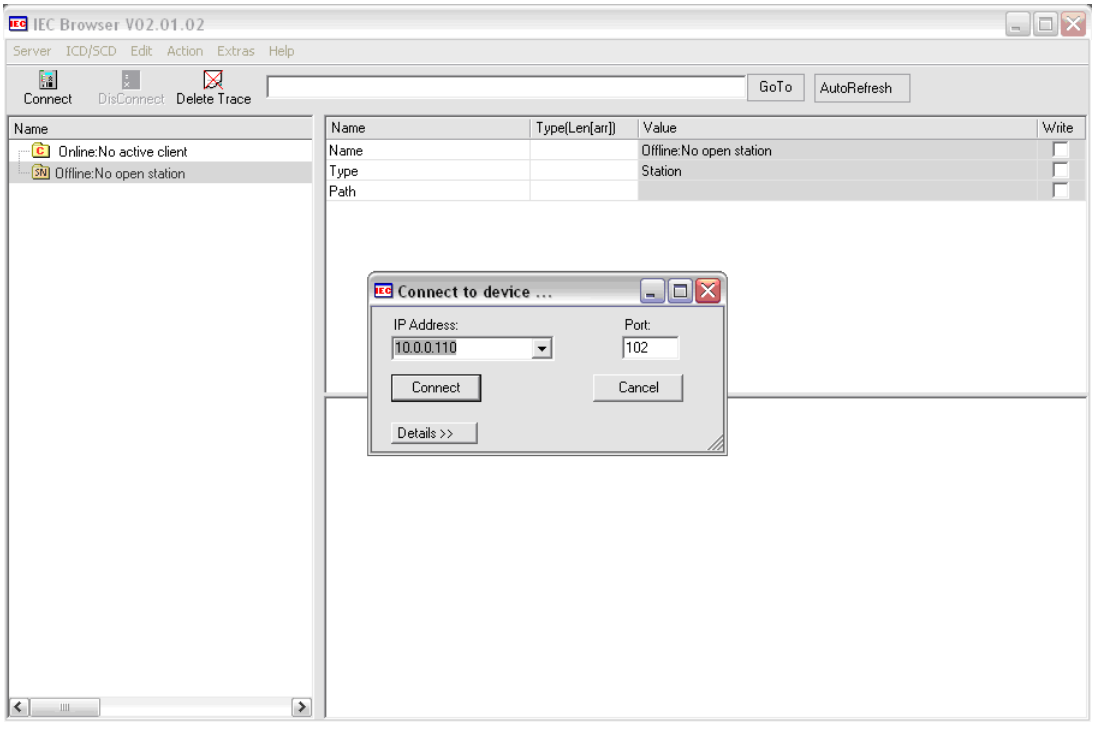
Example

The following example shows you how to change the tripping delay **OpDITmms** of the overvoltage-protection function (PTOV) with the aid of the IEC 61850 Browser.

In this example, the logical node PTOV 7 contains the parameters (BlkOp, DrpoutRat, …). The data object (DO) **OpDITmms** is an integer status setting (ING) and defines the time delay in milliseconds prior to tripping as soon as the tripping condition exists.

Establishing a Connection via the IEC Browser

✧ Use the IEC Browser to establish a connection to the device and make sure that the write function is activated.



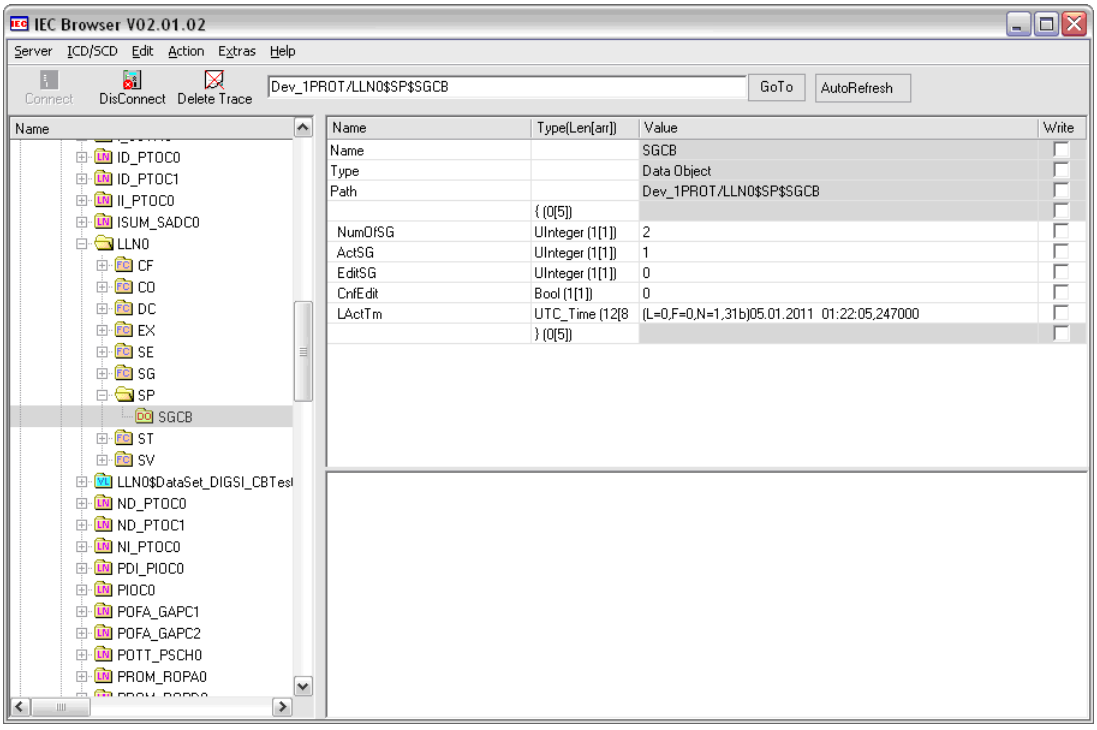
[ScIECVbg-270111-xxXX-01.TIF]

Figure 6-13 Connection via the IEC Browser

Call up the GetSGCBValue Service

Use the GetSGCBValue service to read all attribute values from the SGCB.

✧ Navigate to the SGCB, which can be found under LD **PROT**, LN **LLN0**, and FC **SP**.



[ScGtSGCB-270111-xxXX-01.TIF]

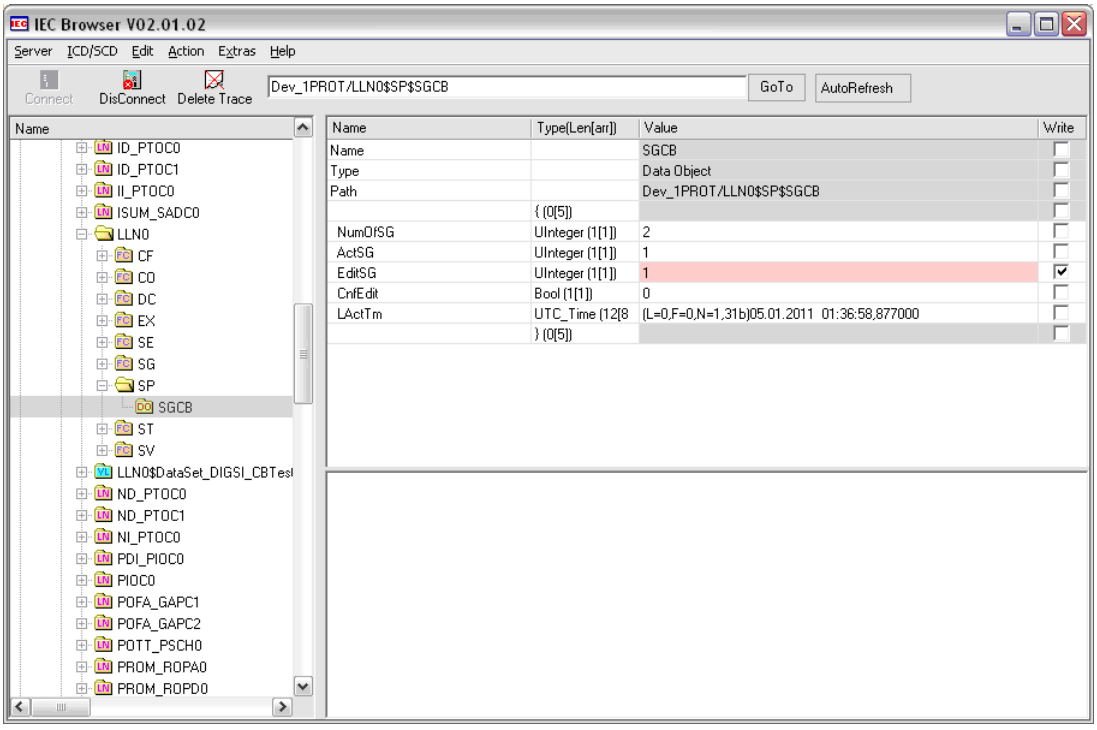
Figure 6-14 GetSGCBValue Service

In this example, 2 different settings groups are defined (NumOfSG=2). The currently active settings group (SETTING GROUP) is SG 1 (ActSG=1).

Call up the SelectEditSG Service

Use the SelectEditSG service to select the settings group SG, which can then be edited after selection.

- ✧ To edit a parameter in the currently active settings group, write **1** in the **Value** field of the attribute **EditSG**.
- ✧ Activate the check box next to the value.
- ✧ Right-click.
- ✧ Select **Write tagged Lines**.



[ScSeEdSG-270111-xxXX-01.TIF]

Figure 6-15 SelectEditSG Service

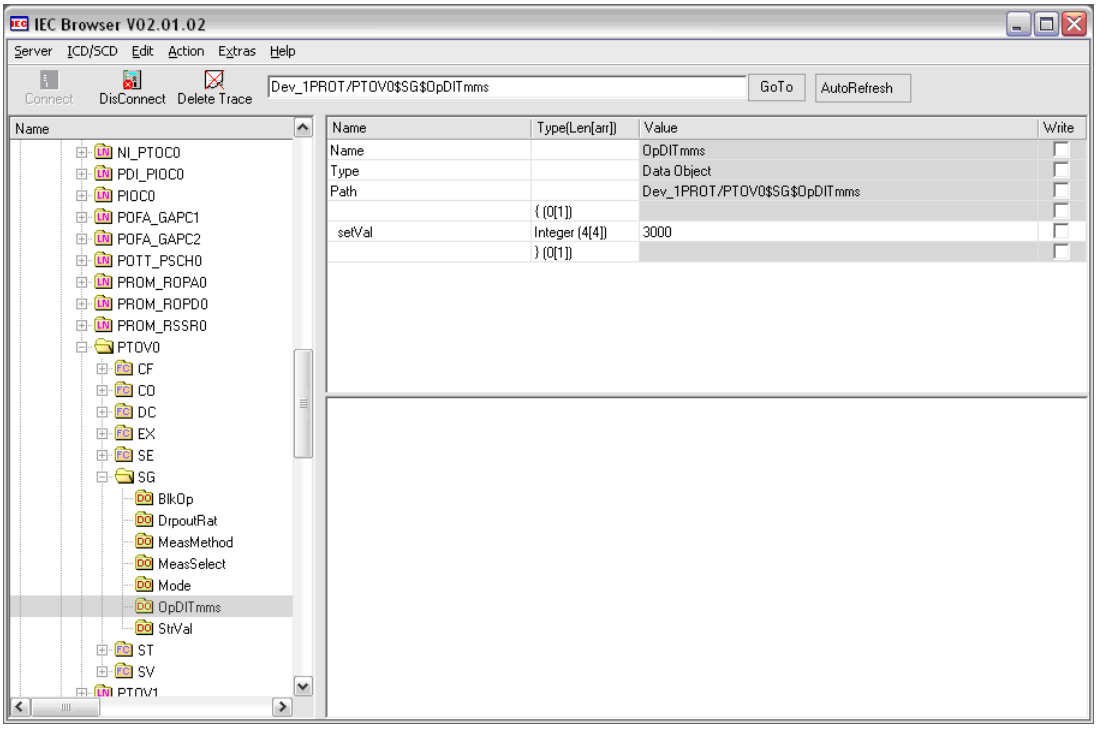
Now you can edit the parameters in SETTING GROUP 1.

Call up the GetSGValue Service

Use the GetSGValue service to read the value of the settings group SG (FC = SE) that was selected to be edited or the active settings group SG (FC = SG).

✧ To read the value of the currently active parameter, navigate to LD **PROT** LN **PTOV0** FC **SG** DO **OpDITmms** in the object-model project tree.

In this example, the parameter is to 3000 ms.



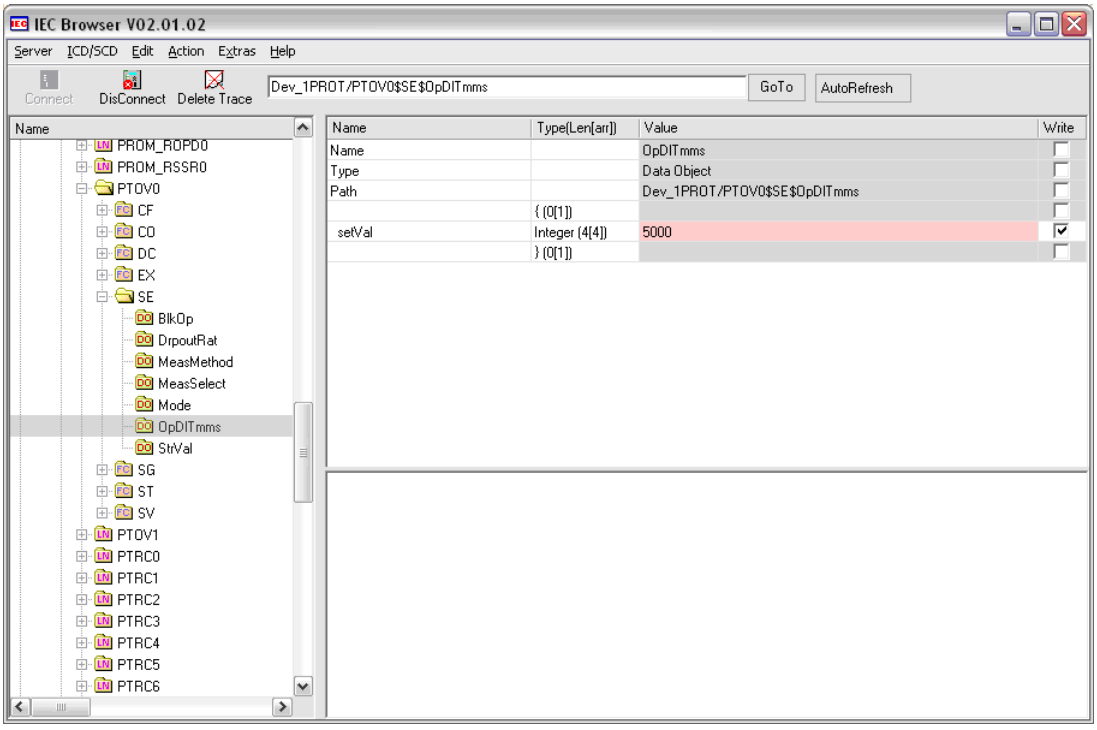
[ScGetSGV-270111-xxXX-01.TIF]

Figure 6-16 GetSGValue Service

Call up the SetSGValue Service

Use the SetSGValue service to write the value into the settings group SG selected to be edited.

- ✧ Navigate to LD **PROT** LN **PTOV0** FC **SE** DO **OpDITmms** in the object-model project tree.
- ✧ Change the value, for example, to **5000**.
- ✧ Activate the check box next to the value.
- ✧ Right-click the cell in the Value column.
- ✧ Select **Write tagged Lines**.



[ScSetSGV-270111-xxXX-01.TIF]

Figure 6-17 SetSGValue Service

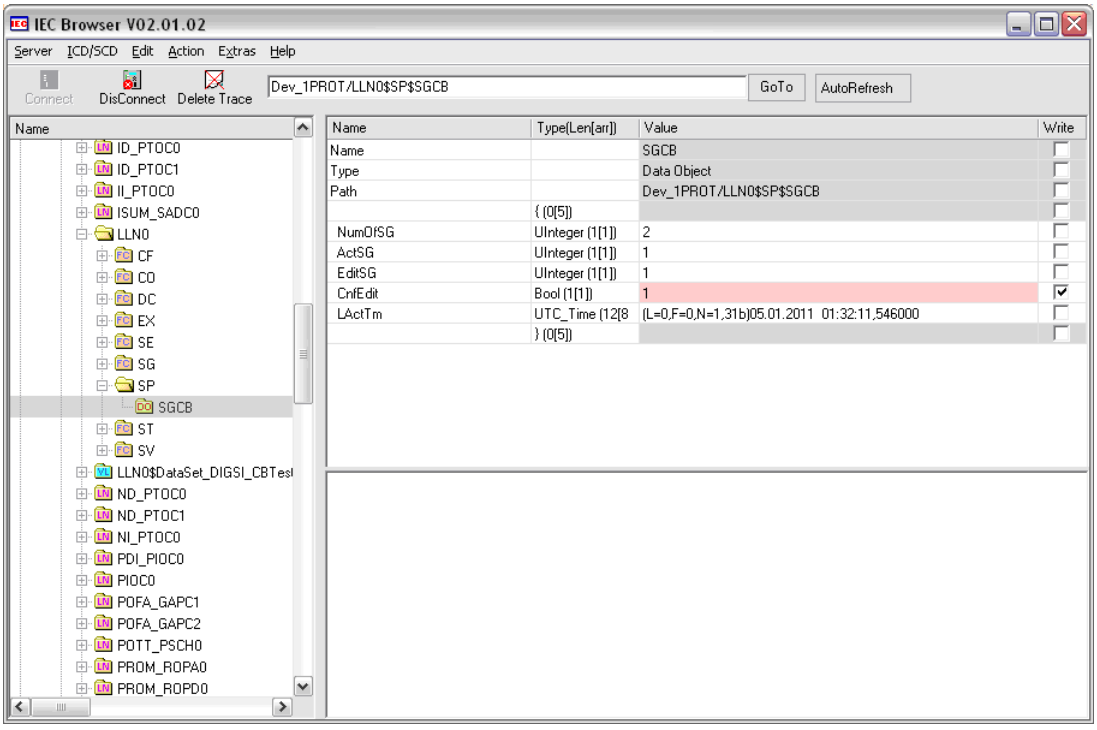
- ✧ As soon as the new value for the parameter has been written, confirm this value.

  The current values in the settings group SG remain unchanged until the client has confirmed overwriting of the values with the new values from the editing buffer.

Call up the ConfirmEditSGValue Service

Use the ConfirmEditSGValue service to confirm that the new value in the settings group SG that was selected to be edited has changed to the value in the settings group SG.

- ✧ Navigate to the SGCB, which can be found under LD **PROT**, LN **LLN0**, and FC **SP**.
- ✧ Change the value of the attribute **CnfEdit** to **1**.
- ✧ Activate the check box next to the value.
- ✧ Right-click the cell in the Value column.
- ✧ Select **Write tagged Lines**.



[ScCfSGVa-270111-xxXX-01.TIF]

Figure 6-18 ConfirmEditSGValue Service

The new value is now transferred from the editing buffer to the active buffer.

- ✧ If you read the current value of **OpDITmms** as described in the step **Call up GetSGValue service**, you will see the new active value, that is, 5000 ms.

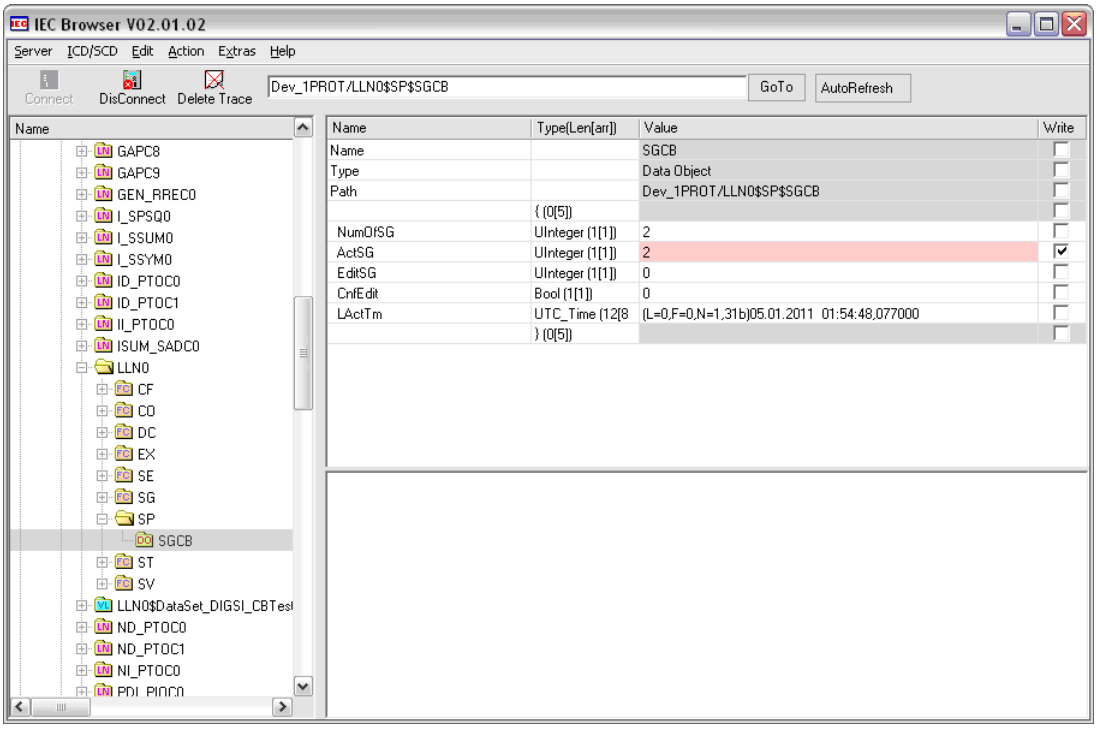
NOTE

For some settings, **Restart required** is marked. For these settings, the device executes a restart after the confirmation.

Call up the SelectActiveSG Service

Use the SelectActiveSG service to select which settings group SG should be the active settings group.

- ✧ To switch to the 2nd settings group SG, change the value of the attribute **ActSG** to **2**.
- ✧ Activate the check box next to the value.
- ✧ Right-click the cell in the Value column.
- ✧ Select **Write tagged Lines**.



[ScSelAct-270111-xxXX-01.TIF]

Figure 6-19 SelectActiveSG Service

6.6 Control via IEC 61850

SIPROTEC 5 devices support all 4 control models defined in the standard:

- Direct with standard safety
- Direct with extended safety
- SBO with standard safety (SBO – Select before operate)
- SBO with extended safety

SBO control models support only the **operate-once** variant. This variant is implemented in SICAM PAS. The command may only interrupted if it conforms with the standard.

The flexible parameterization of a command output is supported.

A control model is preset for all objects, taking into consideration the necessary safety aspects (implementation of the command, reaching the limit position, and safety relevance). For this reason, Siemens recommends retaining the preset control model. However, under certain circumstances it may be necessary to modify this control model.

For controllable objects that are coupled to the process, Siemens and the standard recommend always selecting the control models **with expanded safety** (feedback monitoring).

According to the standard, commands with test state indicator are supported. This implies that a test command can be only implemented if the object **Beh** of the associated LNs has the value **test**.

The IEC 61850 protocol permits testing the switching commands for their operability prior to implementation. Test bits allow the interlocking devices to be switched on and off. The interlocking check bit affects which command checks are to be performed.

SIPROTEC 5 devices use test bits as follows:

- If the synchrocheck is not switched on for a circuit breaker and a switching command with the respective test bit is transmitted via IEC 61850 to the device, this switching command will be rejected with a negative acknowledgment **OPR-**. If the synchronization function is part of the **Circuit-breaker** function group, the test bit will be ignored and the switching command will be executed if all other command checks prove to be successful. More detailed command check information can be found in the respective chapter of the Device manual.
- If the test bit is not set, it will be treated like the **non-interlocked** switching mode. If the **Interlocking** function block is not available in the **Circuit-breaker** function group, the interlocking conditions will not be tested and the switching command will be executed if all other command checks prove to be successful. More detailed command-check information can be found in the respective chapter of the Device manual.

NOTE

For SICAM PAS/WinCC parameterization, there are several WinCC objects for each switching object, for example, switching with interlock or switching with synchrocheck. For this reason, it is mandatory to consider the specific treatment of the test bits during project engineering of the system.

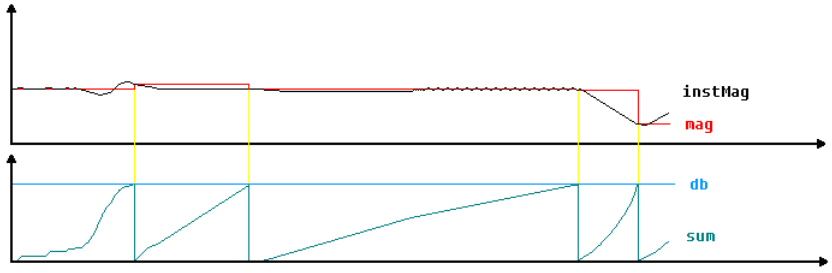
6.7 Measured Values and Measured-Value Description

In order to detect the measured values in the buffer or the report, the application of the deadband is important.

Measured values **instMag** are only indicated with the deadband mechanism if they change outside of an adjustable window. The window is defined as an upper and lower limit, a percentage of the actual measured value.

If the measured value **instMag** deviates from the deadband value **mag**, then the amount of the difference of these 2 values will be added. If over time the accumulated sum exceeds the upper limit **db** (deadband value), the deadband value **mag** will be set to the current value of **instMag**, and the sum will be reset to 0.

By using the trigger option **TrgOp=dchg**, the deadband value **mag** can be saved in the buffer or can be reported. After setting the trigger option **TrgOp=dchg**, the device may wait several milliseconds before the report is sent.



[ScDialEC-230211-xxXX-01.TIF]

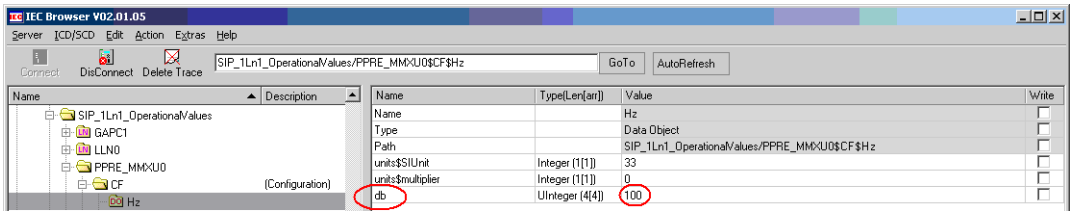
Figure 6-20 Diagram on the Behavior of Values

The diagram illustrates the relationship between the following values:

- Measured value **instMag**
- Deadband value **mag**
- Upper limit **db** (deadband value)

  The upper limit **db** is used as a unit of 0.001 % and refers as a percentage to the currently measured value
- Accumulated sum, referred to simply as **sum**

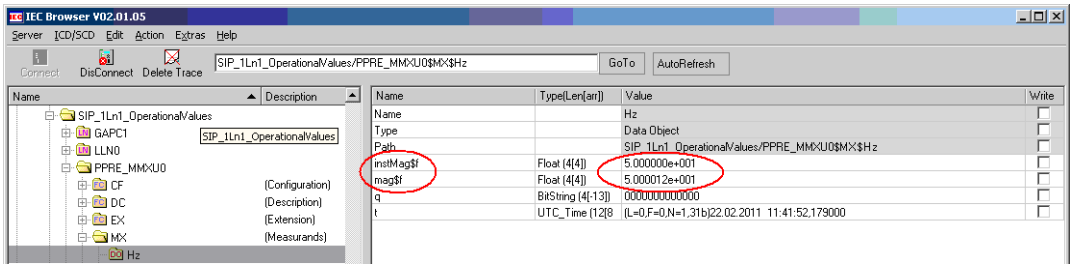
The deadband value **mag** changes significantly slower than the measured value **instMag**.



[ScDbIECB-230211-xxXX-01.TIF]

Figure 6-21 Example of db Value

The figure shows the **db** value in the IEC Browser.



[ScInsMag-230211-xxXX-01.TIF]

Figure 6-22 instMag and mag Values

Large differences between **instMag** and **mag** lead to the repeated updating of **mag**.

Small differences between **instMag** and **mag** lead to an infrequent change of **mag**.

NOTE

Since **db** is a percentage of the measured value, very small measured values and increased noise may cause a flood of **mag** indications. An additional threshold in the device prevents a flood of indications.

6.8 Time Synchronization through SNTP

The SNTP protocol is used for time synchronization.

For time synchronization via Ethernet according to SNTP, a time server must be present in the network. This time server must also be able to address the different time requirements of the devices as defined in SNTP. Time servers can be reached through an IP address.

More information can be found in chapter *4.7.1 Time Synchronization through SNTP*.

Time Fault Indication

A clock fault indication is issued if, after the set monitoring time has elapsed, the time server does not respond to the queries from the SIPROTEC 5 device. From this moment on, the status **Time fault** is set in the time stamp of all indications. The **clock fault** bit from the IEC 61850-8-1 standard is set in the time stamp of the data object.

The clock fault indication does not appear when the SNTP server itself has no connection to the time source (for example, no antenna signal, ...) and sends clock signals to all devices according to its internal accuracy.

If one of the 2 conditions below is met, then the **ClockNotSynchronized** bit is set in the time stamp of the data object:

- No connection to the time server at device startup.
- The time-synchronization message indicates a stratum value greater than 3.

The **ClockNotSynchronized** bit indicates unsynchronized time. It remains set as long as the stratum value is greater than 3 or until connection to the time server has been established.

With some time servers, you can increase the stratum from 1 to 6, for instance, if satellite reception is disturbed. If the Ethernet module determines that the stratum is equal to or greater than 4, it immediately sets the **ClockNotSynchronized** bit in all indications sent to the IEC client.

■

7 Additional Ethernet Services

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7.1 Activation and Ability to Switch Off Services

The following additional Ethernet services are available for the integrated Ethernet interface (Port J) of the device:

- DIGSI 5 protocol (always available)
- DCP
- SNTP

The following additional Ethernet services are available for the Ethernet communication module:

- DIGSI 5 protocol (always available)
- DCP
- SNMP
- SNTP
- SUP Ethernet (for connecting external analog units)
- Homepage
- RSTP, PRP, or HSR

With the exception of the DIGSI 5 protocol, all additional Ethernet services can be switched on and off for each Ethernet interface on the device. As a result, you can decide for yourself under security aspects whether the device should react to SNMP access or not.

Additional information on SUP Ethernet is available in the following manuals: *SIPROTEC Transformer Differential Protection 7UT85 7UT86 7UT87*, *SIPROTEC Distance Protection, Line Differential Protection, and Overcurrent Protection for 3-pole Tripping 7SA84, 7SD84, 7SA86, 7SD86, 7SL86, 7SJ86* and *SIPROTEC Distance Protection, Line Differential Protection, and Switch Management for 1-pole and 3-pole Tripping 7SA87, 7SD87, 7SL87, 7VK87*.

Activating Ethernet Service

✧ To switch on an Ethernet service in the device, activate the corresponding check box in the channel settings of the Ethernet communication module or for the integrated Ethernet interface.

Deactivating Ethernet Service

✧ To switch off an Ethernet service in the device, deactivate the corresponding check box.

You will find additional information regarding network security in the Security Blueprint.

7.2 SIPROTEC 5 Device Ports

The following list of all ports used in a SIPROTEC 5 device should help with the firewall settings for a network with SIPROTEC 5 devices.

Port	Functionality
TCP Port 443	DIGSI 5 protocol
TCP Port 102	IEC 61850-8-1 protocol
UDP-Port 123[1]	SNTP
UDP-Port 161	SNMP
Broadcast	DCP
Port 502[2]	SUP

1. UDP - User Datagram Protocol
2. Can be changed via DIGSI

7.3 DIGSI 5 Protocol

There are 3 ways to connect from DIGSI to a device:

- Via USB
- Via the integrated Ethernet interface (Port J)
- At an Ethernet communication module

NOTE

Only one device may be connected to the PC. This is important if a connection is established from a PC to the device via a USB port.

No additional SIPROTEC 5 devices may be connected to any open USB ports on the PC, because no connection to the device will be established.

An IP-based internal Siemens protocol is used for data transmission between DIGSI and a SIPROTEC 5 device. The device uses TCP port 443.

DIGSI and the SIPROTEC 5 device are authenticated via SSL (Secure Sockets Layer). The necessary certificates are contained in the device or DIGSI upon delivery.

7.4 SNTP

The Simple Network Time Protocol is used to synchronize clocks via the Internet. With SNTP, client computers can synchronize their clocks with a time server via the Internet.

SNTP is available for the integrated Ethernet interface (Port J) of the device:

SNTP uses UDP port 123 (UDP - User Datagram Protocol).

You can find more information in the chapters *4.7.1 Time Synchronization through SNTP* and *6.8 Time Synchronization through SNTP*.

7.5 SNMP

7.5.1 Settings for SNMP

SNMPv3 (SNMP - Simple Network Management Protocol) is implemented in all Ethernet communication modules.

As default, SNMP is deactivated. If you want to switch on SNMP in the device, activate the SNMP check box in the channel settings of the Ethernet communication module.

Then, if necessary, you can set the UDP port where the SNMP agent (Ethernet communication module) receives the queries. The standard setting for the UDP port is 161 and normally should not be changed.

Parameter Name	Settings
UDP port for SNMP agent	UDP port of the SNMP agent (device) Standard setting = 161

SNMP allows the state query of these modules. For the display of MIB information (MIB – Management Information Base), an MIB browser and the description files are required.

7.5.2 SNMP Standard MIBs

The following standard MIBs are supported:

- MIB-II (RFC 1213)
- Interfaces MIB (RFC 2863)
- IP Forwarding MIB (RFC 4292)
- IP- & ICMP-MIB (RFC 2011)
- TCP-MIB (RFC 4022, formerly RFC 2012)
- UDP-MIB (RFC 4113, formerly RFC 2013)
- SNMPv2-MIB (RFC 3418)
- Framework MIB (RFC 2571)
- MPD-MIB (RFC 2572)
- USM-MIB (RFC 2574)
- Target & Notification MIB (RFC 2573)

You can find additional information under *http://www.snmplink.org/OnLineMIB/Standards/*.

7.5.3 SNMP SIPROTEC 5 Enterprise MIB

In addition to standard MIBs, a SIEMENS SIPROTEC 5 Enterprise-MIB (1.3.6.1.4.1.22638.2) is supported. The Siprotec5.mib file describes the information objects available there.

You can find the MIB file on the Internet under *http://www.siprotec.de* or *http://www.siprotec.com*.

sip5Identity

Sip5Identity (1.3.6.1.4.1.22638.2.2) contains the ID of the Ethernet communication module. The information does not change at runtime.

- identityBMNumber:
  Serial number of the Ethernet communication module
- identityProdCode:
  Siemens item number of the Ethernet communication module

sip5Optical

The sip5Optical (1.3.6.1.4.1.22638.2.3) information is relevant only for an optical Ethernet communication module.

- OpticalTransceiverRxPwr:
  Current transceiver receiver power in 0.1 µW increments
- OpticalTransceiverTxPwr:
  Current transceiver transmission power in 0.1 µW increments
- OpticalTransceiverTemp:
  Current transceiver temperature in °C

sip5Rstp

The sip5Rstp (1.3.6.1.4.1.22638.2.4) information is relevant only if RSTP was activated for the Ethernet communication module.

Explanations regarding the RSTP information can be found below in the chapter on RSTP.

sip5Sntp

The sip5Sntp (1.3.6.1.4.1.22638.2.5) information is relevant only if SNTP was activated for the Ethernet communication module.

- sntpPrimarySvr:
  Parameterized IP address of the primary NTP server
- sntpSecondarySvr:
  Parameterized IP address of the secondary NTP server
- sntpClockMaster:
  Current NTP master clock (primary or secondary NTP server)

sip5Goose

The sip5Goose (1.3.6.1.4.1.22638.2.6) information is relevant only if IEC 61850-8-1 was parameterized for the Ethernet communication module and a GOOSE application was activated.

- gooseTxConnConfig:
  Number of parameterized GOOSE connections (Tx only)
- gooseTxConnActive:
  Current number of active GOOSE connections (Tx only)
- gooseRxMismatchTel:
  Current number of faulty GOOSE telegrams received
- gooseRxLostTel:
  Current number of lost GOOSE telegrams (receive direction)

sip5PortStatus

The sip5PortStatus (1.3.6.1.4.1.22638.2.7) information is independent of the module and protocol parameterization.

- portStatusCH1:

  Link status for Channel 1 (Up/Down)
- portStatusCH2:

  Link status for Channel 2 (Up/Down)

7.5.4 SNMP V3 Features

Security is a weak aspect in SNMP versions 1 through 2c. These versions of SNMP do not support log on with password and user names; instead, communities were used. The disadvantage being that every user in the network with a suitable program can read data and even change values

SNMP Version 3 offers encryption and improved authentication. As additional security, for SIPROTEC 5 devices you cannot change any settings or values via SNMP except for settings affecting SNMP.

As default, 3 users are created in a group: Group **initial**, with read and write access:

- initial:

  initial user, see RFC 3414 (2574), Appendix A
- templateMD5:

  template user for MD5/DES authPriv
- templateSHA:

  template user for SHA-1/DES authPriv

As default, all users have the password **12345678**

The manner in which you create groups and users as well as change passwords depends on the MIB browser used. Refer to the corresponding MIB browser documentation.

NOTE

If the parameterization for SNMP is removed and loaded in the device, all previous settings made for SNMP on the Ethernet communication module are deleted. For example, the initial state applies when parameterizing the SNMP again.

7.6 RSTP

7.6.1 Overview

The Rapid Spanning Tree Protocol (RSTP) serves for the reorganization of the network structure in the event of an error. In other words, RSTP reroutes the data to another path after the failure of a network path.

7.6.2 Parameter Settings for Networks

NOTE

In this document, bridge and switch have the same meaning.

Parameter Name	Settings
HelloTime bridge	This time determines at what intervals the HelloTime telegrams are transmitted. 1 s or 2 s Standard setting = 2 s
MaxAge bridge	The extent of a network is relevant when setting the value. MaxAge is a meter that counts down with each pass through a bridge. Each switch must be able to reach the root switch. For this reason, the MaxAge has to be set such that the value on all paths to the root bridge can never be 0. If this condition is not met, then the network will break down and will not regenerate on its own. This results in constant topology changes. 6 to 40 Standard setting = 20
Bridge Forward Delay Time	The Bridge Forward Delay Time setting is only relevant if an STP switch is active in the network. In such a case it determines the reconfiguration time of the network after an interruption. Siemens recommends not changing the Forward Delay Time setting. 4 s to 30 s Standard setting = 15 s
Transmit Hold Count	Transmit Hold Count is a meter that applies to all ports of the bridge. It limits the number of RSTP telegrams per port transmitted in sequence and without delay. When this telegram is transmitted, only one more telegram per second is transmitted. For a highly meshed system, a Transmit Hold Count value that is set low will result in a significant slowing of the reconfiguration when the root switch fails. Siemens recommends not changing the Transmit Hold Count setting. 1 to 10 Standard setting = 6
Bridge Priority	Bridge Priority establishes the position of the bridge in the network. The lower the value, the higher the priority. The bridge with the highest priority is the root bridge. Siemens recommends setting the priority of the root bridge to 0. Siemens recommends setting the priority of the replacement root bridge, which should be located right next to the root bridge, to 4096. The replacement root bridge should replace the root bridge in case of a failure. Siemens recommends setting the priority of all other devices and bridges to 32 768. 0 to 61 440, in increments of 4096 Standard setting = 32 768

Parameter Name	Settings
Bridge Identifier	The priority value of a bridge consists of the Bridge Priority and Bridge Identifier. The Bridge Identifier therefore provides a finer grading of the switches. This enables you to set the location of the alternate switches in the network. Siemens recommends not changing the standard setting of 2048. 0 to 4095 Standard setting = 2048
Auto Edge Port 1	The Auto Edge Port 1 value can be set individually for each port and enables the automatic transition of a port into the edge-port state if no RSTP telegrams are received. Then after the fixed migration time of 3 s, the ports go into the forwarding state. The enabling of this value harbors the danger of circulating telegrams. Siemens recommends keeping this set to **off**. on/off Standard setting = off
Port Priority Port 1	The Port Priority Port 1 value can be set for each port. The Port Priority goes into the valence of vectors on the recipient side and is taken into account by the port identifier. The port identifier consists of the port priority and the port number. Siemens recommends leaving the port priority set to the standard value. 0 to 240, in increments of 16 Standard setting = 128
Port Path Costs Port 1	The path costs indicate the quality of a line. The higher the value, the worse the line. In IEEE Std 802.1D™ - 2004, this value is established depending on velocity. For example, for 100 MBit, path costs of 200,000 are defined. The setting is included in the valence calculation of the vector. Siemens recommends not changing this setting. 0 to 200 000 000 Standard setting = 200 000
Auto Edge Port 2	See Auto Edge Port 1 parameter
Port Priority Port 2	See Port Priority Port 1 parameter
Port Path Costs Port 2	See Port Path Costs Port 1 parameter

7.7 DHCP

7.7.1 DHCP

The Dynamic Host Configuration Protocol (DHCP) enables a client, in this case the Ethernet interface, to access IP address and configuration data from a DHCP server. In this case, a DHCP server has to be available in the network. If DHCP is activated, you do not have to configure the Ethernet interface network settings yourself.

7.7.2 Activating DHCP

- ✧ Select the Ethernet communication module.
- ✧ Navigate to the **Ethernet Addresses** section.
- ✧ In the **IP Protocol** section, activate the **Automatically an IP Address (from the DHCP Server)** check box.

-- or --

- ✧ Set the **IP Address** to **0.0.0.0**.

  The device then acts on the assumption that a DHCP server is available, and receives the addresses from this server.

7.8 Homepage

7.8.1 Content and Structure

The homepage for communication modules is used for diagnostic purposes. On the homepage, you can find information on the communication module as well as the network and communication protocols that run on the communication modules. The homepage only offers access to data from optical and electrical Ethernet modules. The option cannot be set for other modules.

The homepage is physically accessible using a Web browser, such as http://<Module-IP>, via external Ethernet interfaces. You cannot download software using the homepage. It does not offer direct access to device parameters.

The homepage corresponds to the W3C standard. Therefore, incompatibilities among different Web browsers are excluded for the most part.

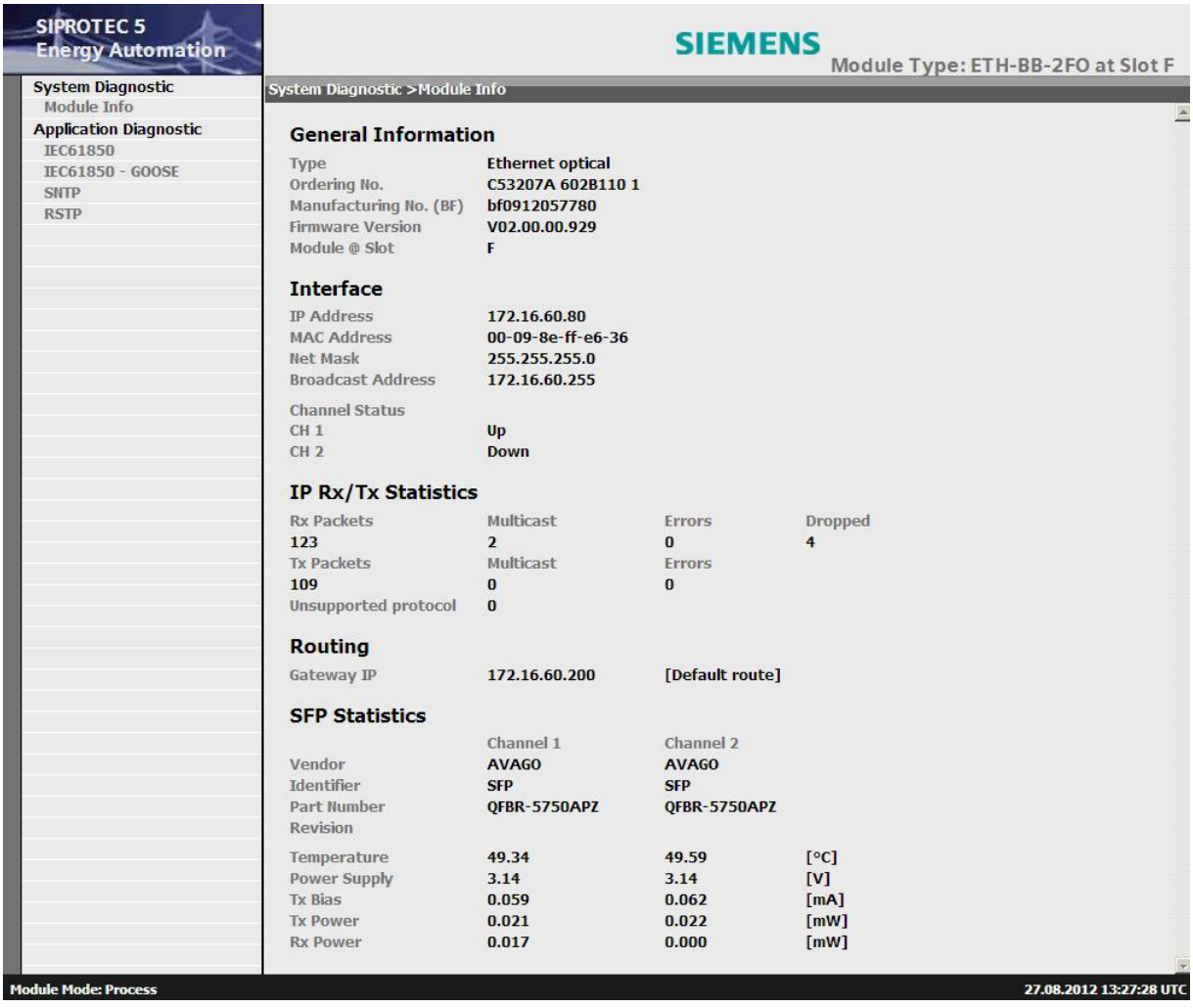
Homepage Content

The homepage shows system diagnostic values, various start/fault logs, and the accessible diagnostic values of the activated communication protocols.

It provides diagnostic values for the following protocols:

- SNTP
- IEC 61850
- IEC 61850 - GOOSE
- RSTP, PRP, and HSR

Homepage Configuration



[ScHomePG-090812-xxXX-01.TIF]

Figure 7-1 Homepage Structure

The homepage is divided into several sections.

The right section contains the dynamic device information.

In the left section, you can select the **System Diagnostic** or **Application Diagnostic** fields. The corresponding device values are shown in the right section.

The **System Diagnostic** field contains the **Module Info** section. The **Application Diagnostic** field is divided into the **SNTP**, **IEC61850**, **IEC61850 - GOOSE**, and **RSTP** sections.

The status is displayed at the lower left. The status indicates in which mode the module is running. There are 2 different modes:

- **Process**

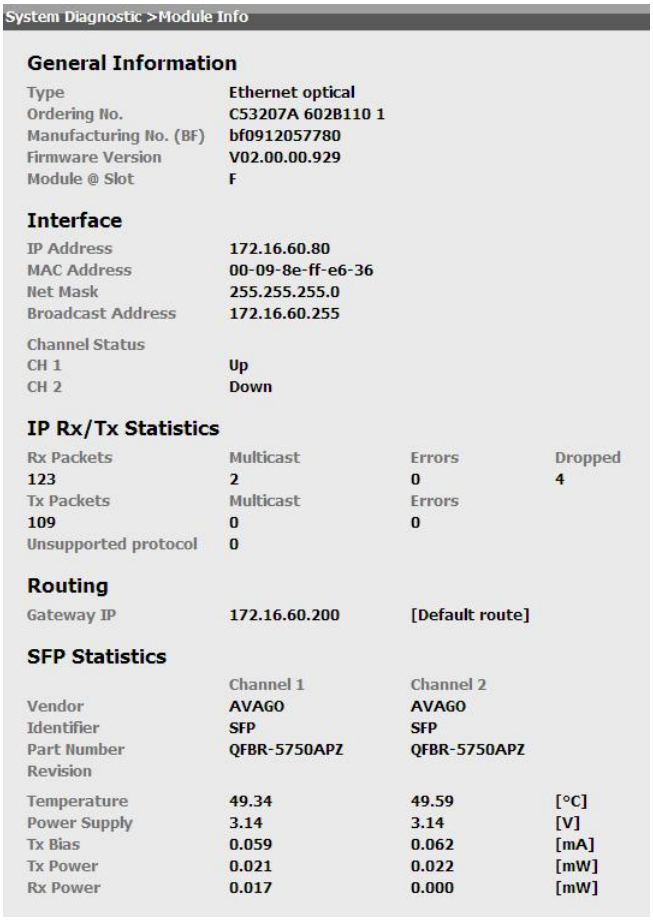
  When this mode is shown the module is in operation.
- **Fallback**

  This mode indicates that an error has occurred, for example when starting up the module.

7.8.2 Structure of the Homepage for Electrical and Optical Modules

7.8.2.1 System Diagnostic

The **Module Info** page is structured as follows:



[ScSysMod-270812-xxXX-01.tif]

Figure 7-2 System Diagnostic – Module Info

General Information

The **General Information** section contains the following information:

- Module Type: Electrical or optical
- Ordering number
- Manufacturing number (BF)
- Firmware version
- Communication-module slot in the device

Interface

The **Interface** section contains the following information:

- IP address
- MAC address
- Net mask
- Broadcast address
- Link status (channel status) of channel 1 (CH 1) and channel 2 (CH 2)

IP Rx/Tx Statistics

The **IP Rx/Tx Statistics** section contains various counters.

Table 7-1 Meaning of the counters in the IP Rx/Tx Statistics section

Rx Packets	Counter of received telegrams
Tx Packets	Counter of sent telegrams
Unsupported protocol	Counter for unsupported protocol telegrams
Multicast	Counter for multicast telegrams that occur
Errors	Counter for errors that occur
Dropped	Counter for dropped telegrams

Routing

The **Routing** section shows the **Default Gateway IP**. For this, the **Default Gateway IP** must be configured.

SFP Statistics

NOTE

The **SFP Statistics** section is visible only for optical modules.

The **SFP Statistics** section contains information on the following diagnostic values:

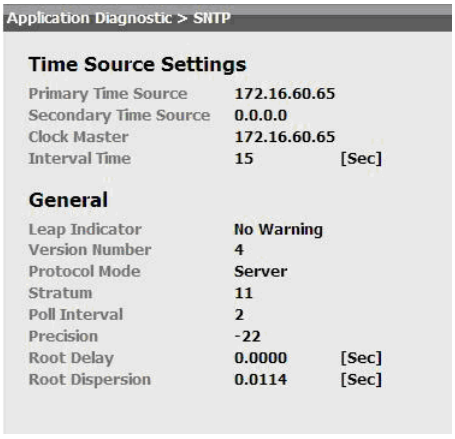
- Vendor
- Identifier
- Part Number
- Revision
- Temperature
- Power Supply
- Tx Bias Current
- Tx Power
- Rx Power

7.8.2.2 Application Diagnostic – SNTP

The **Application Diagnostic** section contains diagnostic pages for the respective protocols.

NOTE

The **Application Diagnostic** section is configured identically for electrical and optical modules.



[ScApSNTP-270812-xxXX-01.tif]

Figure 7-3 Application Diagnostic – SNTP

Time Source Settings

The **Time Source Settings** section contains information on the time sources.

Primary Time Source	Primary time source
Secondary Time Source	Secondary time source
Clock Master	Time source used
Interval Time	Interval in seconds

General

The **General** section contains the following information.

Leap Indicator	Leap warning
Version Number	Protocol version
Protocol Mode	Protocol mode
Stratum	Server-relevant value as an indicator of the time source used
Poll Interval	Poll interval
Precision	Indicates the accuracy of the time-server clock Negative 8-bit value, expressed as a power of 2, for example: 2^{-16} = 15.3 µs 2^{-5} = 31.25 µs Additional details are available in RFC4330.

Root Delay	Server delay Total runtime of the NTP telegram from the root through the individual intermediate nodes
Root Dispersion	Previous total errors produced through calculations in the intermediate nodes

7.8.2.3 Application Diagnostic – IEC61850

[ScAppIEC-270812-xxXX-01.tif]

Figure 7-4 Application Diagnostic – IEC61850

Clients

The **Clients** section contains general information on the clients.

Connection	Number of client connections
IP Address	Client IP address
Port	Port address
Timestamp	Time stamp of connection establishment

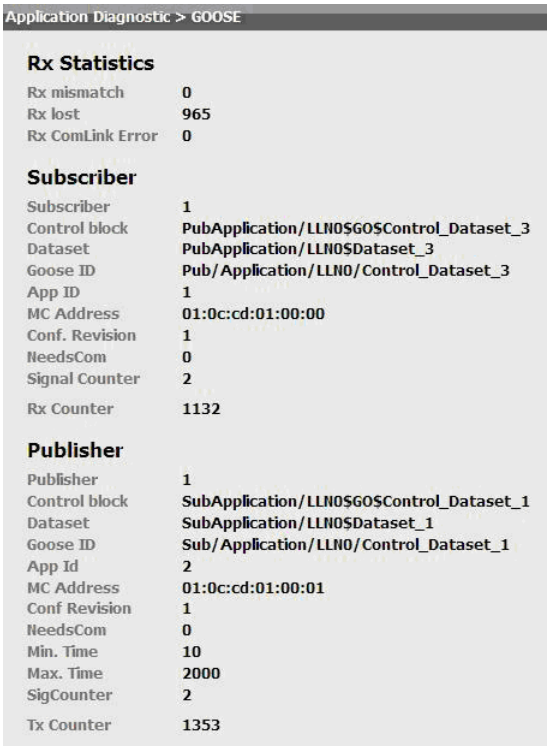
Reports

Every configured report is displayed with corresponding diagnostic values.

Table 7-2 Report diagnostic values

Report	Sequential number of configured reports
CbRef	Control block reference
RptID	Report identifier
RptEna	Report state 0 = Not active 1 = Active
DataSet	Dataset reference
DataSetMembers	Number of signals of referenced reports
ConfRev	Configuration revision number
OptFlds	Optional field: • Bit0: Reserved • Bit1: sequence-number • Bit2: report-time-stamp • Bit3: reason-for-inclusion • Bit4: data-set-name • Bit5: Data reference • Bit6: buffer-overflow • Bit7: entryID • Bit8: conf-revision • Bit9: Reserved
BufTm	Buffer time in ms
TrgOps	Trigger options: • Bit0: Reserved • Bit1: Data-Change • Bit2: Quality-Change • Bit3: Data-Update • Bit4: Integrity • Bit5: Reserved
IntgPd	Integrity period

7.8.2.4 Application Diagnostic – GOOSE



[ScApGOOS-270812-xxXX-01.tif]

Figure 7-5 Application Diagnostic – GOOSE

Rx Statistics

The **Rx Statistics** section contains general diagnostic values.

Rx mismatch	This field indicates that the parameterization is incorrect This is the case for example when the control block has the correct subscriber address, but the configuration does not fit with the expected signals.
Rx lost	This field indicates a possible connection break or failure.

Subscriber

The **Subscriber** section displays all configured GOOSE receiver control blocks, each with the following diagnostic values.

Subscriber	Sequential number of configured GOOSE control blocks
Control block	Control block reference
Dataset	Dataset reference
Goose ID	Control Block Identifier
App ID	Application ID
MC Address	Multicast address
Conf. Revision	Configuration revision number
NeedsCom	Indicator for state of parameterization 0 = OK 1 = Not OK
Signal Counter	Number of signals in the referenced dataset
Rx Counter	Telegram receipt counter

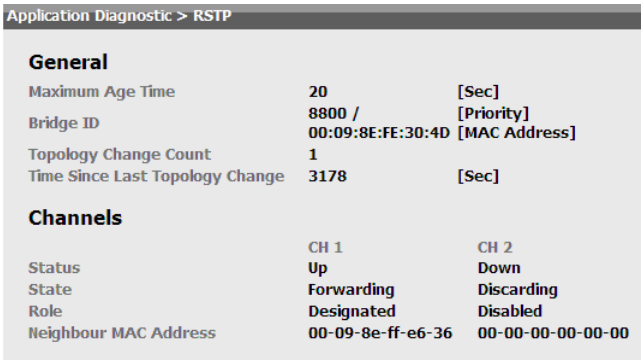
Publisher

The **Publisher** section displays all configured GOOSE transmitter control blocks, each with the following diagnostic values.

Publisher	Sequential number of configured GOOSE control blocks
Control block	Control block reference
Dataset	Dataset reference
Goose ID	Control Block Identifier
App ID	Application ID
MC Address	Multicast address
Conf. Revision	Configuration revision number
NeedsCom	Indicator for state of parameterization 0 = OK 1 = Not OK
Min. Time	Minimum time in ms
Max. Time	Maximum time in ms
SigCounter	Number of signals in the referenced dataset
Tx Counter	Telegram transmission counter

7.8.2.5 Application Diagnostic – RSTP

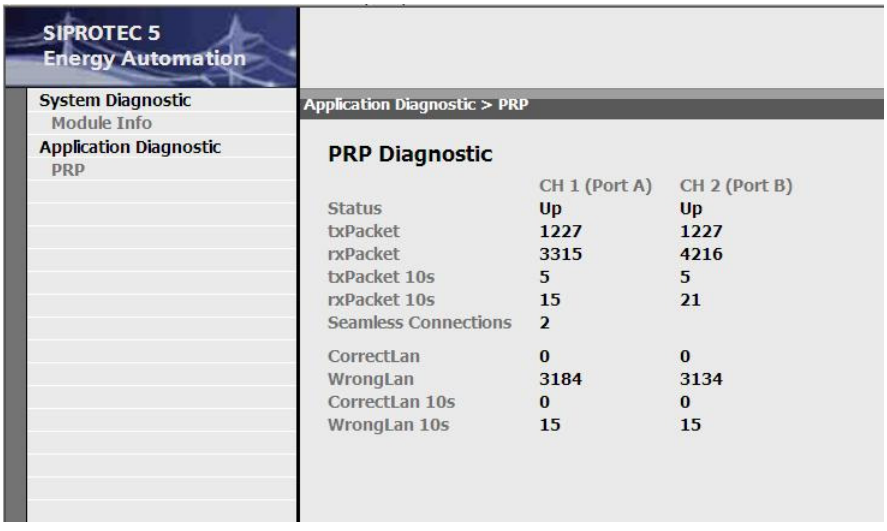
Information on the diagnostic values can be found in section *7.6.2 Parameter Settings for Networks*.



[ScApRSTP-270812-xxXX-01.tif]

Figure 7-6 Application Diagnostic – RSTP

7.8.2.6 Application Diagnostic – PRP



[ScPRPDia-220113-xxXX-01.tif]

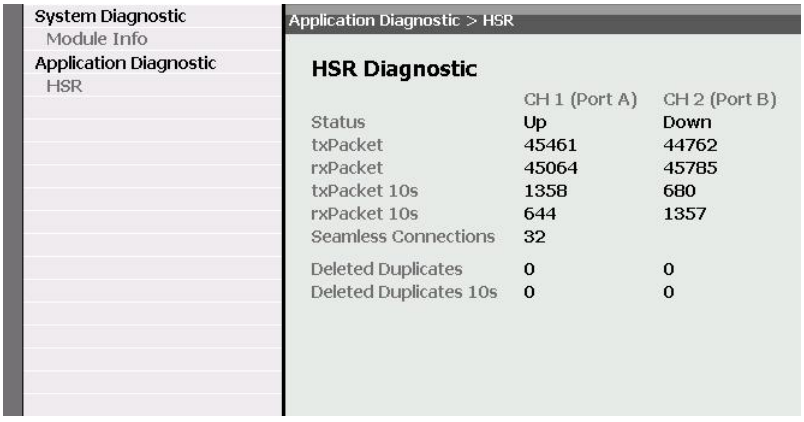
Figure 7-7 Application Diagnostic – PRP

In the **Application Diagnostic > PRP** section, you will find the following entries:

Entry	Meaning
Status	Link status indication
txPacket	Number of data packages sent from the port
rxPacket	Number of data packages received by the port
txPacket 10s	Number of data packages sent from the port within the last 10 s
rxPacket 10s	Number of data packages received by the port within the last 10 s
Seamless Connections	Number of modules to which a seamless connection exists. This value must be < 512.

Entry	Meaning
CorrectLan	Number of PRP packages that were received with a correct PRP LAN ID.
WrongLan	Number of PRP packages that were received with an incorrect PRP LAN ID. If this counter does not equal 0, there may be a wiring error. A wiring error exists, for example, if all modules in the network do not have channel 1 connected to LAN A and channel 2 connected to LAN B.
CorrectLan 10s	Number of PRP packages that were received with a correct PRP LAN ID within the last 10 s.
WrongLan 10s	Number of PRP packages that were received with an incorrect PRP LAN ID within the last 10 s.

7.8.2.7 Application Diagnostic – HSR



[ScHSRDia-220113-xxXX-01.tif]

Figure 7-8 Application Diagnostic – HSR

In the **Application Diagnostic > HSR** section, you will find the following entries:

Entry	Meaning
Status	Link status indication
txPacket	Number of data packages sent from the port
rxPacket	Number of data packages received by the port
txPacket 10s	Number of data packages sent from the port within the last 10 s
rxPacket 10s	Number of data packages received by the port within the last 10 s
Seamless Connections	Number of modules to which a seamless connection exists. This value must be < 512.
Deleted Duplicates	Number of packages removed from the ring via the HSR duplicate filter
Deleted Duplicates 10s	Number of packages removed from the ring via the HSR duplicate filter within the last 10 s

7.8.3 Homepage Activation

You can activate or deactivate the homepage via DIGSI 5. Then, you can also set the parameters for the homepage on the device.

The homepage can be selected using the IP address of the Ethernet module with a standard Web browser, such as Internet Explorer.

NOTE

For security reasons, Siemens recommends using the homepage continuously only if there is a secure network connection.

Activation via DIGSI

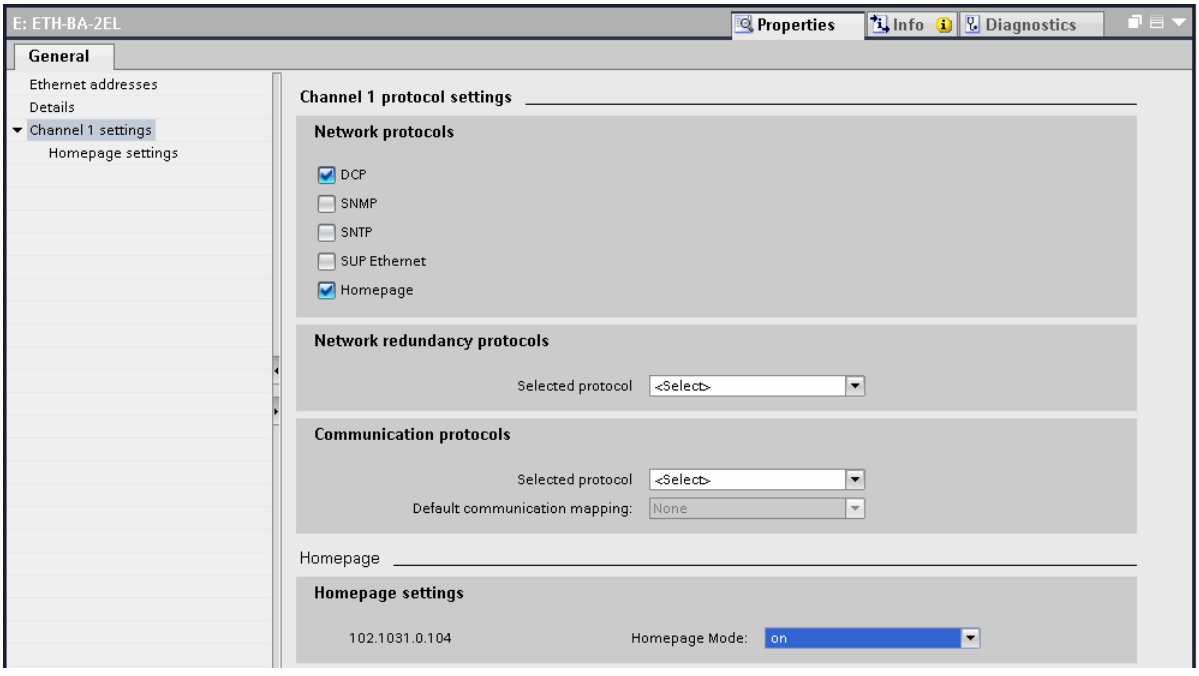
- ✧ Select the device in the project tree.
- ✧ In this device, switch to the **Hardware and Protocol Editor**.
- ✧ In the device. view select the communication module.
- ✧ In the **Properties** section, select **Channel 1 Settings**.

In the **Network protocols** section, the **Homepage** option is displayed.

- ✧ Mark the **Homepage** check box.

An additional **Homepage** section is displayed.

The default setting for the homepage is **on** (activated).



[ScHomDIG-290113-enUS-01.tif]

Figure 7-9 Homepage Section in DIGSI

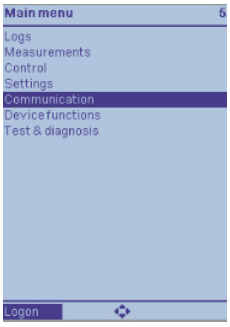
If the check mark is not set, the homepage is not loaded to the module. The homepage is deactivated. In this case, you cannot activate or deactivate the homepage in the on-site operation.

✧ To deactivate the homepage, select the **off** option in the list box.

Activation on the Device

To be able to activate or deactivate the homepage on the device, the homepage has to be activated via DIGSI.

✧ Use the arrow keys to navigate from **Settings** to **Communication**.



[ScDevMn1-090812-xxXX-01.tif]

Figure 7-10 Menu Settings -> Communication

✧ Select **Homepage**.

You can activate (on) or deactivate (off) the homepage there.

[ScDevMn2-090812-xxXX-01.tif]

Figure 7-11 Homepage Menu

■

Glossary

CID

Configured IED Description

Configured IED description

A Configured IED Description (CID) is a file for data exchange between the IED Configuration Tool and the IED itself.

DCP

Discovery and Basic Configuration Protocol

DIGSI

Configuration software for SIPROTEC

Discovery and Basic Configuration Protocol

The DCP protocol is used to detect devices without IP addresses and to assign addresses to these devices.

Drag and drop

Copying, moving and linking function, used in graphic user interfaces. The mouse is used to highlight and hold objects and then move them from one data area to another.

General interrogation

The state of all process inputs, of the status and of the error image are scanned on system startup. This information is used to update the system-side process image. Likewise, the current process state can be interrogated after data loss with a general interrogation (GI).

Generic object-oriented substation event

GOOSE. Protocol of IEC 61850 for communication between bay units.

GOOSE

Generic Object-Oriented Substation Event.

High Availability Seamless Redundancy Protocol

Like PRP (Parallel Redundancy Protocol), HSR (High Availability Seamless Redundancy Protocol) is specified in IEC 62439-3. Both protocols offer redundancy without switching time.

The principle of the function can be found in the definition of PRP. With PRP, the same message is sent via 2 separated networks. In contrast to this, in the case of HSR the message is sent twice in the 2 directions of the ring. The recipient receives it correspondingly via 2 paths in the ring, takes the 1st message and discards the 2nd (see PRP).

Whereas NO messages are relayed in the end device in the case of PRP, a switch function is installed in the HSR node. Thus, the HSR node relays messages in the ring that are not directed at it.

In order to avoid circular messages in the ring, corresponding mechanisms are defined in the case of HSR.

SAN (Single Attached Node) end devices can only be connected with the aid of a REDBOX in the case of HSR. PRP systems and HSR systems can be coupled redundantly with 2 REDBOXES.

HSR

High Availability Seamless Redundancy Protocol

ICD

IED Capability Description

IED capability description

Data exchange from the IED configuration software (DIGSI) to the system configurator. This file describes the performance features of an IED.

Internet protocol

An Internet protocol (IP) enables the connection of participants which are positioned in different networks.

IP

Internet protocol

Management Information Base

A Management Information Base (MIB) is a database which continuously saves information and statistics concerning each device in a network. The performance of each device can be monitored with this information and statistics. In this way, it can also be ensured that all devices in the network function properly. MIBs are used with SNMP.

Manufacturing Message Specification

The Standard Manufacturing Message Specification (MMS) serves for data exchange. The standard is used for the transmission protocols IEC 61850 and IEC 60870-6 TASE.2.

MIB

Management Information Base

MMS

Manufacturing Message Specification

Offline

If there is no communication connection between a PC program (for example, configuration program) and a runtime application (for example, a PC application), the PC program is **offline**. The PC program executes in Offline mode.

Online

If there is a communication connection between a PC program (for example, configuration program) and a runtime application (for example, a PC application), the PC program is **online**. The PC program executes in Online mode.

Parallel Redundancy Protocol

Parallel Redundancy Protocol (PRP) is a redundancy protocol for Ethernet networks that is specified in IEC 62439-3. Unlike conventional redundancy procedures, such as RSTP (Rapid Spanning Tree Protocol, IEEE 802.1D-2004) PRP offers uninterruptible switching, which avoids any outage time in the event of a fault, and thus the highest availability.

PRP is based on the following approach: The redundancy procedure is generated in the end device itself. The principle is simple: The redundant end device has 2 ethernet interfaces with the same address (DAN, Double Attached Node). Now the same message is sent twice, in the case of PRP (**parallel**) to 2 separate networks, and uniquely marks both with a sequence number. The recipient takes the information that it receives first, stores its ID based on the source address and the sequence number in a duplicate filter and thus recognizes the 2nd, redundant information. This redundant information is then discarded. If the 1st message is missing, the 2nd message with the same content comes via the other network. This redundancy avoids a switching procedure in the network and is thus interruption-free. The end device relays no messages to the other network. Since the process is realized in the ethernet layer (same MAC address), it is transparent and usable for all ethernet payload protocols (IEC 61850, DNP, other TCP/IP based protocols). In addition, it is possible to use one of the 2 networks for the transmission of non-redundant messages.

There are 2 versions of PRP: PRP-0 and its successor PRP-1. Siemens implements PRP-1.

Parameterization

Comprehensive term for all setting work on the device. You can parameterize the protection functions with DIGSI 5 or sometimes also directly on the device.

Participant

In an inter-device communication group, up to 16 SIPROTEC devices suitable for this can communicate with one another. The individually involved devices are referred to as participants.

PRP

Parallel Redundancy Protocol

Rapid Spanning Tree Protocol

The Rapid Spanning Tree Protocol (RSTP) is a standardized redundancy process with a short response time. In the Spanning Tree Protocol (STP protocol), structuring times in the multidigit second range apply in the case of a reorganization of the network structure. These times are reduced to several 100 milliseconds for RSTP.

RSTP

Rapid Spanning Tree Protocol

SCD

See Substation Configuration Description

Simple Network Management Protocol

The Simple Network Management Protocol (SNMP) is an Internet standard protocol and serves for the administration of nodes in an IP network.

Simple Network Time Protocol

The Simple Network Time Protocol (SNTP) is a protocol for the synchronization of clocks via the Internet. With SNTP, client computers can synchronize their clocks via the Internet with a time server.

SIPROTEC 5 device

This object type represents a real SIPROTEC device with all the contained setting values and process data.

SNMP

Simple Network Management Protocol

SNTP

Simple Network Time Protocol

Station description

A station description is an IEC 61850-compliant file for data exchange between the system configurator and the IED configurator. The station description contains information on the network structure of a substation. The station description contains for example, information on the assignment of the devices to the primary equipment, as well as on the station-internal communication.

TCP

Transmission Control Protocol

Time stamp

A time stamp is a value in a defined format. The time stamp assigns a time point to an event, for example, in a log file. Time stamps ensure that events can be found again.

Transmission Control Protocol

The Transmission Control Protocol (TCP) is a transmission protocol for transport services in the Internet. TCP is based on IP and ensures connection of the participants during the data transmission. TCP ensures the correctness of the data and the correct sequence of the data packages.

UDP

User Datagram Protocol

User Datagram Protocol (UDP)

UDP is a protocol. The protocol is based on IP as TCP. In contrast to this, however, UDP works without a connection and does not have any safety mechanisms. The advantage of UDP in comparison to IP is the higher transmission rate.

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