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SIPROTEC 5 Application Note

SIP5-APN-001:
Properties and Functional Structure

SIPROTEC 5 - Application: SIP5-APN-001 Properties and Functional Structure

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1 SIPROTEC 5 Properties

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

1.1 General Properties

- Powerful multiprocessor
- Fully digital measured value processing and control, from sampling and digitizing of measurands to closing and tripping decisions for the circuit breaker
- Complete galvanic and interference-free isolation of the internal processing switches from the system measuring, control, and supply circuits through instrument transformers, binary input and output modules, and DC and AC voltage converters
- Easy operation using an integrated operator and display panel, or using a connected personal computer with user interface
- Continuous display of measured and metered values at the front
- Storage of min/max measured values (slave pointer function) and storage of long-term mean values
- Storage of fault indications for system incidents (faults in system) with real-time assignment and instantaneous values for fault recording
- Continuous monitoring of the measurands as well as of the device hardware and software
- Communication with central control and storage devices possible via the device interface
- Battery-buffered, synchronizable clock

1.2 Modular Concept

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

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

SIPROTEC 5 Application catalogue

SIPROTEC 5 Properties

1.3 Redundant Communication

SIPROTEC 5 devices maintain complete communication redundancy:

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

2 Functional Integration - Function groups, application template

2.1 Summary

In this chapter the basic functional structure of SIPROTEC 5 is described. It comprises how functions are grouped and interconnected.

2.2 Functional Structure

SIPROTEC 5 devices offer greater flexibility in working with functions. Functions can be individually loaded into the device. Additionally, it is possible to copy functions within a device or between devices.

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

2.3 Function Groups (FG)

Functions are arranged into function groups. This simplifies working with functions (adding and copying). The function groups are primary objects, such as a line, transformer, or circuit breaker.

The function groups combine functions regarding the following essential tasks:

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

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

The necessary integration of functions into the device is shown by the following example.

EXAMPLE

A breaker-and-a-half application of the 7SA86 distance protection device serves as an example. The following protection functions are required for implementation (simplified and reduced):

- Distance Protection (21)
- Over-current protection, phases (51)
- Circuit-breaker failure protection (50BF), for circuit breakers 1 and 2
- Basic functionality (dealing with activation)

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

EXAMPLE

You must select the correct 7SA86 application template when installing a device in DIGSI 5. In the example, you would select the application template DIS Overhead Line, grounded networks, and breaker-and-a-half

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Functional Integration - Function groups, application template

applications. This application template covers the required range of functions. Selecting this application template determines the preconfigured range of functions. This can be changed as necessary.

2.4 Function Groups (FG)

Functions are arranged into function groups. This simplifies working with functions (adding and copying). The function groups are primary objects, such as a line, transformer, or circuit breaker. The function groups combine functions regarding the following essential tasks:

Assignment of functions to current and/or voltage converters (assignment of functions to the measuring points and thus to the protected object)

Exchange of information between function groups

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

EXAMPLE

The selected application template DIS overhead line, grounded systems, and breaker-and-a-half comprises 3 function groups:

- Protection function group line 1
- Circuit-breaker function group QA 1
- Circuit-breaker function group QA 2

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

SIPROTEC 5 Application

Functional Integration - Function groups, application template

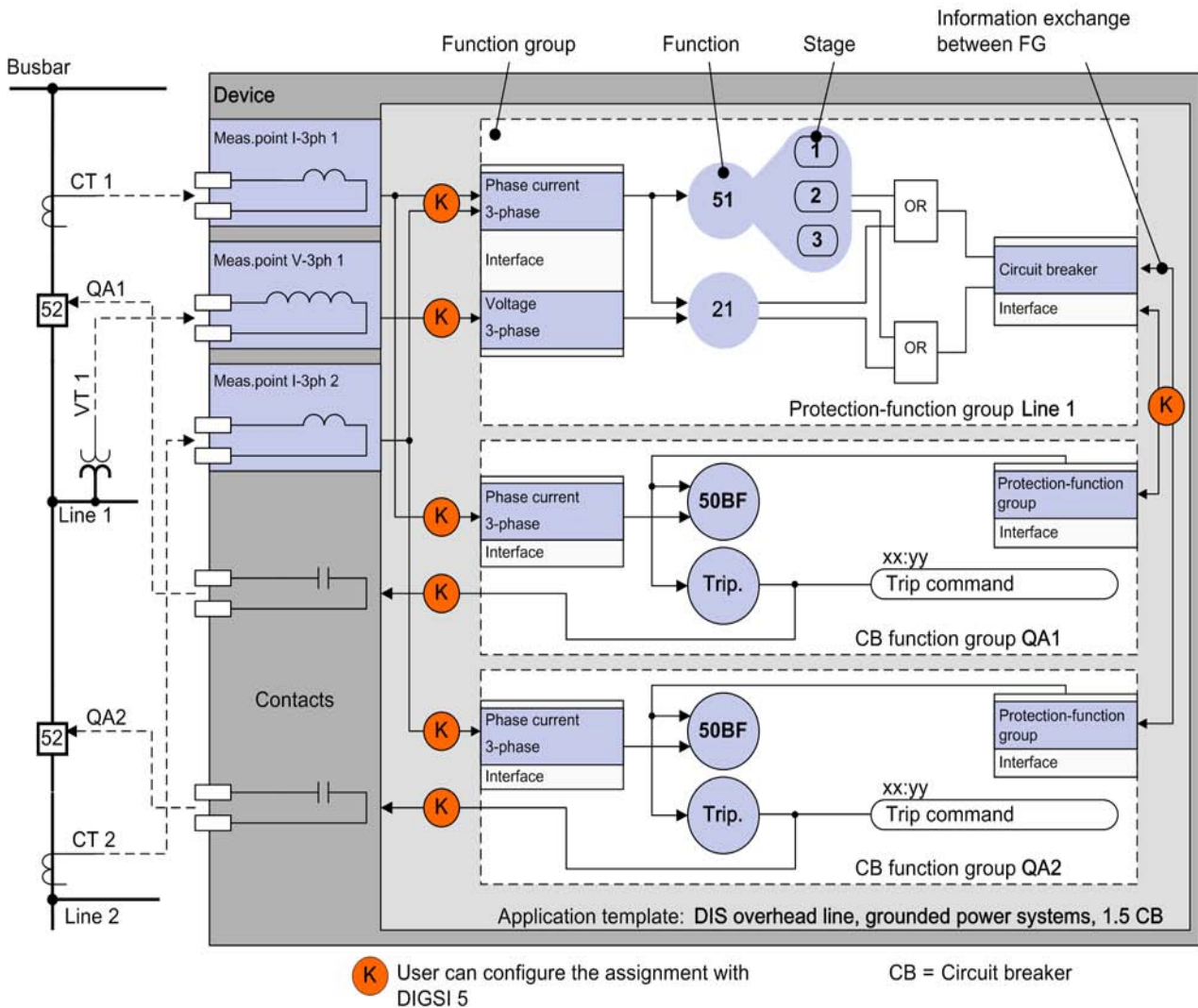


Figure 1: Embedding of Functions in Function Groups

There are various types of function groups depending on the device type:

- Protection function groups
- Switching function groups

Protection function groups combine functions that are assigned to a protected object, that is, to the line. Depending on the type and nature of the protected object, there are different types of protection function groups (line, feeder, transformer, motor etc.).

Switch function groups combine functions assigned to the local switches, that is, circuit breakers and disconnector switches (such as processing of tripping, circuit-breaker failure protection, and automatic reclosing).

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

SIPROTEC 5 Application

Functional Integration - Function groups, application template

2.5 Interface between Function Group and Measuring Point

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

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

EXAMPLE

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

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

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

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



Figure 2: Project Tree in DIGSI 5 (Detail)

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

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Functional Integration - Function groups, application template

▼ Connect measuring points to function group				
	Line 1		Circuit breaker 1	
Measuring point	Voltage 3-phase	Line current 3-phase	Voltage	Line current 3-phase
(All...) ▼	(All...) ▼	(All...) ▼	(All...) ▼	(All...) ▼
Meas.point I-3ph 1		X		X
Meas.point V-3ph 1	X		X	

Figure 3 Connecting Measuring Devices and Function Groups

Interface between Protection (e.g. Line) and Circuit-Breaker Function Groups

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

Which circuit breaker(s) is/are started by the protection functions of the protection FG.

Start of the function circuit-breaker failure protection (if available in the circuit-breaker function group) through the protection functions of the connected protection function group

Start of the function automatic reclosing (AREC, if available in the circuit-breaker function group) through the protection functions of the connected protection function group

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

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

EXAMPLE

The link of the function group in the example shown in Figure 1 is as follows:

The protection function group line is linked to both circuit-breaker function groups QA1 and QA2.

This means that the operate indication of the function Distance protection generates a trip command in both circuit-breaker function groups and thus controls both circuit breakers. The function Circuit-breaker failure protection of both circuit-breaker function groups, QA1 and QA2, is also activated, if these are configured.

The user can change this link, as needed, that is, protection function groups can be freely assigned to the circuit-breaker function groups.

To check or change the assignment of the protection function groups to the circuit-breaker function groups, double-click Function group connections in the DIGSI 5 project tree → 7SL86 (name of the device).

SIPROTEC 5 Application

Functional Integration - Function groups, application template



Figure 4: Project Tree in DIGSI 5 (Detail)

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

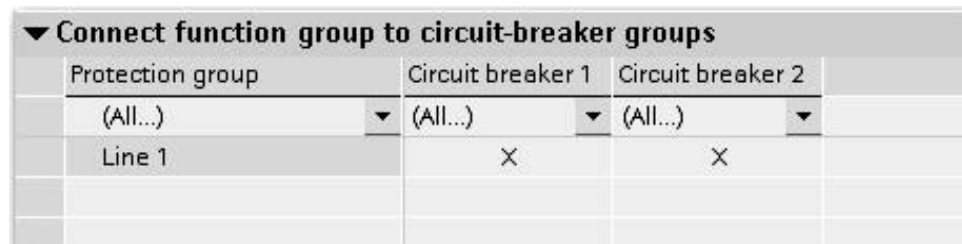


Figure 5: Connection of Protection Function Group Line with Circuit-Breaker Function Group

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

- Open the folder of the SIPROTEC 5 device from the SIPROTEC 5 project tree.
- Open the folder function settings, from the SIPROTEC 5 project tree.
- Open the respective protection function group, in the SIPROTEC 5 project tree, for example, Line 1 (see Figure 6)

SIPROTEC 5 Application

Functional Integration - Function groups, application template

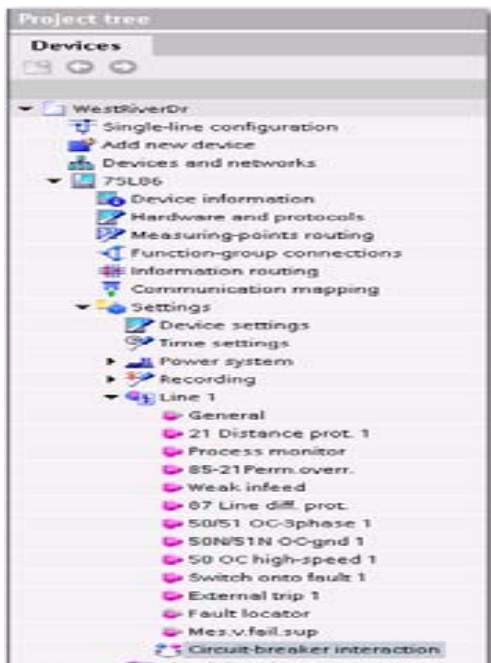


Figure 6: Project Tree in DIGSI 5 (Detail)

- Double-click circuit-breaker interaction (see Figure 6)
- The window for detailed configuration of the interface between the protection function group and the circuit breaker functional group(s) opens in the working area.
- Configure the interface in this view, through the context menu (right-click), see Figure 7.

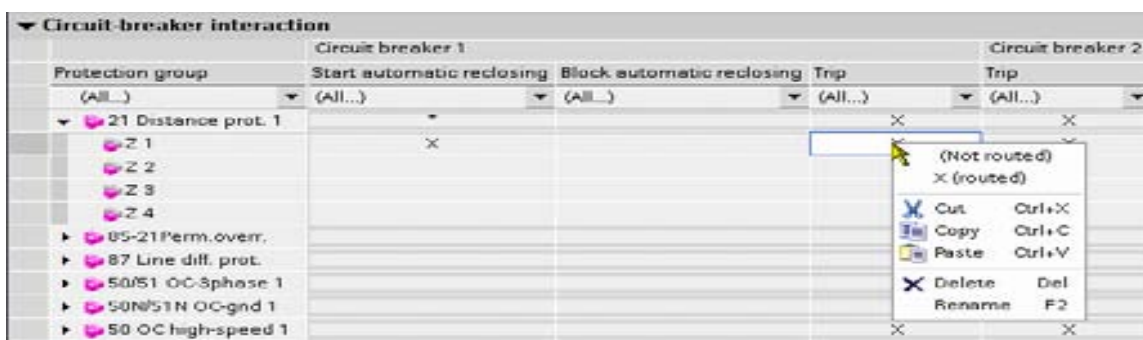


Figure 7: Detail Configuration of the Interface between the Protection Function Groups and the Circuit-Breaker Function Groups

In the detail configuration, you define:

- Which operate indications of the protection functions are included when the operate indication is generated
- Which protection functions start the automatic reclosing function
- Which protection functions block the automatic reclosing function
- Which protection functions start the function circuit-breaker failure protection

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Functional Integration - Function groups, application template

2.6 Function Group Circuit Breaker

At least one function group circuit breaker must be applied. In the breaker-and-a-half configuration two Circuit Breaker Function Groups are required. The typical functions in the FG Circuit Breaker are:

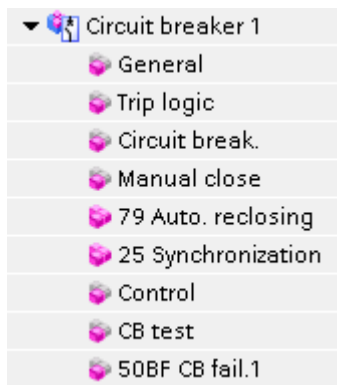


Figure 8: Function Circuit Breaker

Most of the shown functions can be inserted or deleted, but the Functions "General", "Trip logic", "Circuit-breaker" and "Manual close" are always present.

2.7 Routing Matrix

Routing of the signals to (Trip and Close) and from (auxiliary contacts) the circuit breaker is done in the Routing Matrix:

Information			Source							Destination						
			Binary input							Binary output						
			Base module							Base module						
Signals	Number	Type	1	2	3	4	5	6	7	1	2	3	4	5	6	7
(All...)	(All...)	(..)	▼	▼	▼	▼	▼	▼	▼	(...)	▼	▼	▼	▼	▼	▼
▼ Circuit break.	301.4261		*	*	*	*	*				*	*	*			*
▶ >Ready	301.4261.500	SPS					H									
▶ >Acquisition blocking	301.4261.501	SPS														
▶ >Reset switch statist.	301.4261.502	SPS														
▶ External health	301.4261.503	ENS														
▶ Health	301.4261.53	ENS														
▶ Position 3-pole	301.4261.58	DPC	OH													
▶ Position 1-pole phsA	301.4261.459	DPC		CH												
▶ Position 1-pole phsB	301.4261.460	DPC			CH											
▶ Position 1-pole phsC	301.4261.461	DPC				CH										
▶ Trip/open cmd. 3-pole	301.4261.300	SPS								U	U	U				
▶ Trip only pole A	301.4261.401	SPS								X						
▶ Trip only pole B	301.4261.402	SPS									X					
▶ Trip only pole C	301.4261.403	SPS										X				
▶ Close command	301.4261.301	SPS														X
▶ Command active	301.4261.302	SPS														

Figure 9: Routing of trip signals

Where single pole tripping is required the phase selective trip signals must be routed in parallel to the three pole trip. In the above example the Binary Outputs 1 to 3.

The auxiliary contact status is connected to the "Position" Signals. These are of DPC (Controllable Double Point) type. At the binary input the auxiliary contact is considered feedback information which may have one of 4 states:

CH	Close High
CL	Close Low
OH	Open High
OL	Open Low

The shown assignment: Position 3-pole – OH, and the 3 phase positions 1-pole – CH, ensures phase selective auxiliary contact status as well as secure detection of non-plausible states when e.g. there is a failure of the auxiliary supply routed to the contacts.

2.8 Functions, Step/Function Blocks

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

Functions can be further subdivided. For example, protection functions often consist of protection stages (for example, the overcurrent-protection function). Other functions can contain one or more function blocks. Thus the distance protection, for example, offers different zone types and a power-swing blocking.

EXAMPLE

In Figure 1 you can see, that the function Overcurrent protection, phases (51) has 3 stages. The number of zones of the function Distance protection is not shown.

Each stage, each function block, and each function (without stages/function blocks) can be individually switched into specific operating modes (for example, switch on/off).

To adjust the functionality to the specific application, functions, tripping stages, and function blocks can be added, copied, and deleted.

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