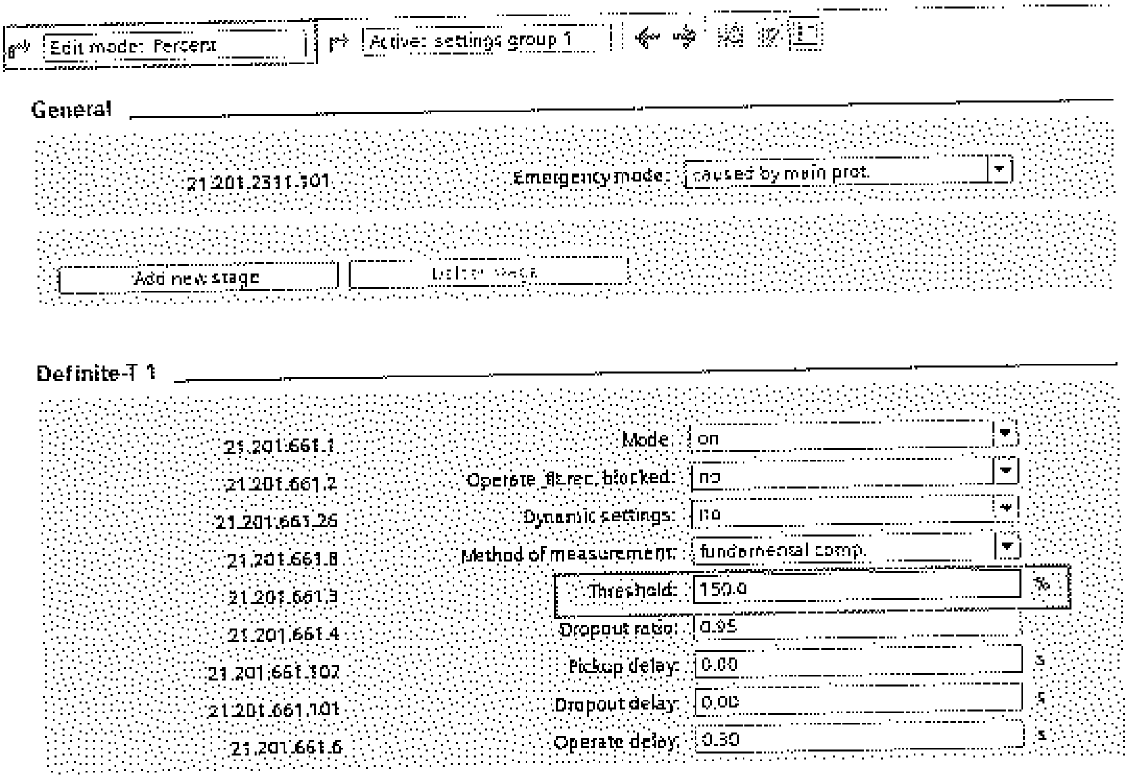


Figure 3-97 Example of the Threshold Value of the Definite Time-Overcurrent Protection (Edit Mode: Percent)

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

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

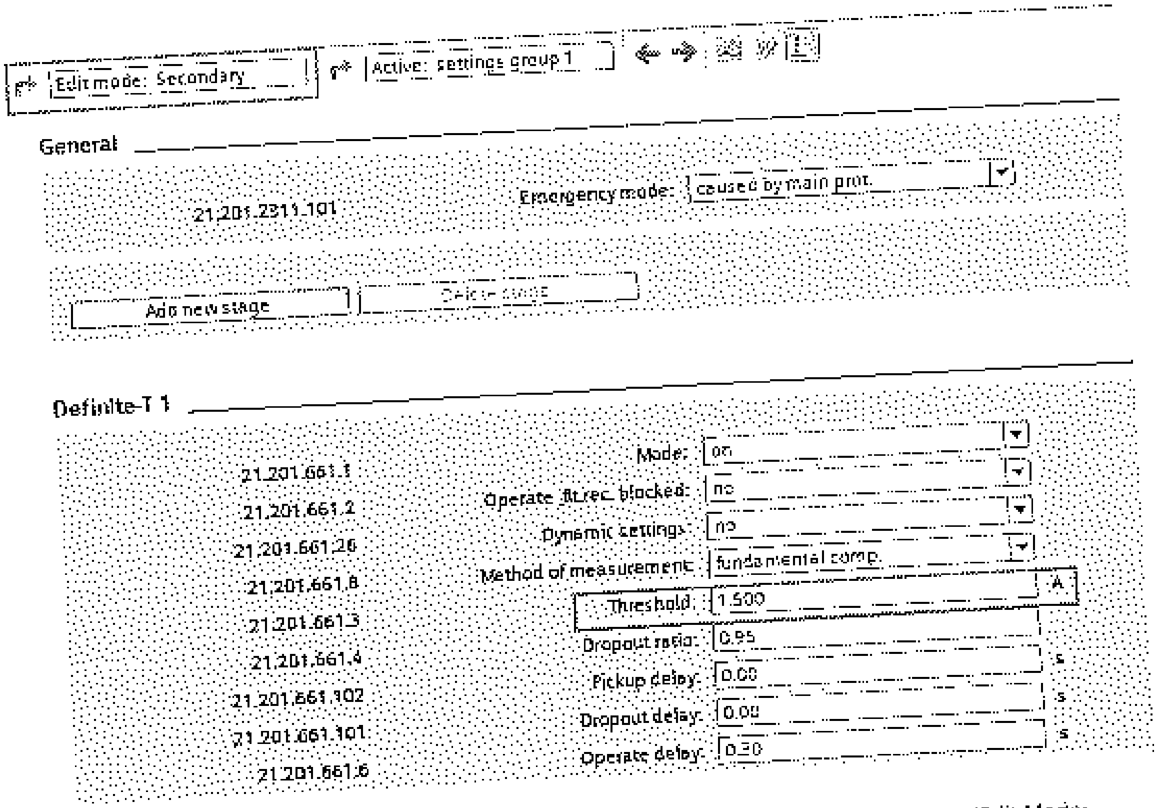


Figure 3-98 Example of the Threshold Value of the Definite Time-Overcurrent Protection (Edit Mode: Secondary)

If you only want to work in the secondary view, DIGSI 5 supports you if the transformer ratio changes during the project phase.

In the example, the current-transformer ratio changes from 1000 A/1 A to 1000 A/5 A. Change the secondary rated current of the current transformer in the setting sheet of the transformer data from 1 A to 5 A (Edit mode: Secondary). If you change the transformer data, a window will appear (see the following figure) that will ask you for the action desired.

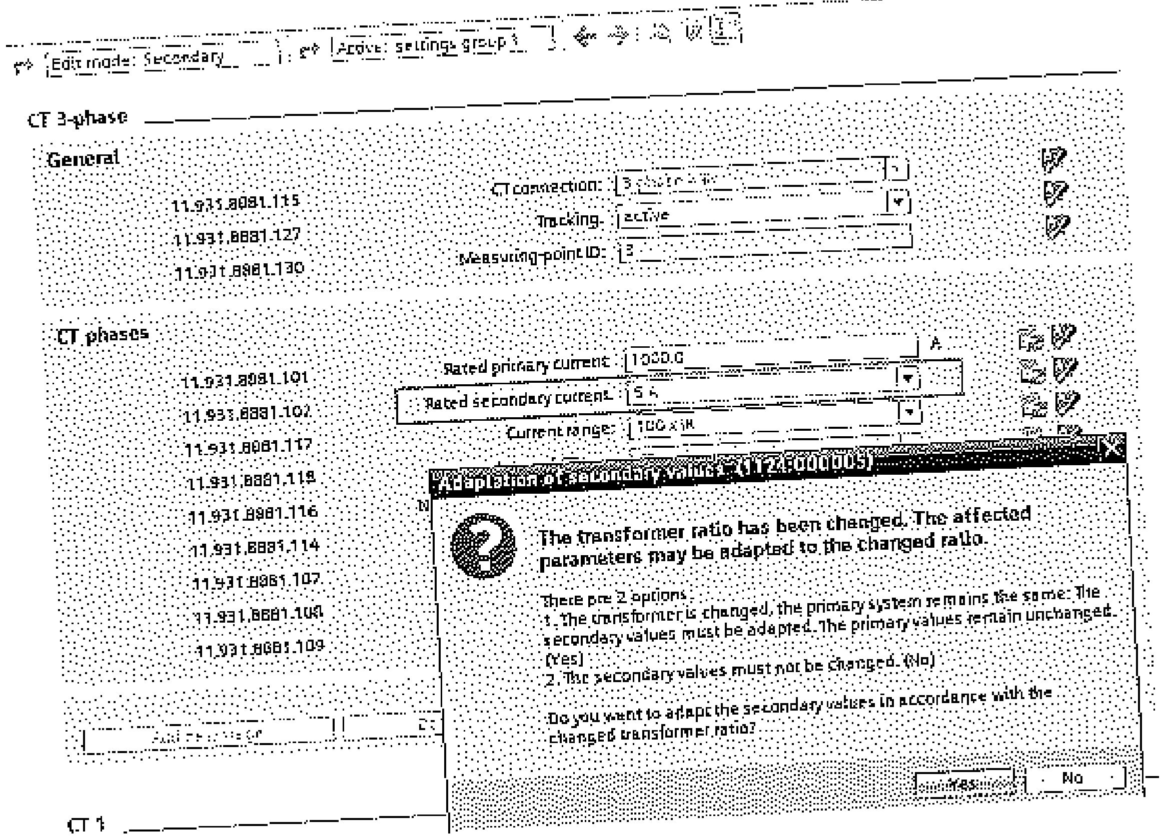


Figure 3-99 Query after Changing the Transformer Data (Setting View: Secondary)

If you answer the question with **Yes**, then DIGSI 5 will recalculate the pickup values (threshold values) in the active secondary view. For the new secondary transformer current 5 A, the new secondary threshold value obtained is 7.5 A (1.5 A * 5 = 7.5 A). The primary and percent values remain unchanged.

The following figure shows the newly calculated threshold value in the secondary view.

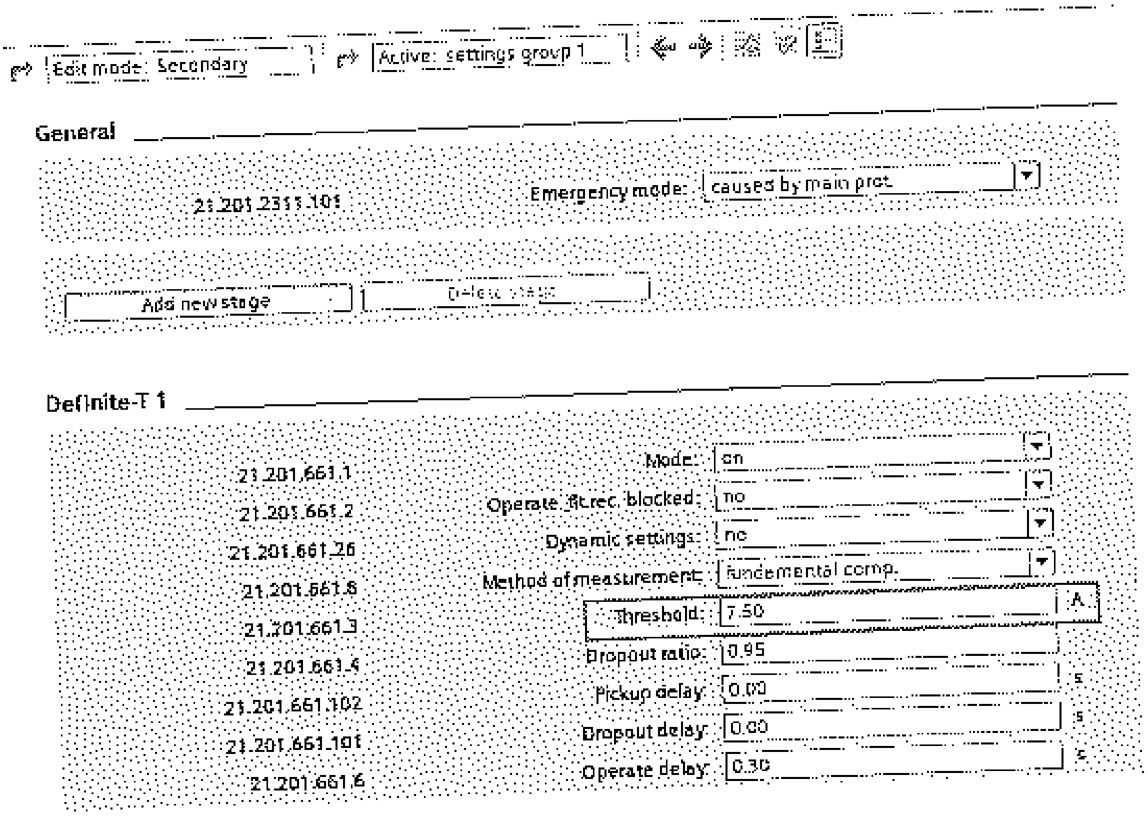


Figure 3-100 Automatically Recalculated Secondary Values After Changes in the Transformer Data

If you have already set the settings in the secondary view by including the new transformation ratio of the transformer in the calculation, then you answer the question with **No**. In this case, the protection settings in the secondary view remain unchanged. DIGSI 5 recalculates the settings (threshold values) of the primary view. In the example, the primary threshold value is then 300 A (1.5 A * 1000 A/5 A = 300 A).

In the example, the current-transformer ratio changes from 1000 A/1 A to 1000 A/5 A. The following table summarizes the pickup values that DIGSI 5 will recalculate in the setting view. The new values (in bold) depend on the answer of your inquiry (see Figure 3-99).

	Reply to the Question	
	Yes	No
Threshold value secondary (active setting view)	**7.5 A**	1.5 A
Threshold value primary (covered setting view)	1500 A	**300 A**

3.9.3 Changing the Transformation Ratios of the Transformer on the Device

The device is preset to the secondary value at the time of delivery. Only secondary values can be set directly on the device.

If you change transformer data directly on the device, it is not followed by a query, like in DIGSI 5 (see Figure 3-99). Instead, the device assumes that all settings remain unchanged in the secondary view.

NOTE

If the device works with IEC 61850 protocol, you change the transformer data only via DIGSI 5 and not directly on the device. If you change the transformer data directly on the device, the IEC 61850 configuration of the measurement and metered values can be faulty.

3.10 Device Settings

3.10.1 General Device Settings

3.10.1.1 Overview

In Device settings in DIGSI 5, you find the following general settings.

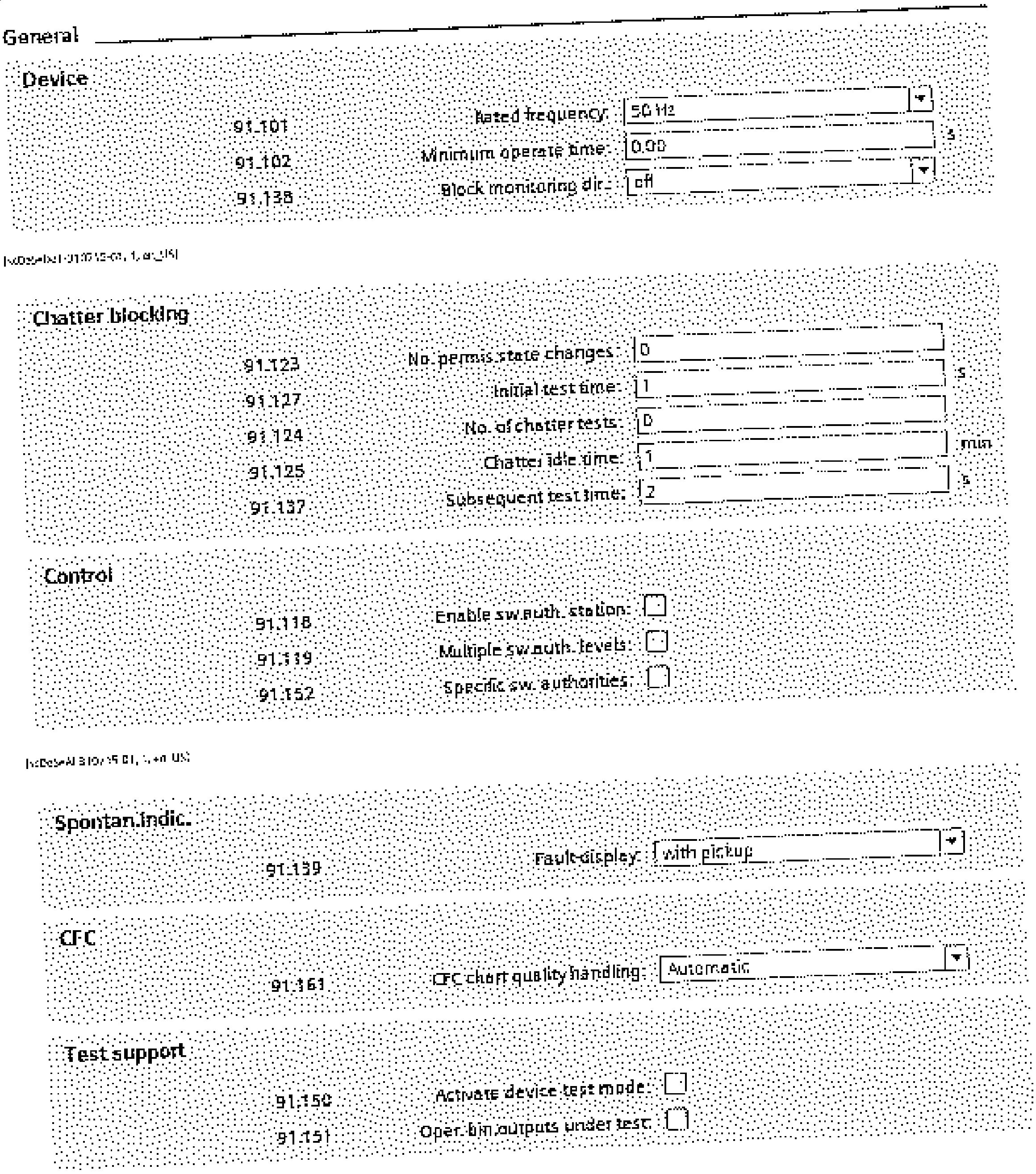


Figure 3-101 General Device Settings

The following list shows you the chapters containing the desired information.

You can find more about:

- **Chatter blocking** in chapter *3.8.1 Signal Filtering and Chatter Blocking for Input Signals* .
- **Control** in chapter *8.3 Control Functionality* .
- **Spontaneous Indications** in chapter *3.1.7 Spontaneous Indication Display in DIGSI 5* .
- **CFC Quality Processing** in Chapter *3.3.3 Quality Processing/Affected by the User in CFC Charts* .

Under **Device**, you set the parameters for the device that are valid across functions.

With the **Test support**, indications issued via communication interfaces are labeled with an additional test bit, if this is supported by the protocol. With this test bit, you can determine that an indication is generated as a test and that all or individual functions of the device are in test mode. In this way, the reactions that are necessary in normal operation due to an indication can be suppressed in other devices that receive these indications. You can also permit, for example, a trip command to close an energized binary output for test purposes. Siemens recommends deactivating the **Test support** again after the test phase.

3.10.1.2 Application and Setting Notes

The major part of the settings is described in the chapters cited above. In the following sections, you can find a description of the parameters of the sections **Device, Spontaneous indication**, and **Test support**.

Parameter: Rated frequency

- Default setting (_:101) **Rated frequency** = *50 Hz*

With the **Rated frequency** parameter, you set the rated frequency of the electrical power system.

Parameter: Minimum operate time

- Default setting (_:102) **Minimum operate time** = -

With the **Minimum operate time** parameter, you set the minimum duration for the trip command of the functions. The trip command is maintained for the set duration.

Parameter: Block monitoring dir.

- Default setting (_:138) **Block monitoring dir.** = *off*

With the **Block monitoring dir.** parameter, you set whether indications are issued via the system interface(s) of the SIPROTEC 5 device or not.

If transmission blocking is switched on, no indications are issued via the system interface(s) of a SIPROTEC 5 device.

Parameter: Fault-display

- Default setting (_:139) **Fault-display** = *with pickup*

With the **Fault-display** parameter, you set whether spontaneous indications are issued for a pickup or for a tripping. Keep the DIGSI 5 routing options in chapters *3.1.7 Spontaneous Indication Display in DIGSI 5* and *Table 3-5* in mind.

Parameter: Activate device test mode

- Default setting (_:150) **Activate device test mode** = inactive

With the **Activate device test mode** parameter, you activate the test mode that adds a test bit to the issued indications.

Parameter: Oper.bin.outp. under test

- Default setting (_:151) **Oper.bin.outp. under test** = inactive

If you activate the parameter **Oper.bin.outp. under test** , you can allow the closing of a binary output for test purposes. In this way, indications are issued during a device-wide test mode and the relays are either activated or not. If an individual function is in test mode, only indications are issued and the relays are not activated.

NOTE

The device remains in test mode during every startup until you set the device back into process mode intentionally. You switch to the process mode by switching the parameterActivate device test mode to inactive again (removing the check mark).

3.10.1.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Device				
_:101	General:Rated frequency		• 50 Hz • 60 Hz	50 Hz
_:102	General:Minimum operate time		0.00 s to 60.00 s	0.00 s
_:138	General:Block monitoring dir.		• off • on	off
Spontan. indic.				
_:139	General:Fault display		• with pickup • with trip	with pickup
Test support				
_:150	General:Activate device test mode		• 0 • 1	false
_:151	General:Oper.bin.outp. under test		• 0 • 1	false

3.10.1.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:510	General:>Test mode on	SPS	I
_:511	General:>Test mode off	SPS	I
_:507	General:>Device funct.logoff on	SPS	I
_:508	General:>Dev. funct.logoff off	SPS	I
_:512	General:>LED reset	SPS	I
_:52	General:Behavior	ENS	O
_:53	General:Health	ENS	O
_:51	General:Test mode	ENC	C
_:321	General:Protection on	SPC	C
_:54	General:Protection inactive	SPS	O
_:323	General:LED reset	SPC	C
_:320	General:LED have been reset	SPS	O

3.10.2 Settings-Group Switching

3.10.2.1 Overview of Functions

For different applications you can save the respective function settings in so-called **Settings groups**, and if necessary enable them quickly.

You can save up to 8 different settings groups in the device. In the process, only one settings group is active at any given time. During operation, you can switch between settings groups. The source of the switchover can be selected via a parameter.

You can switchover the settings groups via the following alternatives:

- Via the on-site operation panel directly on the device
- Via an online DIGSI connection to the device
- Via binary inputs
- Via a communication connection to the substation automation technology.
  The communication protocols IEC 60870-5-103, IEC 60870-5-104, IEC 61850, DNP or Modbus TCP can be used for switching the settings groups.

A settings group includes all switchable settings of the device. Except for a few exceptions (for example, general device settings such as rated frequency), all device settings can be switched.

Detailed information about the settings groups can be found in the Operating Manual and DIGSI 5 Online Help.

3.10.2.2 Structure of the Function

The function of the **Settings group switching** is a supervisory device function. Accordingly, the settings and indications of the settings group switching can be found in DIGSI 5 and at the on-site operation panel of the device, below the general device settings respectively.

If you want to switchover a settings group, navigate to DIGSI 5 or proceed on the on-site operation panel of the device, as follows:

- Via the project tree in DIGSI 5:
  Project -> Device -> Settings -> Device settings
- Via the on-site operation panel of the device:
  Main menu → Settings → General → Group switchover

The indications for the settings group switching can be found in the DIGSI 5 project tree under:

Project → Device → Information routing → General

3.10.2.3 Function Description

Activation

If you want to use the **Settings group switching** function, you must first set at least 2 settings groups in DIGSI 5 (parameter **Number of settings groups** > 1). You can set up a maximum of 8 settings groups. The settings groups set in DIGSI 5 are subsequently loaded into the device.

Mechanism of the Switchover

When switching over from one settings group to another, the device operation is not interrupted. With the `Active settings group` parameter, you are either specifying a certain settings group or you allow switching `via control` (IEC 60870-5-103, IEC 61850) or `via binary input`.

Switching via Control

When using the `Control` function for switching, the settings groups can be switched via a communication connection from the substation automation technology or via a CFC chart.

The communication protocols IEC 60870-5-103, IEC 60870-5-104, IEC 61850, DNP or Modbus TCP can be used for switching the settings groups via a communication connection.

In order to use a CFC chart for switching, you must create a new CFC chart in DIGSI 5. Create the CFC chart in the DIGSI 5 project tree under **Name of the device** → **Charts** → **Add new chart**. Link the signals that control settings group switching in the CFC chart.

Switching via Binary Input

There are 3 appropriate input signals available for switching via binary inputs. These input signals allow selection of the settings group via a binary code. If one of the 3 signals changes, the signal image present will, after 100 ms (stabilization time), result in switching over to the appropriate settings group. If only 2 settings groups must be switched over, only 1 binary input is required. The following table shows the possible binary codes (BCD) and applicable settings groups (PG).

Table 3-19 Binary Codes of the Input Signals and Applicable Settings Groups

BCD Code via Binary Inputs	PG 1	PG 2	PG 3	PG 4	PG 5	PG 6	PG 7	PG 8
>PG selection bit 3	0	0	0	0	1	1	1	1
>PG selection bit 2	0	0	1	1	0	0	1	1
>PG selection bit 1	0	1	0	1	0	1	0	1

Copying and Comparing Settings Groups

In DIGSI 5, you can copy or compare settings groups with each other.

If you want to copy settings groups, select a source and target parameter group in DIGSI 5 in the device settings, and then start the copy process. The device settings can be found in the DIGSI 5 project tree under Project → Device → Settings → Device settings.

If you want to compare settings groups, it is possible to do so in all setting sheets for settings. You will then select in addition to the active settings group, a 2nd settings group for comparison. Active setting values and the comparable values are displayed next to each other. For settings that cannot be switched over, no comparable values are displayed.

Indication of Settings Group Switchings

Every settings group shows an applicable binary indication as well as its activation and deactivation. The process of settings group switching is also logged in the log for settings changes.

3.10.2.4 Application and Setting Notes

Parameter: Number settings groups

- Default setting (_:113) `Number settings groups` = *1*

With the `Number settings groups` parameter, you can set the number of available settings groups; you can switch between these.

Parameter: Activat. of settings group

- Default setting (_:114) `Activat. of settings group` = *settings group 1*

With the `Activat. of settings group` parameter, you specify the settings groups that you want to activate, or the mechanisms via which the switchover is allowed. You can switchover only between the settings groups specified with the `Number settings groups` parameter. Parameter Value

Parameter Value	Description
via control	The switchover between the settings groups can only be initiated via a communication connection from a substation automation technology or via a CFC chart. The communication protocols IEC 60870-5-103, IEC 60870-5-104, IEC 61850, DNP or Modbus TCP can be used for switching the settings groups via a communication connection.
via binary input	The switchover between the settings groups functions exclusively via the binary input signals routed to the settings group switching.
settings group 1 ... *settings group 8*	They define the active settings groups. You can define the active settings groups in DIGSI 5, or directly on the device via the on-site operation.

3.10.2.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Change group				
_:113	General:Number settings groups		1 to 8	1
_:114	General:Activat. of settings group		• via control • via binary input • settings group 1 • settings group 2 • settings group 3 • settings group 4 • settings group 5 • settings group 6 • settings group 7 • settings group 8	settings group 1

3.10.2.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:500	General:>SG choice bit 1	SPS	I
_:501	General:>SG choice bit 2	SPS	I
_:502	General:>SG choice bit 3	SPS	I
_:300	General:Act. settings group 1	SPC	C
_:301	General:Act. settings group 2	SPC	C
_:302	General:Act. settings group 3	SPC	C
_:303	General:Act. settings group 4	SPC	C
_:304	General:Act. settings group 5	SPC	C
_:305	General:Act. settings group 6	SPC	C
_:306	General:Act. settings group 7	SPC	C
_:307	General:Act. settings group 8	SPC	C

4 Applications

4.1 Overview

The Global DIGSI 5 library provides application templates for the applications of the devices. The application template

- Supports the fast realization of complete protection solutions for applications
- Contains the basic configuration for the use case
- Contains functions and default settings for the use case

When using an application template, please note the following:

- Adapt the application template to your specific use (check/adapt default settings, delete/add functions). You can find more detailed information in the 2.1 *Function Embedding in the Device*.
- Check the routing of binary outputs with respect to fast and normal relays.
- Check the CFC charts for the group-warning indications and group-fault indications.

The following describes the application templates and maximum functional scope for the devices shown in this manual.

NOTE

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

4.2 Application Templates and Functional Scope for the Devices 7SJ82/7SJ85

Application templates are available in **DIGSI 5** for the applications of the device 7SJ82/7SJ85. The application templates contain the basic configurations, required functions, and default settings.

The following application templates are available for the device 7SJ82 and 7SJ85 in the **DIGSI 5** function library:

- Non directional OC (4*I)
- Non-directional OC (4*I, 4*V)
- Directional OC, grounded system
- Directional OC, resonant-grounded/isol. system
- Capacitor bank H-bridge + 1*RLC, **7SJ85 only**
- Capacitor bank MSCDN, **7SJ85 only**
- Capacitor bank H-bridge, **7SJ82 only**

To load the application templates to the device, the following minimum hardware configuration requirements must be met:

Application Template		**Hardware Configuration Minimum Requirement**
		9 BI, 8 BO, 4 I
Template 1	Non-directional OC (4*I)	9 BI, 8 BO, 4 I, 4 V
Template 2	Non-directional OC (4*I, 4*V)	
Template 3	Directional OC, grounded system	
Template 4	Directional OC, resonant-grounded / isol. system	
Template 5	Capacitor bank: H-bridge + 1*RLC	2 BI, 2 BO, 12 I
Template 6	Capacitor bank: MSCDN	2 BI, 2 BO, 28 I, 4 V
Template 7	Capacitor bank: H-bridge	2 BI, 2 BO, 8 I

The following table shows the functional scope and the required function points of the application templates for the device 7SJ82/7SJ85:

Table 4-1 Functional Scope of the Application Template for the Device 7SJ82/7SJ85

ANSI	Function	Abbr.	Available in 7SJ82	Available in 7SJ85	Template 1	Template 2	Template 3	Template 4	Template 5	Template 6	Template 7
	Protection functions for 3-pole tripping	3-pole	x	x	x	x	x	x	x	x	x
	Hardware quantity structure expandable	I/O	x	x	x	x	x	x	x	x	x
24	Overexcitation protection	V/f	x	x							
25	Synchrocheck, synchronizing function	Sync	x	x							
27	Undervoltage protection, 3-phase	V<	x	x							

ANSI	Function	Abbr.	Available in 7SJ82	Available in 7SJ85	Template 1	Template 2	Template 3	Template 4	Template 5	Template 6	Template 7
27	Undervoltage protection, positive-sequence system	V1<	x	x							
27	Undervoltage protection, 3-phase, universal, Vx	Vx<	x	x							
27	Undervoltage protection, 1-phase, universal, Vx	Vx<	x	x							
27/Q	Undervoltage-controlled reactive-power protection	QU	x	x							
32R	Reverse power protection	-P<	x	x							
32, 37	Power protection active/reactive power	P<>, Q<>	x	x							
37	Undercurrent protection x	I<	x	x					x	x	x
38	Temperature Supervision	TmpUh	x	x							
46	Negative sequence overcurrent protection	I2>	x	x					x	x	x
46	Unbalanced-load protection (thermal)	I2²t>	x	x							
46	Negative sequence overcurrent protection with direction	I2>, ∠ (V2, I2)	x	x							
49	Thermal overload protection	Θ, I²t	x	x					x	3	x
49	Thermal overload protection with user-def. charac. curve	Θ, I²t	x	x						3	x
49	Thermal overload protection for RLC element	Θ, I²t	x	x					x		
50TD/51	Overcurrent protection, phases - advanced	I>	x	x					x		
50TD/51	Overcurrent protection, phases - basic	I>	x	x	x	x	x	x		3	x
50NTD/51N	Overcurrent protection, ground - advanced	IN>	x	x					x		
50NTD/51N	Overcurrent protection, ground - basic	IN>	x	x	x	x	x			x	x

ANSI	Function	Abbr.	Available in 7SJ82	Available in 7SJ85	Template 1	Template 2	Template 3	Template 4	Template 5	Template 6	Template 7
50N/ 51N	Overcurrent protection, 1-phase - advanced	I>1pA	x	x							
50N/ 51N	Overcurrent protection, 1-phase - basic	I>1pB	x	x							
50HS	High speed instantaneous overcurrent protection	I>>>	x	x							
50Ns/ 51Ns	Sensitive ground-current protection for systems with resonant or isolated neutral	INs>	x	x							
50BF	Circuit-breaker failure protection		x	x						x	
RBRF	Restrike protection		x	x							
51-R	OC-3ph protection for RLC elements		x	x							
51V	OC-3phase voltage-dependent		x	x							
59	Overvoltage protection, 3-phase	V>	x	x						x	
59	Overvoltage protection, positive-sequence system	V1>	x	x							
47	Overvoltage protection, negative-sequence system	V2>	x	x							
47	Overvoltage protection with negative-sequence voltage/positive-sequence voltage	V2/V1>	x	x							
59N	Overvoltage protection, zero-sequence system	V0>	x	x							
59	Overvoltage protection, 3-phase or 1-phase, universal, Vx	Vx>	x	x							
59C	Peak overvoltage protection for capacitors		x	x					x	2	x
60C	Current unbalance protection for capacitors, 3-phase	Iunbal>	x	x					x	2	x
60C	Current Unbalance Protection for Capacitors, 1-phase	Iunbal>	x	x							

ANSI	Function	Abbr.	Available in 7SJ82	Available in 7SJ85	Template 1	Template 2	Template 3	Template 4	Template 5	Template 6	Template 7
67	Directional overcurrent protection 1-pole			x							
67	Directional time-overcurrent protection, phases – advanced	I>, ∠(V,I)	x	x							
67	Directional time-overcurrent protection, phases – basic	I>, ∠(V,I)	x	x			x	x			
67N	Directional overcurrent protection, ground - advanced	IN>, ∠ (V,I)	x	x							
67N	Directional time-overcurrent protection, ground - basic	IN>, ∠ (V,I)	x	x			x				
67Ns	Directional sensitive ground-fault detection for systems with resonant or isolated neutral	INs>, ∠ (V,I)	x	x				x			
67Ns	Transient ground-fault function, for transient and permanent ground faults in resonant-grounded or isolated networks	W0p,tr>	x	x							
74TC	Trip circuit supervision	TCS	x	x							
79	Automatic reclosing	AREC	x	x							
81O	Overfrequency protection	f>	x	x							
81U	Underfrequency protection	f<	x	x							
81R	Rate of frequency change protection	df/dt	x	x							
86	Lockout		x	x	4	4	4	4	x	x	x
87C	Capacitor bank differential protection		x	x						x	
87V	Voltage-differential protection	ΔV		x							
87N	Restricted ground-fault protection	ΔIN	x	x							
90V	Voltage controller		x	x							
Arc Prot	Arc protection		x	x							
DIGFP	Directional intermittent ground-fault protection		x	x							
IGFP	Intermittent ground-fault protection		x	x							

ANSI	Function	Abbr.	Available in 7SJ82	Available in 7SJ85	Template 1	Template 2	Template 3	Template 4	Template 5	Template 6	Template 7
FL	Fault locator, single-ended measurement	FL-one	x	x							
PMU	Synchrophasor measurement	PMU	x	x							
SOTF	Instantaneous tripping at switch onto fault	SOTF	x	x	x	x	x	x			
Monit	Circuit-breaker wear monitoring		x	x							
VSEL	Voltage measuring-point selection		x	x							
20mA MT	20-mA unit Ethernet		x	x							
20mA MS	20-mA unit serial		x	x							
RTDMT	RTD unit Ethernet		x	x							
RTDMS	RTD unit Serial		x	x							
	Signaling-Voltage Supervision		x	x							
	Measuring-voltage failure detection		x	x							
	Switch onto fault		x	x	x	x	x	x			
	CB Test		x	x	x	x	x	x	x	x	x
	Interlocking		x	x	4	4	4	4	x	x	x
	I-jump detection		x	x							
	V-jump detection		x	x							
	Pulse metered value		x	x							
	Measured values, standard		x	x	x	x	x	x	x	2	x
	User-defined function block		x	x							
	Measured values, extended: Min, Max, Avg		x	x							
	Switching statistic counters		x	x							
	CFC standard and control		x	x	x	x	x	x	x	x	x
	CFC arithmetic		x	x							
	Switching sequences function		x	x							
	Inrush current detection		x	x	x	x	x	x			
	External trip initiation		x	x							
	Control		x	x	4	4	4	4	x	x	x

ANSI	Function	Abbr.	Available in 7SJ82	Available in 7SJ85	Template 1	Template 2	Template 3	Template 4	Template 5	Template 6	Template 7
	Fault recording of analog and binary signals		x	x	x	x	x	x	x	x	x
	Monitoring and supervision		x	x	x	x	x	x	x	x	x
	Protection interface, serial		x	x							
	Capacitor bank		x	x					x	2	x
	Circuit Breaker		x	x	x	x	x	x	x	x	x
	Circuit Breaker (control)		x	x							
	Circuit Breaker (status only)		x	x							
	Disconnector		x	x	3	3	3	3			
	Disconnector (status only)		x	x							
	Tap changer		x	x							
	Analog unit		x	x							
	Communication modules		x	x	x	x	x	x	x	x	x
	Function-points class:				0	0	30	45	90	295	80

5 Function-Group Types

5.1 Function-Group Type Voltage-Current 3-Phase

5.1.1 Overview

All functions for protection and supervision of a protected object or equipment allowing 3-phase current and voltage measurement can be used in the function group **Voltage-current 3-phase**. The function group also contains the operational measurement for the protected object or equipment (on this topic, see chapter 10 *Measured Values, Energy Values, and Supervision of the Primary System*).

You will find the **Voltage-current 3-phase** function group under each device type in the Global DIGSI 5 library. You will find all protection and supervision functions that you can use for this function-group type in the function group **Voltage-current 3-phase**. These functions are described in chapter 6 *Protection and Automation Functions* .

You can find additional information on the embedding of the functions in the device in chapter 2 *Basic Structure of the Function* . You can find the function scope of the application templates for the various device types in the chapter 4 *Applications* .

5.1.2 Structure of the Function Group

The function group always contains the following blocks:

- Protected object/equipment data (FB General)
- Operational measured values
- Process monitor
- Output logic of the function group
- Reset LED group

These blocks are essential for the function group under all circumstances, so they cannot be loaded or deleted. You can load the protection and supervision functions required for your application in the function group. The functions are available in the Global DIGSI 5 library. Functions that are not needed can be deleted from the function group.

The following figure shows the structure of the function group **Voltage-current 3-phase**.

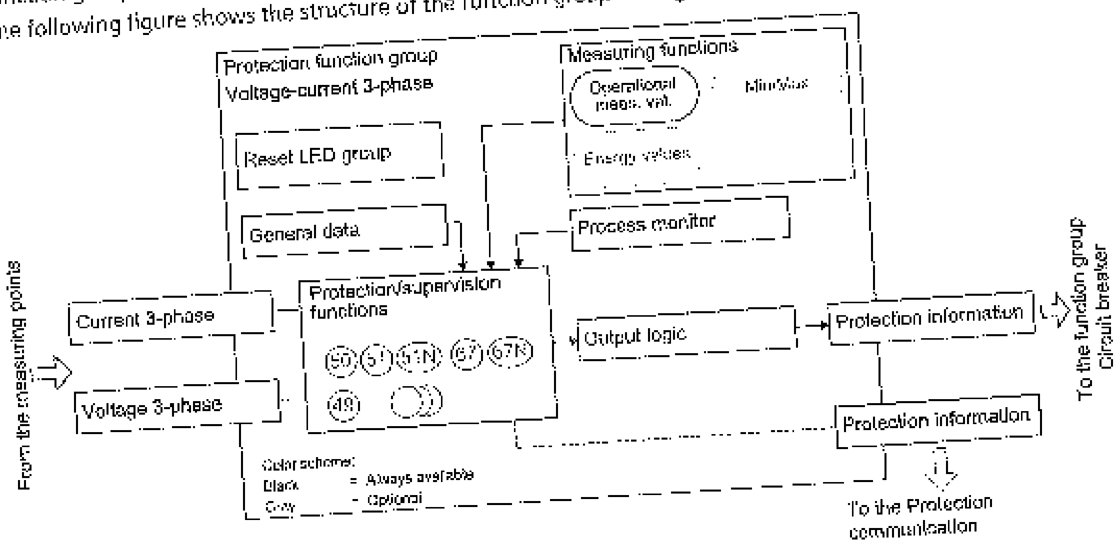


Figure 5-1 Structure of the Voltage-Current 3-Phase Function Group

The function group has interfaces with

- **Measuring points**
- **Circuit-breaker** function group

Interface with Measuring Points

The function group receives the required measured values via its interfaces with the measuring points. If you are using an application template, the function group is already connected to the necessary measuring points. If you add functions to the function group, they will automatically receive the measured values from the correct measuring points. If you add protection functions to the function group but the necessary measuring point is not connected, DIGSI 5 reports an inconsistency. Configure the measuring points in DIGSI 5 via the **Function group connections** editor. You can find more detailed information in chapter *2 Basic Structure of the Function*.

The function group has the following interfaces with the measuring points:

- **3-phase current**
  The measurands from the 3-phase power system are supplied via this interface. Depending on the connection type of the transformers, these are, for example, I_A, I_B, I_C, I_N or $3I_0$. All values that can be calculated from the measurands are also provided via this interface. The function group must always be connected to the **I-3ph** measuring point.
  You can connect the **3-phase current** interface to a maximum of **four** 3-phase current measuring points (for example, for 1 1/2 circuit-breaker layouts). If 2 current measuring points have been connected with the **3-phase current** interface, the total current is also determined from measured values from both measuring points in the function group. All functions in the function group have access to these values.

- **3-phase voltage (optional)**
  The measurands from the 3-phase voltage system are supplied via this interface. There are various types of transformer connections possible. All values that can be calculated from the measurands are also provided via this interface. Connecting the function group to the **V 3ph** measuring point is optional.
  You can connect multiple measuring points with this interface. You can find more information in chapter *6.48 Voltage Measuring Point Selection*.
  If you want to test or change the connection between the voltages and the V-3ph measuring point, double-click in the DIGSI 5 project tree -> **(Name of the device)** on **Measuring point routing** (Connection type = 3 phase-to-ground voltage). For more information, refer to the description of the power-system data starting in chapter *6.1 Power-System Data*.

Interface to the Circuit-Breaker Function Group

All required data is exchanged between the protection and **Circuit-breaker** function groups via the interface with the Circuit-breaker function group. This data includes, for example, the pickup and operate indications of the protection functions sent in the direction of the Circuit-breaker function group and, for example, the circuit-breaker condition information in the direction of the protection function groups.

The **Voltage-current 3-phase** function group is connected to one or more Circuit-breaker function groups. This connection generally determines:

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

Besides the general allocation of the protection function group to the Circuit-breaker function groups, you can also configure the interface for certain functionalities in detail. Configure the details in DIGSI 5 using the **Circuit-breaker Interaction** editor in the protection function group.

In the detail configuration of the interface, you define:

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

If you are using an application template, the function groups are already connected to each other, because this connection is absolutely essential to ensure proper operation. You can modify the connection in DIGSI 5 via the **Function-group connections** Editor.

You can find more detailed information in chapter *2.1 Function Embedding in the Device*.

If the connection is missing, DIGSI 5 reports an inconsistency.

Protected Object/Equipment Data (FB General)

The rated voltage and rated current as well as the neutral-point treatment of the protected object or the equipment are defined here. These data apply to all functions in the **Voltage-current 3-phase** function group.

Resetting the LED Group

Using the **Reset the LED group** function, you can reset the stored LEDs of the functions in one specific function group while the activated, stored LEDs of other functions in other function groups remain activated.

You can find more detailed information in chapter *3.1.10 Resetting Stored Indications of the Function Group* .

Process Monitor

The process monitor is always present in the **Voltage-current 3-phase** function group and cannot be removed.

The process monitor provides the following information in the **Voltage-current 3-phase** function group:

- Current-flow criterion:
  Detection of an open/activated protected object/equipment based on the flow of leakage current
- Closure detection:
  Detection of the switching on of the protected object/equipment
- Cold-load pickup detection (optional, only for protection devices):

These data apply to all functions in the **Voltage-current 3-phase** function group.

The description of the process monitor begins in chapter *5.8 Process Monitor*.

Operational Measured Values

The operational measured values are always present in the **Voltage-current 3-phase** function group and cannot be removed.

The following table shows the operational measured values of the **Voltage-current 3-phase** function group:

Table 5-1 Operational Measured Values of the Voltage-Current 3-Phase Function Group

Measured Values		Primary	Secondary	% Referenced to
I_A, I_B, I_C	Phase currents	A	A	Rated operating current of the primary values
3I0	Calculated zero-sequence current	A	A	Rated operating current of the primary values
I_N	Neutral-point phase current	A	A	Rated operating current of the primary values
I_{NS}	Sensitive ground current	A	mA	Rated operating current of the primary values
V_A, V_B, V_C	Phase-to-ground voltages	kV	V	Operating rated voltage of primary values/√3
V_{AB}, V_{BC}, V_{CA}	Phase-to-phase voltages	kV	V	Rated operating voltage of the primary values
V_0	Zero-sequence voltage	kV	V	Operating rated voltage of primary values/√3
V_{NG}	Neutral-point displacement voltage	kV	V	Operating rated voltage of primary values/√3
f	Frequency	Hz	Hz	Rated frequency
P_{total}	Active power (total power)	MW	W	Active power of the primary values $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$

Measured Values		Primary	Secondary	% Referenced to
Q_{total}	Reactive power (total power)	Mvar	var	Reactive power of the primary values $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
S_{total}	Apparent power (total power)	MVA	VA	Apparent power of the primary values $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
Cos φ	Active power factor	(abs)	(abs)	100 % corresponds to cos φ = 1
P_A, P_B, P_C	Phase-related active power	MW	W	Active power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$
Q_A, Q_B, Q_C	Phase-related reactive power	Mvar	var	Reactive power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$
S_A, S_B, S_C	Phase-related apparent power	MVA	VA	Apparent power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$

The operational measured values are explained in more detail in chapter 10.3 *Operational Measured Values* .

Inversion of Power-Related Measured and Statistical Values (FB General)

The following directional values calculated in operational measured values are defined positively in the direction of the protected object.

- Power
- Active power factor
- Energy
- Minimum, maximum values
- Average values

With the `P, Q sign` parameter, you can invert the sign of these operational measured values such that a power flow from the line to the busbar is displayed positively.

More information can be found in chapter 10.1 *Overview of Functions*.

Output Logic

The output logic treats the pickup and trip signals of the protection and supervision functions that are available in the function group separately, in a pickup logic and a trip logic, respectively. The pickup and trip logic generate the overreaching indications (group indications) of the function group. These group indications are transferred via the **Protection information** interface to the **Circuit-breaker** function group and are processed further there.

The pickup signals of the protection and supervision functions in the **Voltage-current 3-phase** function group are combined in a phase-selective manner and output as a group indication.

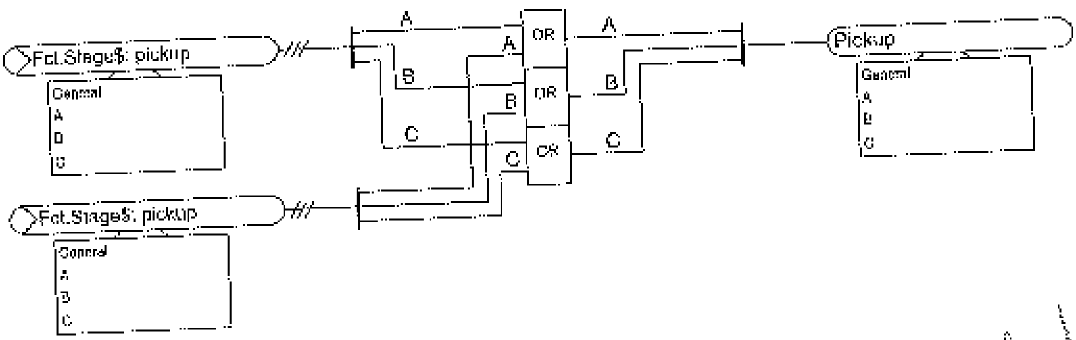


Figure 5-2 Creation of the Pickup Indication of the Voltage-Current 3-Phase Function Group

The trip signals from the protection and supervision functions of the **Voltage-current 3-phase** function group always result in 3-pole tripping of the device.

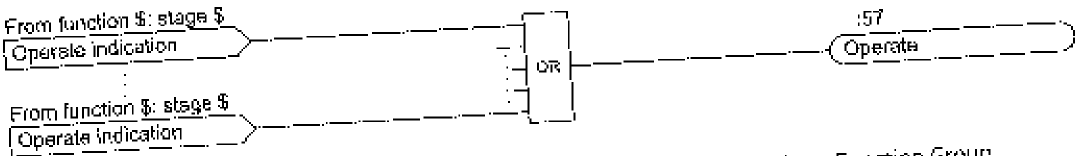


Figure 5-3 Creation of the Operate Indication of the Voltage-Current 3-Phase Function Group

5.1.3 Application and Setting Notes

Interface to the Circuit-Breaker Function Group

With this, you define which circuit-breaker(s) is/are affected by the protection functions of the Protection function group. A feasible default setting has already been provided in the application templates. You can find more information in chapter 2.

Protected Object/Equipment Data (FB General)

The set data applies to all functions in the function group.

Set the protected object/equipment data for your specific application.

Parameter: Rated current

- Default setting (_:9451:101) `Rated current` = *1000 A*

With the `Rated current` parameter, you can set the primary rated current of the protected object or equipment. The `Rated current` parameter is significant for protection functions, as long as the current values are set in percentages. In this case it is the reference value. In addition it is the reference value for the measured values in percent.

If the device works with the IEC 61850 protocol, then you change only the setting value of the parameter via DIGSI 5 and not directly on the device. If you change the setting value directly on the device, then the IEC 61850 configuration of the metered values can be faulty.

Parameter: Rated voltage

- Default setting (_:9451:102) `Rated voltage` = *400.00 kV*

With the `Rated voltage` parameter, you can set the primary rated voltage of the protected object or equipment. The `Rated voltage` parameter is significant for protection functions, as long as the current values are set in percentages. In this case it is the reference value. In addition it is the reference value for the measured values in percent.

If the device works with the IEC 61850 protocol, then you change only the setting value of the parameter via DIGSI 5 and not directly on the device. If you change the setting value directly on the device, then the IEC 61850 configuration of the metered values can be faulty.

Parameter: Power-sys. neutral point

- Default setting (_:9451:149) `Power-sys. neutral point` = *grounded*

With the `Power-sys. neutral point` setting, you specify whether the system neutral is *grounded* , *isolated* , or *suppress. coil grounded* (grounded via arc-suppression coil). Currently, the parameter does not affect any protection function; only if the **Automatic reclosing function** uses the voltage measurement.

You can find more information in Chapter 6.43.1 *Overview of Functions* .

Parameter: `P, Q sign`

- Default setting (_:9451:158) `P, Q sign` = `not reversed`

The power and energy values are defined by the manufacturer such that power in the direction of the protected object is considered positive. You can also define the power output by the protected object (for example, as seen by the consumer) as positive. With the `P, Q sign` setting, you can invert the sign for these components. This inversion does not influence any protection function.

5.1.4 Write-Protected Settings

The settings listed here are used primarily for understanding during configuration of the function groups. They are calculated on the basis of other settings and cannot be directly changed.

Addr.	Parameters	C	Range of Values	Default Setting
Network data				
_:103	General:rated apparent power		0.20 MVA to 5 000.00 MVA	692.82 MVA

NOTE

You can find more detailed information on the Process monitor in chapter 5.8 Process Monitor.

5.1.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Rated values				
_:9451:101	General:Rated current		1 A to 100000 A	1000 A
_:9451:102	General:Rated voltage		0.20 kV to 1200.00 kV	400.00 kV
Power-system data				
_:9451:149	General:Power-sys. neutral point		• grounded • suppress. coil grounded • isolated	grounded
Measurements				
_:9451:158	General:P, Q sign		• not reversed • reversed	not reversed

5.1.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:9451:52	General:Behavior	ENS	O
_:9451:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Reset LED Group			
_:7381:500	Reset LED Group:>LED reset	SPS	I
_:7381:320	Reset LED Group:LED have been reset	SPS	O

No.	Information	Data Class (Type)	Type
Closure detec.			
_:1131:4681:500	Closure detec.:>Disconnector open	SPS	I
_:1131:4681:300	Closure detec.:Closure	SPS	O

5.2 Function-Group Type Voltage-Current 1-Phase

5.2.1 Overview

In the **Voltage-current 1-phase** function group, all functions can be used for protecting and for monitoring a protected object or equipment which allow a 1-phase current and voltage measurement or a zero-sequence voltage measurement via a 3-phase voltage measuring point. The function group also contains the operational measurement for the protected object or equipment (on this topic, see chapter 10 *Measured Values, Energy Values, and Supervision of the Primary System*).

5.2.2 Structure of the Function Group

The **Voltage-current 1-phase** function group has interfaces to the measuring points and the **Circuit-breaker** function group.

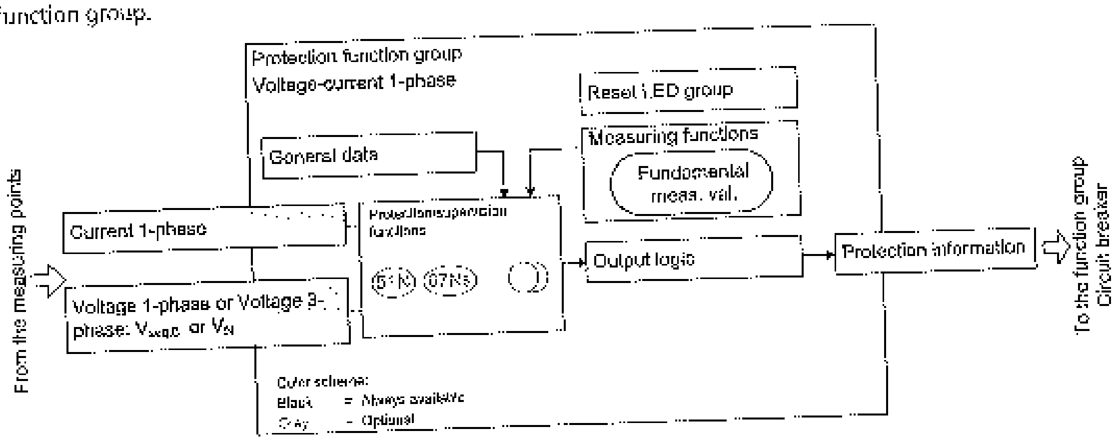


Figure 5-4 Structure of the Voltage-current 1-Phase Function Group

Interface with Measuring Points

You connect the **Voltage-current 1-phase** function group to the current and voltage measuring points via the interfaces to the measuring points. At least one measuring point has to be connected. The other is optional. This assignment can only be made in DIGSI via **Project tree → Function group connections**. To connect the interfaces, set a cross at the intersection between the row and column in the matrix.

The function group has the following interfaces to the measuring points:

- **1-phase current**

  The 1-phase current measured values are supplied via this interface.

  You can connect multiple measuring points with the **1-phase current** interface.

- 1-phase voltage or 3-phase voltage

  You can connect the voltage interface of the function group with a 1-phase or a 3-phase measuring point. The calculated zero-sequence voltage or the measured residual voltage are available for connection with a 3-phase measuring point. The phase-to-ground voltages are not available in the function group **Voltage-current 1-phase**. You can use both connection types at the same time.

  You configure the 1-phase voltage measuring points via the voltage interface (see the following figure).

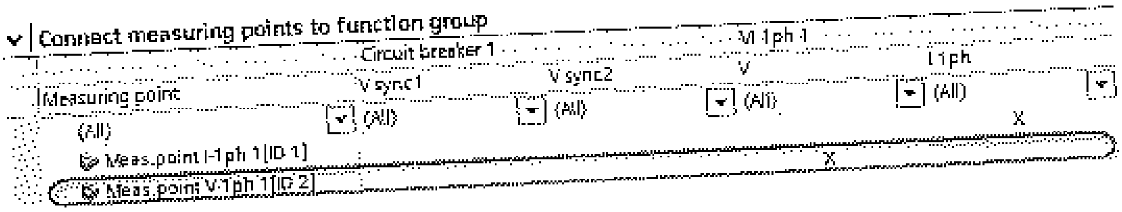


Figure 5-5 Connecting Measuring Points to the Voltage-current 1-Phase Function Group

The converted, calculated zero-sequence voltage or measured residual voltage from the 3-phase voltage system is available via the voltage interface (see following figure).

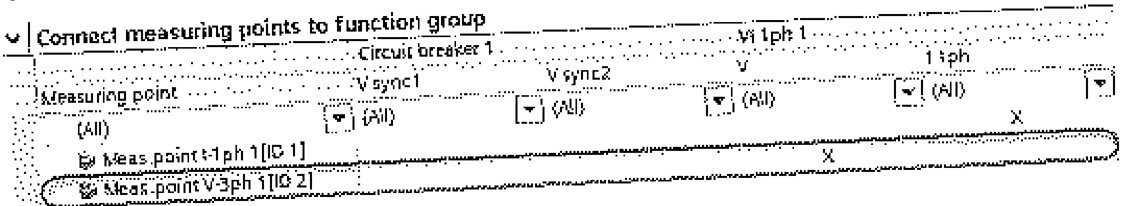


Figure 5-6 Connecting Measuring Points 3-Phase Voltage and 1-Phase Current to the 1-Phase Voltage-Current Function Group

You can connect the voltage interface with precisely one 3-phase voltage measuring point. 3 types of 3-phase voltage measuring-point connections are supported. With the different connection types, the type of voltage input also changes in line with the functions. The following table shows the characteristics of the voltage input depending on the types of connection.

Connection Type of the 3-Phase Voltage Measuring Point	Voltage Input
3 ph-to-gnd voltages	The zero-sequence voltage is calculated from the phase-to-ground voltages and used as a voltage input for all funtions.
3 ph-to-gnd volt. + VN	The residual voltage VN is converted to the voltage equivalent of the zero-sequence voltage. The converted voltage is used as a voltage input for functions.
3 ph-to-ph volt. + VN	

Interface to the Circuit-Breaker Function Group

All required data is exchanged between the protection and circuit-breaker function groups via the interface with the **Circuit-breaker** function group. In this example, the pickup and operate indications of the protection functions are exchanged in the direction of the Circuit-breaker function group.

You must connect the **Voltage-current 1-phase** function group with the **Circuit-breaker** function group. This assignment can only be made in DIGSI via **Project tree → Function group connections**. To connect the interfaces, set a cross at the intersection between the row and column in the matrix. If the interface is not connected, the functions operate as supervision functions in the **Voltage-current 1-phase function group**.

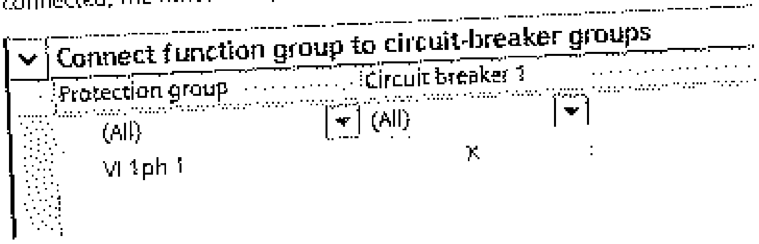


Figure 5-7 Connecting Voltage-current 1-Phase Function Group with Circuit-Breaker Function Group

Fundamental Components

The fundamental components are always present in the **Voltage-current 1-phase** function group and cannot be deleted.

The following table shows the fundamental components of the **Voltage-current 1-phase** function group:

Table 5-2 Fundamental Components of the Voltage-current 1-Phase Function Group

Measured Values		Primary	Secondary	% Referring to
I	1-phase current	A	A	**Rated operating current**
V[7]	1-phase voltage	kV	V	**Rated operating voltage**
V_0 [8]	Zero-sequence voltage	kV	V	**Rated operating voltage**/√3
V_N [9]	Residual voltage	kV	V	**Rated operating voltage**/√3

5.2.3 Application and Setting Notes

NOTE

Prior to creation of the protection functions in the function group, these functions should first be connected to the appropriate **Circuit-breaker** function group.

Parameter: Rated current

- Default setting (_:9451:101) **Rated current** = *1000 A*

The **Rated current** parameter is used to set the primary rated current. The **Rated current** specified here is the reference value for the percentage-measured values and setting values made in percentages.

Parameter: Rated voltage

- Default setting (_:9421:102) **Rated voltage** = *400.00 kV*

With the **Rated voltage** parameter, you set the primary voltage, which serves as a reference for all voltage-related % values within the **Circuit-breaker** function group.

5.2.4 Write-Protected Settings

The settings listed here are used primarily for understanding during configuration of the function groups. They are calculated on the basis of other settings and cannot be directly changed.

Addr.	Parameter	C	Range of Values	Default Setting
Rated values				
_:9421:104	General:rated apparent power		0.20 MVA to 5000.00 MVA	400.00 MVA
Network data				
_:91:214	General:M I-1ph uses measuring point ID		0 to 100	0
_:91:223	General: Scale factor M I-1ph		0.01 to 100.00	1.00

[7] The 1-phase voltage V is only visible if it is connected to a 1 phase voltage measuring point

[8] The zero-sequence voltage V0 is only visible if it is connected to a 3 phase voltage measuring point with the 3-phase phase-to-ground voltage connection type

[9] The residual voltage VN is only visible if it is connected to a 3-phase voltage measuring point with the 3-phase phase-to-ground voltage connection type + VN or 3-phase phase-to-phase voltage + VN

5.2.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Rated values				
_:9421:101	General:Rated current		1 A to 100000 A	1000 A
_:9421:102	General:Rated voltage		0.20 kV to 1200.00 kV	400.00 kV
Power-system data				
_:9421:214	General:MI-1ph uses MeasP with ID		0 to 100	0
_:9421:127	General:Number of Meas.point. 1ph		0 to 11	0

5.2.6 Information List

No.	Information	Data Class (Type)	Type
General			
_:9421:52	General:Behavior	ENS	O
_:9421:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Reset LED FG			
_:4741:500	Reset LED Group:>LED reset	SPS	I
_:4741:320	Reset LED Group:LED have been reset	SPS	O

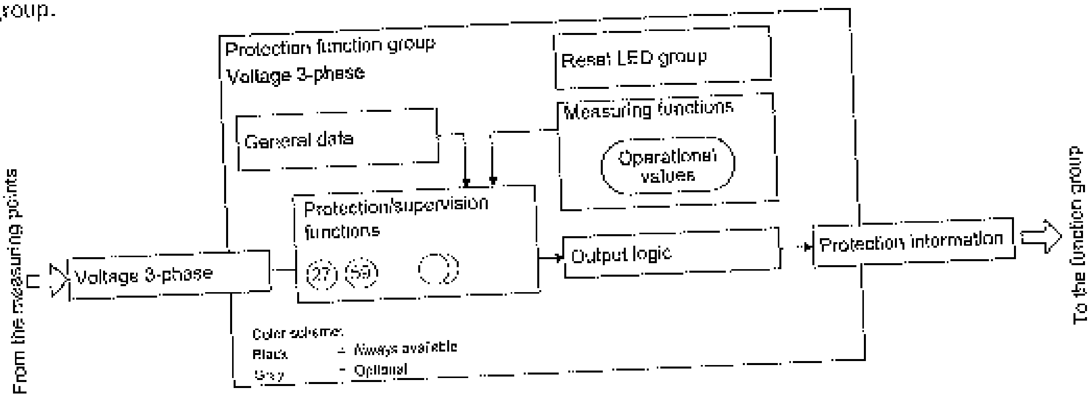
5.3 Function-Group Type Voltage 3-Phase

5.3.1 Overview

In the **Voltage 3-phase** function group, all functions can be used for protecting and for monitoring a protected object or equipment which allows a 3-phase voltage measurement. The function group also contains the operational measurement for the protected object or equipment (on this topic, see chapter *10 Measured Values, Energy Values, and Supervision of the Primary System*). Applicable functions are, for example, Voltage protection or Frequency protection.

5.3.2 Structure of the Function Group

The **Voltage 3-phase** function group has interfaces to the measuring points and the **Circuit-breaker** function group.

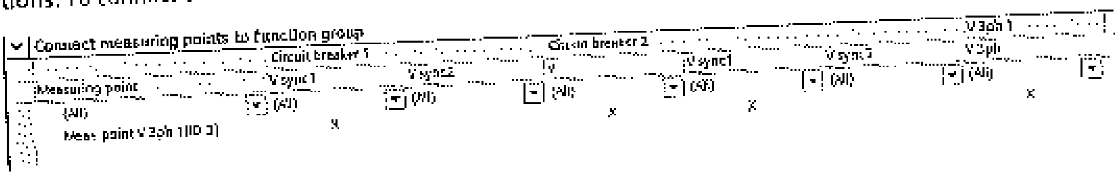


[dw_struct-FG-V3ph, 1, en_US]

Figure 5-8 Structure of the Voltage 3-Phase Function Group

Interface with Measuring Points

You connect the **Voltage 3-phase** function group to the voltage measuring points via the interface to the measuring points. This assignment can only be made in DIGSI via **Project tree → Function group connections**. To connect the interfaces, set a cross at the intersection between the row and column in the matrix.



[sc_Scan-100714-01, 1, en_US]

Figure 5-9 Connecting Measuring Points to the Voltage 3-Phase Function Group

If you add functions to the **Voltage 3-phase** function group, these are connected to the measuring point automatically.

You can connect multiple measuring points with this interface. You can find more information in chapter *6.48 Voltage Measuring Point Selection*.

The measurands from the 3-phase voltage system are supplied via the **V 3-ph** interface. Depending on the type of transformer connections, these are, for example, V_A, V_B, V_C, V_{gnd}. All values that can be calculated from the measurands are also provided via this interface.

Interface to the Circuit-Breaker Function Group

All required data is exchanged between the protection and circuit-breaker function groups via the interface with the **Circuit-breaker** function group. In this example, the pickup and operate indications of the protection functions are exchanged in the direction of the Circuit-breaker function group.

You must connect the **Voltage 3-phase** function group with the **Circuit-breaker** function group. This assignment can be made in DIGSI only via **Project tree → Connect function group**. To connect the interfaces, set a cross at the intersection between the row and column in the matrix.

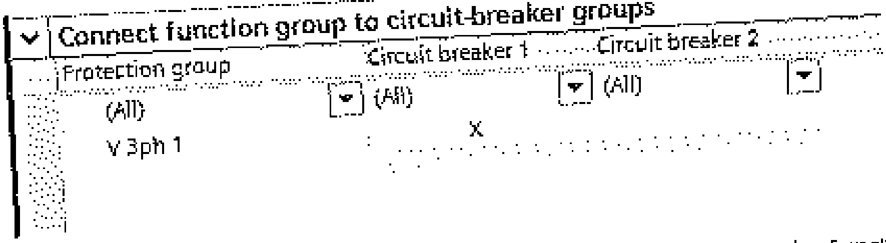


Figure 5-10 Connecting Voltage 3-Phase Function Group with Circuit-Breaker Function Group

Operational Measured Values

The operational measured values are always present in the **Voltage 3-phase** function group and cannot be deleted.

The following table shows the operational measured values of the **Voltage 3-phase** function group:

Table 5-3 Operational Measured Values of the Voltage 3-Phase Function Group

Measured Values		Primary	Secondary	% Referenced to
V_A, V_B, V_C	Phase-to-ground voltages	kV	V	Operating rated voltage of primary values/√3
V_{AB}, V_{BC}, V_{CA}	Phase-to-phase voltage	kV	V	Rated operating voltage of the primary values
V_0	Zero-sequence voltage	kV	V	Operating rated voltage of primary values/√3
V_{NG}	Neutral-point displacement voltage	kV	V	Operating rated voltage of primary values/√3
f	Frequency	Hz	Hz	Rated frequency

5.3.3 Application and Setting Notes

NOTE

Before creating the protection functions in the function group, you should first connect these functions to the appropriate **Circuit-breaker** function group.

Parameter: Rated voltage

- Default setting `(_:9421:102) Rated voltage` = *400.00 kV*

With the `Rated voltage` parameter, you set the primary rated voltage. The `Rated voltage` set here is the reference value for the percentage-measured values and setting values made in percentages.

5.3.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Rated values				
_:9421:102	General:Rated voltage		0.20 kV to 1200.00 kV	400.00 kV

5.3.5 Information List

No.	Information	Data Class (Type)	Type
General			
_:9421:52	General:Behavior	ENS	O
_:9421:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Reset LED FG			
_:4741:500	Reset LED Group:>LED reset	SPS	I
_:4741:320	Reset LED Group:LED have been reset	SPS	O

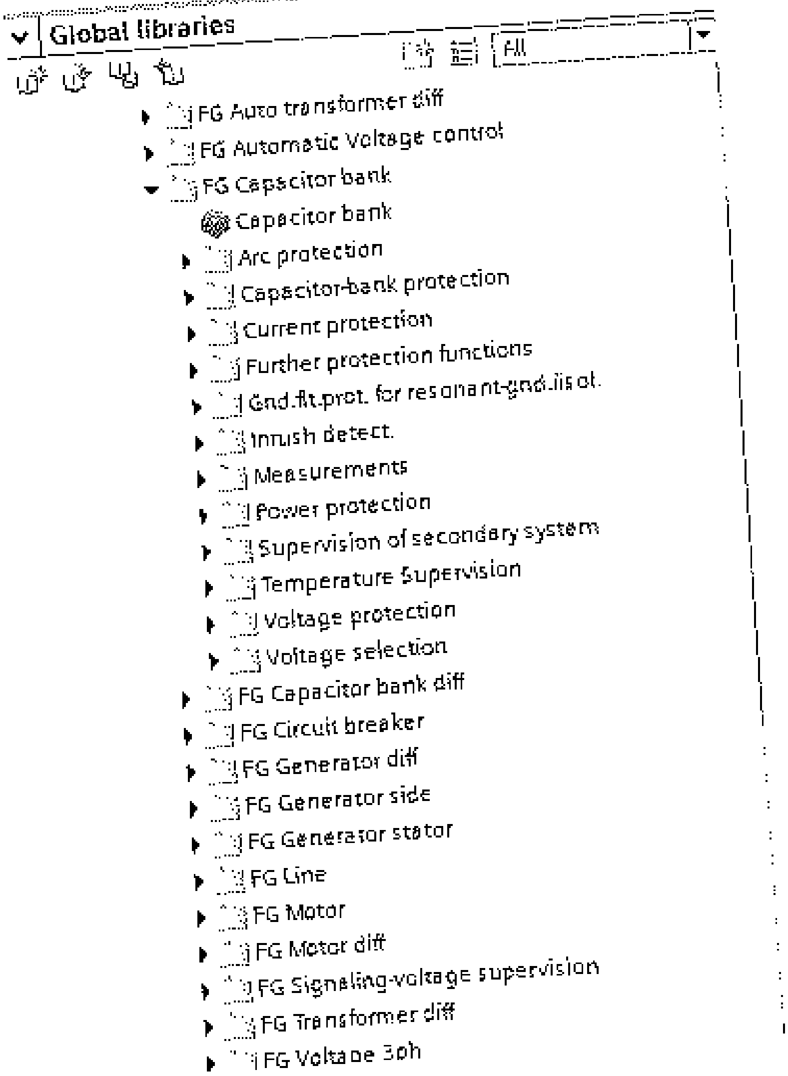
5.4 Function-Group Type Capacitor Bank

5.4.1 Overview

In the **Capacitor bank** function group, all the functions that are necessary for protecting and monitoring a capacitor bank can be used.

You can find the **Capacitor bank** function group under 7SJ82/7SJ85 device types in the Global DIGSI 5 Library. The **Capacitor bank** function group contains all of the protection and supervision functions that you can use for this device type.

Some of these functions are exclusively used for protecting capacitor banks, and others are universal standard functions which can be used for other protected objects as well. You find the exclusive protection functions in the directory **Capacitor-bank protection**.



[scfgcapb-250314-01, 2, en_US]

Figure 5-11 Capacitor Bank Function Group - Functional Scope for Device Type 7SJ85

For more information about the embedding of the functions in the device, refer to chapter 2. For information about the overall functional scope of the application templates for the various device types, refer to chapter 4.

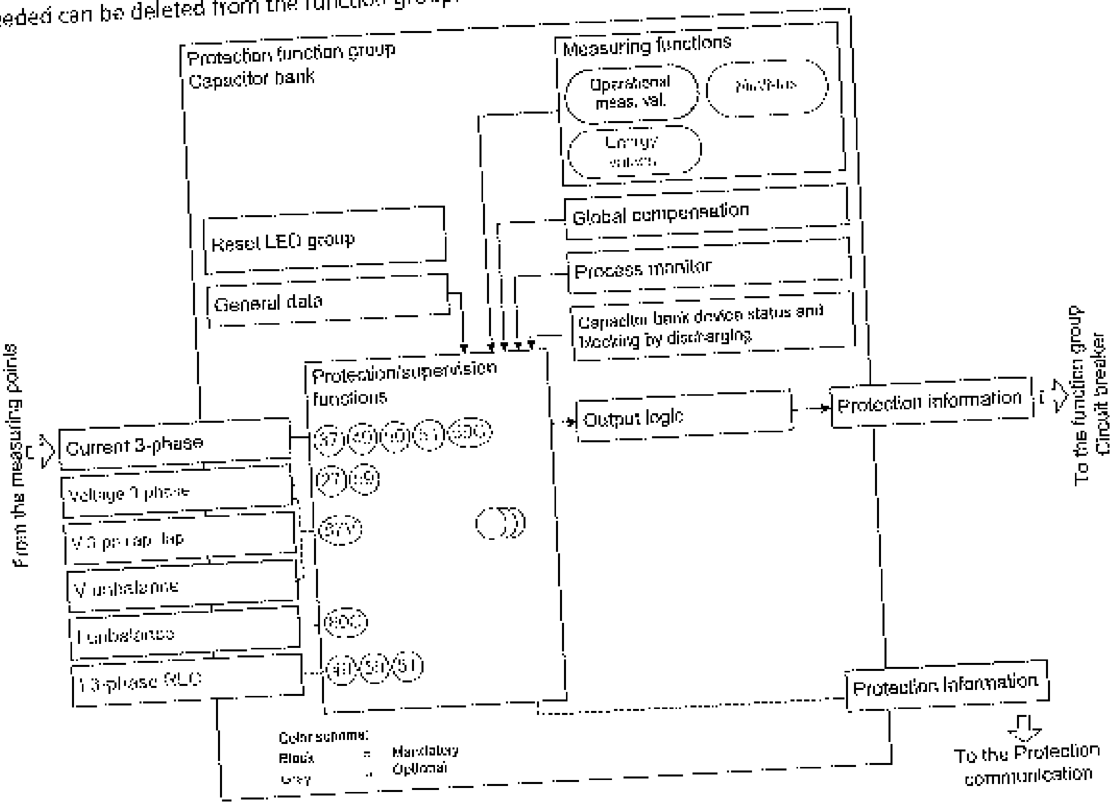
5.4.2 Structure of the Function Group

The **Capacitor bank** function group always contains the following functionality:

- Protected object/equipment data (function block **General**)
- Operational measured values
- Capacitor bank device status and blocking by discharging (function block **General**)
- Process monitor
- Global compensation (function block **General**)
- Output logic of the function group
- Reset LED group

This functionality is essential for the **Capacitor bank** function group, so it cannot be loaded or deleted.

You can load the protection functions and supervision functions required for your application in the **Capacitor bank** function group. The functions are available from the Global DIGSI 5 Library. Functions that are not needed can be deleted from the function group.



[illegible]

Figure 5-12 Structure of the Capacitor Bank Function Group

The **Capacitor bank** function group has interfaces with the following parts:

- **Measuring points**
- **Circuit-breaker** function group

Interfaces with the Measuring Points

The **Capacitor bank** function group receives the required measured values via the interfaces with the measuring points. If you are using an application template, the **Capacitor bank** function group is already connected to the specific measuring points.

You can find more detailed information in Chapter 2.

The **Capacitor bank** function group has the following 6 interfaces with the measuring points. The universal standard functions only work with the standard interfaces `3-phase current` and/or `3-phase voltage`; the other 4 interfaces are provided for the functions which are exclusively used for the capacitor banks. Please also refer to the example given below.

The **Capacitor bank** function group has the following interfaces with the measuring points:

- `3-phase current`:

  The measurands from the 3-phase current system are supplied via this interface. Depending on the connection type of the current transformers, the measurands can be for example I_A, I_B, I_C, I_N or $3I_0$. All values that can be calculated from the measurands are also provided via this interface.

  The **Capacitor bank** function group must always be connected to the **3-phase current measuring point**. You can connect the **3-phase current measuring point** interface to the maximum of two **3-phase current measuring points**. If 2 current measuring points have been connected to the 3 phase current interface, the total current is determined by adding the measured values from both measuring points in the function group. The functions in the **Capacitor bank** function group evaluate the total current.

- `3-phase voltage` (optional):

  The measurands from the 3-phase voltage system are supplied via this interface. Depending on the connection type of the voltage transformers, these can be for example V_A, V_B, V_C, V_N or $3V_0$. All values that can be calculated from the measurands are also provided via this interface.

  The connection of the **3-phase voltage** interface is optional. This connection is only required if protection functions or supervision functions are applied, which require voltage measurements.

- `3-phase voltage CB tap` (optional):

  The measurands of a 3-phase tap voltage within a capacitor bank are supplied via this interface.

  The connection of the **3-phase voltage CB tap** interface is optional. You can connect the 3-phase voltage CB tap interface to a maximum of one **3-phase voltage measuring** point.

- `Voltage unbalance` (optional):

  The unbalanced-voltage measurands (for example, an isolated neutral point of the capacitor bank) are supplied via this interface.

  The connection of the **voltage unbalance** interface is optional. You can connect the **voltage unbalance** interface to a maximum of one **1-phase voltage measuring points.**

- `Current unbalance` (optional):

  The unbalanced current measurands are supplied via this interface.

  The connection of the **current unbalance** interface is optional. You can connect the **current unbalance** interface to a maximum of two **3-phase current measuring points** and six **1-phase current measuring points.** The interface allows mixed connections to 3-phase current measuring point and 1-phase current measuring point; however the sum of the connections is no more than 6.

  For an overview which function are applicable on this interface, please refer to Figure 1 5.

- `3-phase current RLC` (optional)

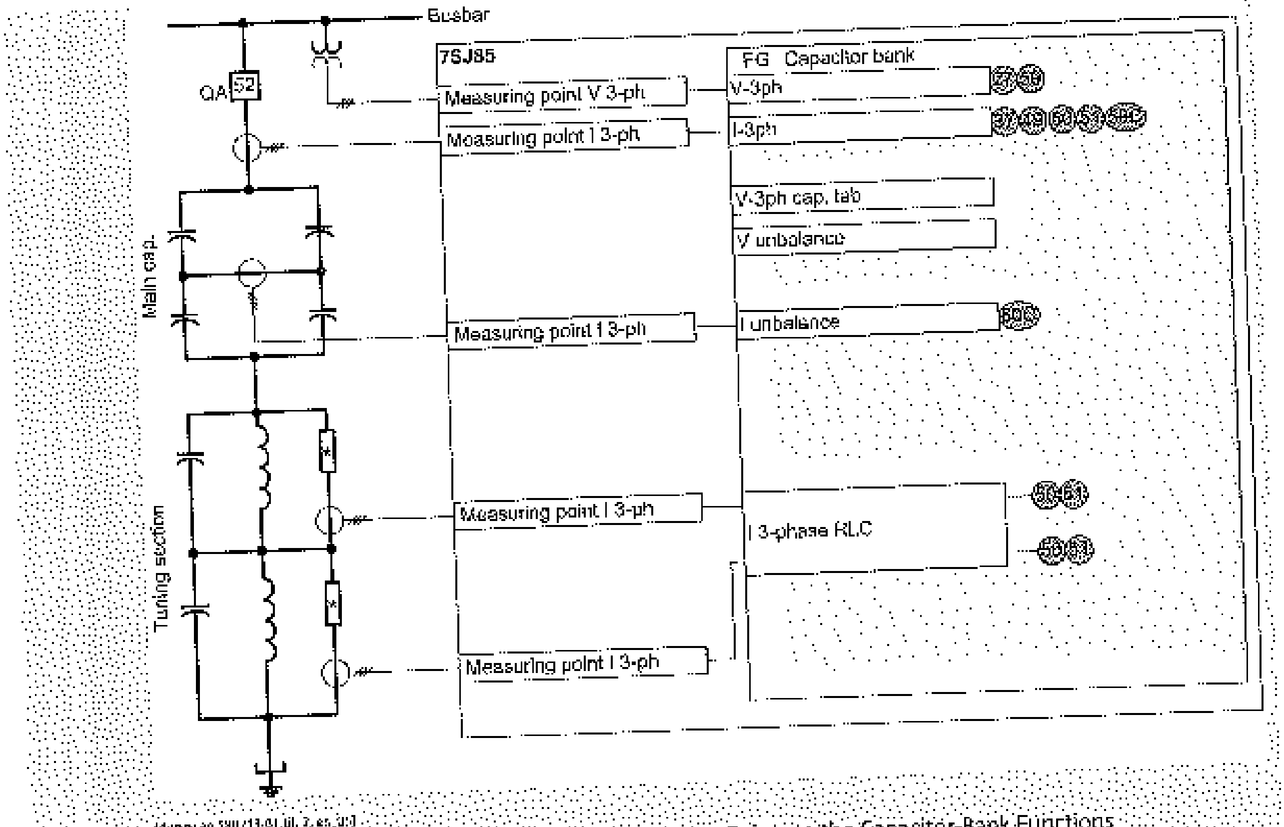
  The measurands from a tuning or filtering section (R, L, or C) of a capacitor bank are supplied via this interface.

  The connection of the **3-phase current RLC** interface is optional. You can connect the **3-phase current RLC** interface to a maximum of nine **3-phase current measuring points.**

  For an overview which function are applicable on this interface, please refer to *Figure 5-13*.

Example

The following figure shows an example of a capacitor in H-configuration and tuning section. In the single line, the primary current and voltage measurement are shown. The required device measuring points and their connections to the function group interfaces are shown as well. In addition, it is indicated which protection function receives its measuring value from which measuring point.



[dwasso ap 580/11-01.00, 2, en US]

Figure 5-13 An Example of Assignment of Measuring Points to the Capacitor-Bank Functions

You can connect the **Capacitor bank** function group to the current and voltage measuring points via interfaces. You make this assignment in DIGSI via **Project tree → Function group connections**. To connect the interfaces, set a cross at the intersection between the row and column in the matrix.

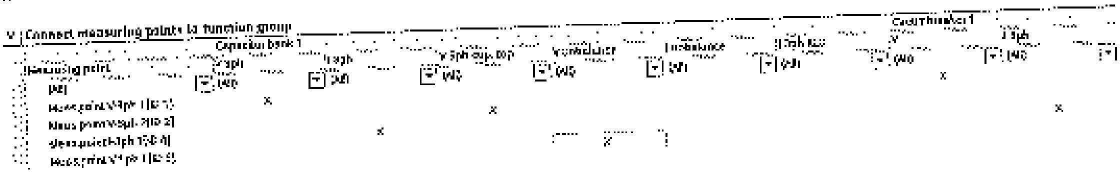
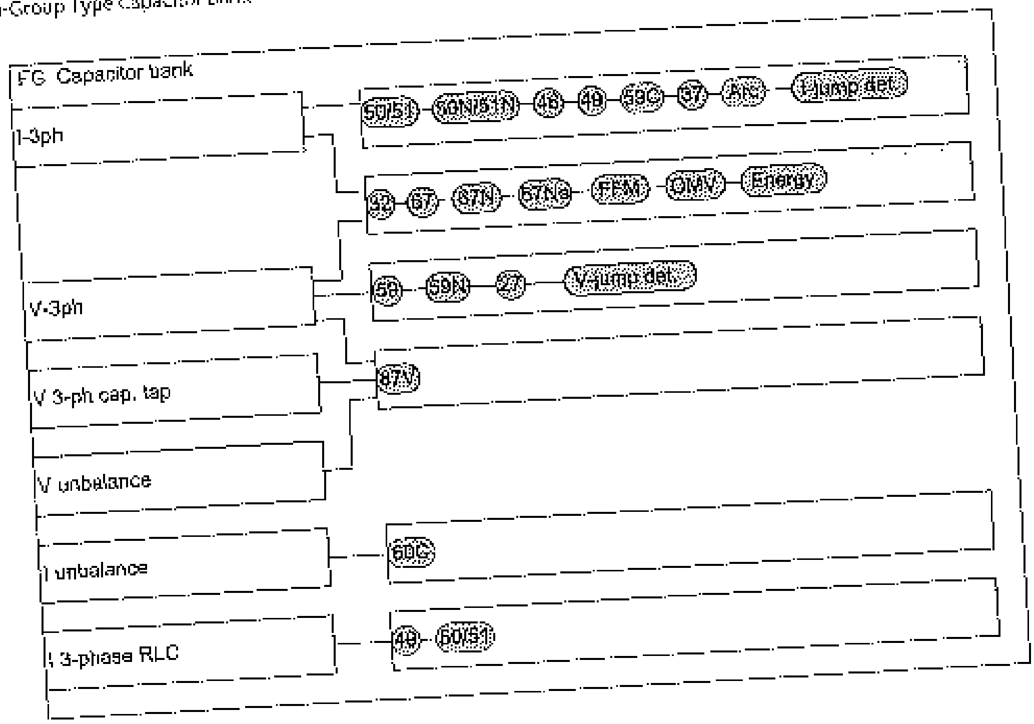


Figure 5-14 Connecting Measuring Points to the Capacitor Bank Function Group

For the protection functions applied on the interfaces **3-phase current** and **3-phase voltage**, if you add these functions to the **Capacitor bank** function group, these functions will automatically receive the measured values from the correct measuring points. If you add protection functions to the function group but the necessary interface is not connected to any measuring point, DIGSI 5 reports an inconsistency. Configure the measuring points in DIGSI 5 using the **Function group connections** editor.

For the protection functions applied on the interfaces **Current unbalance** and **3-phase current**, you have to select the desired measuring points via a setting `MP selection`, which offers a list of all measuring points connected to the specific interface. The setting `MP selection` is located on the setting page of the protection function.

The following figure shows an overview of the protection functions and the interface assignment in the **Capacitor bank** function group.



27	Undervoltage protection
32	General power protection
37	Undercurrent protection
46	Negative-sequence protection
49	Overload protection
50/51	Overcurrent protection, phases
50N/51N	Overcurrent protection, ground
59	Overvoltage protection
59C	Peak overvoltage protection
59N	Overvoltage protection with zero-sequence voltage/residual voltage
60C	Current-unbalance protection
67/67N	Directional overcurrent protection for ground faults
67Ns	Directional sensitive ground-fault detection
87V	Voltage-differential protection
OMV	Operational values
FFM	Fuse-failure monitor

[CapacBank 180413 01.4.en US]

Figure 5-15 Overview of the Protection Functions and Interface Assignment in the Capacitor Bank Function Group

Interfaces with Circuit-Breaker Function Group

All required data are exchanged between the protection function group and the **Circuit-breaker** function group via the interface with the **Circuit-breaker** function group. These data include, for example, the pickup and operate indications of the protection functions sent in the direction of the **Circuit-breaker** function group and, for another example, the information about the circuit-breaker condition sent in the direction of the protection function group.

The **Capacitor bank** function group is connectable to a **Circuit-breaker** function group. This connection generally determines:

- Which circuit breaker is activated by the protection functions of the **Capacitor bank** function group
- Starting of the **Circuit-breaker failure protection** function (if available in the **Circuit-breaker** function group) through the protection functions of the connected **Capacitor bank** function group
- Starting of the **Automatic reclosing** function (if available in the **Circuit-breaker** function group) through the protection functions of the connected **Capacitor bank** function group

NOTE

For capacitor bank protection, the **Automatic reclosing** function is not applied in most cases. However, due to flexibility and standardization, the respective interface is offered.

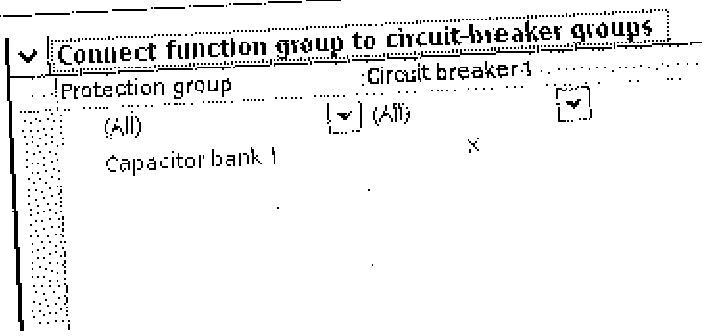


Figure 5-16 Connecting Capacitor Bank Function Group with Circuit-Breaker Function Group

Besides the general assignment of the **Capacitor bank** function group to the **Circuit-breaker** function group, you can also configure the interface for certain functionalities in detail. Configure the details in DIGSI 5 using the **Circuit breaker interaction** editor in the Capacitor bank function group.

In the detailed configuration of the interface, define:

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

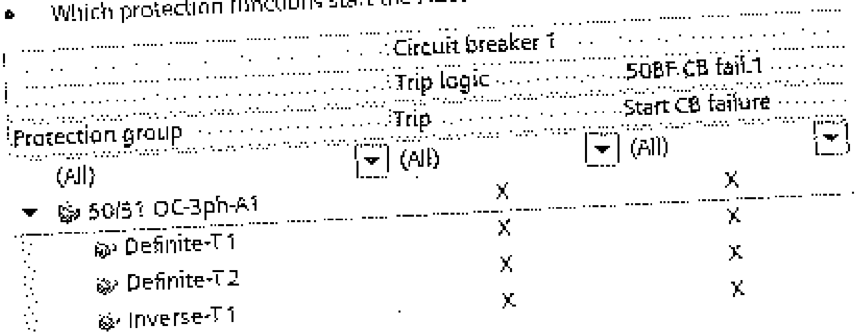


Figure 5-17 Connecting Protection Functions and Stage Using the Circuit-Breaker Interaction Editor

If an application template is used, the function groups have already been connected to each other because this link is essential to ensure proper operation. You can modify the link in DIGSI 5 using the **Function-group connections** editor.

You can find more information in chapter *2.1 Function Embedding in the Device*. If this link is missing, DIGSI 5 reports an inconsistency.

Protected Object/Equipment Data (FB General)

Capacitor-bank rated and reference data are defined as well as further protected object/equipment data. The data applies for all functions in the **Capacitor bank** function group.

For further information, refer to chapter *5.4.3 Application and Setting Notes*.

Capacitor Bank Device Status and Blocking by Discharging (FB General)

The functionality detects whether a capacitor bank is **online** or **offline**. When the status of the capacitor bank changes from **online** to **offline**, the signal *Discharge* is issued during the capacitor-bank discharging time.

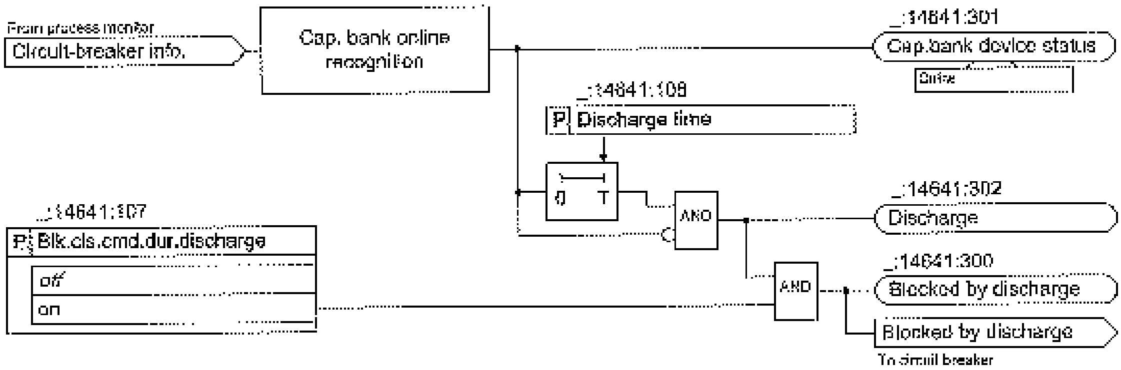


Figure 5-18 Logic Diagram of Capacitor Bank Device Status and Blocking by Discharging

The device can block the closing of the circuit breaker automatically when a capacitor bank discharges. The configuration is made with the parameter **Blk.cls.cmd.dur.discharge**. If the parameter **Blk.cls.cmd.dur.discharge** is set to *on*, the device generates a trip/open command during the discharge time and blocks closing commands additionally, see the following figure. This blocking condition is signaled via the message *Blocked by discharge*.

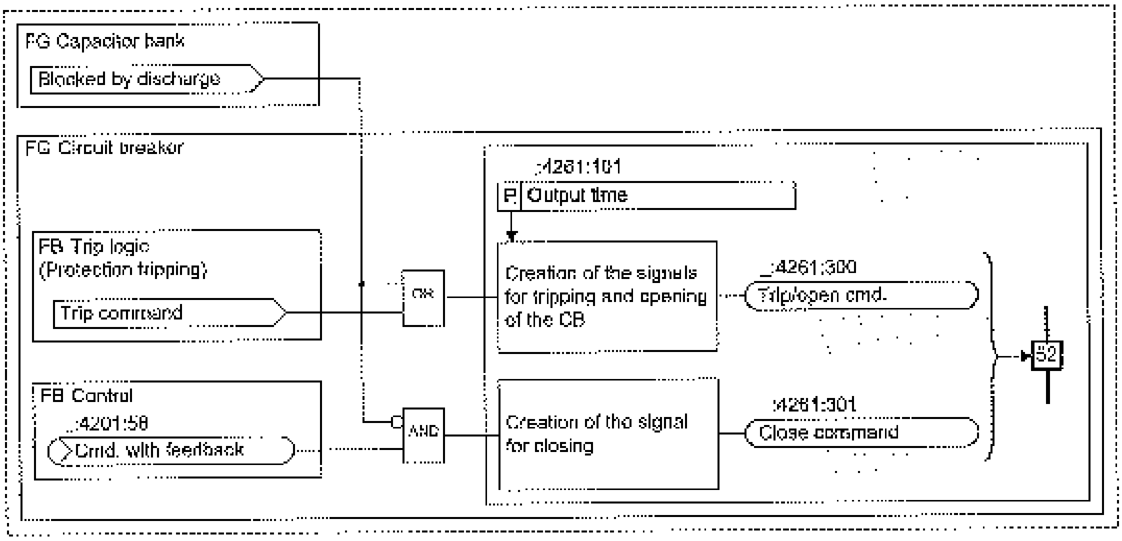


Figure 5-19 Logic Diagram of Processing the Blocked by Discharge Signal

Global Compensation (FB General)

The **Global compensation** function block provides the binary input signal *>Compensate* to carry out the manual compensation for all functions in the FG using compensated measuring values.

In addition, the binary input signal *>Reset comp. val.* is provided to reset all compensation values for the functions using compensated measuring values.

Process Monitor

The **Process monitor** detects the current state of the protected object. It is always present in the function group and cannot be removed.

For detailed description of the **Process monitor**, refer to *5.8.1 Overview of Functions*.

Reset LED Group

The **Reset LED group** function block allows you to reset only the stored LEDs of the functions contained in the respective function group, while stored LEDs activated from functions in other function groups remain active.

For more information refer to chapter *3.1.10 Resetting Stored Indications of the Function Group* .

Operational, Fundamental, Symmetrical Components Measurements

The operational fundamental, symmetrical components and functional measurements are always available in the **Capacitor bank** function group and cannot be deleted.

Table 5-4 Operational Measured Values (True RMS) of the Function Group Capacitor Bank

Measured Values		Primary	Secondary	% Referenced to
I_A, I_B, I_C	Phase currents	A	A	Rated operating current of the primary system
I_N	Neutral-point phase current	A	A	Rated operating current of the primary system
$3I_0$	Residual current	A	A	Rated operating current of the primary system
V_A, V_B, V_C	Phase-to-ground voltages	kV	V	Rated operating voltage of the primary system/√3
V_{AB}, V_{BC}, V_{CA}	Phase-to-phase voltage	kV	V	Rated operating voltage of the primary system
V_0	Zero-sequence voltage	kV	V	Rated operating voltage of the primary system/√3
V_{NG}	Neutral-point displacement voltage	kV	V	Rated operating voltage of the primary system/√3
f	Frequency	Hz	Hz	Rated frequency
P_{tot}	Active power (total power)	MW	–	Rated operating voltage and rated operating current of the primary system $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
Q_{tot}	Reactive power (total power)	MVAr	–	Rated operating voltage and rated operating current of the primary system $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
S_{tot}	Apparent power (total power)	MVA	–	Rated operating voltage and rated operating current of the primary system $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
Cos φ	Active factor	(abs)	(abs)	100 % corresponds to cos φ = 1
P_A, P_B, P_C	Phase-related active power	MW	–	Apperent power of the phase $V_{rated\ Lx} \cdot I_{rated\ Lx}$
Q_A, Q_B, Q_C	Phase-related reactive power	MVAr	–	Apparent power of the phase $V_{rated\ Lx} \cdot I_{rated\ Lx}$
S_A, S_B, S_C	Phase-related apparent power	MVA	–	Apparent power of the phase $V_{rated\ Lx} \cdot I_{rated\ Lx}$

Table 5-5 Fundamental and Symmetrical Components Measurement Values of the Function Group Capacitor Bank

Measured Values		Primary	Secondary	% Referenced to
I_A, I_B, I_C	Phase currents	A	A	Rated operating current of the primary system

Measured Values		Primary	Secondary	% Referenced to
I_N	Neutral-point phase current	A	A	Rated operating current of the primary system
$I_{seq:0}$	Zero-sequence current	A	A	Rated operating current of the primary system
$I_{seq:1}$	Positive-sequence current	A	A	Rated operating current of the primary system
$I_{seq:2}$	Negative-sequence current	A	A	Rated operating voltage of the primary system
V_A, V_B, V_C	Phase-to-ground voltages	kV	V	Rated operating voltage of the primary system/√3
V_{AB}, V_{BC}, V_{CA}	Phase-to-phase voltage	kV	V	Rated operating voltage of the primary system
V_N	Neutral-point phase voltage	kV	V	Rated operating voltage of the primary system/√3
$V_{seq:0}$	Zero-sequence voltage	kV	V	Rated operating voltage of the primary system/√3
$V_{seq:1}$	Positive-sequence voltage	kV	V	Rated operating voltage of the primary system/√3
$V_{seq:2}$	Negative-sequence voltage	kV	V	Rated operating voltage of the primary system/√3

Voltage and power measurements are only available if **V-3ph measuring point** connected to the **Capacitor bank** function group.

The energy measurements are not predefined. If required, they must be loaded from the Global DIGSI 5 Library.

Inversion of Power-Related Measured and Statistical Values (FB General)

The following values calculated in operational measured values are defined positively in the direction of the protected object.

- Power
- Power factor
- Energy
- Minimum, maximum values of the power
- Average values of the power

With the **P, Q sign** setting, you can invert the sign of these operational measured values such that a power flow from the line to the busbar is displayed positively.

More information can be found in Chapter 10.1 *Overview of Functions*.

Output Logic

The output logic treats the pickup and operate indications of the protection functions and supervision functions in the **Capacitor bank** function group separately, in a pickup logic and an output logic respectively. The pickup and output logics generate the group indications of the function group. These group indications are transferred to the **Circuit-breaker** function group via the **protection-information** interface and are processed further there.

The pickup and operate indications of the protection functions and the supervision functions in the **Capacitor bank** function group are combined according to the following figures of group indications.

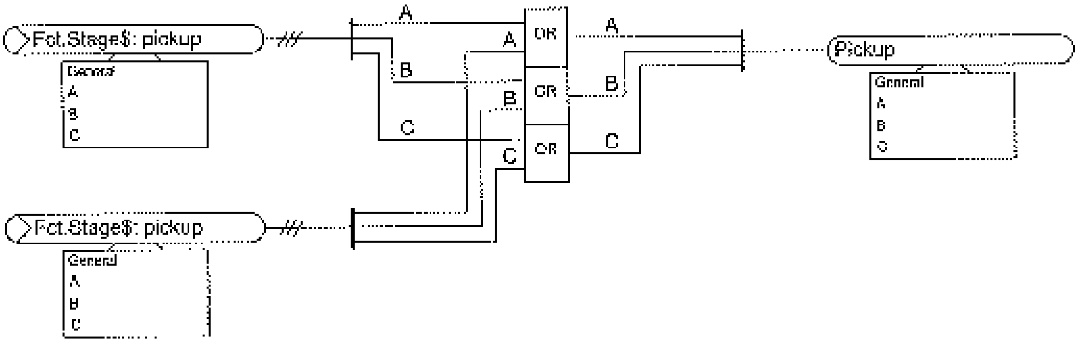


Figure 5-20 Generation of the Pickup Indication of the Capacitor Bank Function Group

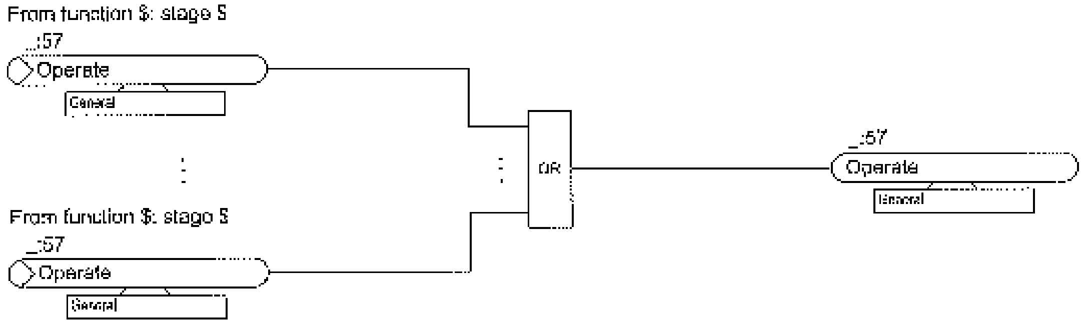


Figure 5-21 Generation of the Operate Indication of the Capacitor Bank Function Group

5.4.3 Application and Setting Notes

Interface to Circuit-Breaker Function Group

The **Capacitor bank** protection function group is linked to one **Circuit-breaker** function group. This **Circuit-breaker** function group is assigned to the circuit breaker of the capacitor bank.

Protected Object/Equipment Data (FB General)

The following application and setting notes apply for the general data. The data are configured in the function block **General** of the **Capacitor bank** function group and apply for all functions in the function group.

Parameter: `Capacitor reference curr.`

- Default setting (_:14641:101) `Capacitor reference curr.` = *1000 A*

With the `Capacitor reference curr.` parameter, you set the reference current for the capacitor bank to be protected. This `Capacitor reference curr.` specified here is the reference value for the percentage-measured values and setting values made in percentages.

Depending on the user philosophy, the reference value could be the capacitor-bank rated current, which includes harmonics, or the capacitor-bank fundamental current.

Parameter: `Capacitor reference volt.`

- Default setting (_:14641:102) `Capacitor reference volt.` = *400.00 kV*

With the parameter `Capacitor reference volt.`, you set the reference voltage of the capacitor bank to be protected. This `Capacitor reference volt.` specified here is the reference value for the percentage-measured values and setting values made in percentages.

Depending on the user philosophy, the reference value could be the system rated voltage (bus voltage), or the capacitor rated voltage

Parameter: `Capacitor element type`

- Default setting (_:14641:106) `Capacitor element type` = *fused*

With the parameter `Capacitor element type`, you set if the capacitor elements contain internal fuses or not. This information is required in the current-unbalance protection for the fault position annunciation.

Parameter: `Blk.cls.cmd.dur.discharge`

- Default setting (_:14641:107) `Blk.cls.cmd.dur.discharge` = *off*

With the parameter `Blk.cls.cmd.dur.discharge`, you set whether closing of the circuit breaker is blocked automatically or not when a capacitor bank discharges.

NOTE

If the parameter `Blk.cls.cmd.dur.discharge` is set to *on*, the device generates a trip/open command during the discharge time.

Parameter: `Discharge time`

- Default setting (_:14641:108) `Discharge time` = *300 s*

With the parameter `Discharge time`, you define capacitor-bank discharging duration. You get the value from the capacitor manufacturer.

Parameter: `Cap.-bank neutral point`

- Default setting (_:14641:109) `Cap.-bank neutral point` = *isolated*

With the parameter `Cap.-bank neutral point`, you can specify whether the neutral point of capacitor bank is *isolated* or *grounded*. This information is required when applying the function **87V voltage differential protection**.

Parameter: `P, Q sign`

- Default setting (_:14611:158) `P, Q sign` = *not reversed*

The power and energy values are defined by the manufacturer such that power in the direction of the protected object is considered positive. You can also define the power output by the protected object as positive. With the `P, Q sign` parameter, you can invert the sign for these components. This inversion does not influence any protection function.

5.4.4 Write-Protected Settings

The settings listed here are primarily to aid understanding when configuring the function groups. They are calculated as a function of other settings and cannot be changed directly.

Addr.	Parameter	C	Setting Options	Default Setting
Rated values				
_:14641:103	General:Rated apparent power		-1.00 MVA to -1.00 MVA	0.00 MVA

NOTE

You can find more detailed information on the Process monitor in Chapter 5.7.1 Overview .

5.4.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Rated values				
_:14641:101	General:Capacitor reference curr.		1 A to 100000 A	1000 A
_:14641:102	General:Capacitor reference volt.		0.20 kV to 1200.00 kV	400.00 kV
Cap.bank data				
_:14641:106	General:Capacitor element type		• fused • unfused	fused
_:14641:107	General:Blk.cls.cmd.dur. discharge		• off • on	off
_:14641:108	General:Discharge time		1 s to 1200 s	300 s
_:14641:109	General:Cap.-bank neutral point		• grounded • isolated	isolated
Measurements				
_:14611:158	Further settings:P, Q sign		• not reversed • reversed	not reversed

5.4.6 Information List

No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Reset LED Group			
_:7381:500	Reset LED Group:>LED reset	SPS	I
_:7381:320	Reset LED Group:LED have been reset	SPS	O
General			
_:14641:500	General:>Compensate	SPS	I
_:14641:501	General:>Reset comp. val.	SPS	I
_:14641:300	General:Blocked by discharge	SPS	O
_:14641:302	General:Discharge	SPS	O
_:14641:301	General:Cap.bank device status	SPC	C

5.5 Function-Group Type Capacitor Bank Differential Protection

5.5.1 Function-Group Types

In the following graphic, you can see the structural association of the function-group types to the **Capacitor bank differential protection**.

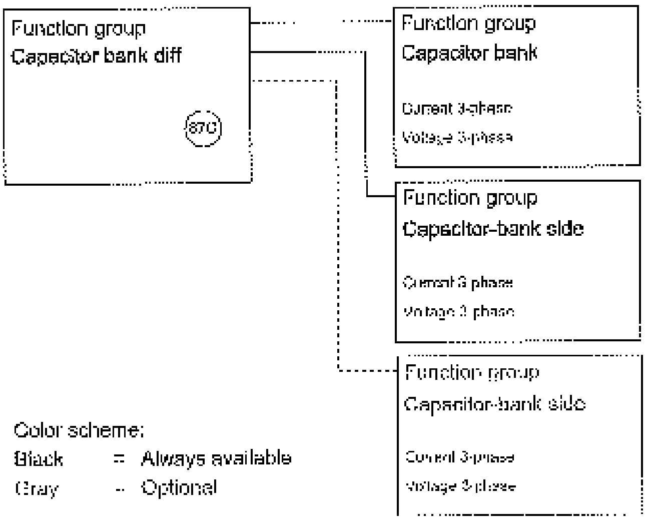


Figure 5-22 Function-Group Types Capacitor Bank Diff

The following function-group types are summarized in the Global DIGSI 5 library: Motor diff

- **Capacitor bank diff**
- **Capacitor bank side**

You can find the description of the function group**Capacitor bank** in chapter *5.4.1 Overview*.

The individual function-group types are stored in the **Capacitor bank diff function group** folder and can be selected. In the protection function folders, you find all protection functions which are operational in each function group. A **Capacitor bank diff** function group always includes the **Capacitor bank** and **Capacitor bank side** function groups. In total, you can assign a maximum of 3 function groups **Capacitor bank** or **Capacitor bank side** to the **Capacitor bank diff** function group.

The following table shows you the number of function-group types that can be instantiated for device 7SJ85.

Table 5-6 Function-Group Types in the Device

Device	Function-Group Type		
	Capacitor Bank Diff	Capacitor Bank	Capacitor Bank Side
7SJ85	Max. 2	Max. 9	Max. 9

Interconnection of the function groups is necessary so that the capacitor bank differential protection functions properly. The **Circuit-breaker** function group is not listed.

Table 5-7 Assignment of Protection Function Groups to Protection Function Groups

	Capacitor Bank Diff 1
	Side (2 to 3)
Capacitor bank	X
Capacitor bank side 1	X

	Capacitor Bank Diff 1 Side (2 to 3)
Capacitor bank side 2	x

The individual function-group types are described in the following.

5.5.2 Function-Group Type Capacitor Bank Diff

5.5.2.1 Overview

The **Capacitor bank diff.** function group contains the differential protection function and protection-function-relevant measured values.

You can find more information in the chapter *10 Measured Values, Energy Values, and Supervision of the Primary System* .

You will find the corresponding function groups and the folders with the usable protection functions in the Global DIGSI library under each device type. In the **Capacitor bank diff.** function group, you can load only the differential protection functions.

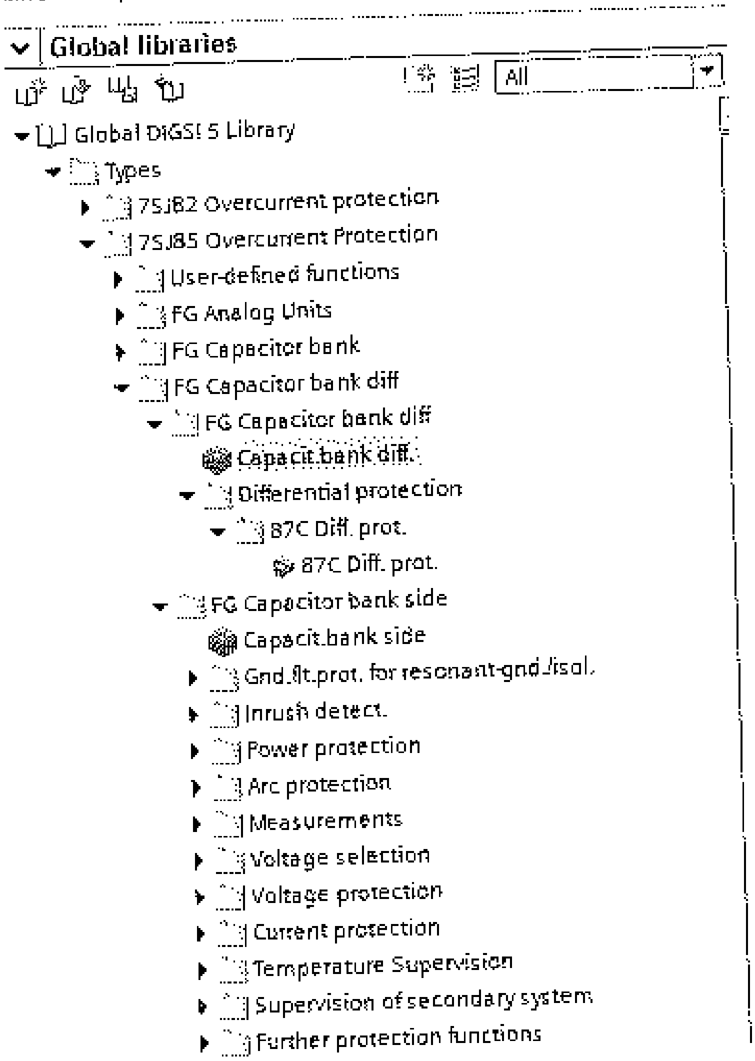


Figure 5-23 Function Group Capacitor Bank Diff. - Functional Scope

For more information about the embedding of the functions in the device, refer to chapter *2 Basic Structure of the Function* . For application templates of the various device types, refer to chapter *4 Applications* .

5.5.2.2 Structure of the Function Group

The **Capacitor bank diff.** function group, according to *5.5.2.1 Overview* , has interfaces with the **Capacitor bank**, the **Capacitor bank side**, and the **Circuit-breaker** function groups. The **Capacitor bank diff.** function group contains the function blocks:

- Protection function (execution of the differential protection function)
- Trip logic (generation of forwarding of the operate indication)

In the **Capacitor bank diff.** function group, the differential protection function must always be available so that the protection functionality can be ensured. If you do not use an application template, load the differential protection function from the Global DIGSI library.

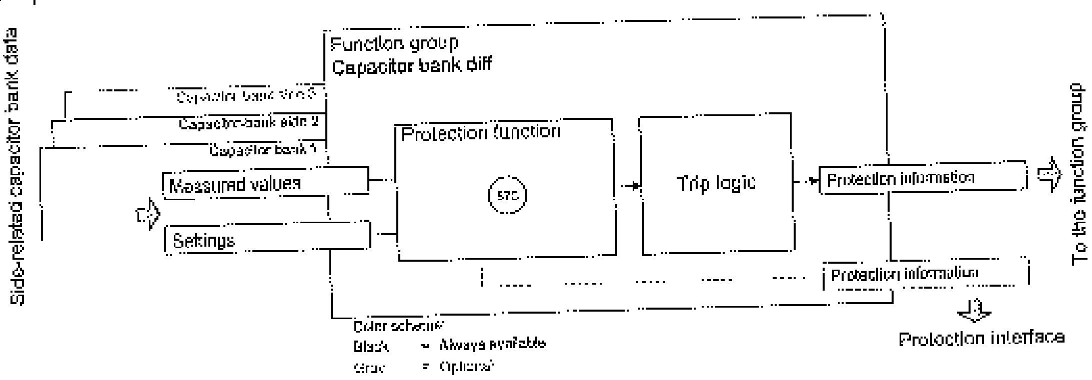


Figure 5-24 Structure of the Capacitor Bank Diff. Function Group

The **Capacitor bank diff.** function group has interfaces to the following components:

- Function group **Capacitor bank**
- Function group **Capacitor bank side**
- **Circuit-breaker** function group

Interfaces with the Circuit-Breaker Function Group

The interface with the **Circuit-breaker** function group is used to exchange all required data between the protection function group and the **Circuit-breaker** function group. The following data is required:

- Pickup and operate indications of the protection functions in the direction of the Circuit-breaker function group
- Information on the circuit-breaker condition in the direction of the Protection function groups

You can connect the **Capacitor bank diff.** function group to one or more **Circuit-breaker** function groups. This connection determines the following:

- Which circuit breakers are activated by the protection functions of the **Capacitor bank diff.** function group
- Start of the **Circuit-breaker failure protection** function, if available in the **Circuit-breaker** function group, through the protection functions of the connected **Capacitor bank diff.** function group

Besides the general assignment of the **Capacitor bank diff.** function group to the **Circuit-breaker** function group, you can also configure the interface for specific functionalities in detail. Configure the details in DIGSI 5 via the **Circuit-breaker interaction** Editor in the **Capacitor bank side diff.** function group.

For the detail configuration of the interface, define the following:

- Which operate indications of the protection functions are included when the trip command is generated
- Which protection functions activate the **Circuit-breaker failure protection** function

If an application template is used, the function groups are connected to each other because this link is absolutely essential to ensure proper operation. You can modify the connection in DIGSI 5 via the **Function-group connections** Editor. If the connection is missing, DIGSI 5 reports an inconsistency.

You can find more detailed information in chapter *2.1 Function Embedding in the Device* .

Resetting the LED Group

Using the **Reset the LED group** function, you can reset the stored LEDs of the functions in one specific function group while the activated, stored LEDs of other functions in other function groups remain activated.

Interface with Protection Communication (optional)

All required data is exchanged between the protection function group and the protection communication via the interface with **Protection communication**. These are for example:

- Binary signals
- Measured values
- Complex data

You can find more detailed information in chapter *3.5 Protection Communication* .

Capacitor-Bank Data (General)

The capacitor-bank data characterizes the data of the capacitor bank to be protected. The data relevant for the differential protection is shown. The **Capacitor bank diff.** function group takes the data from the coupled function groups **Capacitor bank** and **Capacitor bank side**.

Output Logic

The output logic treats the pickup and trip signals of the protection and supervision functions in the function group separately. Pickup logic and output logic are each assigned to the signals. The pickup and output logic generate the overarching indications (group indications) of the function group. These group indications are transferred via the **Protection-information** interface to the **Circuit-breaker** function group and are processed further there.

The pickup and operate indications of the protection and supervision functions in the **Capacitor bank diff.** function group are combined into one group indication using the following numbers and outputs.

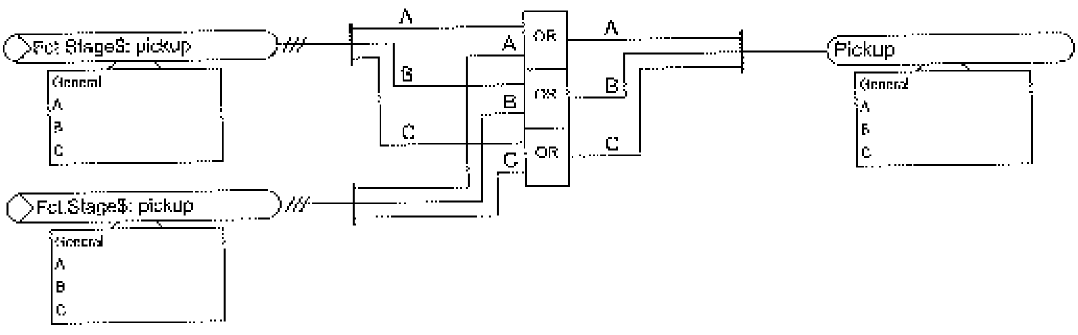
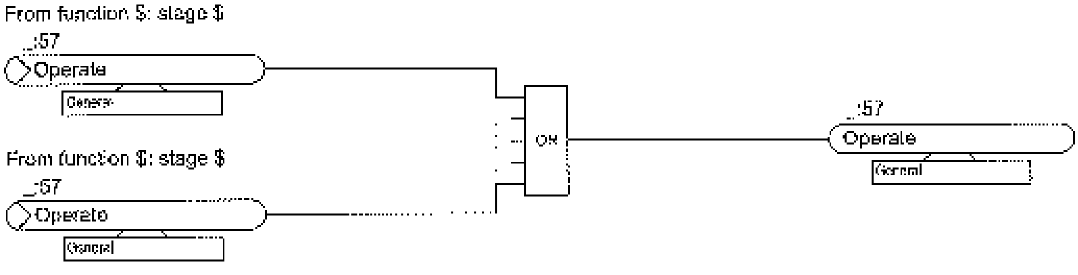


Figure 5-25 Generation of Pickup Indication of the Capacitor Bank Diff. Function Group



[sv]gepi: 231513-01.vsd, 2, en_US]

Figure 5-26 Generation of Operate Indication of the Capacitor Bank Diff. Function Group

5.5.2.3 Information List

No.	Information	Data Class (Type)	Type
General			
_:91:52	General:Behavior	ENS	O
_:91:53	General:Health	ENS	O
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Reset LED Group			
_:7381:500	Reset LED Group:>LED reset	SPS	I
_:7381:320	Reset LED Group:LED have been reset	SPS	O

5.5.3 Function-Group Type Capacitor Bank Side

5.5.3.1 Overview

In the **Capacitor bank side** function group, all of the functions that are necessary for protecting and supervising a capacitor bank side can be used. The **Capacitor bank side** function group also contains the measuring functions.

You can find more information in chapter *10 Measured Values, Energy Values, and Supervision of the Primary System*.

The **Capacitor bank side** function group must always have interfacing to the **Capacitor bank diff.** function group.

You will find the corresponding function groups and the folders with the usable protection functions in the Global DIGSI library under each device type. Depending on the connected measuring points, you can load the respective protection and supervision functions in the **Capacitor bank side** function group. The functions are described in chapter *6 Protection and Automation Functions* .

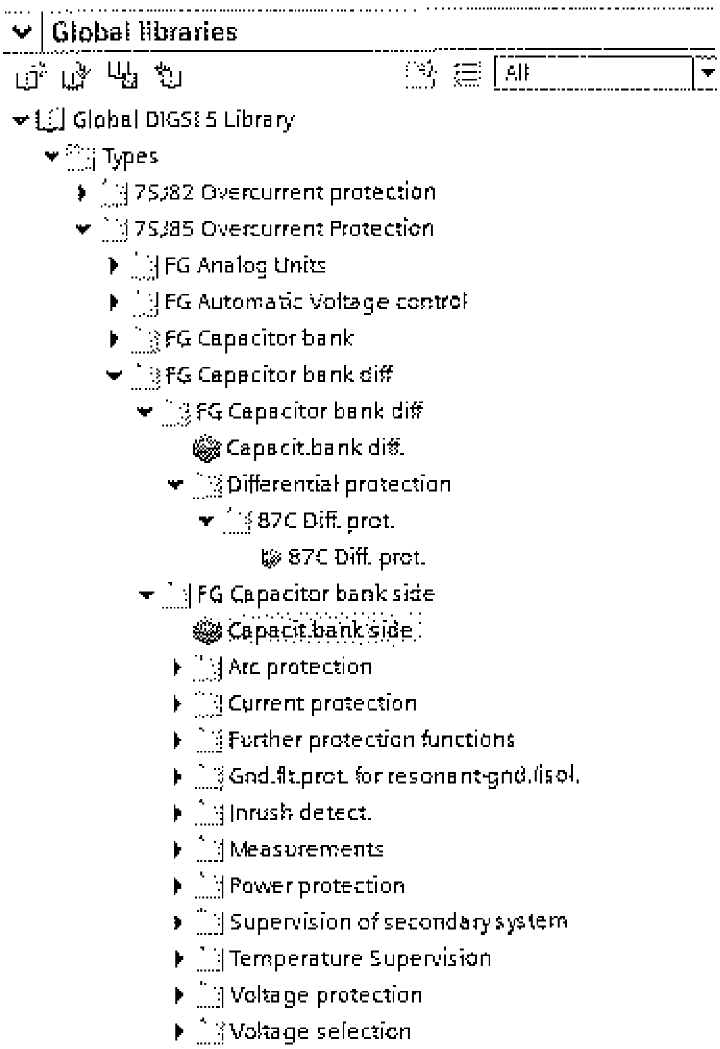


Figure 5-27 Capacitor Bank Side Function Group - Functional Scope

For more information about the embedding of the functions in the device, refer to chapter *2 Basic Structure of the Function* . For application templates for the various device types, refer to chapter *4 Applications* .

5.5.3.2 Structure of the Function Group

The **Capacitor bank side** function group always contains the following function blocks:

- Side-dependent capacitor-bank data
- Operational measured values
- Process monitor
- Output logic of the function group

These blocks are required for the **Capacitor bank side** function group and therefore cannot be loaded or deleted.

You can load the protection and supervision functions required for your application in the **Capacitor bank side** function group. The functions are available in the Global DIGSI 5 library. Functions that are not needed can be deleted from the function group.

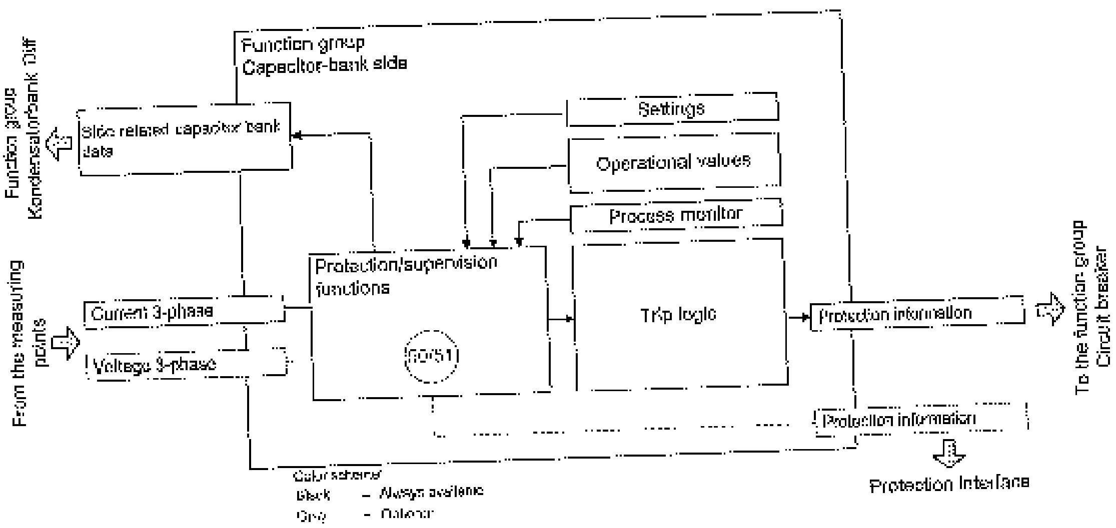


Figure 5-28 Structure of the Capacitor Bank Side Function Group

The **Capacitor bank side** function group has interfaces to the following components:

- **Measuring points**
- **Capacitor bank diff.** function group
- **Circuit-breaker** function group

Interfaces with Measuring Points

The **Capacitor bank side** function group receives the required measured values via its interfaces with the measuring points. If you are using an application template, the **Capacitor bank side** function group is connected to the necessary measuring points.

If you add functions to the **Capacitor bank side** function group, they will automatically receive the measured values from the correct measuring points. If you add protection functions to the function group but the necessary measuring point is not connected, DIGSI 5 reports an inconsistency. Configure the measuring points in DIGSI 5 via the **Function group connections** Editor.

You can find more detailed information in chapter *2 Basic Structure of the Function* .

The **Capacitor bank side** function group has the following interfaces with the measuring points:

- **3-phase current**
  The measurands from the 3-phase power system are supplied via this interface. Depending on the transformer connection type, these are for example: I_A, I_B, I_C, I_N or 3 I_0. All values that can be calculated from the measurands are also provided via this interface. The **Capacitor bank side** function group must always be linked to the **I-3ph measuring point**.
  You can connect the **3-phase current** interface with a maximum of **two** 3-phase current measuring points. If 2 current measuring points have been connected to the **3-phase current** interface, the total current is also determined from measured values from both measuring points in the **Capacitor bank side** function group. All functions in the **Capacitor bank side** function group have access to these values.

- **3-phase voltage** (optional):
  The measurands from the 3-phase voltage system are supplied via this interface. Different transformer connection types are possible. All values that can be calculated from the measurands are also provided via this interface.
  The connection of the **3-phase voltage** is optional. This connection is necessary only if protection or supervision functions that require voltage measurements are used.

Interfaces to the Circuit-Breaker Function Group

The interface with the **Circuit-breaker** function group is used to exchange all required data between the protection function group and the **Circuit-breaker** function group. The following data is required:

- Pickup and operate indications of the protection functions in the direction of the Circuit-breaker function group
- Information on the circuit-breaker condition in the direction of the Protection function groups

You can connect the **Capacitor bank side** function group to one or more **Circuit-breaker** function groups. This connection determines the following:

- Which circuit breakers are activated by the protection functions of the **Capacitor bank side** function group
- Start of the **Circuit-breaker failure protection** function, if available in the **Circuit-breaker** function group, through the protection functions of the connected **Capacitor bank side** function group

Besides the general assignment of the **Capacitor bank side** function group to the **Circuit-breaker** function group, you can also configure the interface for certain functionalities in detail. Configure the details in DIGSI 5 using the **Circuit-breaker interaction** Editor in the **Capacitor bank side** function group.

For the detail configuration of the interface, define the following:

- Which operate indications of the protection functions are included when the trip command is generated
- Which protection functions activate the **Circuit-breaker failure protection** function

If an application template is used, the function groups are connected to each other because this link is absolutely essential to ensure proper operation. You can modify the connection in DIGSI 5 via the **Function-group connections** Editor. If the connection is missing, DIGSI 5 reports an inconsistency.

You can find more detailed information in chapter 2.1 *Function Embedding in the Device* .

Interface with Protection Communication (optional)

All required data is exchanged between the protection function group and the protection communication via the interface with **Protection communication**, for example:

- Binary signals
- Measured values
- Complex data

You can find more detailed information in chapter 3.5 *Protection Communication* .

Resetting the LED Group

Using the **Reset the LED group** function, you can reset the stored LEDs of the functions in one specific function group while the activated, stored LEDs of other functions in other function groups remain activated.

Process Monitor

The process monitor is always present in the **Capacitor bank side** function group and cannot be removed. The process monitor provides the following information in the **Capacitor bank side** function group:

- Current-flow criterion:
  Detection of an open/activated capacitor bank side based on the flow of leakage current
- Closure detection:
  Detection of closure of the capacitor bank side
- Cold-load pickup detection (optional):

This information is in the **Capacitor bank side** function group and is available to all the functions in the function group.

Operational Measured Values

The operational measured values are always present in the **Capacitor bank side** function group and cannot be deleted. If a 3-phase voltage measuring point is connected, the following table shows the total scope. If only current is connected, only the first 3 lines apply.

Table 5-8 Possible Operational Measured Values of the Capacitor Bank Side Function Group

Measured Values		Primary	Secondary	% Referenced to
I_A, I_B, I_C	Phase currents	A	A	Rated operating current of the primary system
3I0	Calculated residual current	A	A	Rated operating current of the primary system
I_N	Measured residual current	A	A	Rated operating current of the primary system
V_A, V_B, V_C	Phase-to-ground voltages	kV	V	Rated operating current of the primary system/√3
V_{AB}, V_{BC}, V_{CA}	Phase-to-phase voltages	kV	V	Rated operating voltage of the primary system
V_0	Calculated zero-sequence voltage	kV	V	Rated operating current of the primary system/√3
V_N	Measured neutral-point displacement voltage	kV	V	Rated operating current of the primary system/√3
f	Frequency	Hz	Hz	Rated frequency
P	Active power (total power)	MW	–	Rated operating voltage and rated operating current of the primary system $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
Q	Reactive power (total power)	MVAr	–	Rated operating voltage and rated operating current of the primary system $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
S	Apparent power (total power)	MVA	–	Rated operating voltage and rated operating current of the primary system $\sqrt{3} \cdot V_{rated} \cdot I_{rated}$
Cos φ	Active factor	(abs)	(abs)	100 % corresponds to cos φ = 1
P_A, P_B, P_C	Phase related active power	MW	–	Active power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$
Q_A, Q_B, Q_C	Phase-related reactive power	MVAr	–	Reactive power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$
S_A, S_B, S_C	Phase-related apparent power	MVA	–	Apparent power of the phase $V_{rated\ phsx} \cdot I_{rated\ phsx}$

If a **V-3ph measuring point** was connected to the **Capacitor bank side** function group, voltage and phase measurements are available.

The energy measurements are not predefined. If necessary, you must load them from the Global DIGSI 5 library.

Depending on the protection and supervision functions used, additional function measurements may be available. The function values are listed in the **information list** of the appropriate protection or supervision function (see chapter 6 *Protection and Automation Functions*).

NOTE

With the `P, Q sign` parameter in the function block **General**, the sign of the following measured values of the respective function group can be inverted (see chapter *10.2 Structure of the Function* Structure of the Function, section Inversion of Power-Related Measured and Statistical Values):

- Active power (total): P total
- Active power (phase-related): P_A, P_B, P_C
- Reactive power (total): Q total
- Reactive power (phase-related): Q_A, Q_B, Q_C

Capacitor-Bank Data (Side-Dependent)

The capacitor-bank data characterizes the data of the capacitor bank to be protected. The side-dependent capacitor-bank data applies to all of the functions in the **Capacitor bank side** function group.

Output Logic

The output logic treats the pickup and trip signals of the protection and supervision functions in the function group separately. Pickup logic and output logic are each assigned to the signals. The pickup and output logic generate the overarching indications (group indications) of the function group. These group indications are transferred via the **Protection information** interface to the **Circuit-breaker** function group and are processed further there.

The pickup and operate indications of the protection and supervision functions in the **Capacitor bank side** function group are combined into one group indication using the following numbers and outputs.

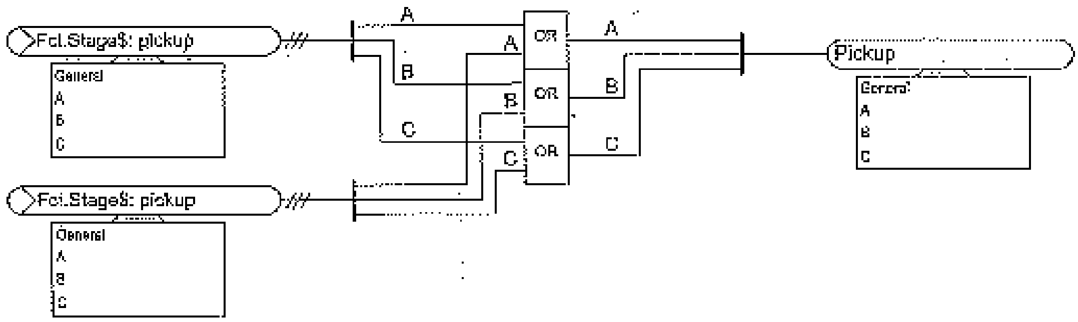


Figure 5-29 Generation of Pickup Indication of the Capacitor Bank Side Function Group

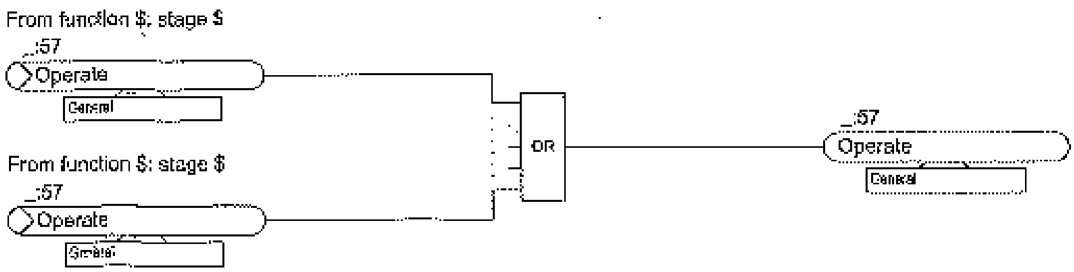


Figure 5-30 Generation of Operate Indication of the Capacitor Bank Side Function Group

5.5.3.3 Application and Setting Notes

Interface to the Circuit-Breaker Function Group

The **Capacitor bank side** function group is usually connected to 1 **Circuit-breaker** function group. The **Circuit-breaker** function group is assigned to the circuit breaker of the capacitor bank.

Parameter: Rated apparent power

- Default setting (_:1781:15571:103) Rated apparent power = *692.82 MVA*.

  The **Rated apparent power** parameter shows the primary rated apparent power of the capacitor bank to be protected. The setting value is determined of the **Capacitor reference volt.** and the **Capacitor reference curr.** parameters.

Parameter: Capacitor reference volt.

- Default setting (_:1781:15571:102) Capacitor reference volt. = *400.00 kV*

You can use the **Capacitor reference volt.** parameter to set the reference voltage of the capacitor bank to be protected. The reference voltage set here is the reference value for the percentage measured values and setting values made in percent.

Depending on user philosophy you can use the system rated voltage (busbar voltage) or the capacitor rated voltage as a reference value.

Parameter: Capacitor reference curr.

- Default setting (_:1781:15571:101) Capacitor reference curr. = *1000 A*

You can use the **Capacitor reference curr.** parameter to set the reference current for the capacitor bank to be protected. The capacitor reference current set here is the reference value for the percentage measured values and setting values in percent.

For Differential protection, these values are used for absolute-value correction (rated current of the protected object).

If the capacitor bank is part of a delta connection, the value to be set here can differ from the capacitor reference current set in the **Capacitor bank** function group (by factor $\sqrt{3}$). Otherwise, set always the same values.

Depending on user philosophy, you can use the capacitor-bank rated current including the harmonics or the capacitor-bank fundamental-component current as a reference value.

Parameter: Neutral point

- Default setting (_:1781:15571:149) Neutral point = *isolated*

With the **Neutral point** parameter, you specify whether the neutral point in the protection range of the differential protection is ***grounded*** or ***isolated***. If there is no neutral point in the protection zone, use the parameter ***isolated***. The neutral point of a capacitor bank is usually not in the protection zone. Therefore, even if the neutral point is grounded, set ***isolated*** here.

You can find further information in the Device manual 7UT8 Chapter 6.2.3 function description neutral point-current handling.

Parameter: Winding configuration

- Default setting (_:1781:15571:104) Winding configuration = *Y (Wye)*

You can use the **Winding configuration** parameter to set *D (Delta)* for a delta connection. Another setting option is *Y (Wye)* for a star connection. The **Winding configuration** parameter is relevant for the Differential protection function.

Parameter: Vector group numeral

- Default setting (_:1781:15571:100) Vector group numeral = *0*

This parameter is used to account for phase-angle rotation, which is expressed by a numeral.

Phase-angle rotation	0°	30°	60°	90°	120°	150°	180°	210°	240°	270°	300°	330°
Vector group numeral	0	1	2	3	4	5	6	7	8	9	10	11

In the function group, the following information is displayed additionally in the setting sheet:

- Side number
- Identification of the measuring points used
- Adaptation factor for the 3-phase measuring point (with reference to the side)

Each **Vector group numeral** can be set from 0 to 11 to the extent possible. Thus, for example, only even numbers are possible for the vector group Yy and Dd and only odd numbers are possible for Yd and Dy.

Parameter: **Side number**

- Default setting (_:1781:14611:130) **Side number** = *not assigned*

The **Side number** parameter shows you which capacitor bank side is currently valid for the following parameters. The side number (*Side 1* to *Side 3*) is automatically assigned with the connection to a capacitor bank side.

Parameter: **MI3ph1 usesMeasP with ID**

- Default setting (_:1781:14611:210) **MI3ph1 usesMeasP with ID** = *0*

The **MI3ph1 usesMeasP with ID** parameter shows you which 3-phase measuring point is connected to the capacitor bank side. Every measuring point is assigned a unique ID.

Parameter: **MI3ph2 usesMeasP with ID**

- Default setting (_:1781:14611:211) **MI3ph2 usesMeasP with ID** = *0*

The **MI3ph2 usesMeasP with ID** parameter shows you which 3-phase measuring point is connected to the capacitor bank side. Every measuring point is assigned a unique ID.

Parameter: **CT mismatch M I-3ph 1**

- Default setting (_:1781:14611:215) **CT mismatch M I-3ph 1** = *0.000*

The **CT mismatch M I-3ph 1** parameter shows you the magnitude adaptation of the phase currents of the 1st assigned measuring point. The numerical value results from the ratio of the primary rated current of the current transformer to the rated current of the side.

Parameter: **CT mismatch M I-3ph 2**

- Default setting (_:1781:14611:217) **CT mismatch M I-3ph 2** = *0.000*

The **CT mismatch M I-3ph 2** parameter shows you the magnitude adaptation of the phase currents of the 2nd assigned measuring point.

5.5.3.4 Write-Protected Settings

The settings listed here are used primarily for understanding during configuration of the function groups. They are calculated on the basis of other settings and cannot be directly changed.

Addr.	Parameter	C	Range of Values	Default Setting
Rated values				
_:1781:15571:103	Rated apparent power		0.20 MVA to 5000.00 MVA	692.82 MVA

Addr.	Parameter	C	Range of Values	Default Setting
Side data				
_:1781:14611:130	Side number		• not assigned • Side 1 • Side 2 • Side 3	Side 2
_:1781:14611:210	MI3ph1 usesMeasP with ID		0 to 100	8
_:1781:14611:215	CT mismatch M I-3ph 1		0.010 to 100.000	1.000

5.5.3.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Rated values				
_:1781:15571:101	General:Capacitor reference curr.		1 A to 100 000 A	1000A
_:1781:15571:102	General:Capacitor reference volt.		0.20 kV to1200.00 kV	400.00 kV
Side data				
_:1781:15571:149	General:Neutral point		• grounded • isolated	isolated
_:1781:15571:104	General:Winding configuration		• Y (Wye) • D (Delta)	Y (Wye)
_:1781:15571:100	General:Vector group numeral		0 to 11	0
Measurements				
_:1781:14611:158	Further settings:P, Q sign		• not reversed • reversed	not reversed

5.5.3.6 Information List

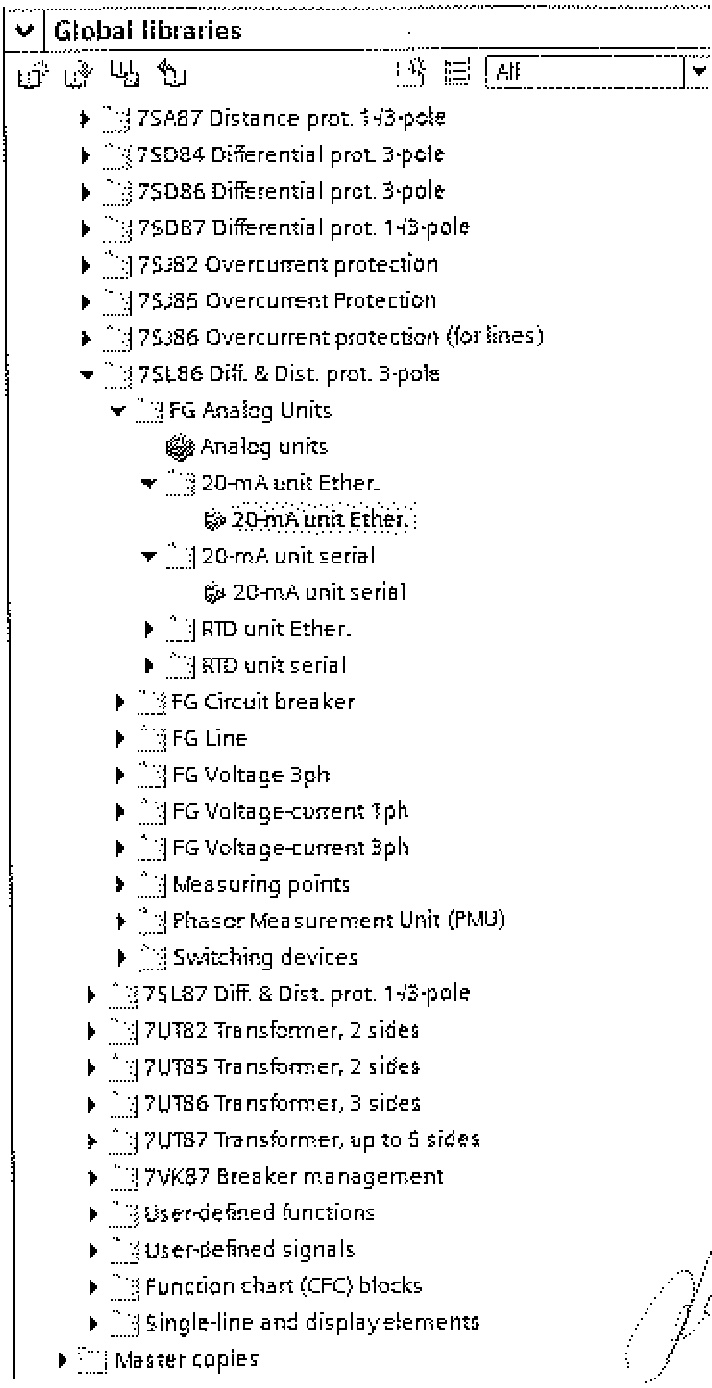
No.	Information	Data Class (Type)	Type
Group indicat.			
_:4501:55	Group indicat.:Pickup	ACD	O
_:4501:57	Group indicat.:Operate	ACT	O
Reset LED Group			
_:7381:500	Reset LED Group:>LED reset	SPS	I
_:7381:320	Reset LED Group:LED have been reset	SPS	O

5.6 Function-Group Type Analog Units

5.6.1 Overview

The **Analog units** function group is used to map analog units and communicate with them. Analog units are external devices, such as RTD units, or analog plug-in modules, such as measuring-transducer modules.

You will find the **Analog units** function group for many device types in the Global DIGSI 5 library.



[illegible]

Figure 5-37 Analog Unit Function Group in DIGSI

5.6.2 Structure of the Function Group

If the device has a measuring transducer, it is automatically mapped in the **Analog units** function group. If one or more RTD units are connected to the device, you have to load one or more **RTD unit Ether.** or **RTD unit serial** functions from the Global DIGSI library in order to map the RTD units.

The following figure shows the structure of the function group.

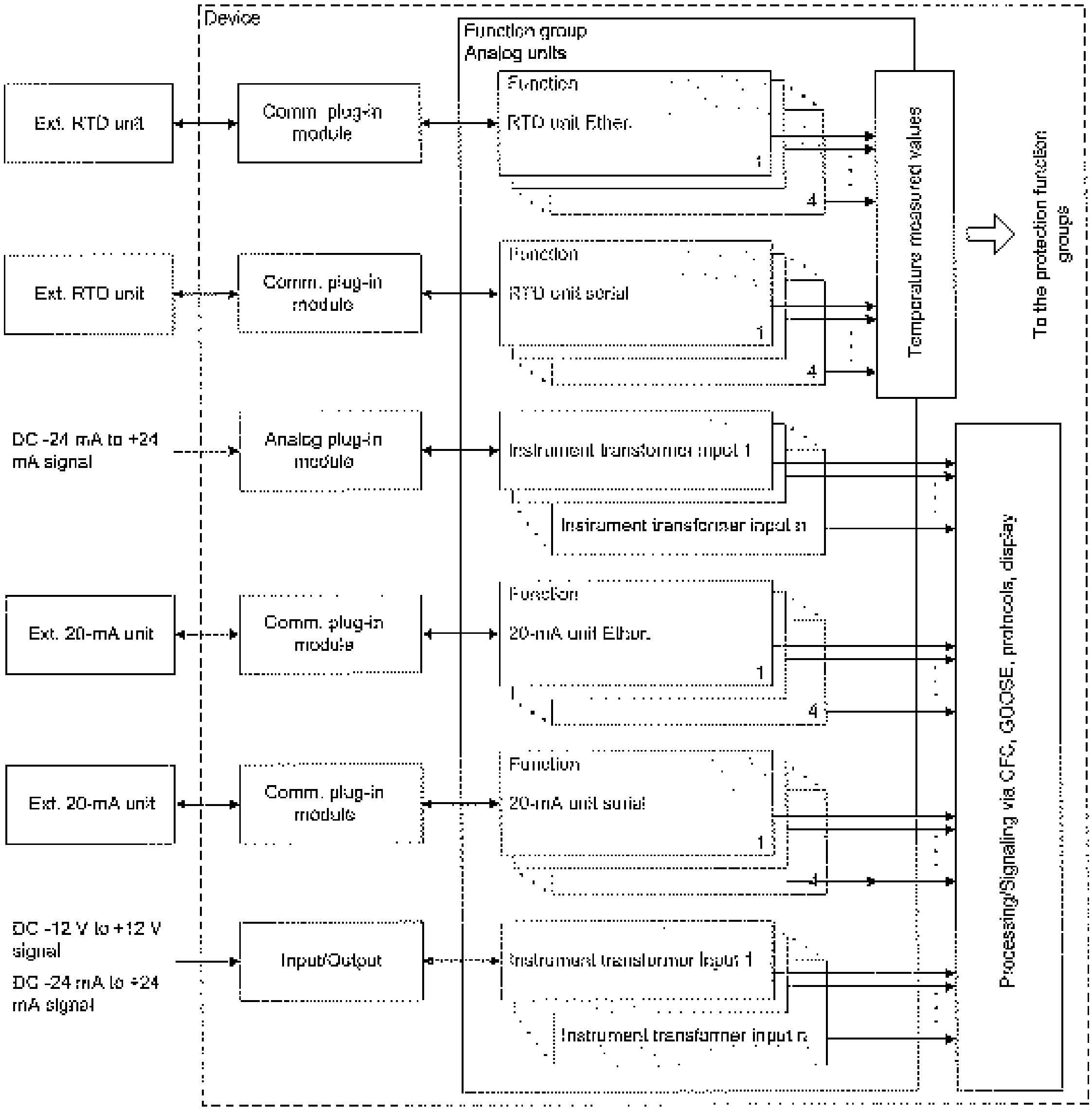


Figure 5-32 Structure of the Analog Unit Function Group

The **Analog units** function group has interfaces to protection function groups. The **Analog units** function group provides measured temperature values that come from an external RTD unit. These measured temperature values are available for all protection function groups in which a temperature monitoring function works.

The **RTD unit Ether.** function is not preconfigured by the manufacturer. A maximum of 20 function instances can work simultaneously.

The **RTD unit serial** function is set up structurally exactly in the same manner as the **RTD unit Ether.** function.

5.6.3 20-mA Unit Ethernet

5.6.3.1 Overview

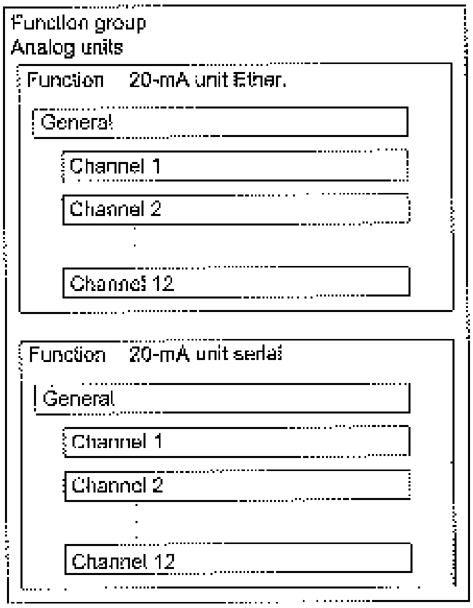
The function **20-mA unit Ether.**:

- Communicates in series with a 20-mA unit via the Slave Unit Protocol (SUP) and records the values measured by the 20-mA unit
- Transforms the measured 20-mA values into slowly changing process tags such as temperature or gas pressure
- Makes the recorded process tags available to CFC, GOOSE, protocols and the device display
- Monitors communication with the 20-mA unit

5.6.3.2 Structure of the Function

The function **20-mA unit Ether.** can work only in the function group **Analog units**. A maximum of 4 function instances can work simultaneously. Each instance contains 12 preconfigured channel function blocks.

The function **20-mA unit Ether.** contains input and output channels which can be configured independently of one another.

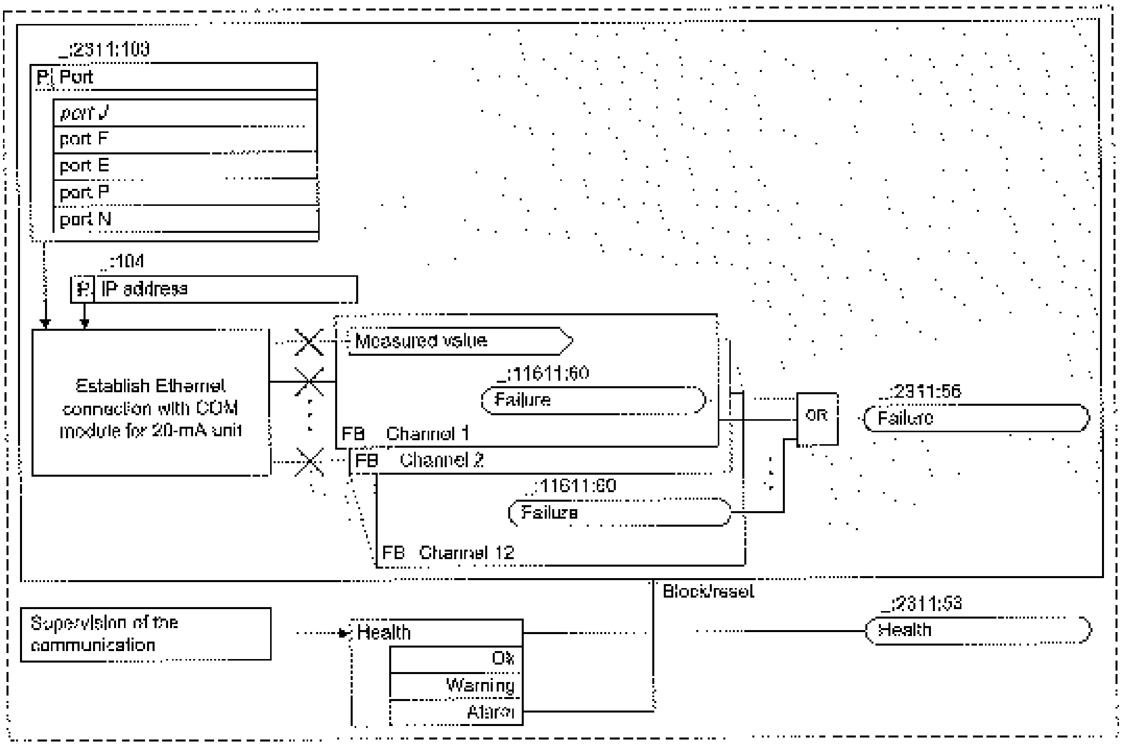


[dwsfm2-...]

Figure 5-33 Structure/Embedding of the Function

5.6.3.3 Communication with 20-mA Unit Ethernet

Logic



[dw20mAcp-15012013-01, 1, en_US]

Figure 5-34 Logic of the Function 20-mA Unit Ethernet

Communication with 20-mA Unit

The function is used to communicate with a 20-mA unit connected via an Ethernet connection. When a connection of the function to an external 20-mA unit via an Ethernet interface has successfully been established, the 20-mA unit sends the measured values of all connected channels to the function **20-mA unit. Ether.**. For the connection to be established successfully, specific communication settings must be specified.

You can find more detailed information in Chapter *5.6.3.4 Application and Setting Notes* .

The 20-mA measurement unit **7XV5674** is supported.

Error Responses

The following table lists the conditions under which the *Health* status transitions to the Alarm or Warning state.

Table 5-9 Error Responses

Error Description	Status Health
The function **20-mA unit Ether.** cannot establish a connection with a communication module.	Alarm
The function **20-mA unit Ether.** sends TCP settings to the communication module, which evidently would like to connect to the 20-mA unit via a serial protocol. This communication module does not establish a connection to the 20 mA unit.	Alarm
The connection between the communication module and the 20-mA unit causes a time-out indication.	Warning

Error Description	Status Health
A communication module has not received any more data from the 20-mA unit for 9 sec.	Warning

The *Failure* signal is set as soon as one of the channel function blocks reports a failure.

5.6.3.4 Application and Setting Notes

Parameter: Port

- Default setting (_:2311:103) `Port` = *port J*

Use the `Port` setting to define the port connecting the 20-mA unit to the SIPROTEC 5 device.

Parameter: IP address

- Default setting (_:2311:104) `IP address` = *10.16.60.1*

With the `IP address` settings, you set the IP address of the 20 mA unit connected to the communication module via the TCP protocol. You must assign each 20-mA unit an unambiguous IP address. The IP address to be set depends on your network configuration. You can set any valid IPv4 address that does not cause conflicts with other IP addresses in the network. First set an IP address for the **7XV5674 20-mA unit**. Then specify the `IP address` settings for the communication module to the same address.

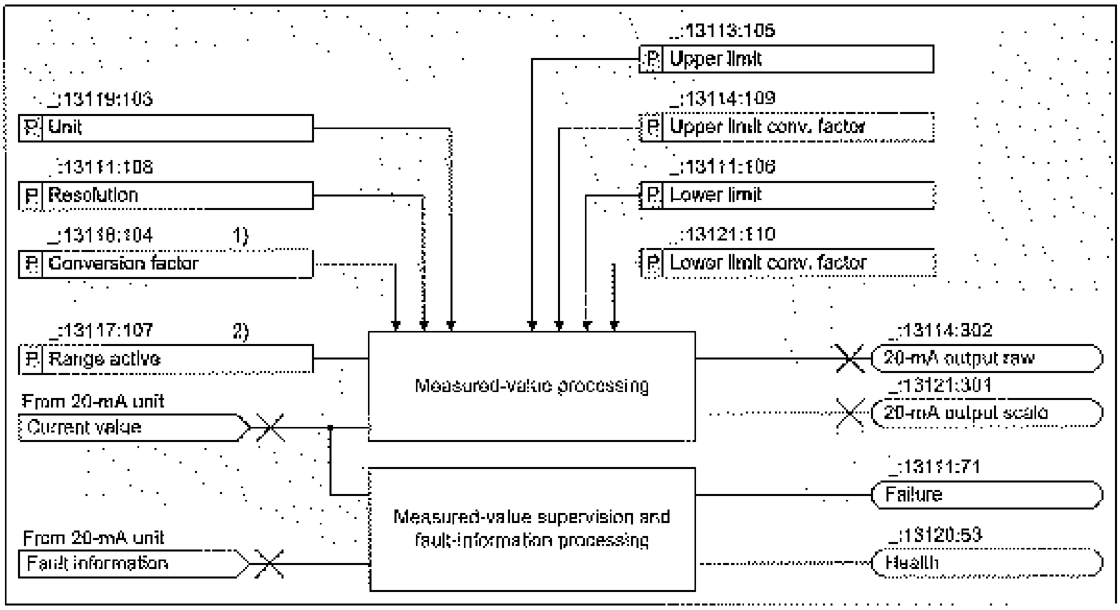
Settings on the 20-mA Unit

The **7XV5674 20-mA unit** is set with a web browser on the laptop computer via the latter's Ethernet interface. Set *Modbus TCP* as bus protocol/operating mode.

You can find detailed notes on the settings in the 7XV5674 manual that accompanies the 20-mA unit. The documents are also available in the SIPROTEC download area *http://www.energy.siemens.com*.

5.6.3.5 20-mA Channel

Logic



[dw20mach-160516-01.tif, 1, en_US]

Figure 5-35 Logic Diagram of the Function 20-mA Channel

(1) If the setting **Range active** is set to **true**, the setting **Transformation ratio** is not displayed.

(2) If the setting **Range active** is set to **false**, the settings **Upper limit**, **Transformation ratio upper limit**, **Lower limit** and **Transformation ratio** are not displayed.

Measured-Value Calculation

The function **20-mA channel** processes a single 20-mA current signal supplied by the 20-mA unit of the corresponding channel. The 20-mA current measured value is converted into the correct physical quantities such as temperature or pressure. In each 20-mA functional unit (Ether. and serial) there are always 12 of the 20-mA channel function blocks, even if fewer channels are connected with the 20-mA unit. The calculated values are available for further processing via CFC, GOOSE, protocols, and the display image.

Measured-Value Processing

The 20-mA unit typically transmits a value which represents a physical quantity, such as a temperature or a pressure. Therefore, the device must contain a characteristic curve that maps the physical quantity to the 20-mA value. If you do not activate the **Range active** setting (no x in the check box), the function operates over the range 0 mA to 20 mA. If a value smaller than 0 mA or greater than 20 mA is active at the input of the 20-mA unit, the measured value is identified as invalid. The setting of the range for the scaled value goes from a usable range of 0 mA to 20 mA. The following figure shows an example.

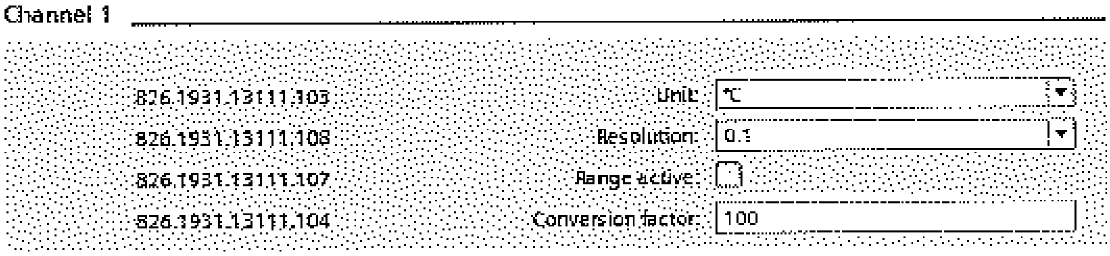


Figure 5-36 Settings for Example 1

In this example, the measured value 0 mA means a temperature of 0 °C and the measured value 20 mA means a temperature of 100 °C. So enter as **Unit** = *°C* and **Conversion factor** = *100*. The resolution (decimal place) of the temperature value can be chosen; for a decimal place, select **Resolution** = *0.1*.

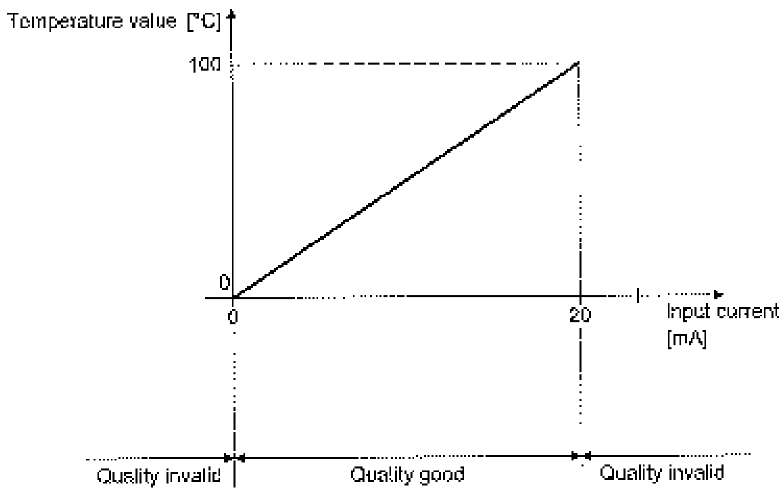
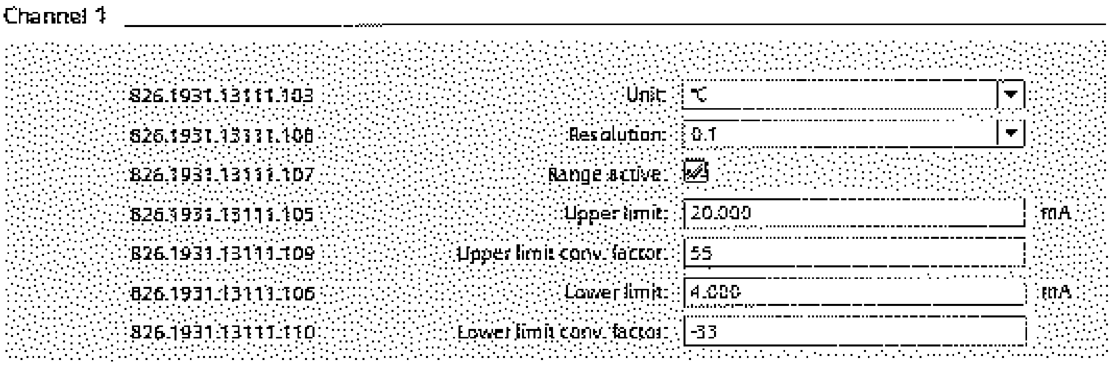


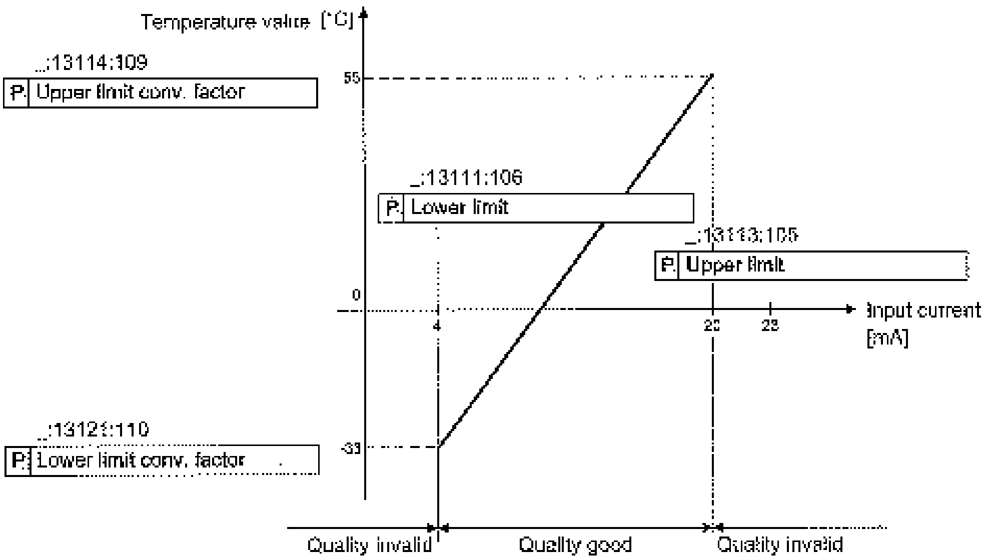
Figure 5-37 Characteristic Curve of a 20-mA Input (Example 1)

If you activate the **Range active** setting, then 4 additional parameters **Upper limit**, **Lower limit**, **Upper limit - Sensor**, and **Lower limit - Sensor** appear. The parameters **Upper limit** and **Lower limit** indicate the range of the input current in mA. The setting **Upper limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Upper limit** setting. The setting **Lower limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Lower limit** setting. The setting of the range for the scaled value corresponds to the useable range between **Lower limit** and **Upper limit** (see following figure).



[sdanum? 190211 01, 1.en_US]

Figure 5-38 Settings for Example 2



[dwbigw2 030513 01, 1.en_US]

Figure 5-39 Characteristic Curve of a 20-mA Unit (Example 2)

In this example, the **Range active** setting is selected. The setting **Upper limit** is at 20 mA, the setting **Lower limit** is at 4 mA. The setting **Upper limit - Sensor** is at 55 and the setting **Lower limit - Sensor** is at -33. If the input current is smaller than 4 mA or greater than 20 mA, the quality of the scaled measured value in this example is invalid.

Each 20-mA channel makes available the scaled measured value in the information routing (these are the temperature values in the examples) and the original current measured value in mA for further processing. The 20-mA values can be displayed in the display page and processed with CFC charts.

Error Responses

If the current input value is determined to be incorrect, the quality attribute of the output value is set to *invalid*. That status for *Health* and the defect status assume the states displayed in the table.

Table 5-10 Error Responses

Error Description	Status *Health*	Error Status
The input value lies outside the given limits	OK	Yes
Channel not connected	OK	No

5.6.3.6 Application and Setting Notes

Parameter: Unit

- Default setting (_:13111:103) **Unit** = *°C*

You use the setting **Unit** to specify which physical unit of measurement the measured values represent. The possible setting values are listed in the settings table.

Parameter: Conversion factor

- Default setting (_:13111:104) **Conversion factor** = *100*

The **Conversion factor** setting allows you to set the conversion factor for the measuring transducer.

Parameter: Resolution

- Default setting (_:13111:108) **Resolution** = *0.1*

The **Resolution** setting is used to specify the measured value resolution.

Parameter: Range active

- Default setting (_:13111:107) **Range active** = *false*

If you do not activate the **Range active** setting (no x in the check box), the function operates over the range -24 mA to +24 mA. The setting of the range for the scaled value goes from a usable range of -20 mA to +20 mA.

If you activate the **Range active** setting, then 4 additional settings **Upper limit**, **Upper limit - Sensor**, **Lower limit**, and **Lower limit - Sensor** appear.

Parameter: Upper limit, Lower limit, Upper limit - Sensor and Lower limit - Sensor

- Default setting (_:13111:105) **Upper limit** = *20000 mA*
- Default setting (_:13111:109) **Upper limit - Sensor** = *100*
- Default setting (_:13111:106) **Lower limit** = *4000 mA*
- Default setting (_:13111:110) **Lower limit - Sensor** = *100*

If you activate the **Range active** setting, then 4 additional settings **Upper limit**, **Lower limit**, **Upper limit - Sensor**, and **Lower limit - Sensor** appear. The setting **Upper limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Upper limit** setting. The setting **Lower limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Lower limit** setting.

The following settings and information table shows only 1 of the 12 channels, as the setting possibilities of the 12 channels do not differ.

5.6.3.7 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:103	General:Port		• port E • port F • port J • port N • port P	port J
Channel 1				
_:13111:103	Channel 1:Unit		• % • ° • °C • °F • Ω • Ω/km • Ω/mi • 1/s • A • As • cos φ • cycles • dB • F/km • F/mi • h • Hz • Hz/s • in • J • J/Wh • K • l/s • m • mi • min • p.u. • Pa • periods • rad • rad/s • s • V • V/Hz • VA • VAh • var • varh • Vs • W • W/s • Wh	m
_:13111:108	Channel 1:Resolution		• 1 • 0.1 • 0.01 • 0.001	0.1

Addr.	Parameter	C	Setting Options	Default Setting
_:13111:107	Channel 1:Range active		• 0 • 1	false
_:13111:104	Channel 1:Conversion factor		1 to 10000	100
_:13111:105	Channel 1:Upper limit		0.00 mA to 20.00 mA	20.00 mA
_:13111:109	Channel 1:Upper limit - Sensor		-10000 to 10000	100
_:13111:106	Channel 1:Lower limit		0.00 mA to 20.00 mA	4.00 mA
_:13111:110	Channel 1:Lower limit - Sensor		-10000 to 10000	100

5.6.3.8 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:53	General:Health	ENS	O
_:2311:56	General:Failure	SPS	O
Channel 1			
_:13111:53	Channel 1:Health	ENS	O
_:13111:71	Channel 1:Failure	SPS	O
_:13111:301	Channel 1:20-mA output scale	MV	O
_:13111:302	Channel 1:20-mA output raw	MV	O

5.6.4 20-mA Unit Serial

5.6.4.1 Overview

The function **20-mA unit Serial**:

- Provides serial communications with a 20-mA unit via the Modbus protocol and records the values measured by the 20-mA unit
- Transforms the measured 20-mA values into slowly changing process variables such as temperature or gas pressure
- Makes the recorded process tags available to CFC, GOOSE, protocols and the device display
- Monitors communication with the 20-mA unit

The function **20-mA unit Serial** is structured in the same way as the function **20-mA Unit Ether.**. The mode of operation is also identical. The only difference is that the measured values are transferred to the communication module via a serial connection instead of an Ethernet connection.

You can find more information in Chapter *5.6.3.2 Structure of the Function*.

5.6.4.2 Application and Setting Notes

Parameter: Port

- Default setting `(_:2311:103) Port = Port J`

With the `Port` setting, you specify the slot for the communication module that will be used for the connection with an external 20-mA unit.

Parameter: Channel number

- Default setting `(_:2311:105) Channel number = 1`

A serial communication module optionally uses 2 channels. With the **Channel number** setting, you specify the channel number (1 or 2) used to connect the 20-mA unit to the device. The communication module inputs are labeled with the channel numbers.

Parameter: Slave address

- Default setting (_:2311:106) **Slave address** = *1*

Use the**Slave address** setting to define the device address of the 20-mA unit. If only one 20-mA unit is connected to the serial bus, the default value *1* can be used. Set the same device address as used with the 20-mA unit. The device address is important for distinguishing several 20-mA units that are connected to a serial bus. Set an unambiguous device address on every 20-mA unit, for example, 1, 2 and 3 when connecting 3 of the 20-mA units. On every 20-mA unit, set for the **Slave address** setting in the 3 functions **20-mA Unit Serial** the same device address for each.

Parameter: Unit

- Default setting (_:13111:103) **Unit** = *°C*

You use the setting **Unit** to specify which physical unit of measurement the measured values represent. The possible setting values are listed in the settings table.

Parameter: Conversion factor

- Default setting (_:13111:104) **Conversion factor** = *100*

The **Conversion factor** setting allows you to set the conversion factor for the measuring transducer.

Parameter: Resolution

- Default setting (_:13111:108) **Resolution** = *0.1*

The **Resolution** setting is used to specify the measured value resolution.

Parameter: Range active

- Default setting (_:13111:107) **Range active** = *false*

If you do not activate the **Range active** setting (no x in the check box), the function operates over the range 0 mA to 20 mA. The setting of the range for the scaled value goes from a usable range of 0 mA to 20 mA.

If you activate the **Range active** setting, then 4 additional settings **Upper limit**, **Upper limit - Sensor**, **Lower limit** and **Lower limit - Sensor** appear.

Parameter: Upper limit, Lower limit, Upper limit - Sensor and Lower limit - Sensor

- Default setting (_:13111:105) **Upper limit** = *20 mA*
- Default setting (_:13111:109) **Upper limit - Sensor** = *100*
- Default setting (_:13111:106) **Lower limit** = *4 mA*
- Default setting (_:13111:110) **Lower limit - Sensor** = *100*

If you activate the **Range active** setting, then 4 additional settings **Upper limit**, **Lower limit**, **Upper limit - Sensor** and **Lower limit - Sensor** appear. The setting **Upper limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Upper limit** setting. The setting **Lower limit - Sensor** is the calculated measured value if the input current corresponds to the value in the **Lower limit** setting.

The following settings and information table shows only 1 of the 12 channels, as the setting possibilities of the 12 channels do not differ.

5.6.4.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:103	General:Port		• port E • port F • port J • port N • port P	port J
_:2311:105	General:Channel number		1 to 2	1
_:2311:106	General:Slave address		1 to 247	1
Channel 1				
_:13111:103	Channel 1:Unit		• % • ° • °C • °F • Ω • Ω/km • Ω/mi • 1/s • A • As • cos φ • cycles • dB • F/km • F/mi • h • Hz • Hz/s • in • J • J/Wh • K • l/s • m • mi • min • p.u. • Pa • periods • rad • rad/s • s • V • V/Hz • VA • VAh • var • varh • Vs • W • W/s • Wh	m

Addr.	Parameter	C	Setting Options	Default Setting
_:13111:108	Channel 1:Resolution		• 1 • 0.1 • 0.01 • 0.001	0.1
_:13111:107	Channel 1:Range active		• 0 • 1	false
_:13111:104	Channel 1:Conversion factor		1 to 10000	100
_:13111:105	Channel 1:Upper limit		0.00 mA to 20.00 mA	20.00 mA
_:13111:109	Channel 1:Upper limit - Sensor		-10000 to 10000	100
_:13111:106	Channel 1:Lower limit		0.00 mA to 20.00 mA	4.00 mA
_:13111:110	Channel 1:Lower limit - Sensor		-10000 to 10000	100

5.6.4.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:53	General:Health	ENS	O
_:2311:56	General:Failure	SPS	O
Channel 1			
_:13111:53	Channel 1:Health	ENS	O
_:13111:71	Channel 1:Failure	SPS	O
_:13111:301	Channel 1:20-mA output scale	MV	O
_:13111:302	Channel 1:20 mA output raw	MV	O

5.6.5 Communication with 20-mA Unit

5.6.5.1 Integration of a Serial 20-mA Unit

Connection of the Communication Lines

Figure 5-40 shows how to connect the 20-mA unit to the SIPROTEC 5 device. Note that Pin 1 of the RJ45 plug is connected to RTD-B and Pin 2 is connected to RTD-A.

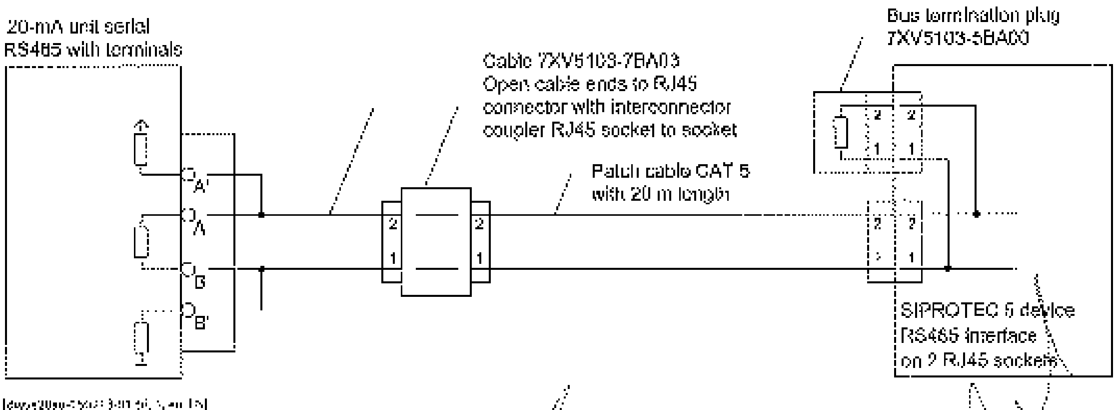
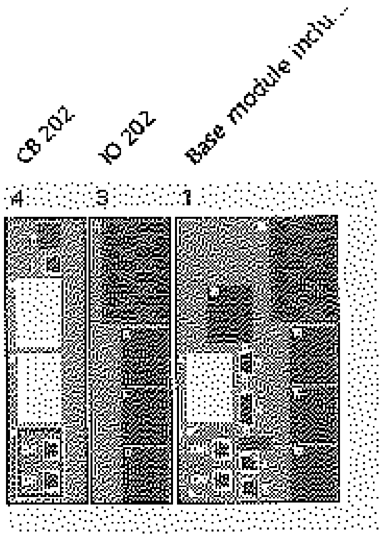


Figure 5-40 Connection of the 20-mA Unit to the SIPROTEC 5 Device

Adding a USART Module

Add a USART-AB-1EL or a USART-AC-2EL USART module in DIGSI to the device. The USART module must be inserted at one of the plug-in positions for communication modules in the base module or in the CB202 expansion module (refer to the following figure).

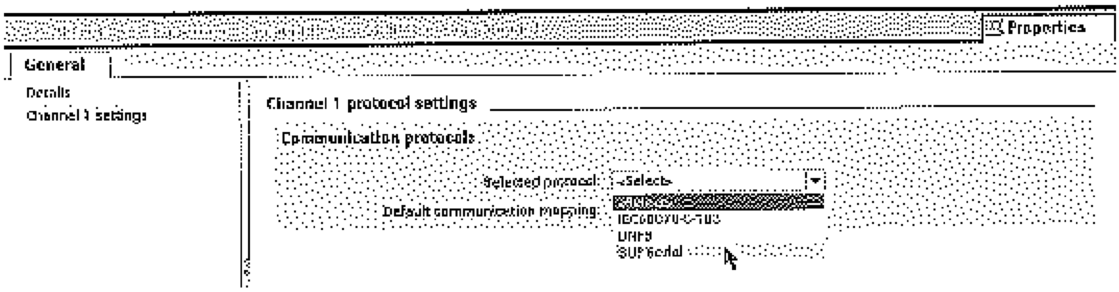


[sc_ins... 2201...]

Figure 5-41 Insertion Position for a USART Module

Selecting the SUP Protocol

Select the Slave Unit Protocol (SUP). This protocol is responsible for the communication between the SIPROTEC 5 device and the 20-mA unit.



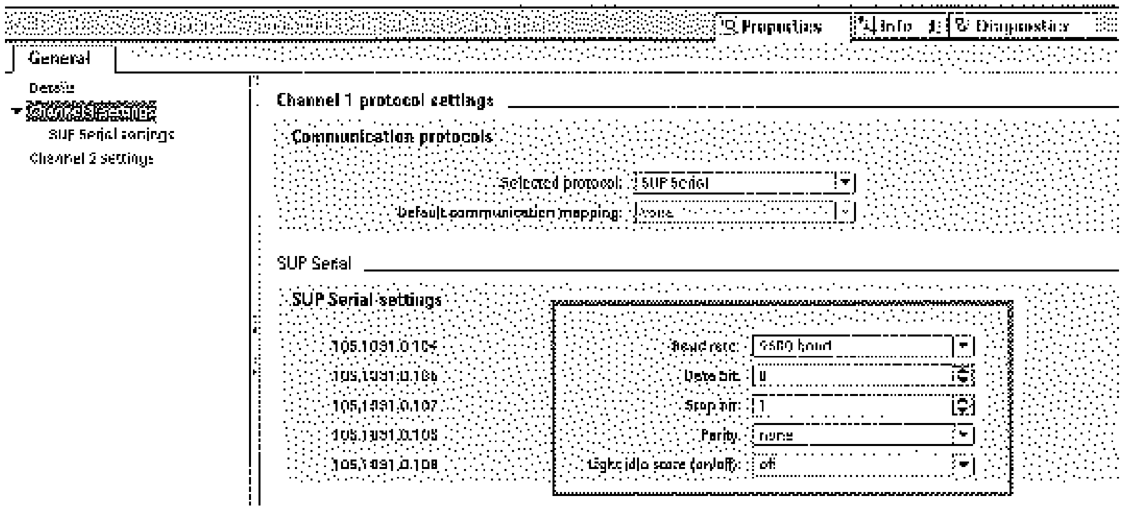
[scrsup...-DE, 1, en_US]

Figure 5-42 Selecting the SUP Protocol

Communication Settings

Make the communications settings for the relevant serial channels. For this, use the default settings specified by the 20-mA unit. Normally, you must adapt only the parameterization of the SIPROTEC 5 device to the settings of the 20-mA unit. Make sure that the setting values in both devices are the same. The settings of the `Non-flickering light (on/off):` is not relevant for the RS485 interface.

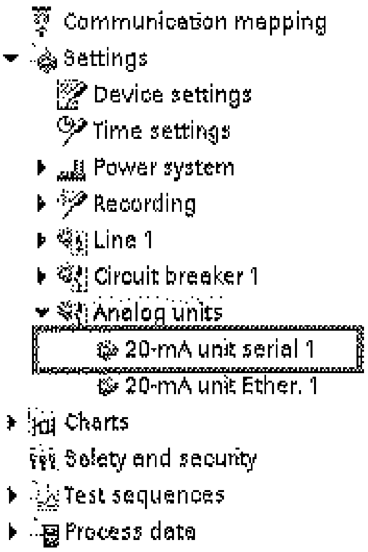
> **NOTE**
>
> The driver for the USART module for the SUP protocol is not preinstalled as standard for the initial use of this interface (following the firmware update).



[scusers5-220111-01-DE, 1 en_US]

Figure 5-43 Making the Communication Settings

With the selection of the SUP protocol for the 20-mA unit DIGSI automatically adds the function group **Analog units** to your device configuration. You can now instantiate the function **20-mA unit serial 1** (see following figure).



[scrteras-220114-01-DE, 1 en_US]

Figure 5-44 Insertion of the Function 20-mA Unit Serial 1

Now, set the channel number over which the SUP protocol runs. In addition, set the slave address of the 20-mA unit. This address must be set with the same value in the 20-mA unit (refer to the following figure).

For the first use of the 20-mA unit, the following device configuration must be set on the 20-mA unit:

- Bus protocol: mod
- Device address: 1
- Baud rate: 9600
- Parity: no

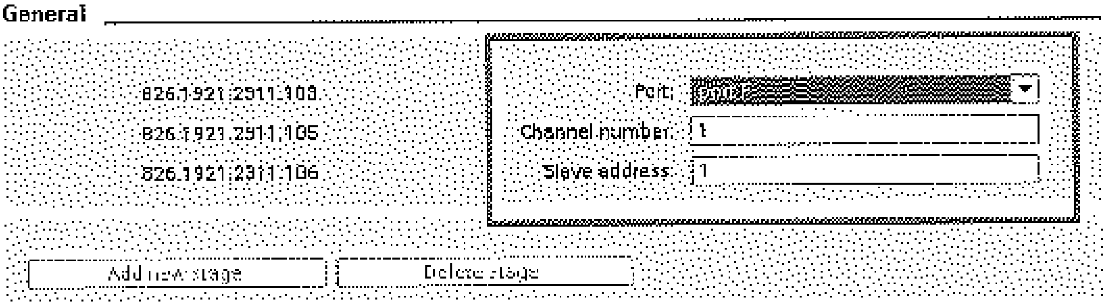


Figure 5-45 Setting the Port, Channel Number, and Device Address

Finally, load the configuration in the device.

5.6.5.2 Integration of a 20-mA Unit Ethernet

Device Configuration

In DIGSI, insert an Ethernet module into the provided slot, thus, adding the module to the device configuration. *Figure 5-46* displays the available slots in the base module or on the expansion module CB 202. Alternatively, you can also use the integrated Ethernet interface Port J.

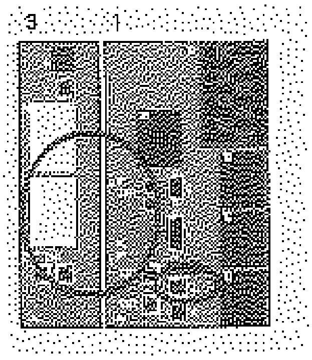
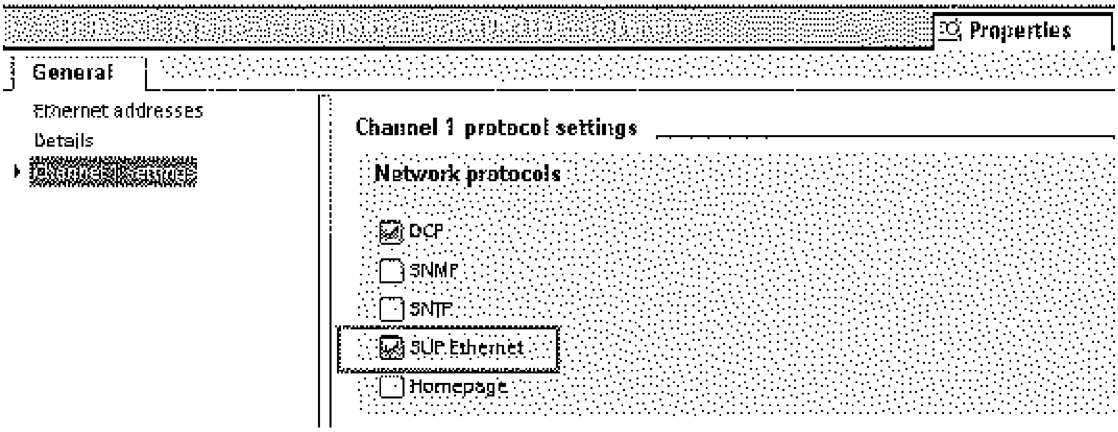


Figure 5-46 Inserting an Ethernet Module

Communication Settings

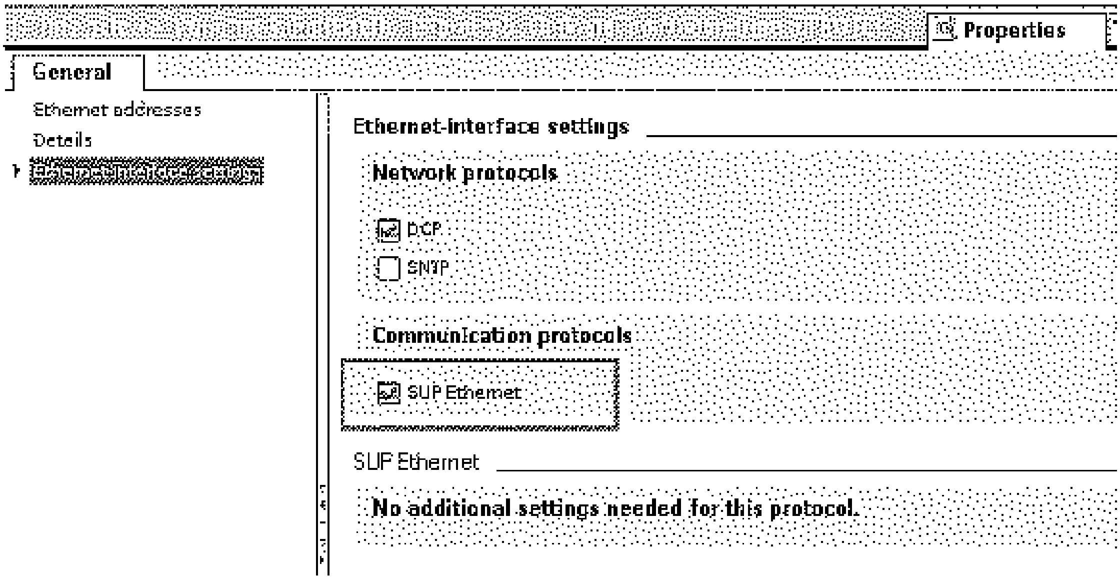
Activate the SUP Ethernet protocol for the Ethernet module.



[scsubcs2 220114 01 DE, 1, en_US]

Figure 5-47 Activation of the protocol

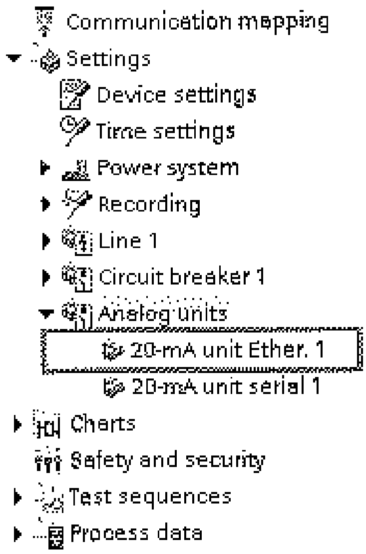
This protocol is also available for Port J of the integrated Ethernet interface of the base module (refer to following figure).



[scsubp3 220114 01 DE, 1, en_US]

Figure 5-48 Selection of the Protocol

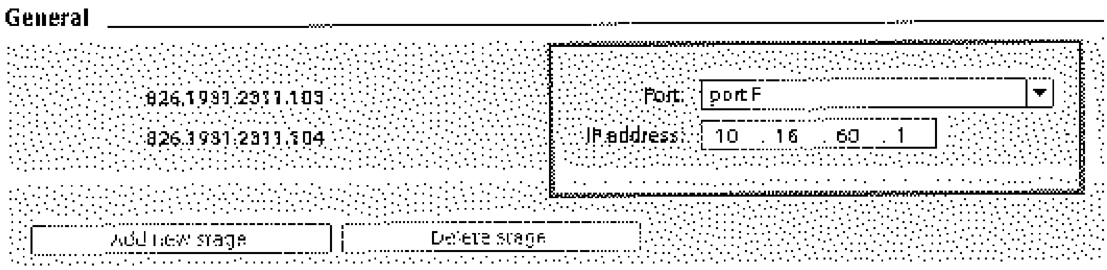
With the selection of the SUP protocol for the 20-mA unit, DIGSI automatically adds the **Analog units** function group and the **20-mA unit Ether.** function to your device configuration (refer to the following figure).



[sc20kpr-220114-01-DE, 1, en_US]

Figure 5-49 Insertion of the Function 20-mA Unit Ether. 1

Now, set the port over which the SUP protocol runs. In addition, set the IP address of the 20-mA unit (refer to the following figure). This address must be set with the same value in the 20-mA unit.



[scsmcp3-220114-01-DE, 1, en_US]

Figure 5-50 Setting the Port and IP Address

Finally, load the configuration in the device.

5.6.6 V/I-Measuring-Transducer Unit with Fast Inputs

5.6.6.1 Overview

The fast analog measuring-transducer inputs process voltage values (DC -10 V to +10 V) as well as current values (DC -20 mA to 20 mA).

The function **MT fast input**:

- Provides sampled values for recording in the fault record (the maximum sampling frequency is 8 kHz for all other SIPROTEC 5 devices). The recorded sampling frequency results from the setting of the fault-recorder function.
- Calculated measured values from the sampled values. These measured values have been deduced from the arithmetic mean values. The measuring range for the mean-value calculation is adjustable in the interval from 10 ms to 100 ms.

- Converts the measured current or voltage values into process values, for example, temperature, gas pressure, etc.
- Provides the recorded process variables for further processing by the fault recorder, the CFC, and in GOOSE-applications for transmission via communication protocols, and for visualization

The fast measuring-transducer inputs are located on the IO212 module with 8 inputs (optionally current or voltage inputs), and the IO210 module with 4 inputs (optionally current or voltage inputs).

5.6.6.2 Structure of the Function

The function **MT fast input** works in the function group **Analog units** and contains the number of available measuring-transducer inputs, depending on the hardware configuration. You can configure these channels independently from one another either as current or voltage inputs.

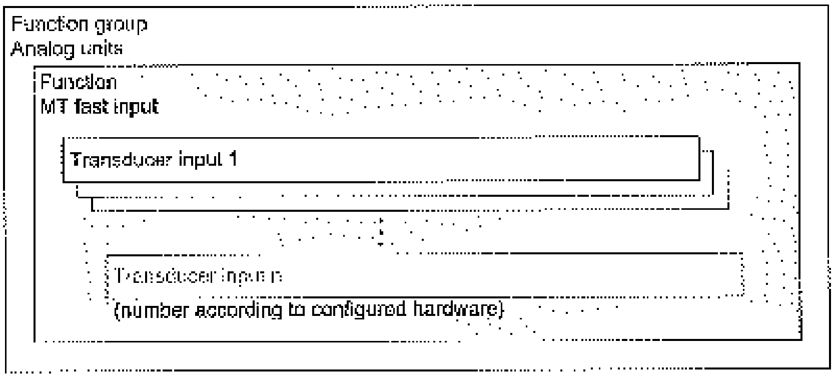


Figure 5-51 Structure/Embedding of the Function

5.6.6.3 Function Description

Once you have instantiated the **MT fast input** function, it will be visible in the project tree in the function group **Analog units**. You can find the function group **Analog units** in DIGSI in the **Settings** folder.

If you open the subdirectory **MT fast input**, you reach the setting sheet for the respective input (for more details, see Application and Setting Notes).

The hardware is designed in such a way that either a current or a voltage can be processed at each input. Use the corresponding terminals (see Hardware manual). Configure the input in accordance with the selected connection (Parameter `TD input-signal type`). With the parameter `Measuring window`, you set the measuring range with which the arithmetic mean value is determined. With the parameter `Measuring window`, you also determine measurement speed for the input. For example, a setting of 100 ms means that the measured value is updated every 100 ms.

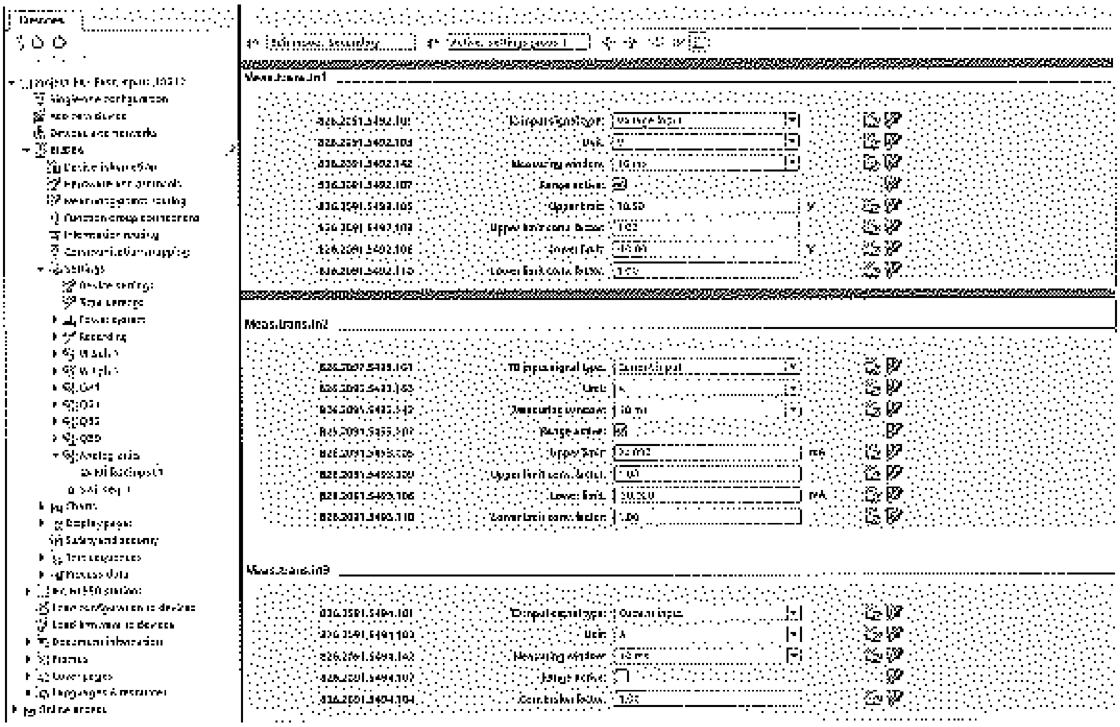


Figure 5-52 Parameters of the Measuring-Transducer Channels.

The fast measuring-transducer channels can be configured either as current or as voltage inputs. Apart from this, their function corresponds to the basic function of the 20-mA-channels (see chapter *5.6.3.5 20 mA Channel*).

5.6.6.4 Application and Setting Notes

Parameter: `TD input-signal type`

- Default setting `(_:101) TD input-signal type` = ***`Current input`***

With the parameter **`TD input-signal type`**, you determine whether the measuring-transducer input channel works as a ***`Current input`*** or as a ***`Voltage input`***.
Make sure that the selected channel has also been wired correctly (see Hardware manual, Input and Output Module IO212).

Parameter: `Unit`

- Default setting `(_:103) Unit` = **`A`**

With the parameter **`Unit`**, you set the physical unit of measurement of the measured values. The possible setting values are listed in the settings table.

Parameter: `Measuring window`

- Default setting `(_:142) Measuring window` = ***`10 ms`***

With the parameter **`Measuring window`**, you set the measuring window that is used to determine the arithmetic mean value from the sampled values. In case of slowly varying signals, Siemens recommends setting the top value to 100 ms. With this value, a new, current measured value is provided every 100 ms for further processing.

Parameter: `Range active`

- Default setting (_:107) `Range active` = *false*

If you do not activate the `Range active` parameter, the function assumes a range of -20 mA to +20 mA or -10 V to +10 V. The setting of the range for the scaled value then assumes a usable range of -20 mA to +20 mA or -10 V to +10 V.

If you activate the `Range active` parameter, then 4 additional parameters `Upper limit`, `Upper limit - Sensor`, `Lower limit`, and `Lower limit - Sensor` appear.

Note that this setting is activated by either placing, or not placing the relevant check mark in DIGSI (see *Figure 5-52*).

Parameter: Conversion factor

- Default setting (_:104) `Conversion factor` = *1.00*

With the parameter `Conversion factor`, you set the conversion factor for the measuring transducer.

Parameter: Upper limit, Lower limit, Upper limit - Sensor, and Lower limit - Sensor

With the following parameters, you set the scaling of the measuring variables. By that, you can scale in an application-specific way:

- Default setting `Upper limit` = *20.00 mA*
- Default setting `Upper limit - Sensor` = *1.00*
- Default setting `Lower limit` = *-20.00 mA*
- Default setting `Lower limit - Sensor` = *1.00*

With these setting parameters, you set the operating range of the measuring transducer as well as the conversion of the values transmitted to the sensor values. Harmonize the operating range of the measuring transducer with the transmitter of the sensor. Using the free scalability of the system, you can meet different requirements. The following figure shows the setting parameters in general terms.

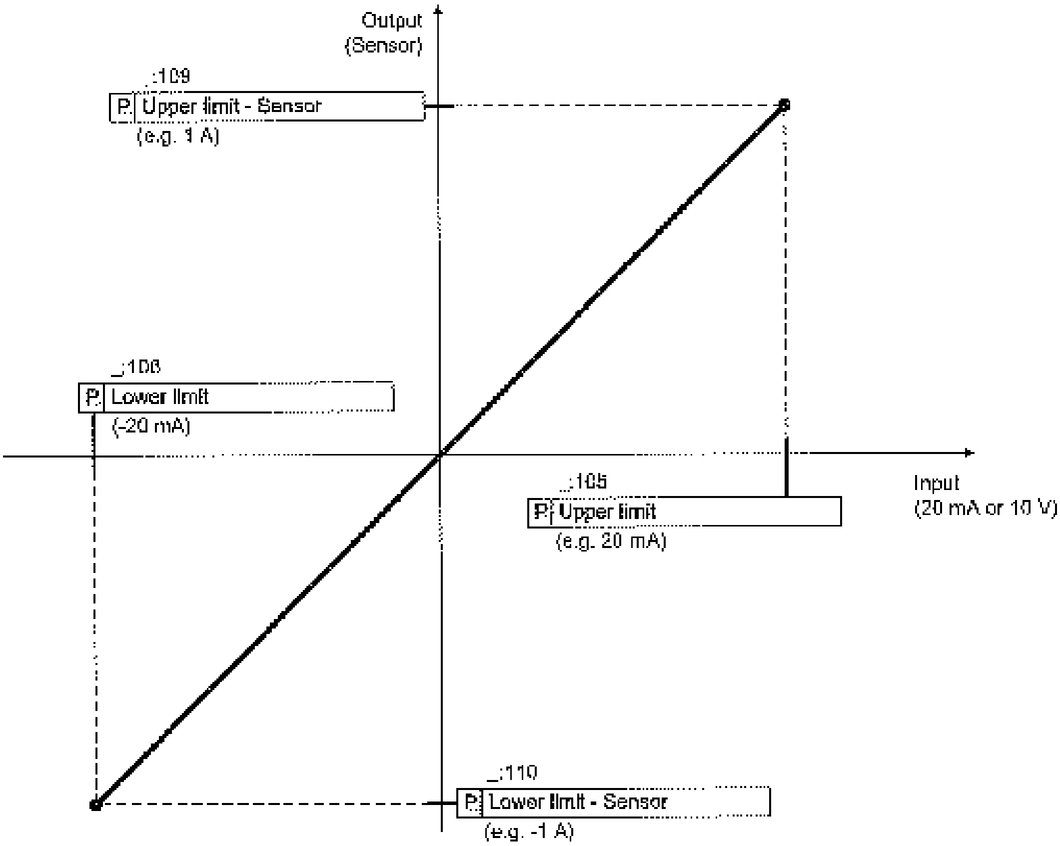


Figure 5-53 Scaling Principle

Setting Example 1:

A measuring transducer transmitting a current signal of 4 mA to 20 mA is used as a transmitter. Currents well below 4 mA indicate a transmitter failure; currents around 0 mA indicate a broken wire. A sensor detecting a temperature is attached to the transmitter. The upper value corresponds to 200 °C and the lower value to -100 °C. This results in the following characteristic. In accordance with the set characteristic curve, the function calculates the sensor value from the measured current. The coefficients of the linear equation (gradient and foot point) are calculated from the set threshold and the sensor values are determined. A supplied current of 9.333 mA corresponds to a temperature of 0 °C.

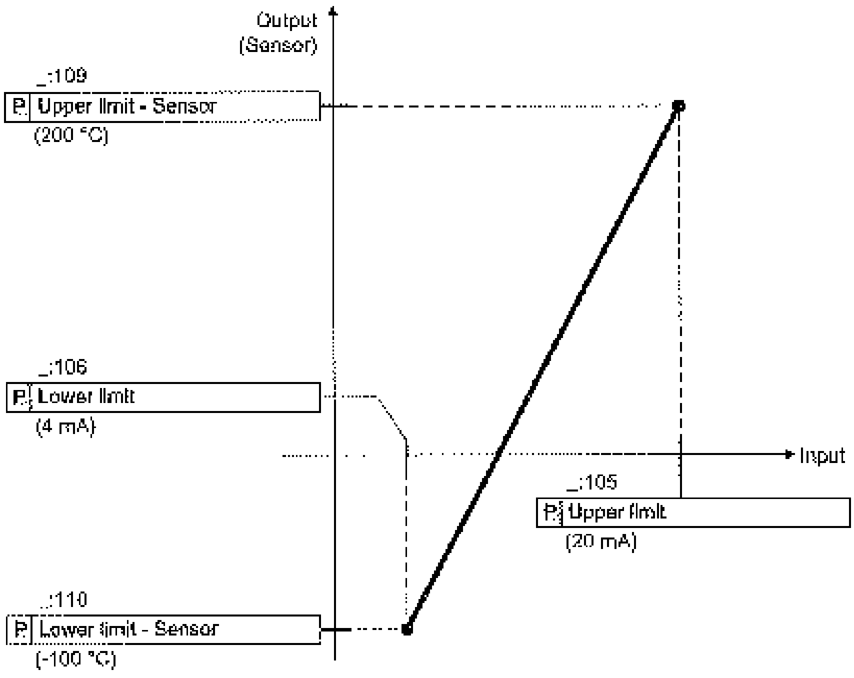


Figure 5-54 Characteristic Curve of Setting Example 1

NOTE

The hardware of the measuring transducer has been designed in such a way that measured values are transmitted and analyzed using the setting range (`Upper limit` or `Lower limit`). Therefore, special applications are possible, if necessary. The limits lie at approximately +20 mA and -20 mA or +10 V and -10 V. If the measured values are supplied above or below these limits, the quality `invalid` is assigned.

Setting Example 2:

For special applications, the transmitter sends a maximum of ±12 V. This voltage shall be issued accordingly as sensor voltage.

Set the parameters as follows:

- `Upper limit` = *10.00 V*
- `Upper limit - Sensor` = *10.00 V*
- `Lower limit` = *-10.00 V*
- `Lower limit - Sensor` = *-10.00 V*

With this setting, a signal of 12 V is issued as a 12-V measured value (see following figure).

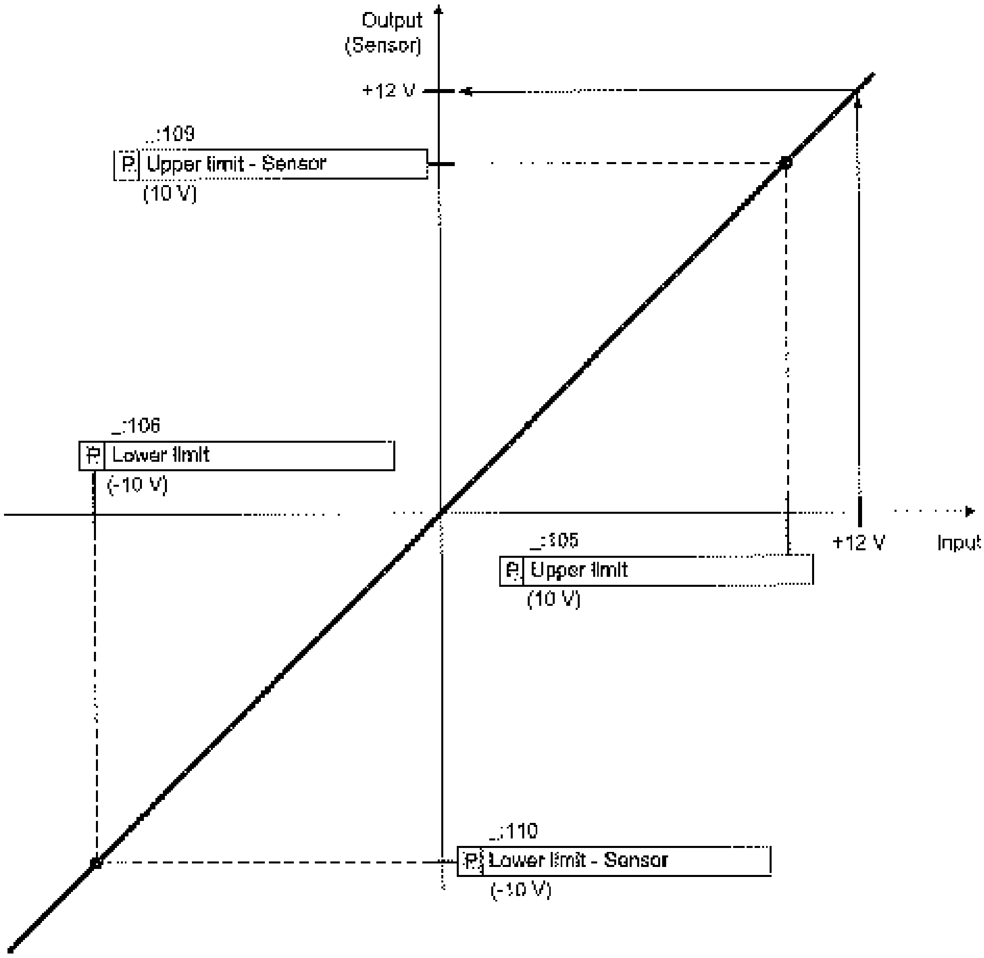


Figure 5-55 Parameter Settings and Representation of an Input Signal Greater than 10 V

5.6.6.5 Settings

Addr.	Parameter	C	Setting Options	Default Setting
MT fast #				
_:101	MT in #:TD input signal type		• Voltage input • Current input	Current input

Addr.	Parameter	C	Setting Options	Default Setting
_:103	MT in #:Unit		• • % • ' • °C • °F • Ω • Ω/km • Ω/mi • 1/s • A • As • cos φ • cycles • dB • F/km • F/mi • h • Hz • Hz/s • in • J • J/Wh • K • l/s • m • mi • min • p.u. • Pa • periods • rad • rad/s • s • V • V/Hz • VA • VAh • var • varh • Vs • W • W/s • Wh	A
_:142	MT in #:Measuring window		• 10 ms • 20 ms • 40 ms • 60 ms • 80 ms • 100 ms	10 ms
_:107	MT in #:Range active		• 0 • 1	false
_:104	MT in #:Conversion factor		-10000.00 to 10000.00	1.00
_:105	MT in #:Upper limit		-20.00 mA to 20.00 mA	5.00 mA
_:109	MT in #:Upper limit - Sensor		-10000.00 to 10000.00	1.00

Addr.	Parameter	C	Setting Options	Default Setting
_:106	MT in #:Lower limit		-20.00 mA to 20.00 mA	4.00 mA
_:110	MT in #:Lower limit - Sensor		-10000.00 to 10000.00	1.00

5.6.6.6 Information List

No.	Information	Data Class (Type)	Type
MT in #			
_:302	MT in #:TD scale MV	MV	O
_:306	MT in #:TD scale SAV	SAV	O

5.6.7 RTD Unit Ethernet

5.6.7.1 Overview

The **RTD unit Ether.** function:

- Communicates with an external RTD unit via the Slave Unit Protocol (SUP) and records the measured temperatures from the RTD unit
- Provides the captured temperatures to the temperature monitoring function
- Monitors communication with the RTD unit

5.6.7.2 Structure of the Function

The **RTD unit Ether.** function can only work in the **Analog units** function group. A maximum of 20 function instances can work simultaneously. Each instance contains 12 preconfigured sensor function blocks.

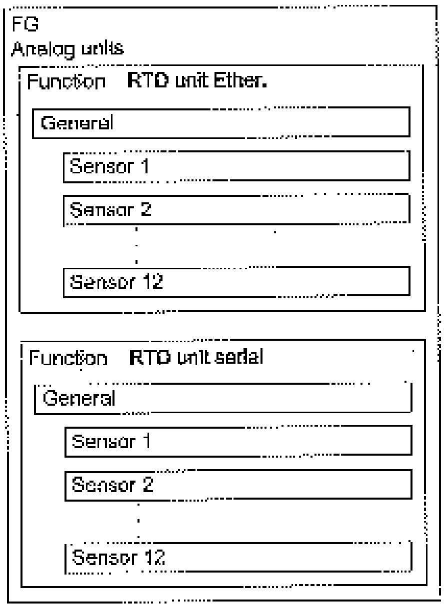
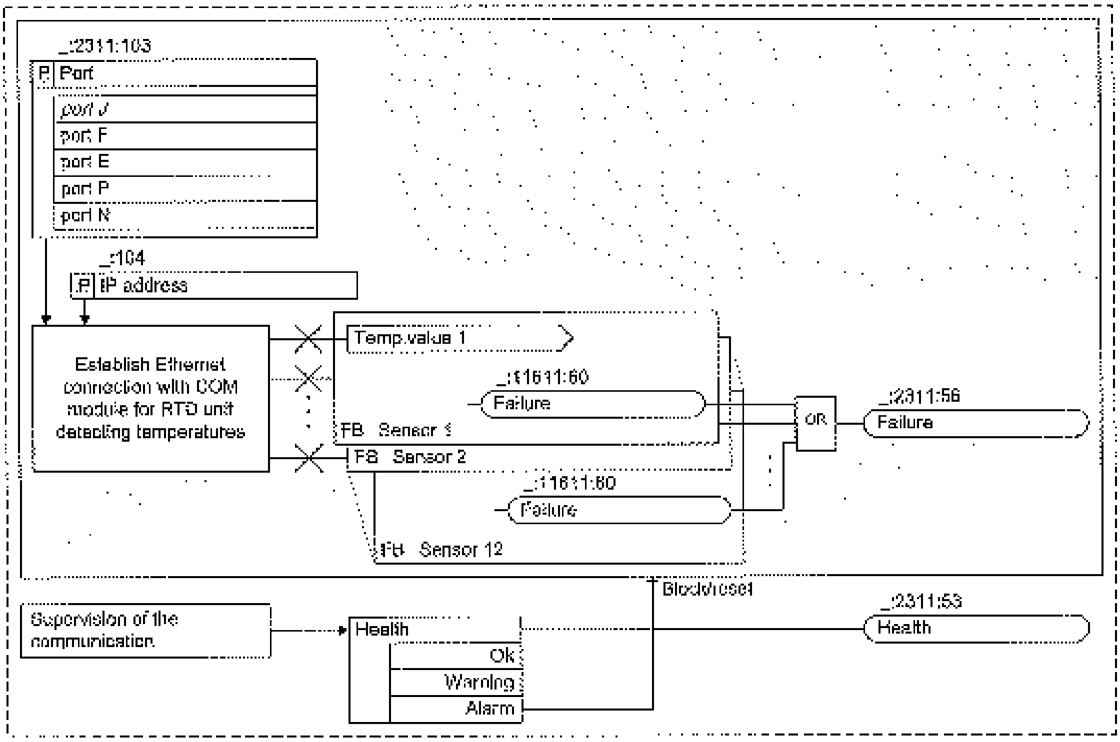


Figure 5-56 Structure/Embedding of the Function

5.6.7.3 Communication with an RTD Unit

Logic



[dwzdao-311012-01.en, 5, en US]

Figure 5-57 Logic of the RTD Unit Ether. Function

Communication with an RTD Unit

The function is used to communicate with an RTD box connected via an Ethernet connection. If the connection of the function is successfully established to the external RTD box via the Ethernet interface, the RTD box transmits the temperatures of all connected sensors to the **RTD box Ether.** function. For the connection to be established successfully, specific communication settings must be set, see chapter *5.6.7.4 Application and Setting Notes*.

The RTD box Ziehl **TR1200 IP** supports only an Ethernet connection of 10 MBit/s. A direct connection to a 100-Mbit communication module is therefore not possible. For this reason, you must connect the RTD box to the communication module via a 10/100 MBit/s autosensing switch which automatically recognizes the transmission rates and adapts them accordingly. Further information can be found in the Application and setting notes, see chapter *5.6.7.4 Application and Setting Notes*.

Error Responses

The following table lists the conditions under which the *Health* status transitions to the Alarm or Warning state.

Table 5-11 Error Responses

Error Description	Status Health
The **RTD unit Ether.** function cannot establish a connection with a communication module.	Alarm
The connection between the communication module and the RTD unit causes a time-out.	Warning

Error Description	Status Health
A communication module has not received any more data from the RTD unit for 9 sec.	Warning

The *Failure* signal is set as soon as one of the sensor function blocks reports a failure.

5.6.7.4 Application and Setting Notes

Parameter: Port

- Default setting (_:2311:103) **Port** = *port J*

Use the **Port** parameter to define over which port the external RTD unit is connected to the SIPROTEC 5 device.

If you want to connect the external RTD unit to the integrated Ethernet interface, set the parameter **Port** = **Port J**. If you want to connect the external RTD unit to an Ethernet plug-in module, set the parameter **Port** = *Port F*, **Port E**, *Port P*, or **Port N**.

You can connect directly the RTD unit to the device via the internal 10-Mbit Ethernet port J. If you operate the RTD unit on another port via a 100-Mbit communication module, you need an interconnected 10/100-Mbit autosensing switch, which adapts transmission rates accordingly.

Parameter: IP address

- Default setting (_:2311:104) **IP address** = *10.16.60.1*

With the **IP address** parameter, you set the IP address of the RTD unit connected to the communication module via the SUP protocol. Every RTD unit has to be assigned a unique IP address. The IP address to be set depends on your network configuration. You can set any valid IPv4 address that does not cause conflicts with other IP addresses in the network. Set an appropriate IP address first at the **Ziehl TR1200** IP RTD unit. Then specify the **IP address** parameter for the communication module to the same address.

Settings on the RTD Unit

The **Ziehl TR1200 IP** RTD unit is set with the front keys or in a Web browser on a laptop computer via its Ethernet interface. Set the connection type of the sensors (3-wire connection or resistance value for 2-wire connection), the idle state of the fault-indication relay, as well as the IP interface setting.

The code lock has to be switched off for parameterization. This is only possible using the front keys of the RTD unit. The code lock is **off** (switched off) in as-delivered condition and has pin **504**.

For detailed information on the settings, refer to the TR1200 IP manual that comes with the RTD unit. The documents are also available in the SIPROTEC download area (http://www.siprotec.de) under **Accessories -> 7XV5662-xAD**.

For an Ethernet connection to a SIPROTEC 5 device communicating with the RTD unit TR1200 IP via the **SUP protocol** (Slave Unit Protocol), the **Modbus TCP** setting must be activated in the RTD unit. You can activate the Modbus TCP protocol using the function keys under the TcP - **mod** menu item or with the Web browser in the **TCP/UDP Config** tab. The **RTD** (RTD protocol) and **UDP Port** settings have no effect here. The Modbus TCP port is permanently set to 502 and cannot be changed.

5.6.7.5 Temperature Sensor

Logic

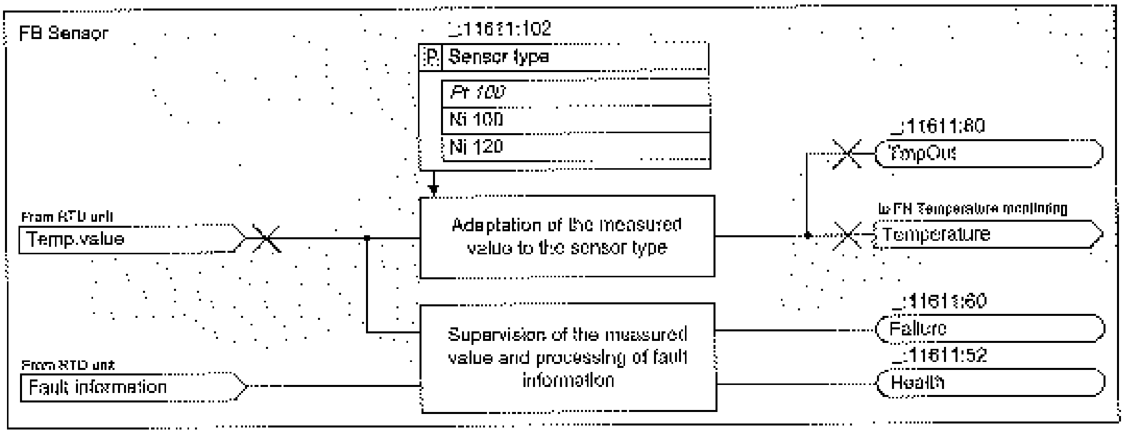


Figure 5-58 Logic Diagram of the Temperature Sensor Function Block

Measured Temperature Value

The **Temperature sensor** function block processes one single measured temperature value delivered from the RTD box for the assigned sensor. 12 temperature sensor function blocks are always available in each RTD box function (both via Ethernet and serial), even if fewer sensors are connected to the RTD box.

Various temperature sensor types are supported: Pt100, Ni100, and Ni120 sensors. The function block is notified regarding the selection of connected type via the `Sensor type` parameter.

The function block delivers a measured temperature value in °C or °F as an output variable. The measured temperature value is available as an operational measured value and can be monitored by the **Temperature supervision** function.

Error Responses

If the measured input value is determined to be incorrect, the quality attribute of the output measured temperature value is set to *invalid*. The statuses for Health and Error take the statuses in accordance with the following table:

Table 5-12 Error response

Error Description	Health Status	Error Status
Sensor or line short circuited	Alarm	Yes
Sensor or line interrupted	Alarm	Yes
Measured temperature value outside the valid measuring range specified in the technical data. The valid measuring range depends on the sensor type.	Alarm	Yes
Sensor not connected	OK	No

5.6.7.6 Application and Setting Notes

Parameter: Sensor type

- Default setting (`_:11611:102`) `Sensor type` = *Pt 100*

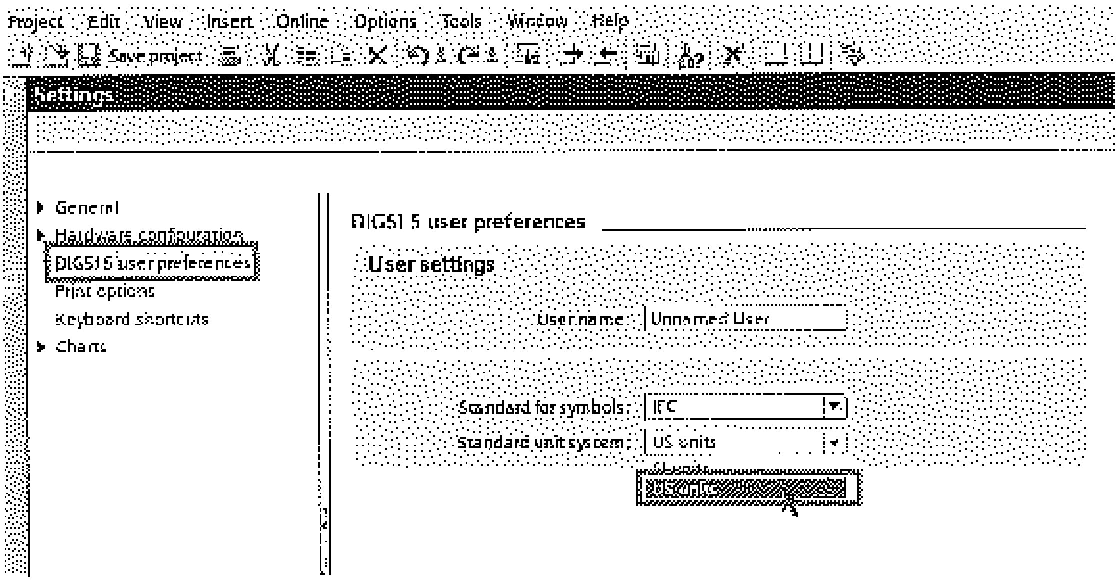
The `Sensor type` parameter is used to set the sensor element used. You can select between *Pt 100*, *Ni 100* and *Ni 120*.

Parameter: Temperature unit

To change the display and evaluation of measured temperature values from °C to °F, adapt the DIGSI user default settings accordingly.

Proceed as follows:

- In DIGSI select the menu item **Extras --> Settings**.
- In the **Settings** view select the menu item **DIGSI 5 User preferences**.
- Under **Standard unit system** change the setting value of the unit system used from *SI units* to *US units*.



[sc_tu_rvs_1002-4 01.1, en US]

Figure 5-59 Change of the Display Between °C and °F

The following settings and information table shows only 1 of the 12 sensors, as the setting possibilities of the 12 sensors do not differ.

5.6.7.7 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:103	General:Port		• port E • port F • port J • port N • port P	port J
Sensor 1				
_:11611:102	Sensor 1:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100

5.6.7.8 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:53	General:Health	ENS	O
_:2311:56	General:Failure	SPS	O

No.	Information	Data Class (Type)	Type
Sensor 1			
_:11611:52	Sensor 1:Health	ENS	O
_:11611:60	Sensor 1:Failure	SPS	O
_:11611:80	Sensor 1:TmpOut	MV	O

5.6.8 RTD Unit, Serial

5.6.8.1 Overview

The **RTD unit serial** function:

- Communicates with an external RTD unit serial via the Slave Unit Protocol (SUP) and records the measured temperatures from the RTD unit
- Provides the captured temperatures to the temperature supervision function
- Monitors communication with the RTD unit

The **RTD unit Serial** function is set up structurally in the same manner as the **RTD unit Ether.** function. The mode of operation is also identical (see *5.6.7.3 Communication with an RTD Unit*).

5.6.8.2 Application and Setting Notes

Parameter: Port

- Default setting (_:2311:103) **Port** = *F*

With the **Port** parameter, you set the slot for the communication module that will be used for the connection with an external RTD unit.
If you want to connect the external RTD box to an Ethernet plug-in module, set the parameter **Port** = ***Port F***, ***Port E***, ***Port P***, or ***plug-in module position***.

Parameter: Channel number

- Default setting (_:2311:105) **Channel number** = *1*

A serial communication module optionally uses 2 channels. With the **Channel number** settings, you set the channel number (1 or 2) through which the RTD unit is connected to the device. The communication module inputs are labeled with the channel numbers.

Parameter: Slave address

- Default setting (_:2311:106) **Slave address** = 1

Use the **Slave address** parameter to define the device address of the RTD unit. If only one RTD unit is connected to the serial bus, the default value *1* can be used. The same device address has to be set on the RTD unit. The device address is important for distinguishing among several RTD units connected to a serial bus. Set a unique device address (for example 1, 2 and 3 when connecting 3 RTD units) for each RTD unit and the same device address for the parameter **Slave address** in the 3 **RTD unit serial** functions.

The following settings and information table shows only 1 of the 12 sensors, as the setting possibilities of the 12 sensors do not differ.

5.6.8.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:103	General:Port		• port F • port E • port P • port N • port J	port J
_:2311:105	General:Channel number		1 to 2	1
_:2311:106	General:Slave address		1 to 254	1
Sensor 1				
_:11611:102	Sensor 1:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 2				
_:11612:102	Sensor 2:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 3				
_:11613:102	Sensor 3:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 4				
_:11614:102	Sensor 4:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 5				
_:11615:102	Sensor 5:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 6				
_:11616:102	Sensor 6:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 7				
_:11617:102	Sensor 7:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 8				
_:11618:102	Sensor 8:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 9				
_:11619:102	Sensor 9:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 10				
_:11611:102	Sensor 10:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100

Addr.	Parameter	C	Setting Options	Default Setting
Sensor 11				
_:11611:102	Sensor 11:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100
Sensor 12				
_:11611:102	Sensor 12:Sensor type		• Pt 100 • Ni 100 • Ni 120	Pt 100

5.6.8.4 Information List

No.	Information	Data Class (Type)	Type
General			
_:2311:53	General:Health	ENS	O
_:2311:56	General:Failure	SPS	O
Sensor 1			
_:11611:52	Sensor 1:Health	ENS	O
_:11611:60	Sensor 1:Failure	SPS	O
_:11611:80	Sensor 1:TmpOut	MV	O
Sensor 2			
_:11612:52	Sensor 2:Health	ENS	O
_:11612:60	Sensor 2:Failure	SPS	O
_:11612:80	Sensor 2:TmpOut	MV	O
Sensor 3			
_:11613:52	Sensor 3:Health	ENS	O
_:11613:60	Sensor 3:Failure	SPS	O
_:11613:80	Sensor 3:TmpOut	MV	O
Sensor 4			
_:11614:52	Sensor 4:Health	ENS	O
_:11614:60	Sensor 4:Failure	SPS	O
_:11614:80	Sensor 4:TmpOut	MV	O
Sensor 5			
_:11615:52	Sensor 5:Health	ENS	O
_:11615:60	Sensor 5:Failure	SPS	O
_:11615:80	Sensor 5:TmpOut	MV	O
Sensor 6			
_:11616:52	Sensor 6:Health	ENS	O
_:11616:60	Sensor 6:Failure	SPS	O
_:11616:80	Sensor 6:TmpOut	MV	O
Sensor 7			
_:11617:52	Sensor 7:Health	ENS	O
_:11617:60	Sensor 7:Failure	SPS	O
_:11617:80	Sensor 7:TmpOut	MV	O
Sensor 8			
_:11618:52	Sensor 8:Health	ENS	O
_:11618:60	Sensor 8:Failure	SPS	O
_:11618:80	Sensor 8:TmpOut	MV	O

No.	Information	Data Class (Type)	Type
Sensor 9			
_:11619:52	Sensor 9:Health	ENS	O
_:11619:60	Sensor 9:Failure	SPS	O
_:11619:80	Sensor 9:TmpOut	MV	O
Sensor 10			
_:11611:52	Sensor 10:Health	ENS	O
_:11611:60	Sensor 10:Failure	SPS	O
_:11611:80	Sensor 10:TmpOut	MV	O
Sensor 11			
_:11611:52	Sensor 11:Health	ENS	O
_:11611:60	Sensor 11:Failure	SPS	O
_:11611:80	Sensor 11:TmpOut	MV	O
Sensor 12			
_:11611:52	Sensor 12:Health	ENS	O
_:11611:60	Sensor 12:Failure	SPS	O
_:11611:80	Sensor 12:TmpOut	MV	O

5.6.9 Communication with RTD Unit

5.6.9.1 Integration of a Serial RTD Unit (Ziehl TR1200)

Connection of the Communication Lines

Figure 5-60 shows how you connect the RTD box to the SIPROTEC 5 device. Note that Pin 1 of the RJ45 plug is connected to RTD-B and Pin 2 is connected to RTD-A.

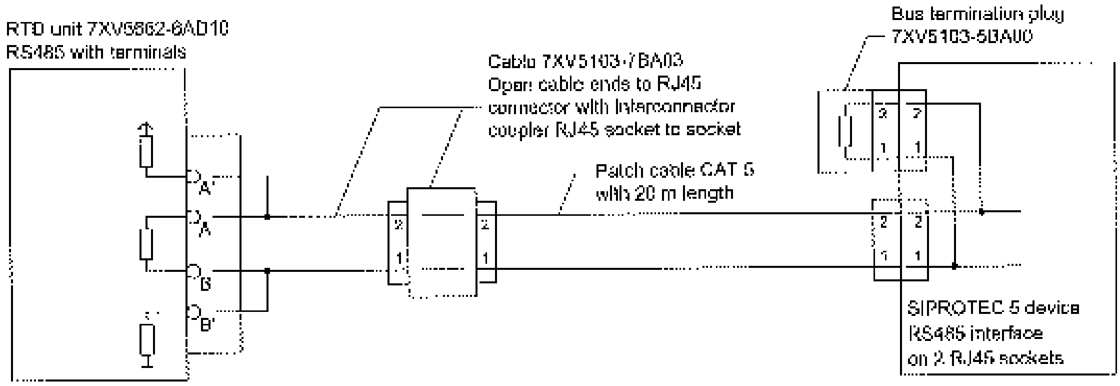
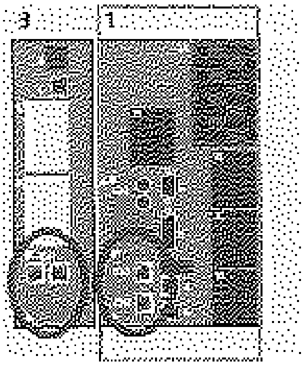


Figure 5-60 Connection of the RTD Unit to the SIPROTEC 5 Device

Adding a USART Module

Add a USART-AB-1EL or a USART-AC-2EL USART module in DIGSI to the device. The USART module must be inserted at one of the plug-in positions for communication modules in the base module or in the CB202 expansion module (refer to the following figure).

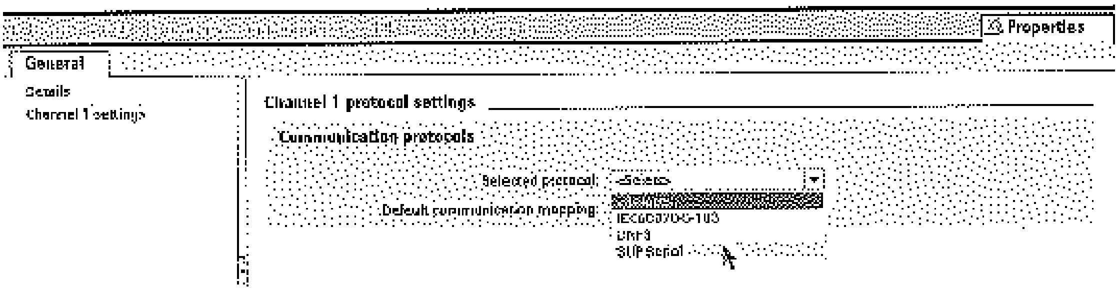


[scuusn3-1407-4-01, 1, en_US]

Figure 5-61 Insertion Position for a USART Module

Selecting the SUP Protocol

Select the Slave Unit Protocol (SUP). This protocol is responsible for the communication between the SIPROTEC 5 device and the RTD Unit.



[scuusn1 22014-01-01, 1, en_US]

Figure 5-62 Selecting the SUP Protocol

Communication Settings

Make the communications settings for the relevant serial channels. For this, use the default settings specified by the RTD box. Normally, you must adapt only the parameterization of the SIPROTEC 5 device to the settings of the RTD box. Make sure that the setting values in both devices are the same. The settings of the `Non-flickering light (on/off)`: is not relevant for the RS485 interface.

NOTE

The driver for the USART module for the SUP protocol is not preinstalled as standard for the initial use of this interface (following the firmware update).

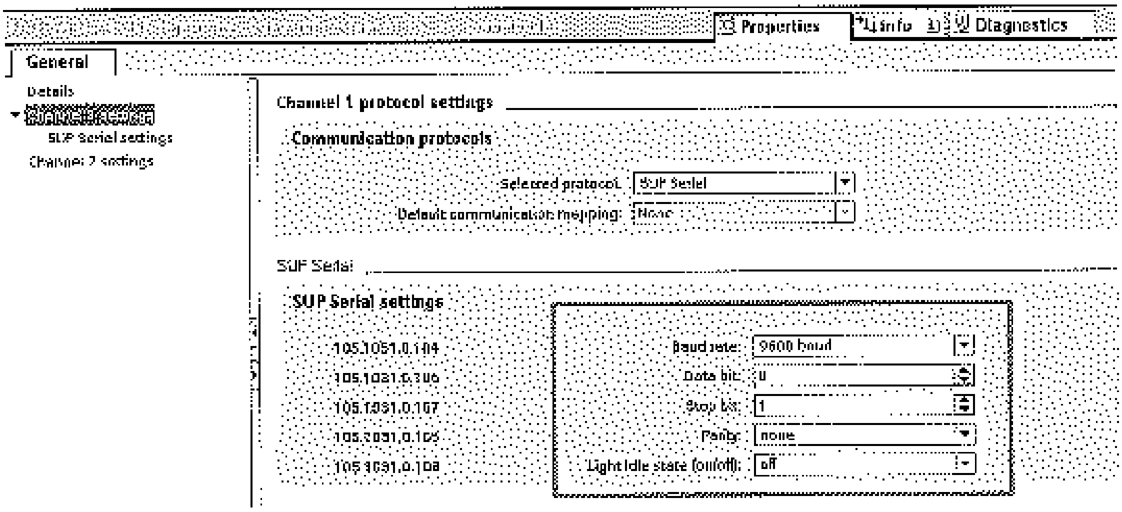


Figure 5-63 Making the Communication Settings

With the selection of the SUP protocol for the RTD box DIGSI automatically adds the function group **Analog units** to your device configuration. You can now instantiate the function **RTD box serial** 1 (refer to the following figure).

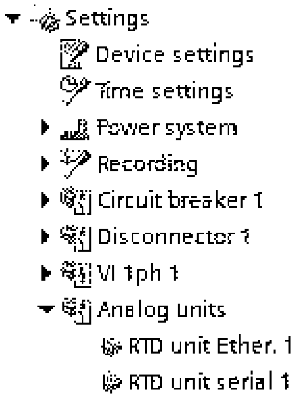


Figure 5-64 Analog Unit Instance

Now, set the channel number over which the SUP protocol runs. In addition, set the slave address of the RTD box. This address must be set with the same value in the RTD box (refer to the following figure).

The following device configuration must be set on the TR1200 RTD unit when the RTD unit is used for the first time:

- Bus protocol: mod
- Device address: 1
- Baud rate: 9600
- Parity: no

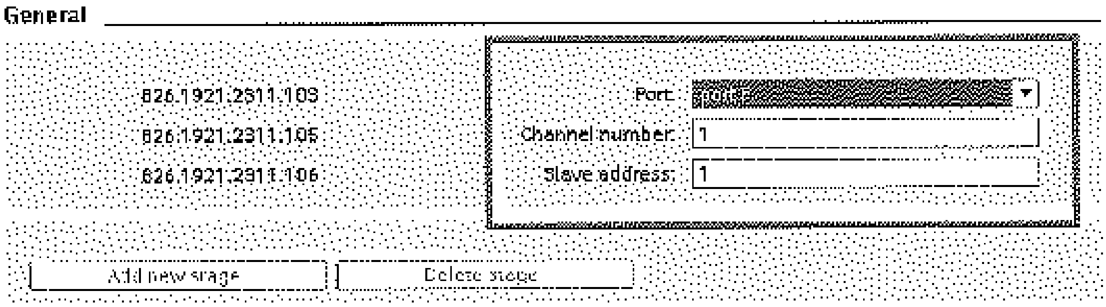


Figure 5-65 Setting the Port, Channel Number, and Slave Address

Finally, load the configuration in the device.

5.6.9.2 Integration of an RTD-Unit Ethernet (TR1200 IP)

Device Configuration

In the DIGSI, insert an Ethernet module into the provided slot, thus, adding the module to the device configuration. *Figure 5-66* displays the available slots in the base module or on the expansion module CB 202. Alternatively, you can also use the integrated Ethernet interface Port J.

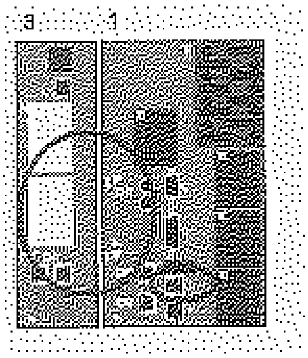


Figure 5-66 Inserting an Ethernet Module

Communication Settings

Activate the SUP Ethernet protocol for the Ethernet module.

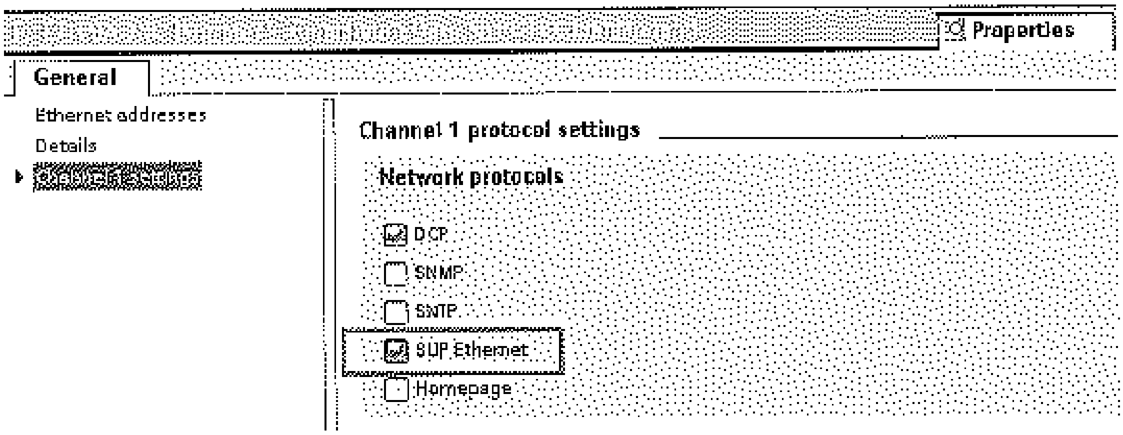


Figure 5-67 SUP Ethernet Protocol Activation

This protocol is also available for Port J of the integrated Ethernet interface of the base module (refer to following figure).

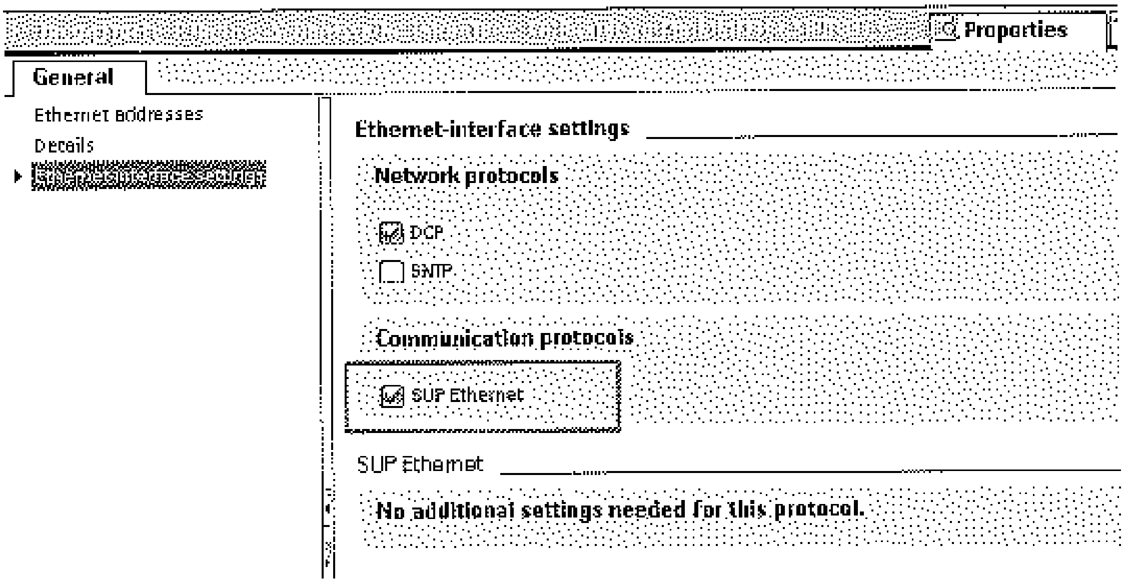


Figure 5-68 SUP Ethernet Protocol Activation (base module)

With the selection of the SUP protocol for the RTD unit, DIGSI automatically adds the **Analog units** function group and the **RTD unit** Ether. function to your device configuration (refer to the following figure).

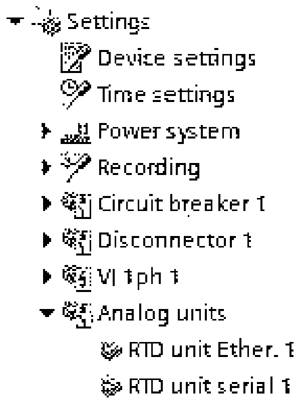


Figure 5-69 Analog Unit Instance

Now, set the port over which the SUP protocol runs. In addition, set the IP address of the RTD box (refer to the following figure). This address must be set with the same value in the RTD box.

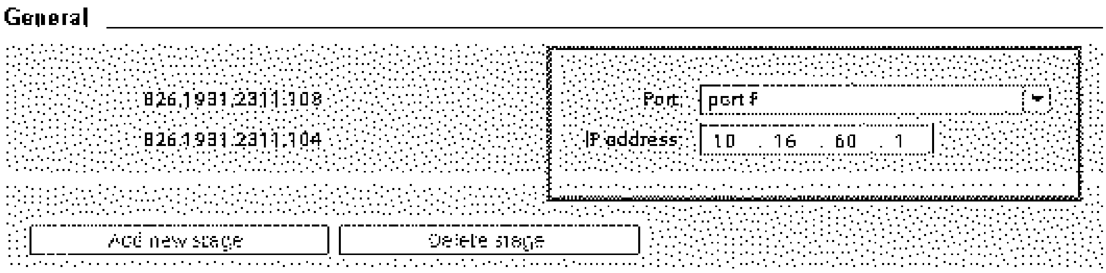


Figure 5-70 Setting the Port and IP Address

Finally, load the configuration in the device.

5.6.9.3 Temperature Simulation without Sensors

Connect a resistor on the sensor terminals of the RTD unit. Using this resistor, simulate a constant temperature. The resistance value should be around 50 Ω to 200 Ω.

If you want to simulate a changeable temperature, connect an adjustable resistor of maximum 470 Ω instead of a fixed resistor.

5.7 Function-Group Type Circuit Breaker

5.7.1 Overview

The **Circuit-breaker** function group combines all the user functions that relate to a circuit breaker.

You will find the **Circuit-breaker** function group under each device type in the function library in DIGSI 5. The **Circuit-breaker** function group contains all of the protection, control, and supervision functions that you can use for this device type. The following figure shows, for example, the functional scope of the **Circuit-breaker** function group.

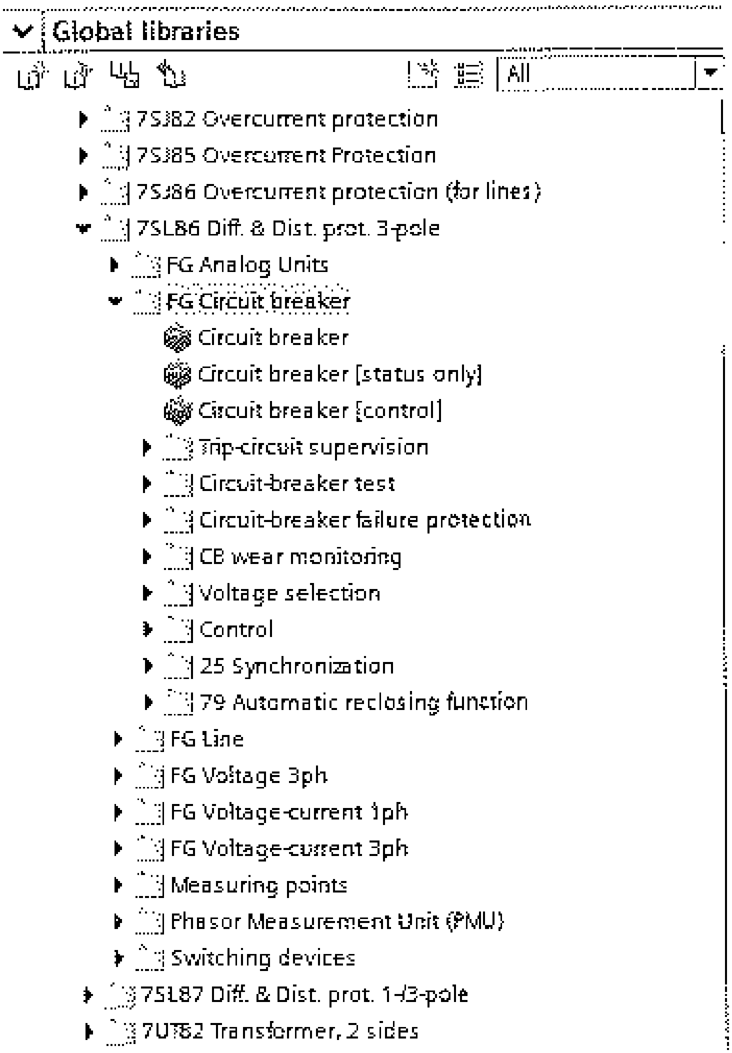


Figure 5-71 Circuit-Breaker Function Group - Example of the Functional Scope

The Circuit-breaker function group includes 3 different types of circuit breakers:

- Circuit breaker
- Circuit-breaker control
- Circuit breaker [status only]

The circuit-breaker type can accept additional basic function blocks for protection functions along with the actual circuit breaker control.

The circuit breaker [status only] is used only for acquiring the circuit-breaker switch position. This type can be used to model switches that can only be read but not controlled by the SIPROTEC 5 device.

The available functions are described in the chapters *6 Protection and Automation Functions* and *8 Control Functions*.

5.7.2 Structure of the Function Group

Besides the user functions, the **Circuit-breaker** function group contains certain functionalities that are essential for general purposes and therefore cannot be loaded or deleted:

- Trip logic
- Mapping the physical circuit breaker
- Circuit-breaker position recognition for protection functions
- Detection of manual closure
- General settings

The following figure shows the structure of the **Circuit-breaker** function group. The individual function blocks in the image are described in the following chapters.

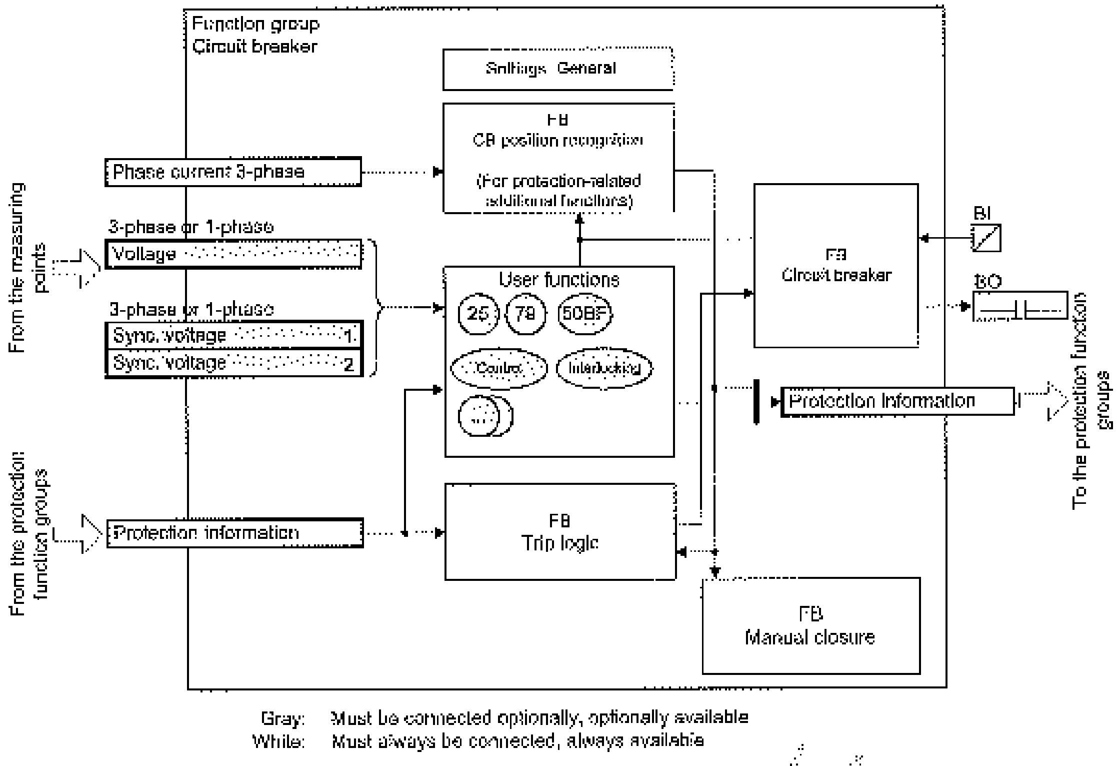


Figure 5-72 Structure of the Circuit-Breaker Function Group

The **Circuit-breaker** function group has interfaces with:

- **Measuring points**
- Protection function groups

Interfaces with Measuring Points

The function group contains the measured values needed from the measuring points associated with this function group.

If an application template is used, the function group is connected to the measuring point of the 3-phase current because this connection is essential. It can be necessary to connect additional measuring points to the function group, depending on the nature of the user functions used. Configuration is carried out using the **Function-group connections** editor in DIGSI 5. You can find more detailed information on this in chapter *2.1 Function Embedding in the Device*.

If a user function, for example, synchronization, is used in the function group but the required measuring point has not linked to it, DIGSI 5 reports an inconsistency. This inconsistency provides an indication of the missing measuring-point connection.

The **Circuit-breaker** function group has interfaces with the following measuring points:

- `3-phase line current`

  The measurands from the 3-phase power system are supplied via this interface. The function group must always be connected to this measuring point.

- `Voltage`

  The measurands of the 3-phase voltage system or 1-phase voltage are supplied via this interface. Depending on the connection type of the transformers, in the 3-phase voltage system these are, for example, V_A, V_B, V_C of the line or feeder.

  The connection to the corresponding measuring point is necessary only if a user function that needs the measurand of the 3-phase voltage system is used, for example, to make use of the **Synchronization** or **Automatic reclosing** function.

- `Sync. Voltage1, Sync. Voltage2`

  A 1-phase synchronization voltage (for example, voltage of the busbar with a 1-phase connection) or a 3-phase synchronization voltage (for example, voltage of the busbar with a 3 phase connection) is supplied via this interface.

  The connection to the corresponding measuring point is necessary only if synchronization is used.

Interface with Protection-Function Groups

All required data is exchanged between the Protection and Circuit-breaker function groups via the interface with the Protection function group. This data includes, for example, the pickup and operate indications of the protection functions sent in the direction of the Circuit-breaker function group and, for example, the circuit-breaker condition information in the direction of the protection function groups.

If an application template is used, the function groups are connected to each other because this connection is essential to ensure proper operation. You can modify the connection using the **Function-group connections** editor in DIGSI 5.

You can find more detailed information in chapter *2.1 Function Embedding in the Device*.

If the connection is missing, DIGSI 5 reports an inconsistency.

Besides the general assignments of the Protection function group or groups to the Circuit-breaker function groups, you can also configure the interface for certain functionalities in detail:

- Which operate indications of the protection functions are included when the trip command is generated?
- Which protection functions activate the **Automatic reclosing** function?
- Which protection functions activate the **Circuit-breaker failure protection** function?

You can find more detailed information in chapter *2.1 Function Embedding in the Device*.

5.7.3 Application and Setting Notes

Interface with Measuring Points

The interface with the 3-phase power system must have been configured. Otherwise, DIGSI 5 supplies an inconsistency message.

If the **Synchronization** function is used, the measuring points that represent voltages V1 and V2 of the parts of the electrical power system to be synchronized must be connected.

You can find more detailed information in the chapter *8.4 Synchronization Function* .

The **Automatic reclosing** function provides the auxiliary functions **Dead-line check** and **Reduced dead time.** For these auxiliary functions, the 3-phase voltage system has to be measured. If you want to use these auxiliary functions, the measuring point of the 3-phase voltage system must be connected to the **Voltage** function group interface. This connection is also necessary if the **Automatic reclosing function with adaptive dead time** function type is used.

Interface with Protection-Function Groups

The protection-function group is connected to 2 circuit breakers (2 **Circuit-breaker** function groups) for 1 1/2 circuit-breaker layouts.

Parameter: Rated Normal Current for % Values

- Default setting (_:2311:101) **Rated normal current** = *1000 A*

With the **Rated normal current** parameter, you set the primary current which serves as a reference for all current-related % values within the Circuit-breaker function group. This applies both for operational measured values and for setting values in %.

Enter the primary rated current of the protected object here.

If the device works with the IEC 61850 protocol, then you change only the setting value of the parameter via DIGSI 5 and not directly on the device. If you change the setting value directly on the device, then the IEC 61850 configuration of the metered values can be faulty.

Parameter: Rated Voltage for % Values

- Default setting (_:2311:102) **Rated voltage** = *400 kV*

With the **Rated voltage** parameter, you set the primary voltage, which serves as a reference for all voltage-related % values within the Circuit-breaker function group. This applies both for operational measured values and for setting values in %.

Enter the primary rated voltage of the protected object (for example, the line) here.

If the device works with the IEC 61850 protocol, then you change only the setting value of the parameter via DIGSI 5 and not directly on the device. If you change the setting value directly on the device, then the IEC 61850 configuration of the metered values can be faulty.

Parameter: Current Threshold Circuit Breaker Open

- Default setting (_:2311:112) **Current thresh. CB open** = *0.10 A*

With the **Current thresh. CB open** parameter, you specify the threshold value below which the circuit-breaker pole or the circuit breaker is recognized as open.

Set the **Current thresh. CB open** parameter so that the current measured when the circuit-breaker pole is open will certainly fall below the parameterized value. If parasitic currents (for example, due to induction) are excluded with the line deactivated, you can make a secondary setting of the value with a high degree of sensitivity, to *0.05 A* for example.

If no special requirements exist, Siemens recommends retaining the setting value of *0.10 A* for secondary purposes.

5.7.4 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Ref. for %-values				
_:2311:101	General:Rated normal current		0.20 A to 100000.00 A	1000.00 A
_:2311:102	General:Rated voltage		0.20 kV to 1200.00 kV	400.00 kV

Addr.	Parameter	C	Setting Options	Default Setting
Breaker settings				
_:2311:112	General:Current thresh. CB open	1 A @ 100 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 100 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 50 Irated	0.030 A to 10.000 A	0.100 A
		5 A @ 50 Irated	0.15 A to 50.00 A	0.50 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	0.100 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	0.500 A
_:2311:136	General:Op. mode BFP		• unbalancing • I> query	unbalancing
Trip logic				
_:5341:103	Trip logic:Reset of trip command		• with I< • with I< & aux.contact • with dropout	with I<
Circuit break.				
_:4261:101	Circuit break.:Output time		0.02 s to 1800.00 s	0.10 s
Manual close				
_:6541:101	Manual close:Action time		0.01 s to 60.00 s	0.30 s
Control				
_:4201:101	Control:Control model		• status only • direct w. normal secur. • SBO w. normal secur. • direct w. enh. security • SBO w. enh. security	SBO w. enh. security
_:4201:102	Control:SBO time-out		0.01 s to 1800.00 s	30.00 s
_:4201:103	Control:Feedback monitoring time		0.01 s to 1800.00 s	1.00 s
_:4201:104	Control:Check switching authority		• no • yes • advanced	yes
_:4201:105	Control:Check if pos. is reached		• no • yes	yes
_:4201:106	Control:Check double activat. blk.		• no • yes	yes
_:4201:107	Control:Check blk. by protection		• no • yes	yes
Switching authority				
_:4201:151	Control:Swi.dev. related sw.auth.		• 0 • 1	false
_:4201:152	Control:Specific sw. authorities		• 0 • 1	true
_:4201:115	Control:Specific sw.auth. valid for		• station • station/remote • remote	station/remote
_:4201:153	Control:Num. of specific sw.auth.		2 to 5	2
_:4201:155	Control:Ident. sw.auth. 1		Freely editable text	
_:4201:156	Control:Ident. sw.auth. 2		Freely editable text	
_:4201:157	Control:Ident. sw.auth. 3		Freely editable text	

Addr.	Parameter	C	Setting Options	Default Setting
_:4201:158	Control:Ident. sw.auth. 4		Freely editable text	
_:4201:159	Control:Ident. sw.auth. 5		Freely editable text	
_:4201:154	Control:Multiple specific sw.auth.		• 0 • 1	false
CB test				
_:6151:101	CB test:Dead time		0.00 s to 60.00 s	0.10 s

5.7.5 Information List

No.	Information	Data Class (Type)	Type
Trip logic			
_:5341:300	Trip logic:Trip indication	ACT	O
Circuit break.			
_:4261:500	Circuit break.:>Ready	SPS	I
_:4261:501	Circuit break.:>Acquisition blocking	SPS	I
_:4261:502	Circuit break.:>Reset switch statist.	SPS	I
_:4261:504	Circuit break.:>Reset AcqBlk&Subst	SPS	I
_:4261:503	Circuit break.:External health	ENS	I
_:4261:53	Circuit break.:Health	ENS	O
_:4261:58	Circuit break.:Position	DPC	C
_:4261:300	Circuit break.:Trip/open cmd.	SPS	O
_:4261:301	Circuit break.:Close command	SPS	O
_:4261:302	Circuit break.:Command active	SPS	O
_:4261:303	Circuit break.:Definitive trip	SPS	O
_:4261:304	Circuit break.:Alarm suppression	SPS	O
_:4261:306	Circuit break.:Op.ct.	INS	O
_:4261:307	Circuit break.:ΣI Brk.	BCR	O
_:4261:308	Circuit break.:ΣIA Brk.	BCR	O
_:4261:309	Circuit break.:ΣIB Brk.	BCR	O
_:4261:310	Circuit break.:ΣIC Brk.	BCR	O
_:4261:311	Circuit break.:Break.-current phs A	MV	O
_:4261:312	Circuit break.:Break.-current phs B	MV	O
_:4261:313	Circuit break.:Break.-current phs C	MV	O
_:4261:314	Circuit break.:Break. voltage phs A	MV	O
_:4261:315	Circuit break.:Break. voltage phs B	MV	O
_:4261:316	Circuit break.:Break. voltage phs C	MV	O
_:4261:322	Circuit break.:CB open hours	INS	O
_:4261:323	Circuit break.:Operating hours	INS	O
Manual close			
_:6541:501	Manual close:>Block manual close	SPS	I
_:6541:500	Manual close:>Input	SPS	I
_:6541:300	Manual close:Detected	SPS	O
Reset LED Group			
_:13381:500	Reset LED Group:>LED reset	SPS	I
_:13381:320	Reset LED Group:LED have been reset	SPS	O

No.	Information	Data Class (Type)	Type
Control			
_:4201:503	Control:>Sw. authority local	SPS	I
_:4201:504	Control:>Sw. authority remote	SPS	I
_:4201:505	Control:>Sw. mode interlocked	SPS	I
_:4201:506	Control:>Sw. mode non-interl.	SPS	I
_:4201:53	Control:Health	ENS	O
_:4201:58	Control:Cmd. with feedback	DPC	C
_:4201:302	Control:Switching auth. station	SPC	C
_:4201:308	Control:Enable sw. auth. 1	SPC	C
_:4201:309	Control:Enable sw. auth. 2	SPC	C
_:4201:310	Control:Enable sw. auth. 3	SPC	C
_:4201:311	Control:Enable sw. auth. 4	SPC	C
_:4201:312	Control:Enable sw. auth. 5	SPC	C
_:4201:313	Control:Switching authority	ENS	O
_:4201:314	Control:Switching mode	ENS	O
Interlocking			
_:4231:500	Interlocking:>Enable opening	SPS	I
_:4231:501	Interlocking:>Enable closing	SPS	I
_:4231:502	Interlocking:>Enable opening(fixed)	SPS	I
_:4231:503	Interlocking:>Enable closing (fixed)	SPS	I
_:4231:53	Interlocking:Health	ENS	O
CB test			
_:6151:53	CB test:Health	ENS	O
_:6151:301	CB test:Test execution	ENS	O
_:6151:302	CB test:Trip command issued	ENS	O
_:6151:303	CB test:Close command issued	ENS	O
_:6151:304	CB test:Test canceled	ENS	O
_:6151:311	CB test:3-pole open-close	SPC	C

5.7.6 Trip Logic

5.7.6.1 Function Description

The **Trip logic** function block receives the group operate indication from the Protection function group or Protection function groups and forms the protection trip command that is transmitted to the **Circuit-breaker** function block.

The **Circuit-breaker** function block activates the device contact and thus causes the circuit breaker to open (see 5.7.7 *Circuit Breaker*). The command output time is also effective here.

The trip logic also decides when the protection trip command is reset (see *Figure 5-74*).

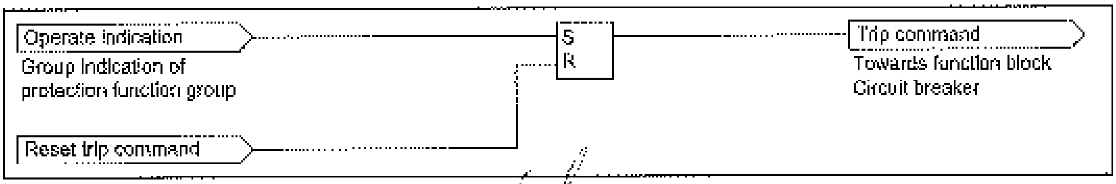


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Figure 5-73 Trip Command

Trip-Command Reset

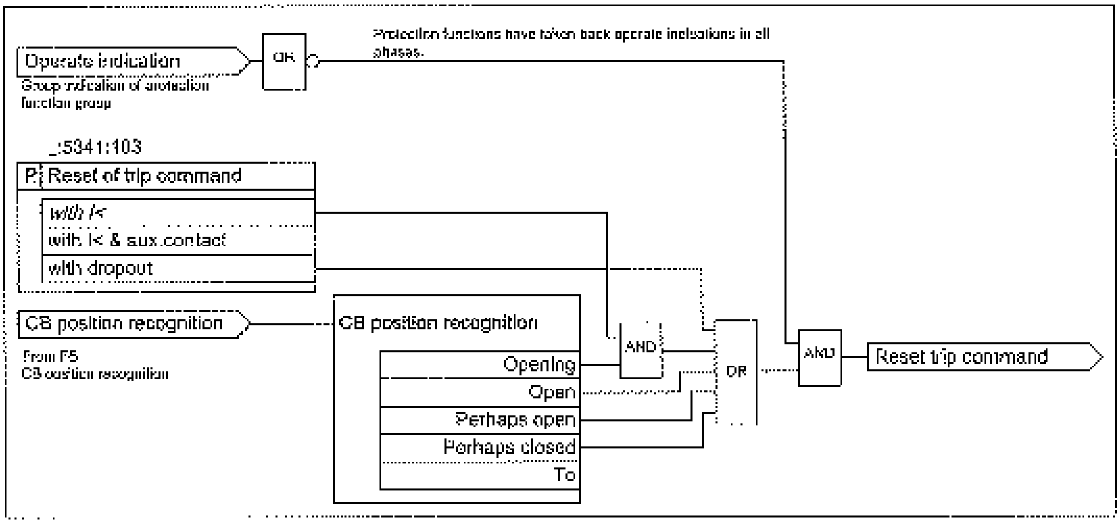

Figure 5-74 Trip-Command Reset

Once a trip command is issued, it is stored (see *Figure 5-73*).

You determine the criteria for resetting a trip command that has been issued with the parameter **`Reset of trip command`**.

- **`with dropout`**

  The trip command is reset if the function that initiated tripping resets its operate indication. This occurs typically with dropout. Command reset of the trip command takes place regardless of verification of the circuit-breaker condition.

- **`with I<`**

- **`with I< & aux.contact`**

  For these criteria, the state of the circuit breaker is also taken into account as a further criterion in addition to the dropout of the tripping function (operate indication is reset by command). You can select whether the state is determined by means of the current (**`with I<`**) or by means of the current in conjunction with the circuit-breaker auxiliary contacts (**`with I< & aux.contact`**). The behavior of these setting options only differs in one situation of the circuit-breaker state. If the circuit breaker is in the **opening** state, the trip command is reset in the case of the option **`with I<`**, whereas it is not reset yet in the case of the option with **`with I< & aux.contact`**. The **opening** state is detected if the auxiliary contacts still detect the circuit breaker as being closed and opening is detected via the decreasing current flow.

  As long as the circuit breaker is detected unambiguously as closed (**fully closed**), the trip command will not be reset with these setting options.

  The information about the condition of the circuit breaker is supplied by the **Circuit-breaker position recognition** function block (see *5.7.8 Circuit-Breaker Position Recognition for Protection-Related Auxiliary Functions*). The determination of the various conditions is also described in this chapter.

5.7.6.2 Application and Setting Notes

Parameter: Reset of trip command

- Recommended setting value (_:5341:103) **`Reset of trip command`** = **`with I<`**

Parameter Value	Description
`with I<`	With this setting, the trip command is reset as soon as the current is removed, provided the tripping function has dropped out. The most important factor for recognition of the open circuit breaker is the current falling short of the value set in the parameter (_:2311:112) `Current thresh. CB open`.
`with I< & aux.contact`	For this setting not only the current has to be removed, but also the circuit-breaker auxiliary contact has to report that the circuit breaker is open. This setting assumes that the setting of the auxiliary contact has been routed via a binary input (for more information, see 5.7.7.3 *Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information*).
`with dropout`	The setting can be selected for special applications in which the trip command does not result in complete interruption of the current in every case. In this case, the trip command is reset if the pickup of the tripping protection function drops out. The setting is useful if the load current in the system cannot be interrupted during the protection device test and the test current is fed in parallel with the load current.

5.7.6.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Trip logic				
_:103	Trip logic:Reset of trip command		• with I< • with I< & aux.contact • with dropout	with I<

5.7.6.4 Information List

No.	Information	Data Class (Type)	Type
Trip logic			
_:300	Trip logic:Trip indication	ACT	O

5.7.7 Circuit Breaker

5.7.7.1 Overview

The **Circuit-breaker** function block represents the physical switch in the SIPROTEC 5 device.

The basic tasks of this function block are the operation of the circuit breaker and the acquisition of the circuit-breaker auxiliary contacts and other circuit-breaker information.

The **Circuit-breaker** function block provides information about:

- Number of switching cycles
- Breaking current, breaking voltage, and breaking frequency
- Summation breaking current

5.7.7.2 Tripping, Opening, and Closing the Circuit Breaker

The circuit breaker is operated in the following situations:

- Tripping of the circuit breaker as a result of a protection trip command
- Opening of the circuit breaker as a result of control operations
- Closing of the circuit breaker as a result of automatic reclosing or control operations

Tripping is always the result of a protection function. The operate indications of the individual protection functions are summarized in the **Trip logic** function block. The trip command that causes the tripping in the **Circuit breaker** function block is generated there.

To operate the circuit breaker, the **Circuit-breaker** function block provides the output signals that must be routed to the corresponding binary outputs of the device (see Table 5-13).

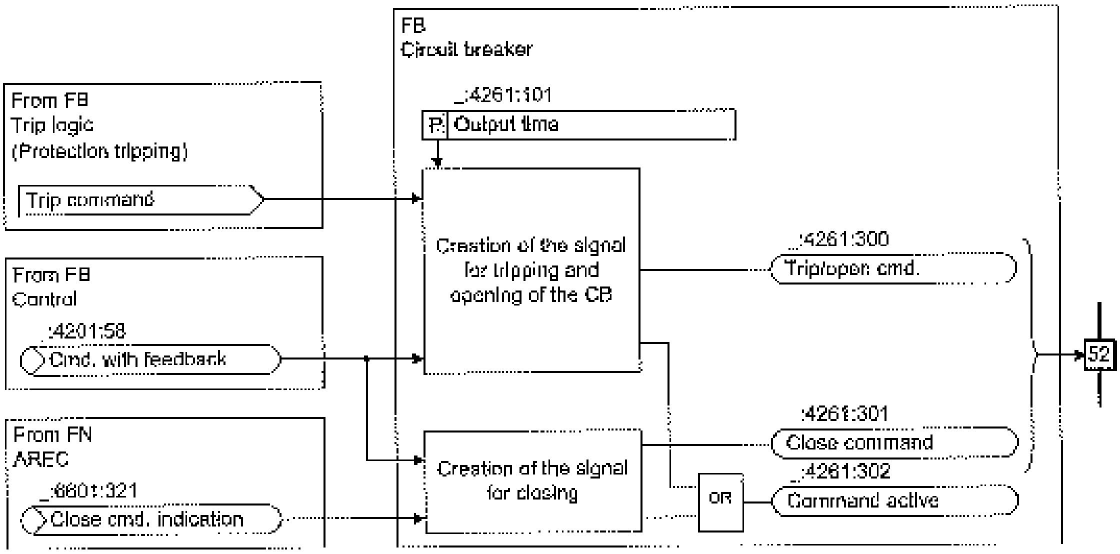

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Figure 5-75 Tripping, Opening, and Closing the Circuit Breaker

Table 5-13 Description of the Output Signals

Signal	Description	Routing Options
`Trip/open cmd.`	This signal executes all tripping and opening operations. The `Output time` parameter affects the signal. The signal is pending for the duration of this period, with the following exceptions: • Only when switched off by the control: The signal is canceled before expiration of the period if the auxiliary contacts report that the circuit breaker is open before expiration of the period. • Only in the event of protection tripping: The signal remains active as long as the trip command is still active after expiration of the period (see also 5.7.6.1 *Function Description*). • Only in the event of protection tripping: With the routing option **Only saved in the event of tripping**, the signal remains pending until it is acknowledged manually. This only applies for protection tripping.	• Unlatched • Only saved in the event of protection tripping (not when opened)
`Close command`	This signal executes all closing operations. The `Output time` parameter affects the signal. The signal is pending for the duration of this period, with the following exception: The signal is canceled before expiration of the period if the auxiliary contacts report that the circuit breaker is closed before expiration of the period.	Normal routing
`Command active`	This signal is active as long as one of the binary outputs assigned to the signals `Trip/open cmd.` and `Close command` is active because a switching command is being executed by the control.	Normal routing

5.7.7.3 Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information

To determine the circuit breaker position, the **Circuit-breaker** function block provides position signals (see next figure).

These signals are of the **Double-point indication** (DPC) type. A double-point indication can be routed to 2 binary inputs so that the open and closed circuit-breaker positions can be reliably acquired.

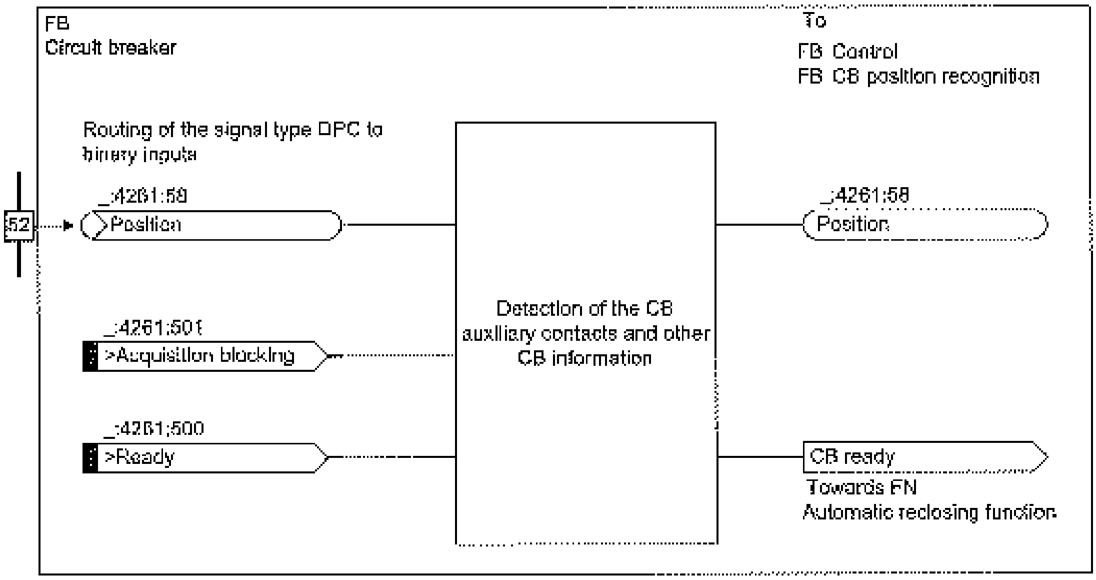

Figure 5-76 Acquisition of the Circuit-Breaker Information

Signal	Type	Description
Position	DPC	Acquisition of the circuit-breaker position The position **3-pole circuit breaker open** and/or the position **3-pole circuit breaker closed** can be acquired by routing to 1 or 2 binary inputs.

The signals must be routed to the binary input that is connected with the CB auxiliary contacts. The **open** and **closed** signals do not necessarily have to be routed in parallel. The advantage of parallel routing is that it can be used to determine an intermediate or disturbed position. On the other hand, this is not possible if only one signal is routed.

In the monitoring direction, the position signals generate the following information when the **open** and **closed** positions are acquired (see following table). This information is further processed by the **Circuit-breaker position recognition** and **Control** function blocks.

Information	Type	Description
Off	SPS	Circuit-breaker position is **opened**.
On	SPS	Circuit-breaker position is **closed**.
Intermediate position	SPS	Circuit-breaker position is in **intermediate position**.
Disturbed position	SPS	Circuit-breaker position is in **disturbed position**.
Not selected	SPS	The circuit breaker is **not selected** for a control operation.

Other input signals are:

Signal	Type	Description
>Acquisition blocking	SPS	This is used to activate acquisition blocking of the circuit-breaker auxiliary contacts (see Other Functions *3.8.3 Persistent Commands* for a description of acquisition blocking).

Signal	Type	Description
>Reset AcqBlk&Subst	SPS	This is used to reset acquisition blocking and manual update of the circuit breaker. Setting acquisition blocking and tracking is blocked with the input activated.
>Ready	SPS	The active signal indicates that the circuit breaker is ready for an **OFF-ON-OFF cycle.** The signal remains active as long as the circuit breaker is unable to trip. The signal is used in the **Automatic reclosing** and **Circuit-breaker test** functions.

Another output signal is:

External health	SPS	This can be used to indicate the health of the physical circuit breaker. For this, you must acquire any failure information for the circuit breaker via a binary input. This failure information can set the appropriate state of the External health signal with a CFC chart (using the **BUILD_ENS** block). The signal has no effect on the health of the function block.

5.7.7.4 Definitive Tripping, Circuit-Breaker Tripping Alarm Suppression

Definitive Tripping

Definitive tripping is always pending whenever the **Automatic reclosing (AREC)** function does not carry out any reclosing after tripping. It follows that this is the case whenever an automatic reclosing is not present or the AREC has been switched off.

Circuit-Breaker Tripping Alarm Suppression

In certain systems, the user may wish to actuate an alarm (for example, a horn) when tripping (circuit-breaker tripping) occurs. This alarm should not to be issued if the circuit breaker is to be reclosed automatically after tripping or if it is to be closed or opened via the control. The alarm is only to be issued in the event of final tripping.

Depending on how the alarm is generated (for example, triggered by a fleeting contact of the circuit breaker), the **Alarm suppression** signal can be used to suppress the alarm.

The signal is generated if:

- A definitive protection tripping is not present
- The automatic reclosing function executes a closure
- The integrated control executes a closure or opening action
- External closing is detected via the **Manual close** function

For further information about its use, please refer to *5.7.9.2 Application and Setting Notes* .

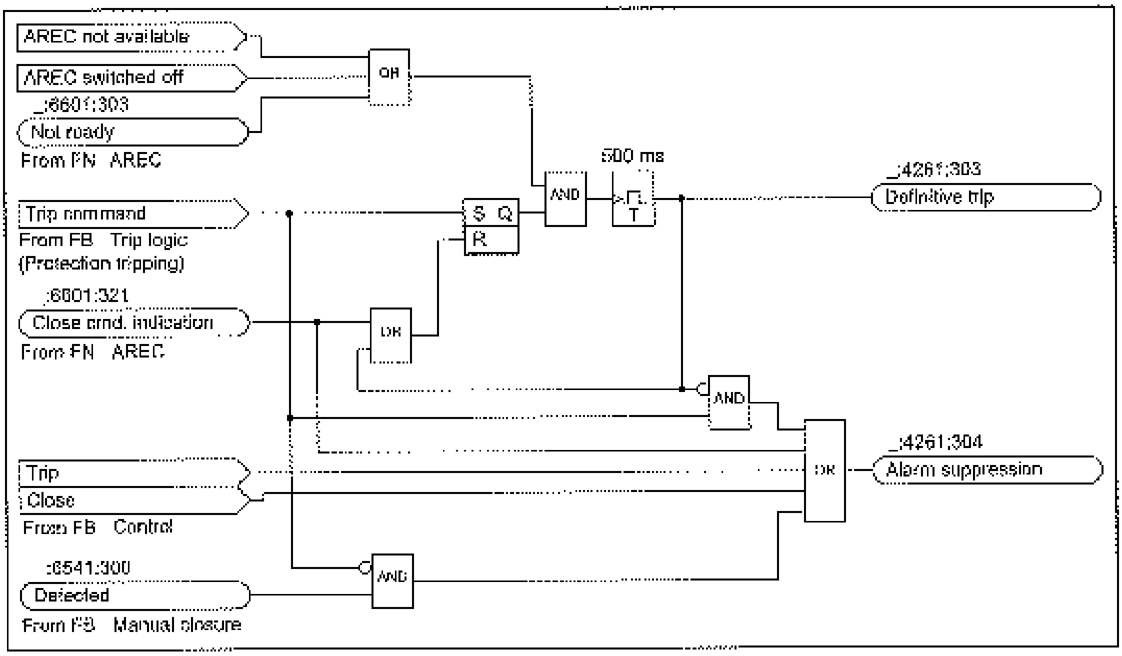

Figure 5-77 Definitive Tripping, Circuit-Breaker Tripping Alarm Suppression

5.7.7.5 Tripping and Opening Information

When a trip command is issued, the tripping information shown in the next figure is saved in the fault log.

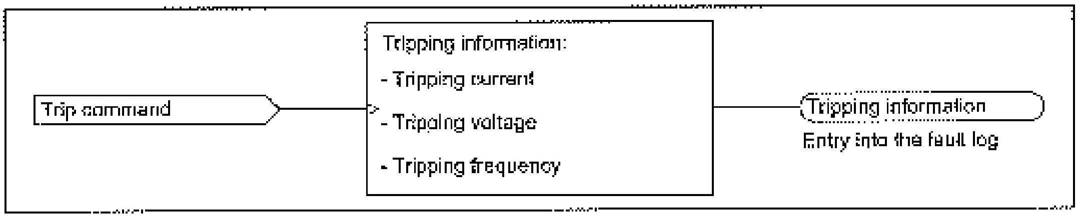

Figure 5-78 Tripping Information

The following statistics information is saved for the circuit breaker:

- Number of switching cycles:
  All tripping, opening, and closing operations are counted.
- Number of closing operations by the automatic reclosing function
- Total of tripping and breaking currents

The statistics information can be individually set and reset via the device control. It is also possible to reset all values via the binary input signal **>Reset switch statist.**.

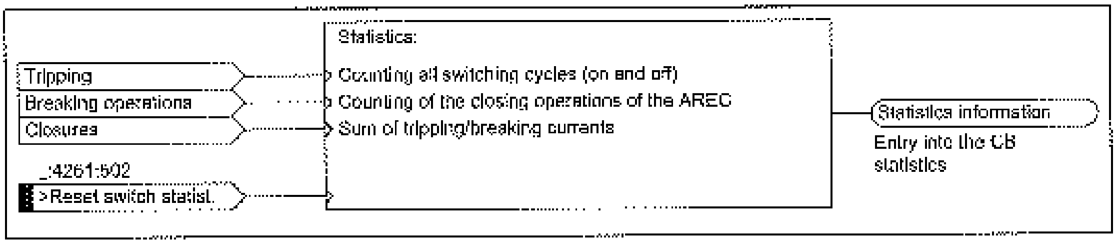

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Figure 5-79 Statistics Information About the Circuit Breaker

5.7.7.6 Application and Setting Notes

Routings for Activation of the Circuit Breaker

Figure 5-80 shows the necessary routings:

- The device can execute 3-pole tripping (via the protection device).
- The device can execute 3-pole opening (via the control).
- The device can execute 3-pole closing (via AREC or via the control).

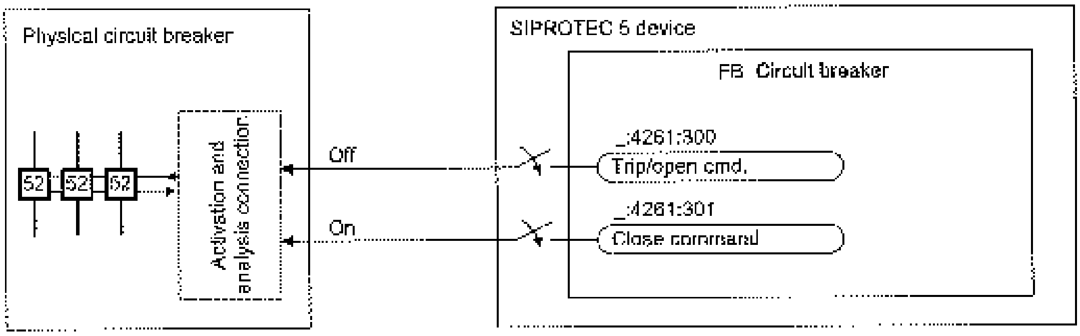

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Figure 5-80 Activation of the Circuit Breaker

By routing the **Trip/open cmd.** signals to 1 or 2 binary outputs, you can carry out 1, 1.5, and 2-pole activations of the circuit breaker. You will find a detailed description of this in *8.2.2.3 Connection Variants of the Circuit Breaker*.

NOTE

Do not confuse these 1-pole, 1.5-pole, and 2-pole activations of the circuit breaker with 1-pole or 3-pole tripping of the circuit breaker.

Routing for Analysis of the Circuit-Breaker Switch Position

For certain functions of the device, it is useful to detect the circuit-breaker switch position via its auxiliary contacts. These are for example:

- **Circuit-breaker position recognition** function block
- **Circuit-breaker failure protection** function
- **Control** function block

The operating principle of the auxiliary contacts is described in the individual functions.

Siemens recommends capturing the *Circuit breaker is open in 3 poles* and *Circuit breaker is closed in 3 poles* information via auxiliary contacts. This is the optimal configuration for the control functionality. For purely protection applications, it is also enough to capture just one of the 2 circuit-breaker positions.

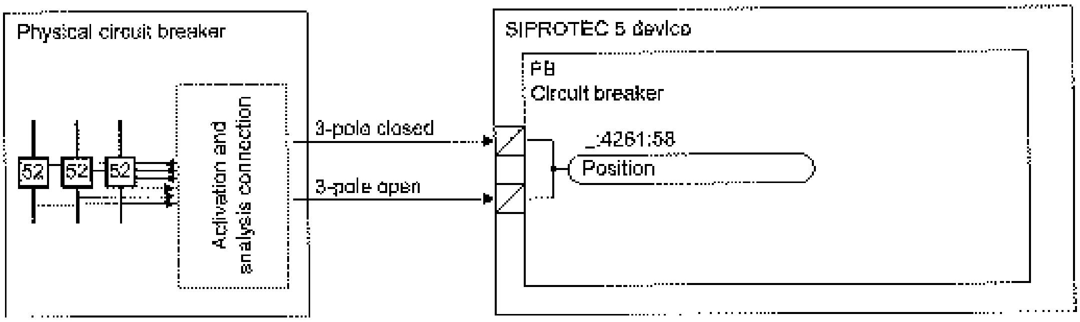


Figure 5-81 Recommended Analysis of the Circuit-Breaker Switch Position when Used as a Protection and Control Device

The following diagram shows the recommended routing, in which H stands for **active with voltage**.

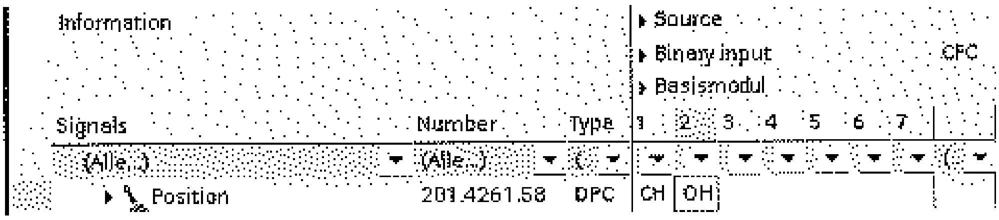


Figure 5-82 Routing for Acquisition of the Circuit-Breaker Switch Position via 2 Auxiliary Contacts

The device can also function without the analysis from the circuit-breaker auxiliary contacts, that is, routing of the auxiliary contacts is not absolutely necessary. However, this is a requirement for control functions.

Parameter: Output time

- Default setting (_:101) `Output time` = *0.10 s*

The `Output time` parameter acts on the signals for tripping, opening, and closing of the circuit breaker.

CAUTION

Do not set a time that is too short.

If you set a time that is too short, there is a danger that the device contacts will interrupt the control circuit. If this happens, the device contacts will burn out.

✧ Set a time that is long enough to ensure that the circuit breaker reliably reaches its final position (**open** or **closed**) after a control operation.

Output Signal: Indication Suppression

Whereas in the case of feeders without an automatic reclosing function every trip command is final due to a protection function, the use of an automatic reclosing function should only cause the motion detector of the circuit breaker (fleeting contact on the circuit breaker) to trigger an alarm if tripping of the circuit breaker is definitive (see next figure for more details). Likewise, a tripping alarm should not be triggered for switching operations by the control.

For this, the alarm activation circuit should be looped via a suitably routed output contact of the device (output signal `Alarm suppression`). In the idle state and when the device is switched off, this contact is permanently closed. For this, an output contact with a break contact must be routed. The contact opens whenever the output signal `Alarm suppression` becomes active, so that tripping or a switching operation does not cause an alarm (see the logic in 5.7.7.3 *Acquisition of Circuit-Breaker Auxiliary Contacts and Further Information* for more details).

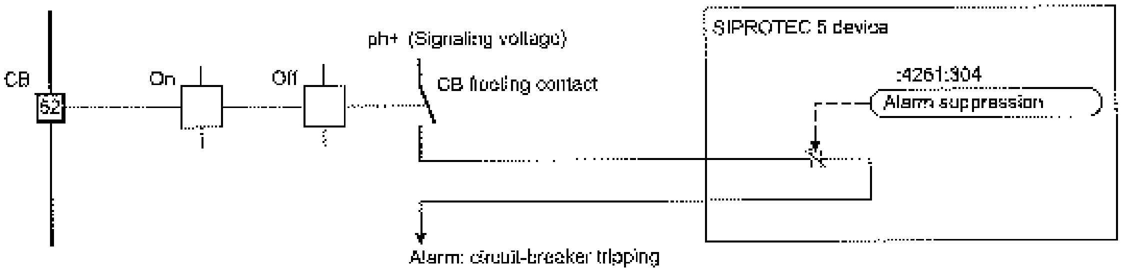


Figure 5-83 Circuit-Breaker Tripping Alarm Suppression

5.7.7.7 Settings

Addr.	Parameter	C	Setting Options	Default Setting
`Circuit break.`				
_:101	Circuit break.:Output time		0.02 s to 1800.00 s	0.10 s

5.7.7.8 Information List

No.	Information	Data Class (Type)	Type
`Circuit break.`			
_:500	Circuit break.:>Ready	SPS	I
_:501	Circuit break.:>Acquisition blocking	SPS	I
_:502	Circuit break.:>Reset switch statist.	SPS	I
_:504	Circuit break.:>Reset AcqBlk&Subst	SPS	I
_:503	Circuit break.:External health	ENS	I
_:53	Circuit break.:Health	ENS	O
_:58	Circuit break.:Position	DPC	C
_:300	Circuit break.:Trip/open cmd.	SPS	O
_:301	Circuit break.:Close command	SPS	O
_:302	Circuit break.:Command active	SPS	O
_:303	Circuit break.:Definitive trip	SPS	O
_:304	Circuit break.:Alarm suppression	SPS	O
_:306	Circuit break.:Op.ct.	INS	O
_:307	Circuit break.:ΣI Brk.	BCR	O
_:308	Circuit break.:ΣIA Brk.	BCR	O
_:309	Circuit break.:ΣIB Brk.	BCR	O
_:310	Circuit break.:ΣIC Brk.	BCR	O
_:311	Circuit break.:Break.-current phs A	MV	O
_:312	Circuit break.:Break.-current phs B	MV	O
_:313	Circuit break.:Break.-current phs C	MV	O
_:314	Circuit break.:Break. voltage phs A	MV	O
_:315	Circuit break.:Break. voltage phs B	MV	O
_:316	Circuit break.:Break. voltage phs C	MV	O
_:322	Circuit break.:CB open hours	INS	O
_:323	Circuit break.:Operating hours	INS	O

5.7.8 Circuit-Breaker Position Recognition for Protection-Related Auxiliary Functions

5.7.8.1 Overview

This function block calculates the position of the circuit breaker from the evaluation of the auxiliary contacts and the current flow.

This information is needed in the following protection-related additional functions:

- Trip logic (see *5.7.6.1 Function Description*)
- Detection of manual closing (see *5.7.9.1 Function Description*)
- Process monitor (Standard VII) *5.8 Process Monitor*)

Its use is described in the respective chapters.

The control does not use this information. The control evaluates the circuit-breaker auxiliary contacts.

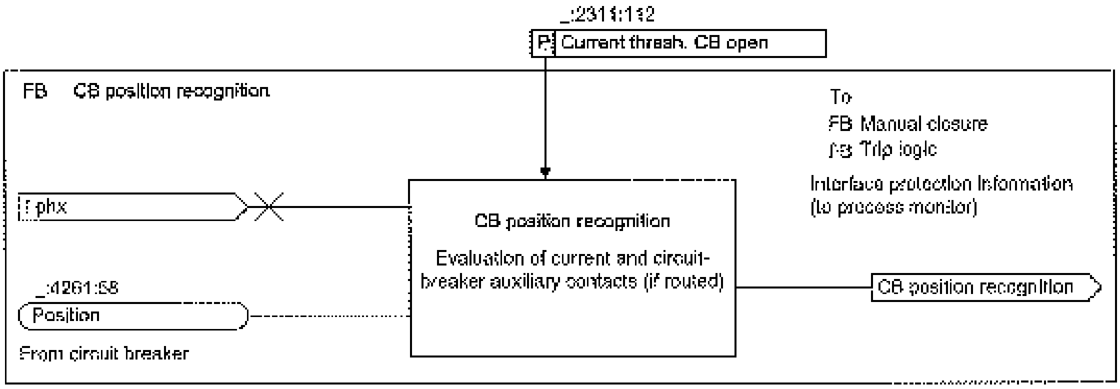


Figure 5-84 Overview of the Circuit-Breaker Condition Position Function

Based on the link between the information from the auxiliary contacts and the current flow, the circuit breaker can assume the following positions:

Circuit-Breaker Condition	Description
Open	The circuit-breaker pole is detected unambiguously as **open** according to both criteria.
Closed	The circuit-breaker pole is detected unambiguously as **closed** according to both criteria.
Possibly open, possibly closed	These conditions can occur if the information is incomplete due to the routing of the auxiliary contacts and the condition can no longer be determined reliably. These **uncertain conditions** are evaluated differently by certain functions.
Opening	This is a dynamically occurring condition that results when, while a trip command is active and the auxiliary contact is still closed, the current is detected to have fallen below the threshold value because the current-flow criterion takes effect faster than the auxiliary contact can open.

5.7.9 Detection Manual Closure (for AREC and Process Monitor)

5.7.9.1 Function Description

Detection of Manual Closure (for AREC and Process Monitor)

The **Manual closure** function block detects any closure carried out by hand. This information is used in function, the **automatic reclosing (AREC)** and **Process monitor** (functions (within protection function groups).

You will find detailed information in the chapters Automatic reclosing function and Process monitor.

The following figure shows the logic for manual closure detection.

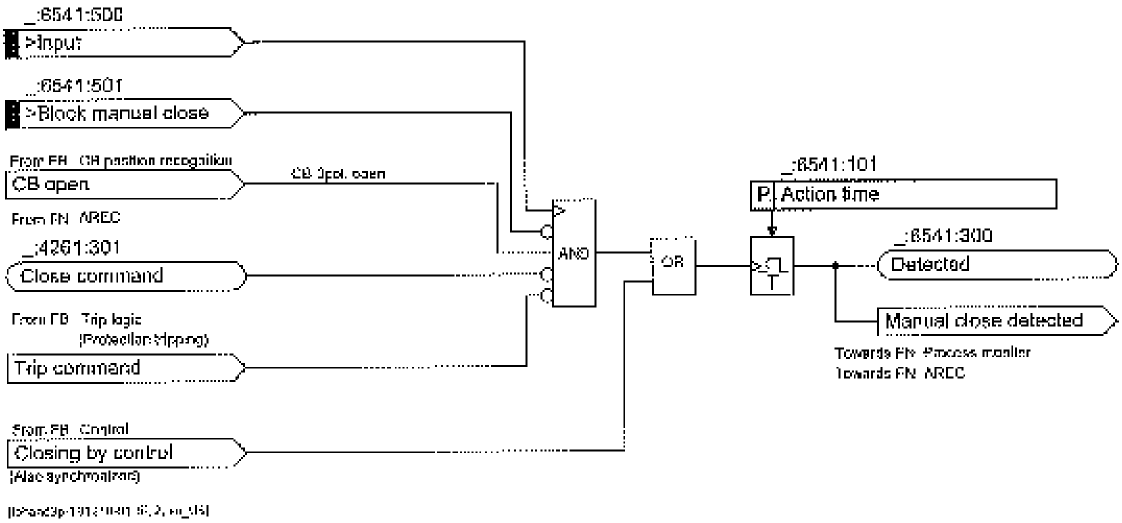


Figure 5-85 Logic for Manual Closure Detection

External Manual Closure

An external manual closure is communicated to the device via the input signal **>Input**. The input signal can also be connected directly to the control circuit of the circuit-breaker closing coil. For this reason, detection is suppressed in the event of a close command by the AREC function. Detection via the input signal **>Input** is also blocked if the circuit breaker is closed or if a protection trip is active.

Internal Manual Closure

Manual closure is detected in all cases if a close command is transmitted by the internal control function of the device. This is possible because the control carries out plausibility checks itself and is also subject to interlocking.

5.7.9.2 Application and Setting Notes

Input Signals: >Input, >Blocking of Manual Closure

In practice, the input signal **>Input** is connected directly to the control circuit of the circuit-breaker closing coil (see following figure).

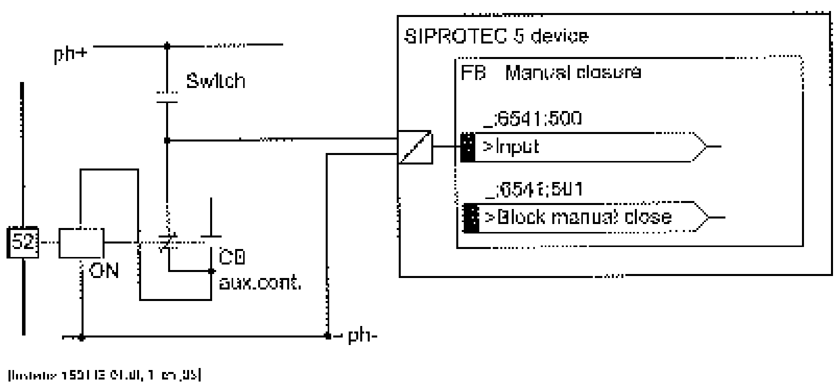


Figure 5-86 Connection of the Input Signal to the Control Circuit of the Circuit-Breaker Closing Coil

Every closure of the circuit breaker is recorded in the process. Therefore, detection is suppressed in the event of a close command by the internal AREC function of the device.

If external close commands are possible (actuation of the circuit breaker by other devices), which are not intended to prompt detection of a manual closure (for example, with an external reclosing device), this can be ensured in 2 ways:

- The input signal is connected in such a way that it is not activated in the event of external close commands.
- The external close command is connected to the blocking input **>Block manual close** for manual closure detection.

Parameter: Action time

- Recommended setting value (_:101) **Action time** = *300 ms*

In order to ensure independence from manual activation of the input signal, the detection function is extended for a defined length of time using the parameter **Action time**.

Siemens recommends an action time of *300 ms*.

5.7.9.3 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Manual close				
_:101	Manual close:Action time		0.01 s to 60.00 s	0.30 s

5.7.9.4 Information List

No.	Information	Data Class (Type)	Type
Manual close			
_:501	Manual close:>Block manual close	SPS	I
_:500	Manual close:>Input	SPS	I
_:300	Manual close:Detected	SPS	O

5.8 Process Monitor

5.8.1 Overview of Functions

All function groups that have functions with dependencies on the state of the protected object contain a process monitor. The process monitor detects the current state of the protected object.

5.8.2 Structure of the Function

The **Process monitor** function is used in the **Standard V/I 3-phase** protection function group.

The **Process monitor** function is provided by the manufacturer with the following function blocks:

- Cold-load pickup detection (optional)
- Current flow criterion
- Circuit-breaker condition
- Closure detection

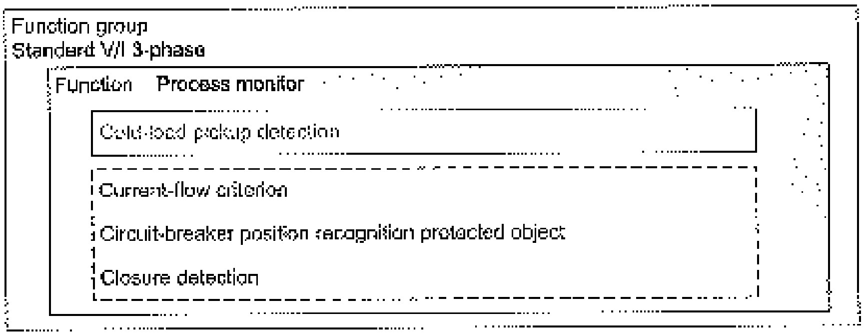


Figure 5-87 Structure/Embedding of the Function

You can activate the cold-load pickup detection as needed. All other stages of the process monitor run permanently in the background and are not displayed in DIGSI.

The following figure shows the relationships of the individual function blocks.

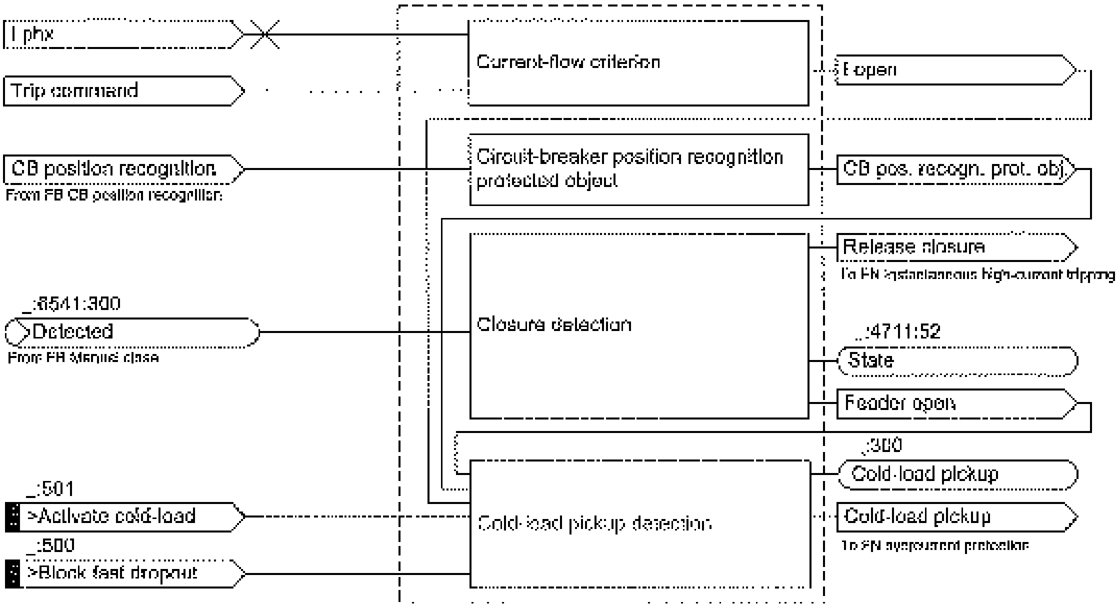


Figure 5-88 Logic Diagram of the Overall Function Process Monitor

5.8.3 Current-Flow Criterion

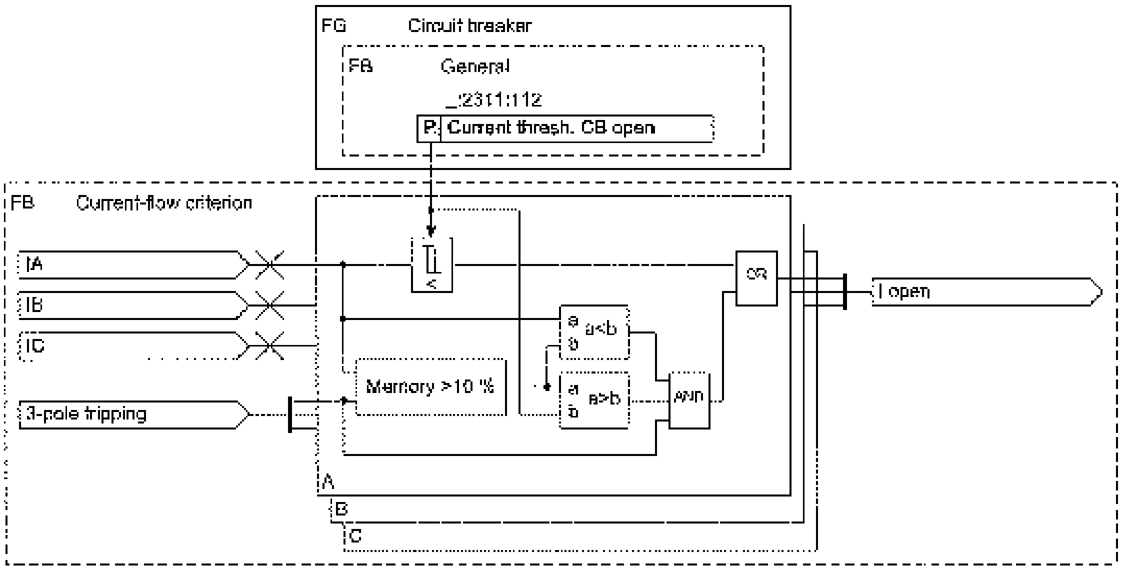


Figure 5-89 Logic Diagram of the Current-Flow Criterion Function Block

The `I open` signal of one phase is generated if one of the following conditions is met:

- A phase current falls below the set threshold of the `Current thresh. CB open` parameter. The hysteresis stabilizes the signal.
- The corresponding phase current, for example, `I A`, falls below 10 % of the phase current when the trip command arrives. If the current does not drop until after a delay due to current transformer influences, an open pole can therefore be detected quickly even after a high-current fault on the line.

With the `Current thresh. CB open` parameter, you define the minimum current as the criterion for a deactivated line. The parameter lies in the **Circuit-breaker** function group. It acts both in the **Circuit-breaker** function group, for example circuit-breaker position recognition, and also for the process monitor in the Protection-function group.

5.8.4 Application and Setting Notes (Current-Flow Criterion)

Parameter: Current thresh. CB open

- Recommended setting value (_:2311:112) `Current thresh. CB open` = *0.100 A*

The `Current thresh. CB open` parameter is used to define the threshold for the leakage current as the criterion for a deactivated line.

Set the `Current thresh. CB open` parameter so that the current measured when the feeder is deactivated falls below the value of the `Current thresh. CB open` parameter with certainty. The hysteresis is additionally active if the threshold is exceeded.

If parasitic currents, for example, due to induction, are ruled out when the feeder is deactivated, set the `Current thresh. CB open` parameter sensitively.

Siemens recommends a setting value of *0.100 A*.

5.8.5 Circuit-Breaker Condition for the Protected Object

Logic

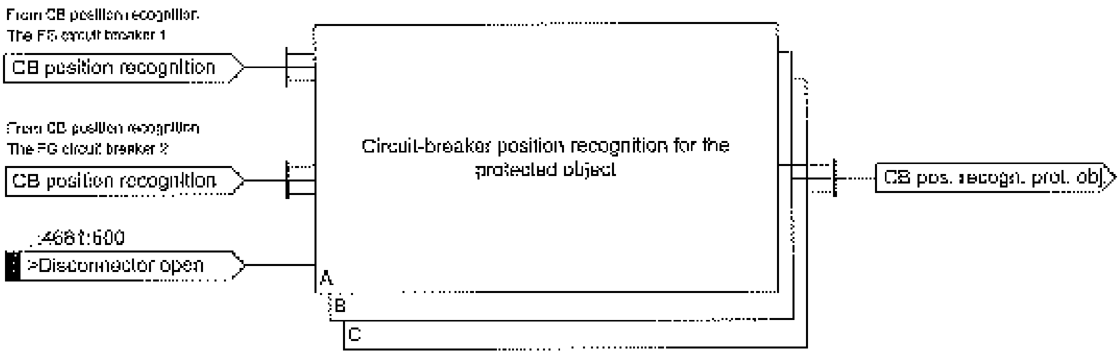


Figure 5-90 Logic Diagram of the Circuit-Breaker Condition for the Protected-Object Function Block

The circuit-breaker position recognition in the **Circuit breaker** (CB) function group provides the circuit-breaker condition by way of the internal signal *CB pos. recogn. prot. obj.*.

If a protected object is supplied via 2 circuit breakers (CBs), for example with the 1 1/2 circuit-breaker layout, then the circuit-breaker switch position of the protected object must be determined with the aid of both circuit breakers. In this case, the **Circuit-breaker position recognition for the protected object** function block connects the individual CB states. The connection provides the internal *CB pos. recogn. prot. obj.* signal to the other function blocks of the process monitor and to other functions, for example, **Trip in the event of weak infeed** and **Echo function for teleprotection method**, within the same function group.

If one of the following 2 conditions is met, the *CB pos. recogn. prot. obj.* signal is in the *Open* state:

- All connected circuit breakers signal the *Open* state internally.
- The `>Disconnector open` input is active.

If the following 2 conditions are met, the *CB pos. recogn. prot. obj.* signal is in the *Closed* state:

- At least one of the connected circuit breakers signals the *Closed* state internally.
- The `>Disconnector open` input is not active.

5.8.6 Closure Detection

The closure detection enables the immediate tripping of selected protection functions or protection stages when switching to short circuit or the reduction of the responsivity. The closure detection determines whether the protected object is switched on.

Logic

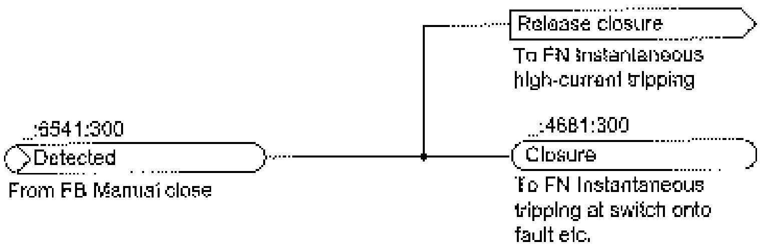


Figure 5-91 Logic Diagram of Closure Detection

For an applied binary input signal `Detected` (from Manual close function block), the indication `Closure` is active.

5.8.7 Information List

No.	Information	Data Class (Type)	Type
Closure detec.			
_:4681:500	Closure detec.:>Disconnector open	SPS	I
_:4681:300	Closure detec.:Closure	SPS	O

5.8.8 Cold-Load Pickup Detection (Optional)

Logic

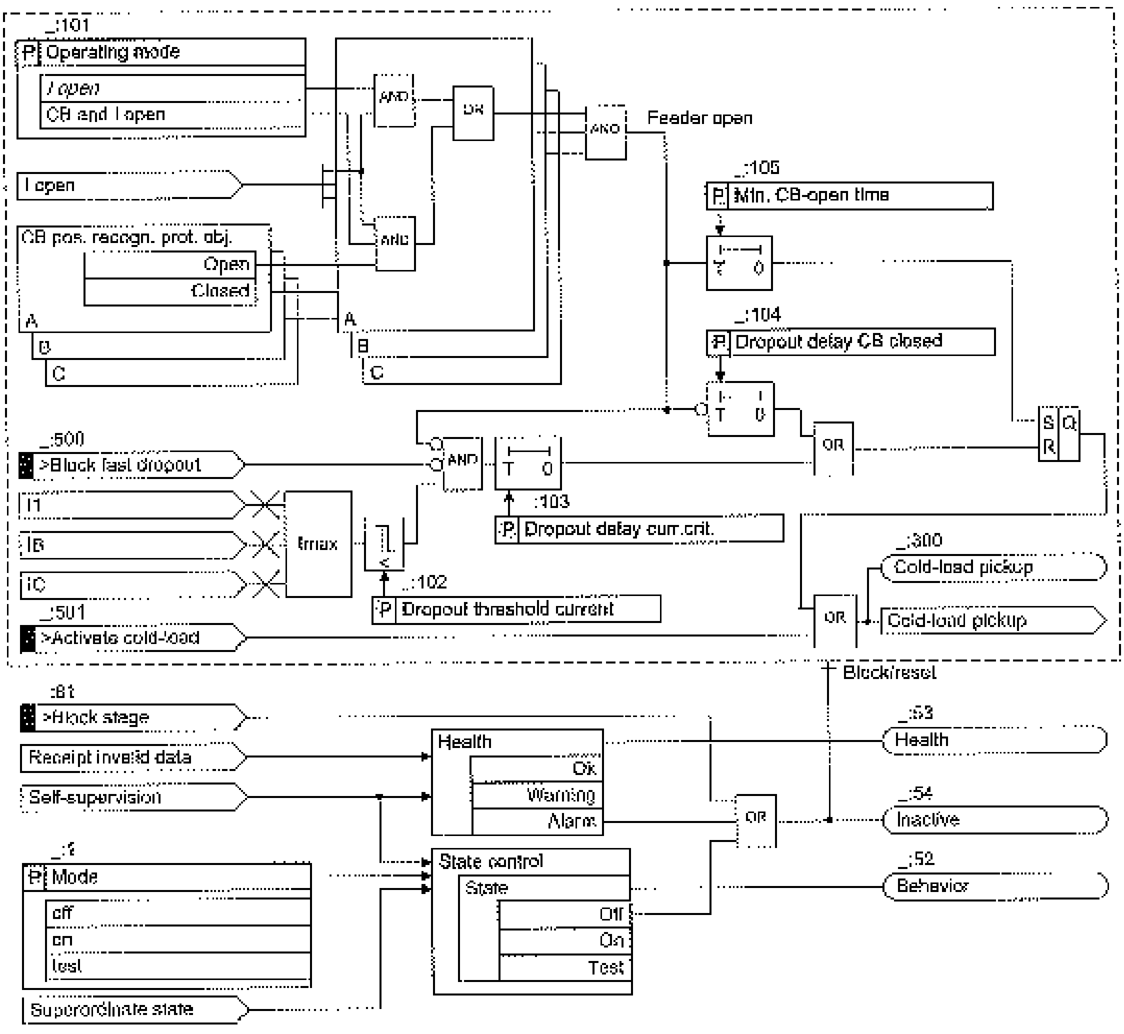


Figure 5-92 Logic Diagram of the Cold-Load Pickup Detection Function Block

The **Cold-load pickup detection** function block detects that a specific time has been exceeded after deactivation of the line or protected object. If you want to connect the protected object again, you must note that an increased load-current requirement exists for a limited time after connection. This results from the nature of the load.

The **Cold-load pickup detection** function block ensures that different parameters are used for an adjustable time after connection. For example, for the time of the `Min. CB-open time` parameter, you can increase the threshold value of a protection function or you can select a special characteristic curve.

If the **Cold-load pickup detection** function block detects an open feeder and the set time of the `Min. CB-open time` parameter has expired, the indication `>Activate cold-load` is generated.

With the `>Activate cold-load` indication, you can activate a parameter set of the **Cold-load pickup** function. Via the binary input signal `>Activate cold-load`, you can also activate the `>Activate cold-load` indication directly.

If the **Cold-load pickup detection** function block detects closure and the corresponding load current, it starts the time set in the `Dropout delay CB closed` parameter. The `>Activate cold-load` indication and the activated parameter set are deactivated after this time has elapsed.

If, for the time set in the **Dropout delay curr.crit.** parameter, the maximum phase current falls below the threshold value **Dropout threshold current**, the parameter set for the **Cold-load pickup detection** function block is also deactivated. As a result, if the load current is very low, the action time **Dropout delay curr.crit.** of the **>Activate cold-load** indication can be shortened.

5.8.9 Application and Setting Notes (Cold-Load Pickup Detection)

NOTE

The settings and indications described in this chapter are only available when using the optional **Cold-load pickup detection** function block.

Parameter: Operating mode

- Default setting (_:101) **Operating mode** = *I open*

With the **Operating mode** parameter, you set the criteria with which the Closure-detection function block operates.

Parameter Value	Description
I open	When the Current-flow criterion function block detects a clearing open condition, the decision is made for pickup. For this setting, make sure that the **Current thresh. CB open** parameter is set lower than the possible load current. If this is not the case, open is detected continuously and each fault current that exceeds the **Current thresh. CB open** parameter is interpreted as closure.
CB and I open	Closure is detected if one of the following conditions is met: • Analysis of the circuit breaker auxiliary contact detects a clearing open condition in at least one phase. • The current-flow criterion detects a clearing open condition.

Parameter: Dropout threshold current

- Default setting (_:102) **Dropout threshold current** = *1.00 A*

With the **Dropout threshold current** parameter, you set the threshold at which the output signal **Cold-load pickup** is deactivated when the current in at least one phase falls below this threshold.

Parameter: Dropout delay current criterion

- Default setting (_:103) **Dropout delay curr.crit.** = *600 s*

With the **Dropout delay curr.crit.** parameter, you set the time for which the actual value must be below the **Dropout threshold current** threshold so that the output signal **Cold-load pickup** can be deactivated prematurely.

Parameter: Dropout delay CB closed

- Default setting (_:104) **Dropout delay CB closed** = *3600 s*

With the **Dropout delay CB closed** parameter, you set the action time for the dynamic parameter set switching in the event of cold-load pickup detection.

Parameter: Min. CB open time

- Default setting (_:105) **Min. CB-open time** = *3600 s*

With the **Min. CB-open time** parameter, you set the time after which the dynamic parameter set is activated in the event of **cold-load pickup** when the line is opened.

5.8.10 Settings

Addr.	Parameter	C	Setting Options	Default Setting
Cold-load PU				
_:1	Cold-load PU:Mode		• off • on • test	off
_:101	Cold-load PU:Operating mode		• I open • CB and I open	I open
_:102	Cold-load PU:Dropout threshold current	1 A @ 100 Irated	0.030 A to 10.000 A	1.000 A
		5 A @ 100 Irated	0.15 A to 50.00 A	5.00 A
		1 A @ 50 Irated	0.030 A to 10.000 A	1.000 A
		5 A @ 50 Irated	0.15 A to 50.00 A	5.00 A
		1 A @ 1.6 Irated	0.001 A to 1.600 A	1.000 A
		5 A @ 1.6 Irated	0.005 A to 8.000 A	5.000 A
_:103	Cold-load PU:Dropout delay curr.crit.		1 s to 600 s	600 s
_:104	Cold-load PU:Dropout delay CB closed		1 s to 21600 s	3600 s
_:105	Cold-load PU:Min. CB-open time		0 s to 21600 s	3600 s

5.8.11 Information List

No.	Information	Data Class (Type)	Type
Cold-load PU			
_:81	Cold-load PU:>Block stage	SPS	I
_:500	Cold-load PU:>Block fast dropout	SPS	I
_:501	Cold-load PU:>Activate cold load	SPS	I
_:54	Cold-load PU:Inactive	SPS	O
_:52	Cold-load PU:Behavior	ENS	O
_:53	Cold-load PU:Health	ENS	O
_:300	Cold-load PU:Cold-load pickup	SPS	O

6 Protection and Automation Functions

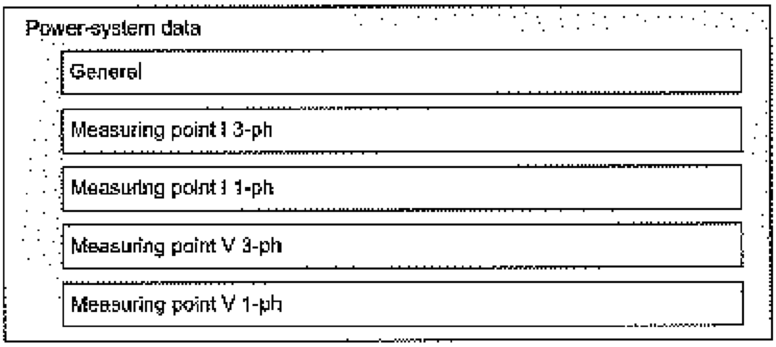
6.1 Power-System Data

6.1.1 Overview

The **Power-system data** are provided with each SIPROTEC 5 device and cannot be deleted. You will find them in DIGSI under **Settings → Power-system data.**

6.1.2 Structure of the Power-System Data

The **Power-system data** contain the block **General** and the **Measuring points** of the device. The following figure shows the structure of the **Power-system data:**



[dwandata 190912-01.tif, 2, en_US]

Figure 6-1 Structure of the Power-System Data

In order to adjust its functions to the application, the device requires some data about the power system. The necessary settings can be found in the Power-system data under **General** as well as in the **Measuring points.**

NOTE

You can find information on the supervision-function parameters in chapter *9.3 Supervision of the Secondary System.*

Type and scope of the required measuring points depend on the application. Possible measuring points are:

- Voltage 3-phase (measuring point V 3-ph)
- Current 3-phase (measuring point I 3-ph)
- Voltage 1-phase (measuring point V 1-ph)
- Current 1-phase (measuring point I 1-ph)

The measuring points have interfaces to the function groups requiring voltage and/or current measured values of the power system.

6.1.3 Application and Setting Notes – General Settings

Parameter: Phase sequence

- Recommended setting value `(_:2311:101) Phase sequence` = **ABC**

The parameter `Phase sequence` is used to set the phase sequence (*ABC*) or (*ACB*). The setting value applies to the entire SIPROTEC 5 device.

Use the **General** function to set the settings in the power-system data.

6.1.4 Application and Setting Notes for Measuring-Point Voltage 3-Phase (V-3ph)

The following example describes the settings of the voltage measuring point **Measuring point V-3ph** (voltage 3-phase). Settings for the supervision functions are also located in the voltage measuring point. The description of these settings can be found in chapter Supervision Functions .

Parameter: Rated primary voltage

- Default setting (_:8911:101) **Rated primary voltage** = *400.000 kV*

The **Rated primary voltage** parameter is used to set the primary rated voltage of the voltage transformer.

Parameter: Rated secondary voltage

- Default setting (_:8911:102) **Rated secondary voltage** = *100 V*

The **Rated secondary voltage** parameter is used to set the secondary rated voltage of the voltage transformer.

Parameter: Matching ratio Vph / VN

- Default setting (_:8911:103) **Matching ratio Vph / VN** = 1.73

With the parameter **Matching ratio Vph / VN**, you set the deviation between the calculated zero-sequence voltage and the residual voltage measured directly via a measuring input. The different transmission ratio of the voltage transformers is the cause for the deviation (see Figure 6-2).

The **Matching ratio Vph / VN** is equal to the ratio $3V_{0\,sec}/V_{N\,sec}$

with

$V_{0\,sec}$	Calculated zero-sequence voltage
$V_{N\,sec}$	Measured residual voltage

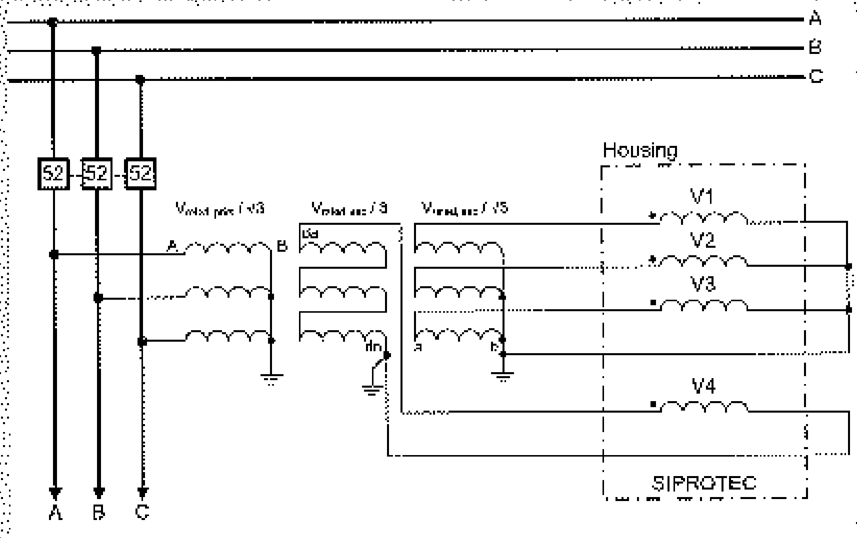
The zero voltage is calculated as phase-to ground voltages. The residual voltage is measured on the open delta winding of the voltage transformer. For 1-phase voltage transformers, the residual voltage is measured in the generator or the transformer neutral point.

NOTE

The measurement residual voltage $V_{N\,sec}$ is converted to a zero-sequence voltage in the device as follows:

$$V_{0\,sec} = V_{N\,sec} \cdot \frac{\text{Matching ratio Vph/VN}}{3}$$

EXAMPLE 1:



[dw_bsp5uwdl_gegenfaktor_2, en_US]

Figure 6-2 3-Phase Voltage Transformer: Connection = 3 Phase-to-Ground Voltage + VN

If the connection type of the voltage transformer is **3 ph-to-gnd volt. + VN** (parameter: **VT connection**) and the voltage input V4 is connected to the broken-delta winding of the voltage transformer (da/dn), the **Matching ratio Vph / VN** is as follows:

When changing the neutral point according to *Figure 6-2*, this results in the following values:

- The calculated secondary zero-sequence voltage $V_{0\ sec}$ is equal to the secondary phase-to-ground voltage. Expressed as secondary transformer rated voltage, then $V_{rated\ sec}/\sqrt{3}$.
- The measured residual voltage on the open delta winding is the sum of the voltage drops on the 3 sides. Expressed with the side ratio, the result is $V_{N\ sec} = 3\ V_{rated,sec}/3$.

Calculate the **Matching ratio Vph / VN** parameter as follows:

$$\text{Matching ratio}\ \frac{\text{Vph}}{\text{VN}} = \frac{3 \cdot V_{0\ sec}}{V_{N\ sec}} = \frac{3 \cdot \frac{V_{nom\ sec}}{\sqrt{3}}}{3 \cdot \frac{V_{nom\ sec}}{3}} = \frac{3}{\sqrt{3}} = \sqrt{3} = 1.73$$

[fo_3vph1_1, en_US]

Set **Matching ratio Vph / VN = 1.73**.

In example 1 $V_{rated\ sec}$, the phase-to-ground voltage and the secondary voltage on the open delta winding were identical. If these voltages are different, use the actual numerical values in the calculation.

EXAMPLE 2:

Phase-to-ground voltage	$V_{rated\ sec} = 100$ V
Broken-delta winding (for example, grounding transformer in generator protection)	$V_{rated\ sec} = 500$ V The voltage input of the device is designed for a continuous operation using 230 V max. Therefore, the voltage on the open delta winding (500 V) is reduced to a 5:2 ratio, using an Ohmic divider. In order to calculate the matching factor, the secondary voltage of 200 V will be applied.

Calculate the **Matching ratio Vph / VN** parameter as follows:

$$\text{Matching ratio}\ \frac{\text{Vph}}{\text{VN}} = \frac{3 \cdot V_{0\ sec}}{V_{N\ sec}} = \frac{3 \cdot \frac{V_{nom\ sec}}{\sqrt{3}}}{3 \cdot \frac{V_{nom\ sec}}{3}} = \frac{3 \cdot \frac{100\ V}{\sqrt{3}}}{3 \cdot \frac{200\ V}{3}} = \frac{3}{2 \cdot \sqrt{3}} = \frac{\sqrt{3}}{2} = 0.866$$

[fo_lsp2_1_en_US]

Set **Matching ratio Vph / VN** = *0.866*.

Interpretation of the result:

The zero-sequence voltage calculated from the phase-to-ground voltage is 57.73 V (= 100V/√3). The measured residual voltage is 200 V. The calculated adaptation factor is 0.866. The measured residual voltage is converted to a zero-sequence voltage inside the device:

$$V_{0\ sec} = V_{N\ sec} \cdot \frac{\text{Matching ratio Vph/VN}}{3} = 200\ V \cdot \frac{0.866}{3} = 57.73\ V$$

[fo_umrechnung2_2_en_US]

NOTE

During the ground fault test, the set adaptation factor can be checked by comparing the operational measured values. The operational measured values contain the calculated zero-sequence voltage $V_{0\ sec}$ and the measured residual voltage $V_{N\ sec}$. Proceed with the compilation as follows:

$$\text{Matching ratio}\ \frac{\text{Vph}}{\text{VN}} = \frac{3 \cdot V_{0\ sec}}{V_{N\ sec}}$$

The **Matching ratio Vph / VN** parameter is significant for the following functions:

- Overvoltage protection with zero-sequence voltage/residual voltage
- Measured-value supervision
- Scaling of the faulty and measured values

Parameter: VT connection

- Default setting (_:8911:104) **VT connection** = *3 ph-to-gnd volt. + VN*

The parameter **VT connection** shows the connection type of the voltage transformer for the 3-phase voltage measuring point. The parameter can be found in the DIGSI 5 project tree under **Name of the device → Settings → Power-system data → Measuring point V 3-phase**. You cannot change the connection type of the voltage transformer in the power-system data.

You can change the connection type of the voltage transformer only under measuring point routing in DIGSI 5. Under **Name of the device → Measuring-points routing → Voltage measuring points**, select the desired connection type under **Connection type**. The following types of connections are possible:

- *3 ph-to-gnd volt. + VN*
- *3 ph-to-gnd voltages*
- *3 ph-to-ph volt. + VN*
- *3 ph-to-ph voltages*
- *2 ph-to-ph volt. + VN*
- *2 ph-to-ph voltages*
- *2 ph-to-gnd volt. + VN*
- *2 ph-to-gnd voltages*

Depending on the connection type selected, you must route the measured values to the terminals of the voltage measuring point in DIGSI 5. You can find connection examples for voltage transformers in the chapters

A.8 Connection Examples for Voltage Transformers for 7SJ85 and *A.9 Connection Examples for Voltage Transformers for 7SJ82*. The connection examples provide assistance when selecting the type of connection.

Parameter: Inverted phases

- Default setting (_:8911:106) Inverted phases = *none*

The **Inverted phases** parameter is intended for special applications, for example, pumped-storage hydropower plants (see chapter Phase-rotation reversal). This default setting may be retained for power-system protection applications.

Parameter: Tracking

- Default setting (_:8911:111) Tracking = *active*

The **Tracking** parameter is used to determine whether the measuring channels of this measuring point shall be used to determine the sampling frequency.

The sampling frequency of the device is adjusted to the power frequency. The device selects a measuring channel, through which the sampling frequency is determined. Preferably, this should be a voltage metering channel. This validity of the signal is monitored (minimum level, frequency range). If these values are invalid, the device switches to another channel (etc.). Once switched to a current channel, the system automatically switches back to this channel if a voltage channel is valid again.

Parameter Value	Description
active	If the parameter **Tracking** = *active* has been set, the measuring point will be included when determining the sampling frequency. If possible, only the 3-phase measuring points shall be considered. Siemens recommends using the default setting. **Note:** If the parameter **Tracking** = *active* , the determined sampling frequency applies to all functions in the device that do not use fixed sampling rates.
inactive	If the channels of the measuring point are not to be considered for determining the sampling frequency, please select the setting value *inactive*.

Parameter: Magnitude correction

- Default setting (_:3811:103) Magnitude correction = *1.000*

When using the **Magnitude correction** parameter, the magnitude (magnitude correction) is adjusted for the voltage input. This allows you to correct the tolerances of the primary current transformer phase-selectively. The magnitude correction may be required for highly precise measurements. Use a comparison measurement to determine the setting value (for example, a high-precision measuring-voltage transformer). If a primary correction is not necessary, retain the default setting.

NOTE

The **Magnitude correction** parameter has nothing to do with the internal adjustment of the input circuit.

6.1.5 Application and Setting Notes for Measuring Point Current 3-Phase (I-3ph)

The following example describes the settings for the current **Measuring point I 3-ph** (Current 3-phase). The supervision function settings are also located in the current measuring point. The description of these settings can be found in chapter *9 Supervision Functions*.

Parameter: CT connection

- Default setting (_:8881:115) CT connection = *3-phase + IN-separate*

The parameter **CT connection** shows the connection type of the current transformer for the 3-phase current measuring point. The parameter can be found in the DIGSI 5 project tree under **Name of the device → Settings → Power-system data → Measuring point I 3-phase**. You cannot change the connection type of the current transformer in the **Power-system data**.

You can change the connection type of the current transformer only under measuring point routing in DIGSI 5. Under **Name of the device → Measuring point routing → Current measuring points**, select the desired connection type under Connection type. The following types of connections are possible:

- *3-phase + IN-separate*
- *3-phase + IN*
- *3-phase*
- *3-phase, 2 primary CT*
- *3ph,2prim.CT + IN-sep*
- *2ph, 2p. CT + IN-sep*

Depending on the connection type selected, you must route the measured values to the terminals of the current measuring point in DIGSI 5. You can find connection examples for current transformers in chapter *A.7 Connection Examples for Current Transformers* . The connection examples provide assistance when selecting the type of connection.

Parameter: Tracking

- Default setting (_:8881:127) **Tracking** = *active*

With the parameter**Tracking**, you specify whether you would like to work with the sampling frequency tracking function.

Parameter Value	Description
active	If the parameter **Tracking** = *active* has been set, the measuring point will be included when determining the sampling frequency. If possible, only the 3-phase measuring points shall be considered. Siemens recommends using the default setting. **Note:** If the parameter **Tracking** = *active*, the determined sampling frequency applies to all functions in the device not using fixed sampling rates.
inactive	If the channels of the measuring point are not to be considered for determining the sampling frequency, please select the setting value *inactive*.

Parameter: Rated primary current

- Default setting (_:8881:101) **Rated primary current** = *1000 A*

With the **Rated primary current** parameter, the active rated primary current of the current transformer is set.

Parameter: Rated secondary current

- Default setting (_:8881:102) **Rated secondary current** = *1 A*

With the **Rated secondary current** parameter, you set the current rated secondary current of the current transformer.

Parameter: Current range

- Default setting 7SJ82 (_:8881:117) **Current range** = *50 x IR*
- Default setting 7SJ85 (_:8881:117) **Current range** = *100 x IR*

The **Current range** parameter allows you to set the dynamic range for the current input. Please retain the default setting for power-system protection applications. The current measuring range 1.6 x Irated applies for the connection type *3-phase + IN-separate* and the sensitive current input or for the measuring inputs.

Parameter: Neutr.point in dir.of ref.obj

- Default setting `(_:8881:116) Neutr.point in dir.of ref.obj` = *yes*

The `Neutr.point in dir.of ref.obj` parameter is used to set the direction of the neutral point of the current transformer (see following figure). Often, the neutral point of the current transformer is determined by the direction of the protected object (for example, in the direction of the line, cable, transformer). For this reason, the default setting of the parameter was defined as *yes*.

When switching the parameter, the direction of the phase currents and of the ground current IN or IN-separate is rotated device-internally.

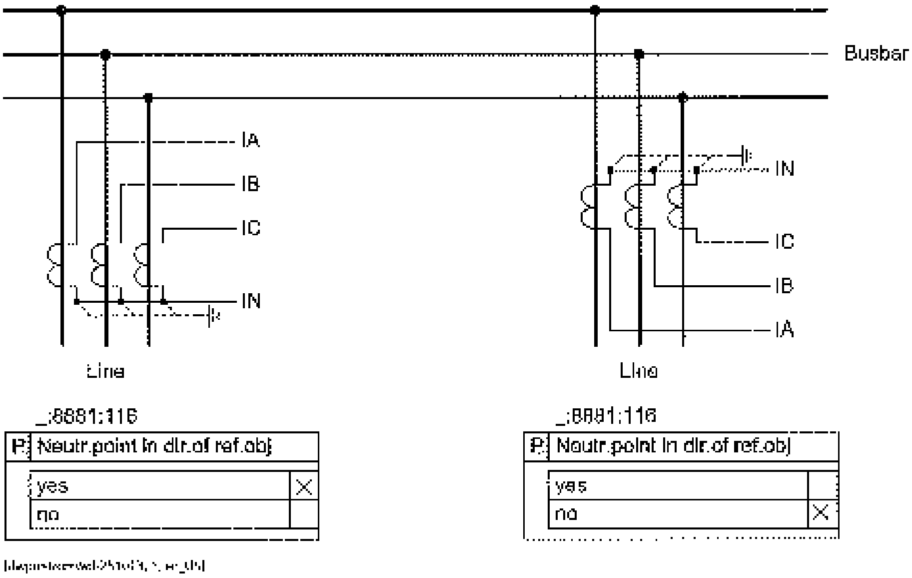


Figure 6-3 Polarity of Current Transformers

Parameter: Inverted phases

- Default setting `(_:8881:114) Inverted phases` = *none*

The `Inverted phases` parameter is intended for special applications, for example, pumped-reservoir plants (see Chapter Phase-rotation reversal). This default setting may be retained for power-system protection applications.

Parameter: Magnitude correction

- Default setting `(_:3841:103) Magnitude correction` = *1.000*

When using the `Magnitude correction` parameter, you adjust the amplitude (amplitude correction) for the current input. This allows you to correct the tolerances of the primary current transformer phase-selectively. The magnitude correction may be required for highly precise measurements. Use a comparison measurement to determine the setting value (for example, a high-precision measuring-voltage transformer). If a primary correction is not necessary, retain the default setting.

NOTE

The `Magnitude correction` parameter has nothing to do with the internal adjustment of the input circuit.

Note Regarding Routable Data

Indications for the current rotating field and the information pertaining to the sampling-frequency tracking can be found in **Information routing** under **Power-system data → General** in DIGSI 5. The indication *Freq.out of oper. range* means that the frequency operating range has been exceeded. Either the frequency is out of range (10 Hz to 80 Hz) or the input signals are too small for a manual update. Should this condition occur, the system switches the update frequency to a sampling rate that corresponds to the rated frequency.

Furthermore, there are 2 additional measured frequency values available. The measured value *f sys* displays the current system frequency, and the measured value *f track* displays the sampling frequency currently set. Siemens recommends routing both measured values as fault-recording channel.

6.1.6 Settings

General Information

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Phase sequence		• ABC • ACB	ABC

Measuring Point I-1ph

Addr.	Parameter	C	Setting Options	Default Setting
General				
_:2311:101	General:Rated primary current		1.0 A to 100000.0 A	1000.0 A
_:2311:102	General:Rated secondary current		• 1 A • 5 A	1 A
_:2311:103	General:Current range		• 1.6 x IR • 100 x IR • 50 x IR	100 x IR
_:2311:104	General:Internal CT type		• CT protection • CT measurement • CT Process bus	CT protection
_:2311:116	General:Term. 1,3,5,7 in dir. of obj.		• no • yes	yes
_:2311:105	General:Tracking		• inactive • active	inactive
_:2311:130	General:Measuring-point ID		0 to 100	0
CT 1				
_:3841:103	CT 1:Magnitude correction		0.010 to 10.000	1.000
_:3841:117	CT 1:Phase		• I A • I B • I C • IN • INsens • Ix	