SIEMENS

SIPROTEC 4

Voltage and Frequency Protection 7RW80

V4.6

Manual

C53000-G1140-C233-4

NOTE

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

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Preface

Purpose of the Manual

This manual describes the functions, operation, installation, and commissioning of devices 7RW80. In particular, one will find:

- Information regarding the configuration of the scope of the device and a description of the device functions and settings → Chapter 2;
- Instructions for Installation and Commissioning → Chapter 3;
- Compilation of the Technical Data → Chapter 4;
- As well as a compilation of the most significant data for advanced users → Appendix.

General information with regard to design, configuration, and operation of SIPROTEC 4 devices are set out in the SIPROTEC 4 System Description */1/ SIPROTEC 4 System Description*.

Target Audience

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

Scope

This manual applies to: SIPROTEC 4 Voltage and Frequency Protection 7RW80; Firmware-Version V4.6.

Indication of Conformity

CE	This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage Directive 2006/95 EC). This conformity is proved by tests conducted by Siemens AG in accordance with the Council Directive in agreement with the generic standards EN 61000-6-2 and EN 61000-6-4 for EMC directive, and with the standard EN 60255-27 for the low-voltage directive. The device has been designed and produced for industrial use. The product conforms with the international standards of the series IEC 60255 and the German standard VDE 0435.

Additional Standards IEEE Std C37.90 (see Chapter 4 "Technical Data")

This product is UL-certified according to the Technical Data. file E194016

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Additional Support

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

Support

Our Customer Support Center provides a 24-hour service.

Phone:	+49 (180) 524-7000
Fax:	+49 (180) 524-2471
E-Mail:	*support.energy@siemens.com*

Training Courses

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

Siemens AG
Siemens Power Academy TD

Humboldtstraße 59
90459 Nürnberg
Germany

Phone:	+49 (911) 433-7415
Fax:	+49 (911) 433-7929
E-Mail:	*poweracademy@siemens.com*
Internet:	*www.siemens.com/poweracademy*

Notes on Safety

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

DANGER

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

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

WARNING

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

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

CAUTION

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

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

NOTICE

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

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

NOTE

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

Qualified Electrical Engineering Personnel

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

Proper Use

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

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

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

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

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

Typographic and Symbol Conventions

The following text formats are used when literal information from the device or to the device appear in the text flow:

`Parameter Names`

Designators of configuration or function parameters which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI), are marked in bold letters in monospace type style. The same applies to titles of menus.

`1234A`

Parameter addresses have the same character style as parameter names. Parameter addresses contain the suffix **`A`** in the overview tables if the parameter can only be set in DIGSI via the option **Display additional settings**.

`Parameter Options`

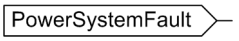
Possible settings of text parameters, which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI), are additionally written in italics. The same applies to the options of the menus.

Indications

Designators for information, which may be output by the relay or required from other devices or from the switch gear, are marked in a monospace type style in quotation marks.

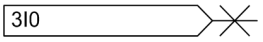
Deviations may be permitted in drawings and tables when the type of designator can be obviously derived from the illustration.

The following symbols are used in drawings:

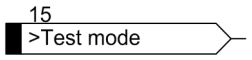


Device-internal logical input signal

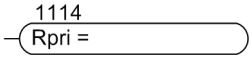
Device-internal logical output signal



Internal input signal of an analog quantity

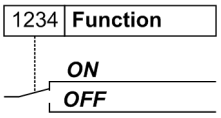


External binary input signal with number (binary input, input indication)



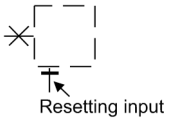
External binary output signal with number (example of a value indication)

External binary output signal with number (device indication) used as input signal

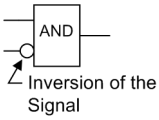


Example of a parameter switch designated **FUNCTION** with address 1234 and the possible settings ***ON*** and ***OFF***

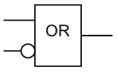
Besides these, graphical symbols are used in accordance with IEC 60617-12 and IEC 60617-13 or similar. Some of the most frequently used are listed below:



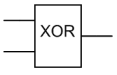
Analog input variable



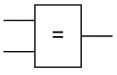
AND-gate operation of input values



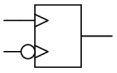
OR-gate operation of input values



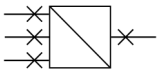
Exclusive OR gate (antivalence): output is active, if only **one** of the inputs is active



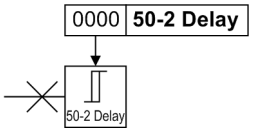
Coincidence gate: output is active, if **both** inputs are active or inactive at the same time



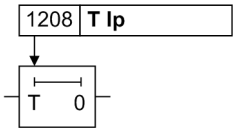
Dynamic inputs (edge-triggered) above with positive, below with negative edge



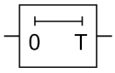
Formation of one analog output signal from a number of analog input signals



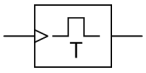
Limit stage with setting address and parameter designator (name)



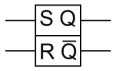
Timer (pickup delay T, example adjustable) with setting address and parameter designator (name)



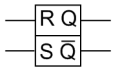
Timer (dropout delay T, example non-adjustable)



Dynamic triggered pulse timer T (monoflop)



Static memory (SR flipflop) with setting input (S), resetting input (R), output (Q) and inverted output ($\overline{Q}$), setting input dominant



Static memory (RS-flipflop) with setting input (S), resetting input (R), output (Q) and inverted output ($\overline{Q}$), resetting input dominant

Table of Contents

1 Introduction

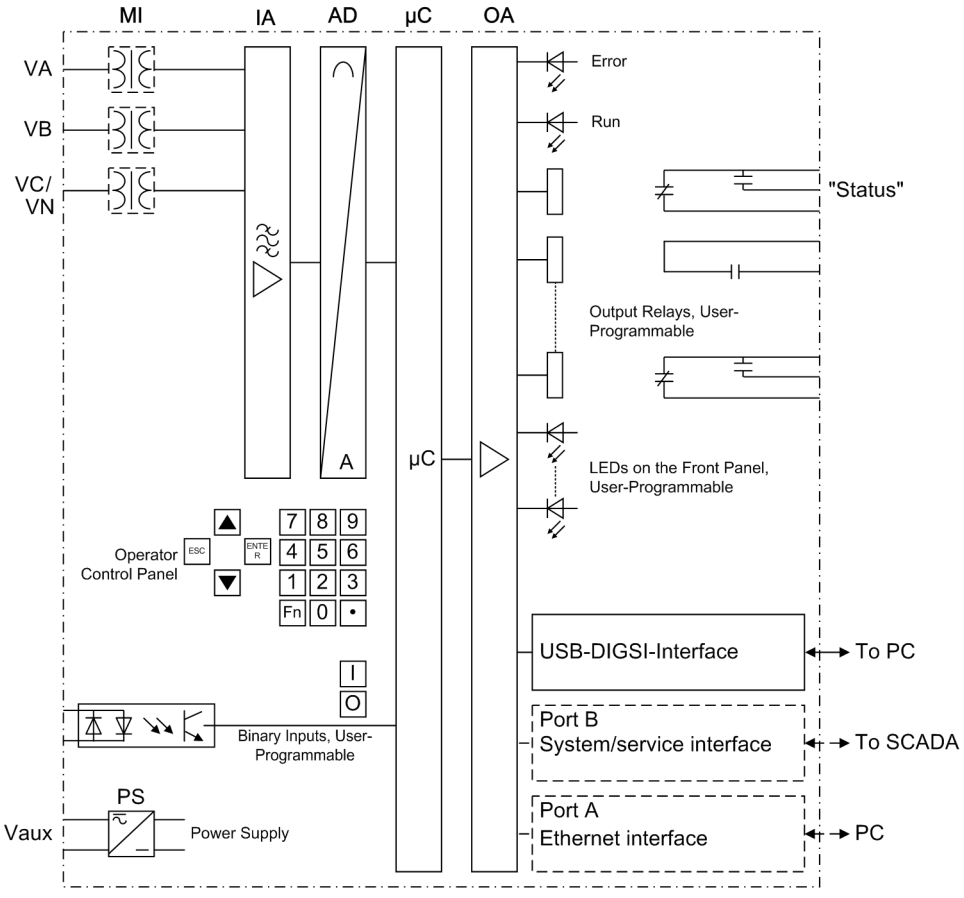
The device family SIPROTEC 7RW80 devices is introduced in this section. An overview of the devices is presented in their application, characteristics, and scope of functions.

1.1 Overall Operation

The Voltage and Frequency protection SIPROTEC 7RW80 is equipped with a high performance microprocessor. This provides numerical processing of all functions in the device, from the acquisition of the measured values up to the output of commands to the circuit breakers. *Figure 1-1* shows the basic structure of the device 7RW80.

Analog Inputs

The measuring inputs MI transform the voltages derived from the instrument transformers and match them to the internal signal levels for processing in the device. Three voltage inputs are available in the MI section.



[hw-struktur-7rw80-100519, 1, en_US]

Figure 1-1 Hardware structure of the numerical Voltage and Frequency Protection Device 7RW80

Voltage inputs can either be used to measure the three phase-to-ground voltages, or two phase-to-phase voltages and the displacement voltage (e–n voltage) or for any other voltage. It is also possible to connect two phase-to-phase voltages in open-delta connection.

The analog input quantities are passed on to the input amplifiers (IA). The input amplifier IA element provides a high-resistance termination for the input quantities. It consists of filters that are optimized for measured-value processing with regard to bandwidth and processing speed.

The analog-to-digital (AD) transformer group consists of a an analog-to-digital converter and memory components for the transmission of data to the microcomputer.

Microcomputer System

Apart from processing the measured values, the microcomputer system (µC) also executes the actual protection and control functions. They especially include:

- Filtering and preparation of the measured quantities
- Continuous monitoring of the measured quantities
- Monitoring of the pickup conditions for the individual protective functions
- Interrogation of limit values and sequences in time
- Control of signals for the logic functions
- Output of control commands for switching devices
- Recording of messages, fault data and fault values for analysis
- Management of the operating system and the associated functions such as data recording, real-time clock, communication, interfaces, etc.
- The information is distributed via output amplifiers (OA).

Binary Inputs and Outputs

The computer system obtains external information through the binary input/output boards (inputs and outputs). The computer system obtains information from the system (e.g remote resetting) or from external equipment (e.g. blocking commands). These outputs include, in particular, trip commands to circuit breakers and signals for the remote indication of important events and conditions.

Front Panel

Information such as messages related to events, states, measured values and the functional status of the device are visualized by light-emitting diodes (LEDs) and a display screen (LCD) on the front panel.

Integrated control and numeric keys in conjunction with the LCD enable interaction with the remote device. These elements can be used to access the device for information such as configuration and setting parameters. Similarly, setting parameters can be accessed and changed if needed.

In addition, control of circuit breakers and other equipment is possible from the front panel of the device.

Interfaces

Communication with a PC can be implemented via the **USB DIGSI interface** using the DIGSI software, allowing all device functions to be easily executed.

Communication with a PC is also possible via **port A** (Ethernet interface) and **port B** (System/Service interface) using DIGSI.

In addition to the device communication via DIGSI, **port B** can also be used to transmit all device data to a central evaluator or a control center. This interface may be provided with various protocols and physical transmission schemes to suit the particular application.

Power Supply

A power supply unit (Vaux or PS) delivers power to the functional units using the different voltage levels. Voltage dips may occur if the voltage supply system (substation battery) becomes short-circuited. Usually, they are bridged by a capacitor (see also Technical Data).

A buffer battery is located under the flap at the lower end of the front cover.

1.2 Application Scope

The digital voltage and frequency protection SIPROTEC 4 7RW80 is a versatile device designed for protection, control, and monitoring of transformers, electrical machines and distribution systems.

The device can be used for

- System decoupling or for load shedding if ever there is a risk of a system collapse as a result of inadmissibly large frequency drops
- Monitoring voltage and frequency thresholds

Voltage, frequency and overexcitation protection can be used to protect generators and transformers in the event of

- Defective voltage control or defective frequency control
- Full load rejection
- Islanding generation systems.

Protection Functions

Multilevel voltage and frequency protection is the basic function of the device.

Further protection functions included are load restoration, synchrocheck, overexcitation protection, vector jump and flexible protective functions.

Control Functions

The device provides a control function which can be accomplished for activating and deactivating the switchgear via operator buttons, port B, binary inputs and - using a PC and the DIGSI software - via the front interface.

The status of the primary equipment can be transmitted to the device via auxiliary contacts connected to binary inputs. The present status (or position) of the primary equipment can be displayed on the device, and used for interlocking or alarm condition monitoring. The number of operating equipments to be switched is limited by the binary inputs and outputs available in the device or the binary inputs and outputs allocated for the switch position indications. Depending on the primary equipment being controlled, one binary input (single point indication) or two binary inputs (double point indication) may be used for this process.

The capability of switching primary equipment can be restricted by a setting associated with switching authority (Remote or Local), and by the operating mode (interlocked/non-interlocked, with or without password request).

Processing of interlocking conditions for switching (e.g. switchgear interlocking) can be established with the aid of integrated, user-configurable logic functions.

Messages and Measured Values; Recording of Event and Fault Data

The operational indications provide information about conditions in the power system and the device. Measurement quantities and values that are calculated can be displayed locally and communicated via the serial interfaces.

Device messages can be assigned to a number of LEDs on the front cover (allocatable), can be externally processed via output contacts (allocatable), linked with user-definable logic functions and/or issued via serial interfaces.

During a fault (system fault) important events and changes in conditions are saved in fault protocols (Event Log or Trip Log). Instantaneous fault values are also saved in the device and may be analyzed subsequently.

Communication

The following interfaces are available for communication with external operating, control and memory systems.

The USB DIGSI interface on the front cover serves for local communication with a PC. By means of the SIPROTEC 4 operating software DIGSI, all operational and evaluation tasks can be executed via this **operator interface**, such as specifying and modifying configuration parameters and settings, configuring user-specific

logic functions, retrieving operational messages and measured values, inquiring device conditions and measured values, issuing control commands.

Depending on the ordered variant, additional interfaces are located at the bottom of the device. They serve for establishing extensive communication with other digital operating, control and memory components:

Port A serves for DIGSI communication directly on the device or via network.

Port B serves for central communication between the device and a control center. It can be operated via data lines or fiber optic cables. For the data transfer, there are standard protocols in accordance with IEC 60870-5-103 available. The integration of the devices into the SINAUT LSA and SICAM automation systems can also be implemented with this profile.

Alternatively, additional connection options are available with PROFIBUS DP and the DNP3.0 and MODBUS protocols. If an EN100 module is available, you can use the protocol IEC 61850.

1.3 Characteristics

General Characteristics

- Powerful 32-bit microprocessor system
- Complete digital processing and control of measured values, from the sampling of the analog input quantities to the initiation of outputs, for example, tripping or closing circuit breakers or other switchgear devices
- Total electrical separation between the internal processing stages of the device and the external transformer, control, and DC supply circuits of the system because of the design of the binary inputs, outputs, and the DC or AC converters
- Easy device operation through an integrated operator panel or by means of a connected personal computer running DIGSI
- Continuous calculation and display of measured and metered values on the front of the device
- Storage of min./max. measured values (slave pointer function) and storage of long-term mean values
- Recording of event and fault data for the last 8 system faults (fault in a network) with real-time information as well as instantaneous values for fault recording for a maximum time range of 20 s
- Constant monitoring of the measured quantities, as well as continuous self-diagnostics covering the hardware and software
- Communication with SCADA or substation controller equipment via serial interfaces through the choice of data cable, modem, or optical fibers
- Battery-buffered clock which can be synchronized via a synchronization signal at the binary input or via a protocol
- Statistics: Recording of the number of trip signals instigated by the device.
- Commissioning aids such as connection and direction check, status indication of all binary inputs and outputs, easy testing of port B, and influencing of information at port B during test operation.

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- Three-element undervoltage detection via the positive sequence system of the voltages, phase-to-phase or phase-ground voltages
- Separate overvoltage detection of the voltages applied or detection of the positive or negative sequence component of the voltages
- Settable dropout ratio for all elements of the undervoltage and overvoltage protection
- User-defined characteristic

Frequency Protection 81 O/U

- Monitoring of falling below (f<) and/or exceeding (f>) with 4 frequency limits and time delays that are independently adjustable
- Insensitive to harmonics and abrupt phase angle changes
- Adjustable undervoltage threshold.

Load Restoration

- 4 separately adjustable load restoration stages
- Individually assignable low frequency stages, which start the load restoration stage (1 to 4 for each load restoration element)
- Settable dropout ratio for all stages of the load restoration
- Monitoring of the settable restoration cycles (no ON/OFF chattering)

Monitoring Functions

- Increased reliability due to monitoring of the internal measurement circuits as well as the hardware and software
- Monitoring of the current transformer and voltage transformer secondary circuits using sum and symmetry supervision with optional protection function blocking
- Broken-wire Monitoring of Voltage Transformer Circuits
- Trip circuit monitoring possible
- Phase rotation check.

Flexible Protective Functions

- Up to 20 customizable protection functions with three-phase or single-phase operation
- Any calculated or directly measured quantity can be evaluated on principle
- Standard protection logic with definite time characteristic
- Internal and configurable pickup and dropout delay
- Modifiable message texts.

Synchrocheck

- Check of the synchronism conditions or de-energized state before manual closing of the circuit breaker
- Fast measurement of the voltage difference ΔV, the phase angle difference $\Delta\phi$ and the frequency difference Δf
- Setable minimum and maximum voltage
- Measurement also possible via transformer without external intermediate matching transformer
- Measuring voltages optionally phase–to–phase or phase–to–ground.

Overecxitation Protection

- Calculation of the V/f ratio V/f
- Adjustable warning and tripping stage
- Standard characteristic or arbitrary trip characteristic selectable for calculation of the thermal stress.

Jump of Voltage Vector

- Sensitive phase jump detection to be used for network disconnection.

Phase Rotation

- Selectable ABC or ACB by setting (static) or binary input (dynamic).

User Defined Functions

- Freely programmable linking of internal and external signals in order to implement user-defined logic functions
- All standard logic functions (AND, OR, NOT, EXCLUSIVE-OR, etc.)
- Time delays and limit value interrogations
- Processing of measured values, including zero suppression, adding a knee curve for a transducer input, and live-zero monitoring.
- Linking of multiple devices for load restoration with prioritization of the stages

Breaker Control

- Switching devices can be opened and closed manually using control keys, programmable function keys, via port B (e.g. of SICAM or LSA), or via the user interface (using a personal computer and the DIGSI operating software)

2 Functions

This chapter describes the numerous functions available on the SIPROTEC 4 device 7RW80. It shows the setting possibilities for each function in maximum configuration. Information with regard to the determination of setting values as well as formulas, if required, are also provided.

Based on the following information, it can also be determined which of the provided functions should be used.

2.1 General

The settings associated with the various device functions can be modified using the operating or service interface in DIGSI in conjunction with a personal computer. Some parameters can also be changed using the controls on the front panel of the device. The procedure is described in detail in the SIPROTEC System Description */1/ SIPROTEC 4 System Description*.

2.1.1 Functional Scope

The 7RW80 relay contains protection functions as well as auxiliary functions. The hardware and firmware is designed for this scope of functions. Additionally, the control functions can be matched to the system requirements. Individual functions can be enabled or disabled during the configuration procedure. The interaction of functions may also be modified.

2.1.1.1 Functional Description

Setting the Functional Scope

The available protection and additional functions can be configured as ***Enabled*** or ***Disabled***. For individual functions, a choice between several alternatives may be possible, as described below.

Functions configured as ***Disabled*** are not processed by the 7RW80. There are no messages and corresponding settings (functions, limit values) queried during configuration.

NOTE

Available functions and default settings are depending on the order variant of the relay (see *A Ordering Information and Accessories*).

2.1.1.2 Setting Notes

Setting the Functional Scope

Your protection device is configured using the DIGSI software. Connect your personal computer either to the USB port on the device front or to port A or port B on the bottom side of the device depending on the device version (ordering code). The operation via DIGSI is explained in the SIPROTEC 4 System Description.

The **Device Configuration** dialog box allows you to adjust your device to the specific system conditions.

Password no. 7 is required (for parameter set) for changing configuration parameters in the device. Without the password the settings can only be read but not edited and transmitted to the device.

Special Features

Most settings are self-explanatory. The special cases are described in the following.

If you want to use the setting group change function, set address 103 **Grp Chge OPTION** to ***Enabled***. In this case, you can select up to four different groups of function parameters between which you can switch quickly and conveniently during operation. Only **one** setting group can be used when selecting the option ***Disabled***.

The synchronization function is activated in address 161 **25 Function 1** by the setting ***SYNCHROCHECK*** or it is set to ***Disabled***.

Under address 182 **74 Trip Ct Supv** it can be selected whether the trip-circuit supervision works with two (***2 Binary Inputs***) or only one binary input (***1 Binary Input***), or whether the function is configured ***Disabled***.

In address 617 **ServiProt (CM)** you can specify for which purpose port B is used. ***T103*** means that the device is connected to a control and protection facility via serial port, DIGSI means that you are using the port to connect ***DIGSI*** or you are not using port B (***Disabled***).

The flexible protection functions can be configured via parameter **FLEXIBLE FUNC.**. You can create up to 20 flexible functions by setting a checkmark in front of the desired function. If the checkmark of a function is

removed, all settings and configurations made previously will be lost. After re-selecting the function, all settings and configurations are in default setting. Setting of the flexible function is done in DIGSI under “Parameters”, “Additional Functions” and “Settings”. The configuration is done, as usual, under “Parameters” and “Configuration”.

2.1.1.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
103	Grp Chge OPTION	Disabled Enabled	Disabled	Setting Group Change Option
104	OSC. FAULT REC.	Disabled Enabled	Enabled	Oscillographic Fault Records
143	24 V/f	Disabled Enabled	Disabled	24 Overexcit. Protection (Volt/ Hertz)
146	VECTOR JUMP	Disabled Enabled	Disabled	Jump of Voltage Vector
150	27/59	Disabled Enabled	Enabled	27, 59 Under/Overvoltage Protection
152	VT BROKEN WIRE	Disabled Enabled	Enabled	VT broken wire supervision
154	81 O/U	Disabled Enabled	Enabled	81 Over/Underfrequency Protection
155	Load Restore	Disabled Enabled	Disabled	Load Restoration
161	25 Function 1	Disabled SYNCHROCHECK	Disabled	25 Function group 1
182	74 Trip Ct Supv	Disabled 2 Binary Inputs 1 Binary Input	Disabled	74TC Trip Circuit Supervision
617	ServiProt (CM)	Disabled T103 DIGSI	T103	Port B usage

Addr.	Parameter	Setting Options	Default Setting	Comments
-	FLEXIBLE FCT. 1...20	Flexible Function 01 Flexible Function 02 Flexible Function 03 Flexible Function 04 Flexible Function 05 Flexible Function 06 Flexible Function 07 Flexible Function 08 Flexible Function 09 Flexible Function 10 Flexible Function 11 Flexible Function 12 Flexible Function 13 Flexible Function 14 Flexible Function 15 Flexible Function 16 Flexible Function 17 Flexible Function 18 Flexible Function 19 Flexible Function 20	Please select	Flexible Functions 1...20

2.1.2 Device, General Settings

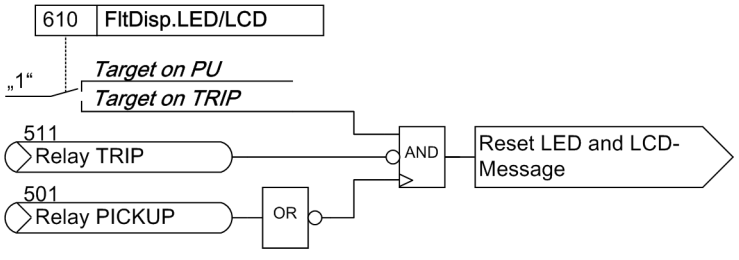
The device requires some general information. This may be, for example, the type of annunciation to be issued in the event of an occurrence of a power system fault.

2.1.2.1 Functional Description

Command-Dependent Messages "No Trip – No Flag"

The storage of indications assigned to local LEDs and the availability of spontaneous indications can be made dependent on whether the device has issued a trip command. This information is then not issued if during a system disturbance one or more protection functions have picked up but the 7RW80 did not trip because the fault was cleared by another device (e.g. on another line). These messages are then limited to faults in the line to be protected.

The following figure illustrates the generation of the reset command for stored indications. The instant the device drops out, the presetting of parameter 610 **`FltDisp.LED/LCD`** decides whether the new fault remains stored or is reset.



[dw_ruecksetzbefehl-fuer-n-speicher-led-lcd-meld, 1, en_US]

Figure 2-1 Creation of the reset command for the latched LED and LCD messages

Spontaneous Messages on the Display

You can determine whether or not the most important data of a fault event is displayed automatically after the fault has occurred (see also Subsection "Fault Messages" in Section "Auxiliary Functions").

2.1.2.2 Setting Notes

Fault Messages

A new pickup of a protection function generally turns off any previously set light displays so that only the latest fault is displayed at any one time. It can be selected whether the stored LED displays and the spontaneous messages on the display appear after the new pickup or only after a new trip signal is issued. In order to select the desired mode of display, select the Device submenu in the SETTINGS menu. Under address 610 **FltDisp.LED/LCD** the two options ***Target on PU*** and ***Target on TRIP*** ("No trip – no flag") can be selected.

For devices with graphic display, use parameter 611 **Spont. FltDisp.** to specify whether a spontaneous fault message should appear automatically on the display (***YES***) or not (***NO***). For devices with text display such indications will appear after a system fault in any case.

Selection of Default Display

The start page of the default display appearing after startup of the device can be selected in the device data via parameter640 **Start image DD**. The pages available for each device version are listed in the Appendix *D Default Settings and Protocol-dependent Functions*.

2.1.2.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
610	FltDisp.LED/LCD	Target on PU Target on TRIP	Target on PU	Fault Display on LED / LCD
611	Spont. FltDisp.	YES NO	NO	Spontaneous display of flt.annunciations
640	Start image DD	image 1 image 2 image 3	image 1	Start image Default Display

2.1.2.4 Information List

No.	Information	Type of Information	Comments
-	>Light on	SP	>Back Light on
-	Reset LED	IntSP	Reset LED
-	DataStop	IntSP	Stop data transmission
-	Test mode	IntSP	Test mode
-	Feeder gnd	IntSP	Feeder GROUNDED
-	Brk OPENED	IntSP	Breaker OPENED
-	HWTestMod	IntSP	Hardware Test Mode
-	SynchClock	IntSP_Ev	Clock Synchronization
-	Distur.CFC	OUT	Disturbance CFC
1	Not configured	SP	No Function configured
2	Non Existent	SP	Function Not Available
3	>Time Synch	SP_Ev	>Synchronize Internal Real Time Clock
5	>Reset LED	SP	>Reset LED
15	>Test mode	SP	>Test mode

No.	Information	Type of Information	Comments
16	>DataStop	SP	>Stop data transmission
51	Device OK	OUT	Device is Operational and Protecting
52	ProtActive	IntSP	At Least 1 Protection Funct. is Active
55	Reset Device	OUT	Reset Device
56	Initial Start	OUT	Initial Start of Device
67	Resume	OUT	Resume
68	Clock SyncError	OUT	Clock Synchronization Error
69	DayLightSavTime	OUT	Daylight Saving Time
70	Settings Calc.	OUT	Setting calculation is running
71	Settings Check	OUT	Settings Check
72	Level-2 change	OUT	Level-2 change
73	Local change	OUT	Local setting change
110	Event Lost	OUT_Ev	Event lost
113	Flag Lost	OUT	Flag Lost
125	Chatter ON	OUT	Chatter ON
140	Error Sum Alarm	OUT	Error with a summary alarm
160	Alarm Sum Event	OUT	Alarm Summary Event
177	Fail Battery	OUT	Failure: Battery empty
178	I/O-Board error	OUT	I/O-Board Error
181	Error A/D-conv.	OUT	Error: A/D converter
191	Error Offset	OUT	Error: Offset
193	Alarm NO calibr	OUT	Alarm: NO calibration data available
236.2127	BLK. Flex.Fct.	IntSP	BLOCK Flexible Function
301	Pow.Sys.Flt.	OUT	Power System fault
302	Fault Event	OUT	Fault Event
303	sens Gnd flt	OUT	sensitive Ground fault
320	Warn Mem. Data	OUT	Warn: Limit of Memory Data exceeded
321	Warn Mem. Para.	OUT	Warn: Limit of Memory Parameter exceeded
322	Warn Mem. Oper.	OUT	Warn: Limit of Memory Operation exceeded
323	Warn Mem. New	OUT	Warn: Limit of Memory New exceeded
502	Relay Drop Out	SP	Relay Drop Out
510	Relay CLOSE	SP	General CLOSE of relay
545	PU Time	VI	Time from Pickup to drop out
546	TRIP Time	VI	Time from Pickup to TRIP
10080	Error Ext I/O	OUT	Error Extension I/O
10081	Error Ethernet	OUT	Error Ethernet
10083	Error Basic I/O	OUT	Error Basic I/O

2.1.3 Power System Data 1

2.1.3.1 Functional Description

The device requires certain basic data regarding the protected equipment so that the device can adapt to its desired application. These may be, for instance, nominal power system and transformer data, measured quantity polarities and their physical connections, breaker properties (where applicable) etc. There are also certain parameters that are common to all functions, i.e. not associated with a specific protection, control or monitoring function. The following section discusses these parameters.

2.1.3.2 Setting Notes

General

Some **P.System Data 1** can be entered directly at the device. See Section *2.14 Notes on Device Operation* for more information regarding this topic.

In DIGSI double-click **Settings** to open the corresponding dialog box. In doing so, a dialog box with tabs will open under **P.System Data 1** where individual parameters can be configured. The following descriptions are therefore structured according to these tabs.

Rated Frequency (Power System)

The nominal frequency of the system is set under the Address 214 **Rated Frequency**. The factory pre-setting in accordance with the model need only be changed if the device will be employed for a purpose other than that which was planned when ordering.

In the US device versions (ordering data position 10= C), parameter 214 is preset to 60 Hz. 214.

Voltage Connection (Power System)

Address 213 specifies how the voltage transformers are connected.

VT Connect. 3ph = ***Van, Vbn, Vcn*** means that the three phase voltages are wye connected, i.e. the three phase-to-ground voltages are measured.ground.

VT Connect. 3ph = ***Vab, Vbc, VGnd*** means that two phase-to-phase voltages (open delta voltage) and the displacement voltage V_{GND} are connected.

VT Connect. 3ph = ***Vab, Vbc*** means that two phase-to-phase voltages (open delta voltage) are connected. The third voltage transformer of the device is not used.

VT Connect. 3ph = ***Vab, Vbc, Vx*** means that two phase-to-phase voltages (open delta voltage) are connected. Furthermore, any third voltage V_x is connected that is used exclusively for the flexible protection functions. The transformer nominal voltages for V_x are set at address 232 and 233.

VT Connect. 3ph = ***Vab, Vbc, VSyn*** means that two phase-to-phase voltages (open delta voltage) and the reference voltage for V_{SYN} are connected. This setting is enabled if the synchronization function of the device is used.

VT Connect. 3ph = ***Vph-g, VSyn*** is used if the synchronization function of the device is used and only phase-to-ground voltages are available for the protected object to be synchronized. One of these voltages is connected to the first voltage transformer; the reference voltage V_{SYN} is connected to the third voltage transformer.

The selection of the voltage transformer connection affects the operation of all device functions that require voltage input.

The settings ***Vab, Vbc*** or ***Vab, Vbc, Vx*** or ***Vab, Vbc, VSyn*** or ***Vph-g, VSyn*** do not allow determining the zero sequence voltage. The associated protection functions are inactive in this case.

The table gives an overview of the functions that can be activated for the corresponding connection type (depends also on the ordering number). The functions which are not shown are available for all connection types.

Table 2-1 Connection Types of the Voltage Transformers

Connection type	Synchronization
Van, Vbn, Vcn	no
Vab, Vbc, VGnd	no
Vab, Vbc	no
Vab, Vbc, Vx	no
Vab, Vbc, VSyn	yes
Vph-g, VSyn	yes

Measured values, which due to the chosen voltage connection cannot be calculated, will be displayed as dots.

The Appendix provides some connection examples for all connection types at*C Connection Examples*.

Nominal Values of Voltage Transformers (VTs)

At addresses 202 **Vnom PRIMARY** and 203 **Vnom SECONDARY**, information is entered regarding the primary nominal voltage and secondary nominal voltage (phase-to-phase) of the connected voltage transformers.

Transformation Ratio of Voltage Transformers (VTs)

Address 206 **Vph / Vdelta** informs the device of the adjustment factor between the phase voltage and the displacement voltage. This information is relevant for the processing of ground faults (in grounded systems and ungrounded systems), for the operational measured value V_N and measured-variable monitoring.

If the voltage transformer set provides open delta windings and if these windings are connected to the device, this must be specified accordingly in address 213 (see above margin heading "Voltage Connection"). Since the voltage transformer ratio is normally as follows:

$$\frac{V_{nomPrimary}}{\sqrt{3}} / \frac{V_{nomSecondary}}{\sqrt{3}} / \frac{V_{nomSecondary}}{3}$$

[uebersetzung-spannungswandler-020313-kn, 1, en_US]

the factor V_{ph}/V_N (secondary voltage, address 206 **Vph / Vdelta**) must be set to $3/\sqrt{3} = \sqrt{3} = 1.73$ which must be used if the VN voltage is connected. For other transformation ratios, i.e. the formation of the displacement voltage via an interconnected transformer set, the factor must be corrected accordingly.

Please take into consideration that also the calculated secondary V_0-voltage is divided by the value set in address 206. Thus, even if the V_0-voltage is not connected, address 206 has an impact on the secondary operational measured value V_N.

If ***Vab, Vbc, VGnd*** is selected as voltage connection type, parameter **Vph / Vdelta** is used to calculate the phase-to-ground voltages and is therefore important for the protection function. With voltage connection type ***Van, Vbn, Vcn***, this parameter is used only to calculate the operational measured value of the secondary voltage V_N.

Trip and Close Command Duration (Breaker)

In address 210 the minimum trip command duration **TMin TRIP CMD** is set. This setting applies to all protection functions that can initiate tripping.

In address 211 the maximum close command duration **TMax CLOSE CMD** is set. It applies to the integrated reclosing function. It must be set long enough to ensure that the circuit breaker has securely closed. An excessive duration causes no problem since the closing command is interrupted in the event another trip is initiated by a protection function.

Pickup Thresholds of the Binary Inputs (Thresholds BI)

At address 220 **Threshold BI 1** to 226 **Threshold BI 7** you can set the pickup thresholds of the binary inputs of the device. The settings ***Thresh. BI 176V***, ***Thresh. BI 88V*** or ***Thresh. BI 19V*** are possible.

Voltage Protection (Protection Operating Quantities)

In a three-phase connection, the fundamental harmonic of the three phase-to-phase voltages (***Vphph***) or phase-ground voltages (***Vph-n***) or the positive sequence voltage (***V1***) or the negative sequence voltage (***V2***) is supplied to the overvoltage protection elements.

In three-phase connection, undervoltage protection relies either on the positive sequence voltage (***V1***) or the phase-to-phase voltages (***Vphph***) or the phase-to-ground voltages (***Vph-n***).

This is configured by setting the parameter value in address 614 **OP. QUANTITY 59** and 615 **OP. QUANTITY 27**.

Via Parameter 5009 **59 Phases** and 5109 **27 Phases** you may configure which measured quantity is to be evaluated (***All phases*** or ***Largest phase*** or ***Smallest phase***).

With single-phase voltage transformers, a direct comparison of the measured quantities with the threshold values is carried out and the parameterization of the characteristic quantity switchover is ignored.

NOTE

If parameter 213 **VT Connect. 3ph** is set to ***Vph-g, VSyn***, the voltage measured by voltage transformer 1 is always used for voltage protection. Then parameters 614 and 615 are not available.

NOTE

If parameter 213 **VT Connect. 3ph** is set to ***Vab, Vbc, VSyn*** or ***Vab, Vbc*** or ***Vab, Vbc, Vx***, the setting option ***Vph-n*** for parameter 614 and 615 is not available.

2.1.3.3 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under "Additional Settings".

Addr.	Parameter	Setting Options	Default Setting	Comments
202	Vnom PRIMARY	0.10 .. 800.00 kV	20.00 kV	Rated Primary Voltage
203	Vnom SECONDARY	34 .. 225 V	100 V	Rated Secondary Voltage (L-L)
206A	Vph / Vdelta	1.00 .. 3.00	1.73	Matching ratio Phase-VT To Open-Delta-VT
209	PHASE SEQ.	A B C A C B	A B C	Phase Sequence
210A	TMin TRIP CMD	0.01 .. 32.00 sec	0.15 sec	Minimum TRIP Command Duration
211A	TMax CLOSE CMD	0.01 .. 32.00 sec	1.00 sec	Maximum Close Command Duration
213	VT Connect. 3ph	Van, Vbn, Vcn Vab, Vbc, VGnd Vab, Vbc, VSyn Vab, Vbc Vph-g, VSyn Vab, Vbc, Vx	Van, Vbn, Vcn	VT Connection, three-phase
214	Rated Frequency	50 Hz 60 Hz	50 Hz	Rated Frequency
220	Threshold BI 1	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 1
221	Threshold BI 2	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 2
222	Threshold BI 3	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 3
223	Threshold BI 4	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 4
224	Threshold BI 5	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 5

Addr.	Parameter	Setting Options	Default Setting	Comments
225	Threshold BI 6	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 6
226	Threshold BI 7	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 7
232	VXnom PRIMARY	0.10 .. 800.00 kV	20.00 kV	Rated Primary Voltage X
233	VXnom SECONDARY	100 .. 225 V	100 V	Rated Secondary Voltage X
614A	OP. QUANTITY 59	Vphph Vph-n V1 V2	Vphph	Opera. Quantity for 59 Overvolt. Prot.
615A	OP. QUANTITY 27	V1 Vphph Vph-n	V1	Opera. Quantity for 27 Undervolt. Prot.

2.1.3.4 Information List

No.	Information	Type of Information	Comments
5145	>Reverse Rot.	SP	>Reverse Phase Rotation
5147	Rotation ABC	OUT	Phase rotation ABC
5148	Rotation ACB	OUT	Phase rotation ACB

2.1.4 Oscillographic Fault Records

The Multifunctional Protection with Control 7RW80 is equipped with a fault record memory. The instantaneous values of the measured values

v_A, v_B, v_C, v_{A2}, v_{B3}, v_{C1}, v_N, v_X, v_{ph-n}, v_{SYN}

(voltages depending on connection) are sampled at intervals of 1.0 ms (at 50 Hz) and stored in a revolving buffer (20 samples per cycle). In the event of a fault, the data are recorded for a set period of time, but not for more than 5 seconds. A maximum of 8 faults can be recorded in this buffer. The fault record memory is automatically updated with every new fault, so no acknowledgment for previously recorded faults is required. In addition to protection pickup, the recording of the fault data can also be started via a binary input or via the serial interface.

2.1.4.1 Functional Description

The data of a fault event can be read out via the device interface and evaluated with the help of the SIGRA 4 graphic analysis software. SIGRA 4 graphically represents the data recorded during the fault event and also calculates additional information from the measured values. Currents and voltages can be presented either as primary or as secondary values. Signals are additionally recorded as binary tracks (marks), e.g. "pickup", "trip".

If port B of the device has been configured correspondingly, the fault record data can be imported by a central controller via this interface and evaluated. Currents and voltages are prepared for a graphic representation. Signals are additionally recorded as binary tracks (marks), e.g. "pickup", "trip".

The retrieval of the fault data by the central controller takes place automatically either after each protection pickup or after a tripping.

Depending on the selected type of connection of the voltage transformers (address 213 **`VT Connect. 3ph`**), the following measured values are recorded in the fault record:

	Voltage connection					
	Van, Vbn, Vcn	***Vab, Vbc, VGnd***	***Vab, Vbc***	***Vab, Vbc, Vx***	***Vab, Vbc, VSyn***	***Vph-g, VSyn***
V_{AB}	yes	yes	yes	yes	yes	
V_{BC}	yes	yes	yes	yes	yes	
V_{CA}	yes	yes	yes	yes	yes	
V_{A}	yes	yes				
V_{B}	yes	yes				
V_{C}	yes	yes				
V						yes
V_{en}	yes	yes				
V_{SYN}					yes	yes
V_{x}				yes		

NOTE

The signals used for the binary tracks can be allocated in DIGSI.

2.1.4.2 Setting Notes

Configuration

Fault recording (waveform capture) will only take place if address 104 **OSC. FAULT REC.** is set to ***Enabled***. Other settings pertaining to fault recording (waveform capture) are found in the **Osc. Fault Rec.** submenu of the SETTINGS menu. Waveform capture makes a distinction between the trigger instant for an oscillographic record and the criterion to save the record (address 401 **WAVEFORMTRIGGER**). Normally, the trigger is the pickup of a protection element, i.e. the time 0 is defined as the instant the first protection function picks up. The criterion for saving may be both the device pickup (***Save w. Pickup***) or the device trip (***Save w. TRIP***). A trip command issued by the device can also be used as trigger instant (***Start w. TRIP***), in this case it is also the saving criterion.

A fault event starts with the pickup by any protection function and ends when the last pickup of a protection function has dropped out. Usually this is also the extent of a fault recording (address 402 **WAVEFORM DATA** = ***Fault event***). If automatic reclosing is performed by external equipments, the entire system fault — with several reclosing attempts if necessary — can be recorded until the fault has been cleared for good (address 402 **WAVEFORM DATA** = ***Pow.Sys.Flt.***). This facilitates the representation of the entire system fault history, but also consumes storage capacity during the automatic reclosing dead time(s).

The actual storage time begins at the pre-fault time **PRE. TRIG. TIME** (address 404) ahead of the reference instant, and ends at the post-fault time **POST REC. TIME** (address 405) after the storage criterion has reset. The maximum storage duration of each fault record (**MAX. LENGTH**) is entered at address 403. Recording per fault must not exceed 5 seconds. In maximum 8 records can be saved altogether with a maximum total time of 20 s 18 s .

An oscillographic record can be triggered by a status change of a binary input, or from a PC via the operator interface. Storage is then triggered dynamically. The length of the fault recording is set in address 406 **BinIn CAPT.TIME** (but not longer than **MAX. LENGTH**, address 403). Pre-fault and post-fault times will add to this. If the binary input time is set to ∞, the length of the record equals the time that the binary input is activated (static), but not longer than the **MAX. LENGTH** (address 403).

2.1.4.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
401	WAVEFORMTRIGGER	Save w. Pickup Save w. TRIP Start w. TRIP	Save w. Pickup	Waveform Capture
402	WAVEFORM DATA	Fault event Pow.Sys.Flt.	Fault event	Scope of Waveform Data
403	MAX. LENGTH	0.30 .. 5.00 sec	2.00 sec	Max. length of a Waveform Capture Record
404	PRE. TRIG. TIME	0.05 .. 0.50 sec	0.10 sec	Captured Waveform Prior to Trigger
405	POST REC. TIME	0.05 .. 0.50 sec	0.10 sec	Captured Waveform after Event
406	BinIn CAPT.TIME	0.10 .. 5.00 sec	0.50 sec	Capture Time via Binary Input

2.1.4.4 Information List

No.	Information	Type of Information	Comments
-	FltRecSta	IntSP	Fault Recording Start
4	>Trig.Wave.Cap.	SP	>Trigger Waveform Capture
203	Wave. deleted	OUT_Ev	Waveform data deleted
30053	Fault rec. run.	OUT	Fault recording is running

2.1.5 Settings Groups

Up to four different setting groups can be created for establishing the device's function settings.

2.1.5.1 Functional Description

Changing Setting Groups

During operation the user can switch back and forth setting groups locally, via the operator panel, binary inputs (if so configured), the service interface using a personal computer, or via the system interface. For reasons of safety it is not possible to change between setting groups during a power system fault.

A setting group includes the setting values for all functions that have been selected as ***Enabled*** during configuration (see Section *2.1.1.2 Setting Notes*). In 7RW80 relays, four independent setting groups (A to D) are available. While setting values may vary, the selected functions of each setting group remain the same.

2.1.5.2 Setting Notes

General

If setting group change option is not required, Group A is the default selection. Then, the rest of this section is not applicable.

If the changeover option is desired, group changeover must be set to **`Grp Chge OPTION`** = ***Enabled*** (address 103) when the function extent is configured. For the setting of the function parameters, each of the required setting groups A to D (a maximum of 4) must be configured in sequence. The SIPROTEC 4 System Description gives further information on how to copy setting groups or reset them to their status at delivery and also how to change from one setting group to another.

Section *3.1 Mounting and Connections* of this manual tells you how to change between several setting groups externally via binary inputs.

2.1.5.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
302	CHANGE	Group A Group B Group C Group D Binary Input Protocol	Group A	Change to Another Setting Group

2.1.5.4 Information List

No.	Information	Type of Information	Comments
-	P-GrpA act	IntSP	Setting Group A is active
-	P-GrpB act	IntSP	Setting Group B is active
-	P-GrpC act	IntSP	Setting Group C is active
-	P-GrpD act	IntSP	Setting Group D is active
7	>Set Group Bit0	SP	>Setting Group Select Bit 0
8	>Set Group Bit1	SP	>Setting Group Select Bit 1

2.1.6 Power System Data 2

2.1.6.1 Functional Description

The general protection data (**`P.System Data 2`**) include settings associated with all functions rather than a specific protection or monitoring function. In contrast to the **`P.System Data 1`** as discussed before, they can be changed with the setting group.

Applications

When the primary reference voltage and the primary reference current of the protected object are set, the device is able to calculate and output the operational measured value percentage.

2.1.6.2 Setting Notes

Rated Values of the System

At address 1101 **`FullScaleVolt.`** the reference voltage (phase-to-phase) of the monitored equipment is entered. If these reference values match the primary values of the voltage transformer, they correspond to the setting at Address 202 (Section *2.1.3.2 Setting Notes*). They are generally used to show values referenced to full scale.

2.1.6.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
1101	FullScaleVolt.	0.10 .. 800.00 kV	20.00 kV	Measurem:FullScale-Voltage(Equipm.rating)

2.1.6.4 Information List

No.	Information	Type of Information	Comments
126	ProtON/OFF	IntSP	Protection ON/OFF (via system port)

No.	Information	Type of Information	Comments
356	>Manual Close	SP	>Manual close signal
501	Relay PICKUP	OUT	Relay PICKUP
511	Relay TRIP	OUT	Relay GENERAL TRIP command
561	Man.Clos.Detect	OUT	Manual close signal detected
4601	>52-a	SP	>52-a contact (OPEN, if bkr is open)
4602	>52-b	SP	>52-b contact (OPEN, if bkr is closed)

2.1.7 EN100-Module

2.1.7.1 Functional Description

The Ethernet EN100-Modul enables integration of the 7RW80 in 100-Mbit communication networks in control and automation systems with the protocols according to IEC 61850 standard. This standard permits uniform communication of the devices without gateways and protocol converters. Even when installed in heterogeneous environments, SIPROTEC 4 relays therefore provide for open and interoperable operation. Parallel to the process control integration of the device, this interface can also be used for communication with DIGSI and for inter-relay communication via GOOSE.

2.1.7.2 Setting Notes

Interface Selection

No special settings are required for operating the Ethernet system interface module (IEC 1850, **`Ethernet EN100-Modul`**). If the ordered version of the device is equipped with such a module, it is automatically allocated to the interface available for it, namely **`Port B`**.

2.1.7.3 Information List

No.	Information	Type of Information	Comments
009.0100	Failure Modul	IntSP	Failure EN100 Modul
009.0101	Fail Ch1	IntSP	Failure EN100 Link Channel 1 (Ch1)
009.0102	Fail Ch2	IntSP	Failure EN100 Link Channel 2 (Ch2)

2.2 Voltage Protection 27, 59

Voltage protection has the task to protect electrical equipment against undervoltage and overvoltage. Both operational states are abnormal as overvoltage may cause for example insulation problems or undervoltage may cause stability problems.

There are three elements each available for overvoltage protection and undervoltage protection.

Applications

- Abnormally high voltages often occur e.g. in low loaded, long distance transmission lines, in islanded systems when generator voltage regulation fails, or after full load rejection of a generator from the system.
- The undervoltage protection function detects voltage collapses on transmission lines and electrical machines and prevents inadmissible operating states and a possible loss of stability.

2.2.1 Measurement Principle

Connection/Measured Values

The voltages supplied to the device may correspond to the three phase-to-ground voltages V_{A-N}, V_{B-N}, V_{C-N} or the two phase-to-phase voltages (V_{A-B}, V_{B-C}) and the displacement voltage (ground voltage V_N) or - in the case of a single-phase connection - any phase-to-ground voltage. The connection type has been specified during the configuration in parameter 213 **VT Connect. 3ph** (see Section *2.1.3.2 Setting Notes*).

The following table indicates which voltages can be evaluated by the function. The settings for this are made in the **P.System Data 1** (see Section *2.1.3.2 Setting Notes*). Furthermore, it is indicated to which value the threshold must be set. All voltages are fundamental frequency values.

Table 2-2 Voltage protection, selectable voltages

Connection, threephase (parameter213)	Selectable voltage parameter 614/ 615	Threshold to be set as
Overvoltage		
Van, Vbn, Vcn	***Vphph*** (largest phase-to-phase voltage)	Phase-to-phase voltage
	Vph-n ((largest phase-to-ground voltage)	Phase-to-ground voltage
	V1(positive sequence voltage)	Positive sequence voltage calculated from phase-to-groundvoltage or phase-tophase voltage / $\sqrt{3}$
	V2 (negative sequence voltage)	Negative sequence voltage
Vab, Vbc, VGnd ***Vab, Vbc*** ***Vab, Vbc, VSyn*** ***Vab, Vbc, Vx***	***Vphph*** (largest phase-to-phase voltage)	Leiter-Leiter-Spannung
	V1(positive sequence voltage)	Positive sequence voltage
	V2 (negative sequence voltage)	Negative sequence voltage
Vph-g, VSyn	None (direct evaluation of the voltage connected to voltage input 1)	Direct voltage value
Undervoltage		
Van, Vbn, Vcn	***Vphph*** (smallest phase-to-phase voltage)	Phase-to-phase voltage
	Vph-n (smallest phase-to-ground voltage)	Phase-to-ground voltage
	V1 (positive sequence voltage)	Positive sequence voltage· $\sqrt{3}$

Connection, threephase (parameter213)	Selectable voltage parameter 614/ 615	Threshold to be set as
Vab, Vbc, VGnd	***Vphph*** (smallest phase-to-phase voltage)	Phase-to-phase voltage
Vab, Vbc	***V1*** ((positive sequence voltage)	Positive sequence voltage· $\sqrt{3}$
Vab, Vbc, VSyn		
Vab, Vbc, Vx		
Vph-g, VSyn	None (direct evaluation of the voltage connected to voltage input 1)	Direct voltage value

The positive and negative sequence voltages stated in the table are calculated from the phase-to-ground voltages.

2.2.2 Overvoltage Protection 59

Function

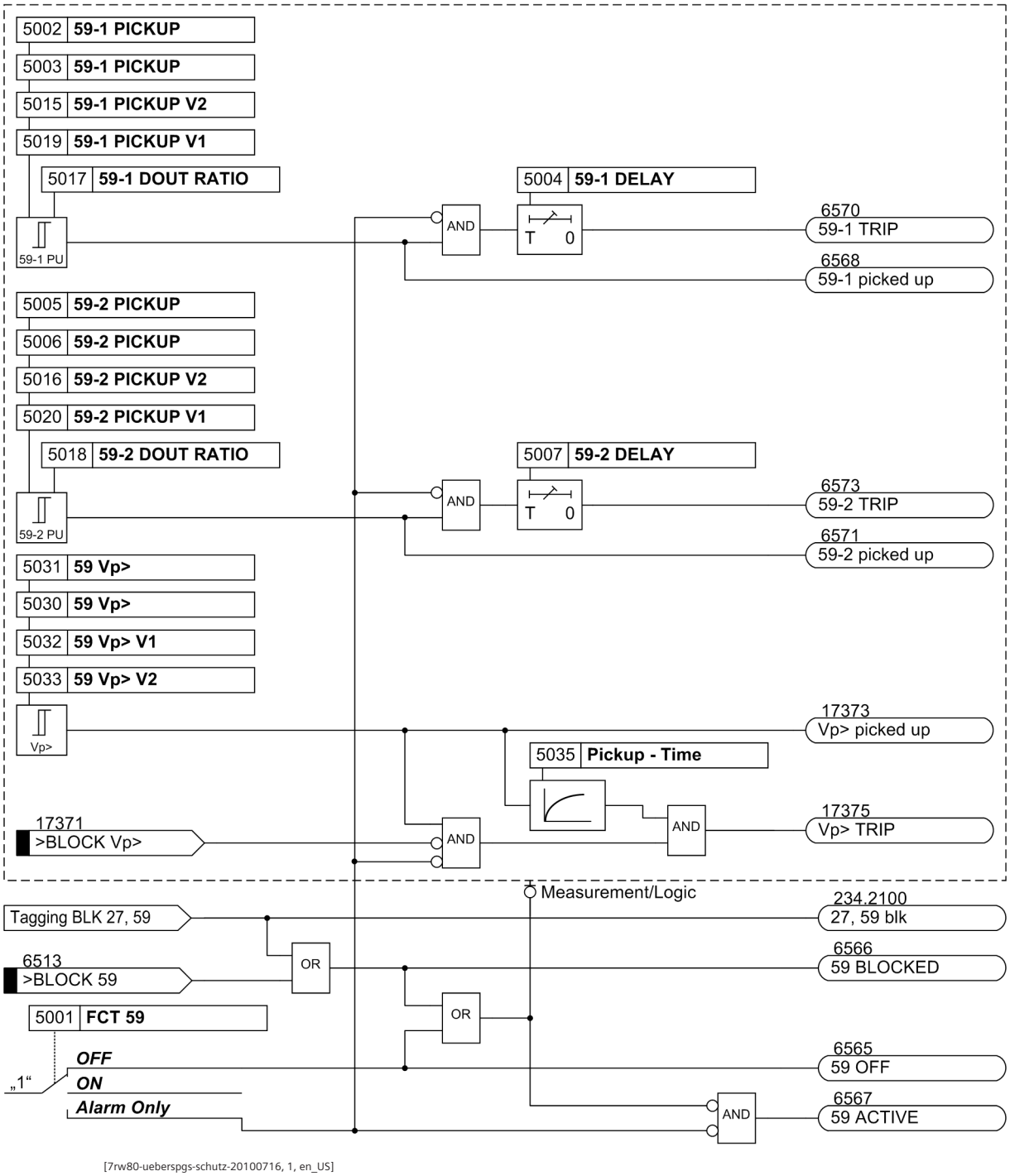
The overvoltage protection includes three elements (**59-1 PICKUP**, **59-2 PICKUP**, **59 Vp>**). In case of a high overvoltage, the switchoff is performed with a short-time delay, whereas in case of lower overvoltages, the switchoff is performed with a longer time delay. When an adjustable setting is exceeded, the 59 element picks up, and after an adjustable time delay elapses, initiates a trip signal. The time delay is not dependent on the magnitude of the overvoltage.

Additionally the element **59 Vp>** allows the definition of a user defined tripping curve with 20 value pairs (voltage/ time). Parameterization is done via DIGSI.

For both over-voltage elements **59-1 PICKUP**, **59-2 PICKUP** the dropout ratio (= $V_{dropout}/V_{pickup}$) can be parameterized.

A parameter is set to specify, whether the measured values of all phases or only phases with the highest value for monitoring are being used.

The following figure shows the logic diagram of the overvoltage protection function.



[7rw80-ueberspgs-schutz-20100716, 1, en_US]

Figure 2-2 Logic diagram of the overvoltage protection

2.2.3 Undervoltage Protection 27

Funktion

Undervoltage protection consists of three elements (**27-1 PICKUP**, **27-2 PICKUP**, **27 Vp<**). Therefore, tripping can be time-graded depending on how severe voltage collapses are. Voltage thresholds and time delays can be set individually for both elements **27-1 PICKUP** and **27-2 PICKUP**.

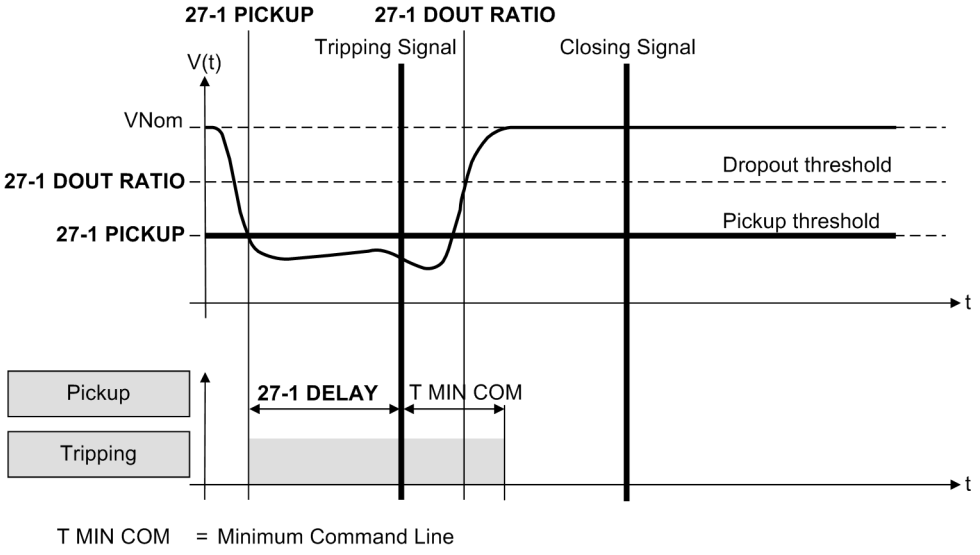
Additionally the element**27 Vp<** allows the definition of a user defined tripping curve with 20 value pairs (voltage/ time). Parameterization is done via DIGSI.

For both under-voltage elements **27-1 PICKUP** and **27-2 PICKUP** the dropout ratio (= $V_{dropout}/V_{pickup}$) can be parameterized.

A parameter is set to specify, whether the measured values of all phases or only phases with the lowest value for monitoring are being used.

The undervoltage protection works in an additional frequency range. This ensures that the protective function is preserved even when it is applied e.g. as motor protection in context with decelerating motors. However, the r.m.s. value of the positive-sequence voltage component is considered too small when severe frequency deviations exist. This function therefore exhibits an overfunction.

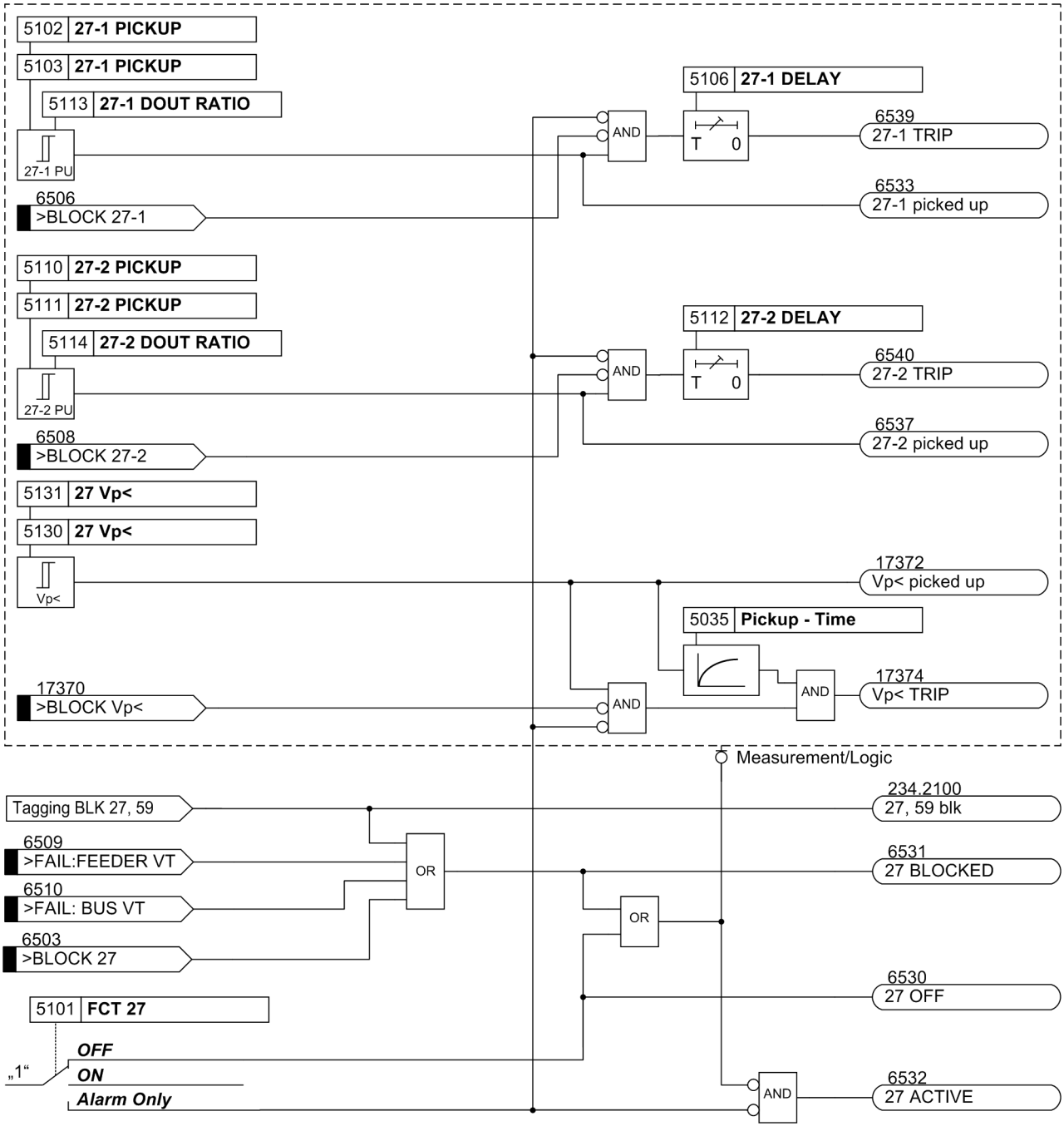
Figure 2-3 shows a typical voltage profile during a fault for source side connection of the voltage transformers. After the voltage has decreased below the pickup setting, tripping is initiated after time delay **27-1 DELAY**. As long as the voltage remains below the drop out setting, reclosing is blocked. Only after the fault has been cleared, i.e. when the voltage increases above the drop out level, the element drops out and allows reclosing of the circuit breaker.



[stoerfallverlauf-speiseseitig-20100525, 1, en_US]

Figure 2-3 Typical fault profile for supply-side connection of the voltage transformers

The following Figure shows the logic diagram of the undervoltage protection function.



[7rw80-unterspgs-schutz-20100525, 1, en_US]

Figure 2-4 Logic diagram of the undervoltage protection

2.2.4 Setting Notes

General

Voltage protection is only in effect and accessible if address 150 **27/59** is set to ***Enabled*** during configuration of protective functions. If the function is not required ***Disabled*** is set.

The voltage to be evaluated is selected in Power System Data 1 (see Chapter *2.2 Voltage Protection 27, 59*, *Table 2-2*).

Overvoltage protection can be turned ***ON*** or ***OFF*** or set to ***Alarm Only*** at address 5001 **FCT 59**.

Undervoltage protection can be turned ***ON*** or ***OFF*** or set to ***Alarm Only*** at address 5101 **FCT 27**.

With the protection function ***ON*** tripping, fault record and fault recording will occur when limit values were exceeded and after time delays expired.

When setting ***Alarm Only*** no trip command is given, no fault is recorded and no spontaneous fault annunciation is shown on the display.

For over-voltage and under-voltage protection user-defined curves with 20 value pairs (voltage/time) may be configured. Usage of a curve has to be activated at address 5035 **Pickup - Time** for the element **59 Vp>** and at address 5133 **Pickup - Time** for the element **27 Vp<**.

Overvoltage Protection (59-1, 59-2) with phase-to-phase / phase-to-ground voltage

For over-voltage protection with phase-to-phase or phase-to-ground voltages you have to configure at address 5009 **59 Phases** the measured quantity that is to be evaluated for the over voltage protection. While being configured***All phases*** all voltages have to exceed their threshold. At***Largest phase*** only one voltage has to exceed its threshold.

The threshold values are set in the value to be evaluated (see Chapter *2.2 Voltage Protection 27, 59*, *Table 2-2*).

Overvoltage protection includes three elements. The pickup value of the lower threshold is set at address 5002 or 5003, **59-1 PICKUP**, (depending on if the phase-to-ground or the phase-to-phase voltages are connected), while time delay is set at address 5004, **59-1 DELAY** (a longer time delay). The pickup value of the upper element is set at address 5005 or 5006, **59-2 PICKUP**, while the time delay is set at address 5007, **59-2 DELAY** (a short time delay). A third element can be activated at address 5031 **59 Vp>**, which works with a user-defined curve (address 5035).

There are not clear cut procedures on how to set the pickup values. However, since the overvoltage function is primarily intended to prevent insulation damage on equipment and loads, the setting value 5002 , 5003 **59-1 PICKUP** should be set between 110 % and 115 % of nominal voltage, and setting value 5005, 5006 **59-2 PICKUP** should be set to about 130 % of nominal voltage.

The time delays of the overvoltage elements are entered at addresses 5004 **59-1 DELAY**, 5007 **59-2 DELAY** and 5034 **59 T Vp>** and should be selected to allow the brief voltage spikes that are generated during switching operations and to enable clearance of stationary overvoltages in time.

The option to choose between phase-to-ground and phase-to-phase voltage, allows voltage asymmetries (e.g. caused by a ground fault) to be taken into account (phase-to-ground) or to remain unconsidered (phase–to-phase) during evaluation.

Overvoltage Protection - Positive Sequence System V1

In a three-phase voltage transformer connection the positive sequence system can be evaluated for the overvoltage protection by means of configuring parameter 614 **OP. QUANTITY 59** to ***V1***. In this case, the threshold values of the overvoltage protection must be set in parameters 5019 **59-1 PICKUP V1** or 5020 **59-2 PICKUP V1**. A third element can be activated at address 5032 **59 Vp> V1**, which works with a user-defined curve (address 5035).

Overvoltage Protection - Negative Sequence System V2

In a three-phase transformer connection, parameter 614 **OP. QUANTITY 59** can determine that the negative sequence system ***V2*** can be evaluated as a measured value for the overvoltage protection. The negative sequence system detects voltage asymmetries.

Overvoltage protection includes three elements. Thus, with configuration of the negative system, a longer time delay (Adresse 5004, **59-1 DELAY**) may be assigned to the lower element (address 5015, **59-1 PICKUP V2**) depending on whether phase-to-ground or phase-to-phase voltages are connected) and a shorter time delay (address 5007, **59-2 DELAY**) may be assigned to the upper element (Address 5016, **59-2 PICKUP V2**). A third element can be activated at address 5033 **59 Vp> V2**, which works with a user-defined curve (address 5035).

There are not clear cut procedures on how to set the pickup values **59-1 PICKUP V2** or **59-2 PICKUP V2**, as they depend on the respective station configuration.

The time delays of the overvoltage elements are entered at addresses 5004 **59-1 DELAY** and 5007 **59-2 DELAY**, and should be selected in such manner that they make allowance for brief voltage peaks that are generated during switching operations and also enable clearance of stationary overvoltages in due time.

Dropout Threshold of the Overvoltage Protection

The dropout thresholds of the 59-1 element and the 59-2 element can be configured via the dropout ratio r = $V_{Dropout}/V_{Pickup}$ at addresses 5017 **59-1 DOUT RATIO** or 5018 **59-2 DOUT RATIO**. The following marginal condition applies to r:

r · (configured pickup threshold) ≤ 150 V with connection of phase-to-phase voltages and phase-to-ground voltages or

r · (configured pickup threshold) ≤ 260 V with calculation of the measured values from the connected voltages (e.g. phase-to-phase voltages calculated from the connected phase-to-ground voltages).

The minimum hysteresis is 0.6 V.

Undervoltage Protection - Positive Sequence System V1

The positive sequence component (***V1***) can be evaluated for the undervoltage protection. Especially in case of stability problems, their acquisition is advantageous because the positive sequence system is relevant for the limit of the stable energy transmission. Concerning the pickup values there are no specific notes on how to set them. However, because the undervoltage protection function is primarily intended to protect induction machines from voltage dips and to prevent stability problems, the pickup values will usually be between 60 % and 85 % of the nominal voltage.

The threshold value is multiplied as positive sequence voltage and set to $\sqrt{3}$, thus realizing the reference to the nominal voltage.

Undervoltage protection with evaluation of the positive sequence componentscomprises two elements. The pickup value of the lower threshold is set at address 5110 or 5111, **27-2 PICKUP** (depending on the voltage transformer connection, phase-to-ground or phase-to-phase), while time delay is set at address 5112, **27-2 DELAY** (short time delay). The pickup value of the upper element is set at address 5102 or 5103, **27-1 PICKUP**, while the time delay is set at address 5106, **27-1 DELAY** (a somewhat longer time delay). Setting these elements in this way allows the undervoltage protection function to closely follow the stability behavior of the system.

The time settings should be selected such that tripping occurs in response to voltage dips that lead to unstable operating conditions. On the other hand, the time delay should be long enough to avoid tripping on short-term voltage dips.

Undervoltage Protection with Phase-to-phase or Phase-to-ground Voltages

For undervoltage protection with phase-to-phase or phase-to-ground voltages you have to configure at address 5109 **27 Phases** the measured quantity that is to be evaluated for the undervoltage protection. While being configured ***All phases*** all voltages have to underrun their threshold. At ***Smallest phase*** only one voltage has to underrun its threshold.

The threshold values are set in the value to be evaluated (see Chapter *2.2 Voltage Protection 27, 59*, *Table 2-2*)

Undervoltage protection includes three elements. The pickup value of the lower threshold is set at address 5110 or 5111, **27-2 PICKUP** (depending on the voltage transformer connection, phase-to-ground or phaseto- phase), while time delay is set at address 5112, **27-2 DELAY** (short time delay). The pickup value of the upper element is set at address 5102 or 5103, **27-1 PICKUP**, while the time delay is set at address 5106, **27-1 DELAY** (a somewhat longer time delay). Setting these elements in this matter allows the undervoltage protection function to closely follow the stability behaviour of the system. A third element can be activated at address 5131 **27 Vp<**, which works with a user-defined curve (address 5133). The corresponding delay time can be configured at address 5132 **27 T Vp<**.

The time settings should be selected such that tripping occurs in response to voltage dips that lead to unstable operating conditions. On the other hand, the time delay should be long enough to avoid tripping on short-term voltage dips.

Dropout Threshold of the Undervoltage Protection

The dropout thresholds of the 59-1 element and the 59-2 element can be parameterized via the dropout ratio $r = V_{dropout}/V_{pickup}$ (5113 **27-1 DOUT RATIO** or 5114 **27-2 DOUT RATIO**). The following marginal condition applies to r:

r · (configured pickup threshold) ≤ 130 V with connection of phase-to-phase voltages and phase-to-ground voltages) or

r· (configured pickup threshold) ≤ 225 V with calculation of the measured values from the connected voltages (e.g. calculated phase-to-phase voltages from the connected phase-to-ground voltages).

The minimum hysteresis is 0.6 V.

NOTE

If a setting is selected such that the dropout threshold (= pickup threshold · dropout ratio) results in a greater value than 130 V/225 V, it will be limited automatically. No error message occurs.

2.2.5 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under "Additional Settings".

Addr.	Parameter	Setting Options	Default Setting	Comments
5001	FCT 59	OFF ON Alarm Only	OFF	59 Overvoltage Protection
5002	59-1 PICKUP	20 .. 260 V	110 V	59-1 Pickup
5003	59-1 PICKUP	20 .. 150 V	110 V	59-1 Pickup
5004	59-1 DELAY	0.00 .. 100.00 sec	0.50 sec	59-1 Time Delay
5005	59-2 PICKUP	20 .. 260 V	120 V	59-2 Pickup
5006	59-2 PICKUP	20 .. 150 V	120 V	59-2 Pickup
5007	59-2 DELAY	0.00 .. 100.00 sec	0.50 sec	59-2 Time Delay
5009	59 Phases	All phases Largest phase	Largest phase	Phases for 59
5015	59-1 PICKUP V2	2 .. 150 V	30 V	59-1 Pickup V2
5016	59-2 PICKUP V2	2 .. 150 V	50 V	59-2 Pickup V2
5017A	59-1 DOUT RATIO	0.90 .. 0.99	0.95	59-1 Dropout Ratio
5018A	59-2 DOUT RATIO	0.90 .. 0.99	0.95	59-2 Dropout Ratio
5019	59-1 PICKUP V1	20 .. 150 V	110 V	59-1 Pickup V1
5020	59-2 PICKUP V1	20 .. 150 V	120 V	59-2 Pickup V1
5030	59 Vp>	20 .. 260 V	110 V	59 Pickup Vp>
5031	59 Vp>	20 .. 150 V	110 V	59 Pickup Vp>
5032	59 Vp> V1	20 .. 150 V	110 V	59 Pickup Vp> V1
5033	59 Vp> V2	2 .. 150 V	30 V	59 Pickup Vp> V2
5034	59 T Vp>	0.1 .. 5.0 sec	5.0 sec	59 T Vp> Time Delay
5035	Pickup - Time	1.00 .. 20.00 0.01 .. 999.00		Pickup - Time
5101	FCT 27	OFF ON Alarm Only	OFF	27 Undervoltage Protection
5102	27-1 PICKUP	10 .. 210 V	75 V	27-1 Pickup
5103	27-1 PICKUP	10 .. 120 V	45 V	27-1 Pickup
5106	27-1 DELAY	0.00 .. 100.00 sec	1.50 sec	27-1 Time Delay

Addr.	Parameter	Setting Options	Default Setting	Comments
5109	27 Phases	Smallest phase All phases	All phases	Phases for 27
5110	27-2 PICKUP	10 .. 210 V	70 V	27-2 Pickup
5111	27-2 PICKUP	10 .. 120 V	40 V	27-2 Pickup
5112	27-2 DELAY	0.00 .. 100.00 sec	0.50 sec	27-2 Time Delay
5113A	27-1 DOUT RATIO	1.01 .. 3.00	1.20	27-1 Dropout Ratio
5114A	27-2 DOUT RATIO	1.01 .. 3.00	1.20	27-2 Dropout Ratio
5130	27 Vp<	10 .. 210 V	75 V	27 Pickup Vp<
5131	27 Vp<	10 .. 120 V	45 V	27 Pickup Vp<
5132	27 T Vp<	0.1 .. 5.0 sec	1.0 sec	27 T Vp< Time Delay
5133	Pickup - Time	0.05 .. 1.00 0.01 .. 999.00		Pickup - Time

2.2.6 Information List

No.	Information	Type of Information	Comments
234.2100	27, 59 blk	IntSP	27, 59 blocked via operation
6503	>BLOCK 27	SP	>BLOCK 27 undervoltage protection
6506	>BLOCK 27-1	SP	>BLOCK 27-1 Undervoltage protection
6508	>BLOCK 27-2	SP	>BLOCK 27-2 Undervoltage protection
6513	>BLOCK 59	SP	>BLOCK 59 overvoltage protection
6530	27 OFF	OUT	27 Undervoltage protection switched OFF
6531	27 BLOCKED	OUT	27 Undervoltage protection is BLOCKED
6532	27 ACTIVE	OUT	27 Undervoltage protection is ACTIVE
6533	27-1 picked up	OUT	27-1 Undervoltage picked up
6534	27-1 PU CS	OUT	27-1 Undervoltage PICKUP w/curr. superv
6537	27-2 picked up	OUT	27-2 Undervoltage picked up
6538	27-2 PU CS	OUT	27-2 Undervoltage PICKUP w/curr. superv
6539	27-1 TRIP	OUT	27-1 Undervoltage TRIP
6540	27-2 TRIP	OUT	27-2 Undervoltage TRIP
6565	59 OFF	OUT	59 Overvoltage protection switched OFF
6566	59 BLOCKED	OUT	59 Overvoltage protection is BLOCKED
6567	59 ACTIVE	OUT	59 Overvoltage protection is ACTIVE
6568	59-1 picked up	OUT	59-1 Overvoltage V> picked up
6570	59-1 TRIP	OUT	59-1 Overvoltage V> TRIP
6571	59-2 picked up	OUT	59-2 Overvoltage V>> picked up
6573	59-2 TRIP	OUT	59-2 Overvoltage V>> TRIP
17370	>BLOCK Vp<	SP	>Block Undervoltage protection Vp<
17371	>BLOCK Vp>	SP	>Block Overvoltage protection Vp>
17372	Vp< picked up	OUT	Vp< Undervoltage picked up
17373	Vp> picked up	OUT	Vp> Overvoltage picked up
17374	Vp< TRIP	OUT	Vp< Undervoltage TRIP
17375	Vp> TRIP	OUT	Vp> Overvoltage TRIP

2.3 Frequency Protection 81 O/U

The frequency protection function detects abnormally high and low frequencies in the system or in electrical machines. If the frequency lies outside the allowable range, appropriate actions are initiated, such as load shedding or separating a generator from the system.

Applications

- Decrease in system frequency occurs when the system experiences an increase in the real power demand, or when a malfunction occurs with a generator governor or automatic generation control (AGC) system. The frequency protection function is also used for generators which (for a certain time) operate to an island network. This is due to the fact that the reverse power protection cannot operate in case of a drive power failure. The generator can be disconnected from the power system by means of the frequency decrease protection.
- Increase in system frequency occurs e.g. when large blocks of load (island network) are removed from the system, or again when a malfunction occurs with a generator governor. This entails risk of self-excitation for generators feeding long lines under no-load conditions.

2.3.1 Functional Description

Detection of Frequency

The frequency is detected preferably from the positive sequence voltage. If this voltage is too low, the phase-to-phase voltage V_{A-B} at the device is used. If the amplitude of this voltage is too small, one of the other phase-to-phase voltages is used instead.

Through the use of filters and repeated measurements, the frequency evaluation is free from harmonic influences and very accurate.

Overfrequency/Underfrequency

Frequency protection consists of four frequency elements. To make protection flexible for different power system conditions, theses elements can be used alternatively for frequency decrease or increase separately, and can be independently set to perform different control functions.

Operating Range

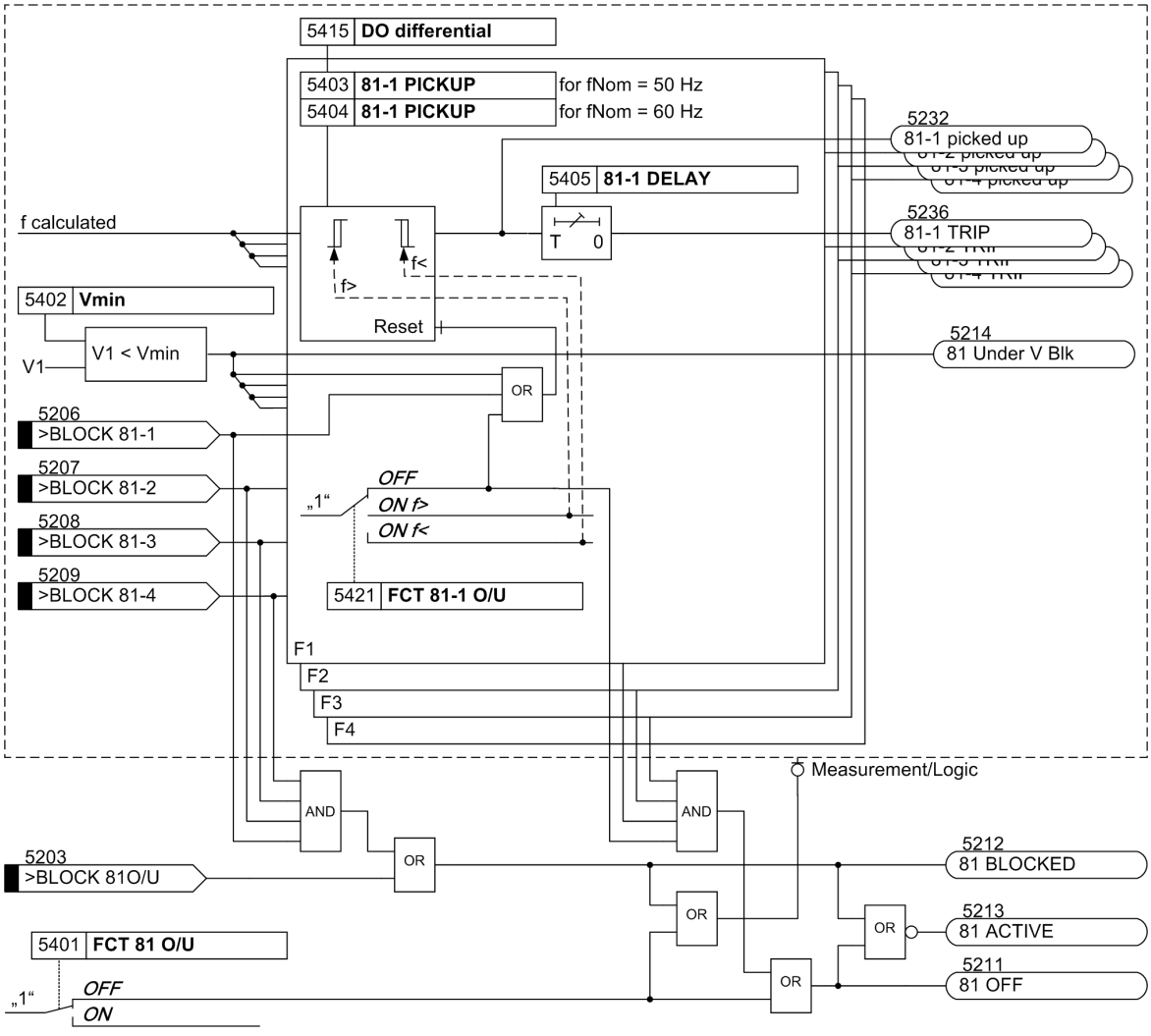
The frequency can be determined as long as in a three-phase voltage transformer connection the positive-sequence system of the voltages, or alternatively, in a single-phase voltage transformer connection, the respective voltage is present and of sufficient magnitude. If the measured voltage drops below a settable value **`Vmin`**, the frequency protection is blocked because no precise frequency values can be calculated from the signal.

Time Delays / Logic

Each frequency element has an associated settable time delay. When the time delay elapses, a trip signal is generated. When a frequency element drops out, the tripping command is immediately terminated, but not before the minimum command duration has elapsed.

Each of the four frequency elements can be blocked individually via binary inputs.

The following figure shows the logic diagram for the frequency protection function.



[dw_7sj6x_frequenzschutz, 1, en_US]

Figure 2-5 Logic diagram of the frequency protection

2.3.2 Setting Notes

General

Frequency protection is only in effect and accessible if address 154 **81 O/U** is set to ***Enabled*** during configuration of protective functions. If the function is not required ***Disabled*** is set. The function can be turned ***ON*** or ***OFF*** under address 5401 **FCT 81 O/U**.

By setting the parameters 5421 to 5424, the function of each of the elements **81-1 PICKUP** to **81-4 PICKUP** is set individually as overfrequency or underfrequency protection or set to ***OFF***, if the element is not required.

Minimum Voltage

Address 5402 **Vmin** is used to set the minimum voltage. Frequency protection is blocked as soon as the minimum voltage is undershot.

The threshold value has to be set as phase-to-phase quantity if the connection is three-phase. With a single-phase phase-to-ground connection the threshold is set as phase voltage.

Pickup Values

The setting as overfrequency or underfrequency element does not depend on the parameter threshold values of the respective element. An element can also function, for example, as an overfrequency element if its threshold value is set below the nominal frequency and vice versa.

If frequency protection is used for load shedding purposes, the setting values depend on the actual power system conditions. Normally, a time coordinated load shedding is required that takes into account the importance of the consumers or consumer groups.

Further application examples exist in the field of power stations. Here too, the frequency values to be set mainly depend on the specifications of the power system / power station operator. The underfrequency protection safeguards the power station's own demand by disconnecting it from the power system on time. The turbo governor regulates the machine set to the nominal speed. Consequently, the station's own demands can be continuously supplied at nominal frequency.

Under the assumption that the apparent power is reduced by the same degree, turbine-driven generators can, as a rule, be continuously operated down to 95% of the nominal frequency. However, for inductive consumers, the frequency reduction not only means an increased current input, but also endangers stable operation. For this reason, only a short-term frequency reduction down to about 48 Hz (for fN = 50 Hz) or 58 Hz (for fN = 60 Hz) is permissible.

A frequency increase can, for example, occur due to a load shedding or malfunction of the speed regulation (e.g. in an island network). In this way, the frequency increase protection can, for example, be used as overspeed protection.

Dropout Thresholds

The dropout threshold is defined via the adjustable dropout-difference address 5415 **DO differential**. It can thus be adjusted to the network conditions. The dropout difference is the absolute-value difference between pickup threshold and dropout threshold. The default value of 0.02 Hz can usually remain. Should, however, frequent minor frequency fluctuations be expected, this value should be increased.

Time Delays

The delay times **81-1 DELAY** to **81-4 DELAY** (addresses 5405, 5408, 5411 and 5414) allow the frequency elements to be time coordinated, e.g. for load shedding equipment. The set times are additional delay times not including the operating times (measuring time, dropout time) of the protection function.

2.3.3 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under "Additional Settings".

Addr.	Parameter	Setting Options	Default Setting	Comments
5401	FCT 81 O/U	OFF ON	OFF	81 Over/Under Frequency Protection
5402	Vmin	10 .. 150 V	65 V	Minimum required voltage for operation
5402	Vmin	20 .. 150 V	35 V	Minimum required voltage for operation
5403	81-1 PICKUP	40.00 .. 60.00 Hz	49.50 Hz	81-1 Pickup
5404	81-1 PICKUP	50.00 .. 70.00 Hz	59.50 Hz	81-1 Pickup
5405	81-1 DELAY	0.00 .. 100.00 sec	60.00 sec	81-1 Time Delay
5406	81-2 PICKUP	40.00 .. 60.00 Hz	49.00 Hz	81-2 Pickup
5407	81-2 PICKUP	50.00 .. 70.00 Hz	59.00 Hz	81-2 Pickup
5408	81-2 DELAY	0.00 .. 100.00 sec	30.00 sec	81-2 Time Delay
5409	81-3 PICKUP	40.00 .. 60.00 Hz	47.50 Hz	81-3 Pickup
5410	81-3 PICKUP	50.00 .. 70.00 Hz	57.50 Hz	81-3 Pickup
5411	81-3 DELAY	0.00 .. 100.00 sec	3.00 sec	81-3 Time delay

Addr.	Parameter	Setting Options	Default Setting	Comments
5412	81-4 PICKUP	40.00 .. 60.00 Hz	51.00 Hz	81-4 Pickup
5413	81-4 PICKUP	50.00 .. 70.00 Hz	61.00 Hz	81-4 Pickup
5414	81-4 DELAY	0.00 .. 100.00 sec	30.00 sec	81-4 Time delay
5415A	DO differential	0.02 .. 1.00 Hz	0.02 Hz	Dropout differential
5421	FCT 81-1 O/U	OFF ON f> ON f<	OFF	81-1 Over/Under Frequency Protection
5422	FCT 81-2 O/U	OFF ON f> ON f<	OFF	81-2 Over/Under Frequency Protection
5423	FCT 81-3 O/U	OFF ON f> ON f<	OFF	81-3 Over/Under Frequency Protection
5424	FCT 81-4 O/U	OFF ON f> ON f<	OFF	81-4 Over/Under Frequency Protection

2.3.4 Information List

No.	Information	Type of Information	Comments
5203	>BLOCK 81O/U	SP	>BLOCK 81O/U
5206	>BLOCK 81-1	SP	>BLOCK 81-1
5207	>BLOCK 81-2	SP	>BLOCK 81-2
5208	>BLOCK 81-3	SP	>BLOCK 81-3
5209	>BLOCK 81-4	SP	>BLOCK 81-4
5211	81 OFF	OUT	81 OFF
5212	81 BLOCKED	OUT	81 BLOCKED
5213	81 ACTIVE	OUT	81 ACTIVE
5214	81 Under V Blk	OUT	81 Under Voltage Block
5232	81-1 picked up	OUT	81-1 picked up
5233	81-2 picked up	OUT	81-2 picked up
5234	81-3 picked up	OUT	81-3 picked up
5235	81-4 picked up	OUT	81-4 picked up
5236	81-1 TRIP	OUT	81-1 TRIP
5237	81-2 TRIP	OUT	81-2 TRIP
5238	81-3 TRIP	OUT	81-3 TRIP
5239	81-4 TRIP	OUT	81-4 TRIP

2.4 Load Restoration

The Load Restoration has the task to reconnect elements of the system automatically, which have been disconnected due to overload. Overload causes the network frequency to drop, which is detected by the underfrequency protection and leads to separation of system components.

2.4.1 Functional Description

General

The load restoration function has 4 independently adjustable load restoration elements. Elements of the load restoration are switched on or off separately by parameters. Every element can be assigned up to 4 underfrequency elements, which start the load restoration when tripped.

The process can be canceled via the binary input *>LR Block*.

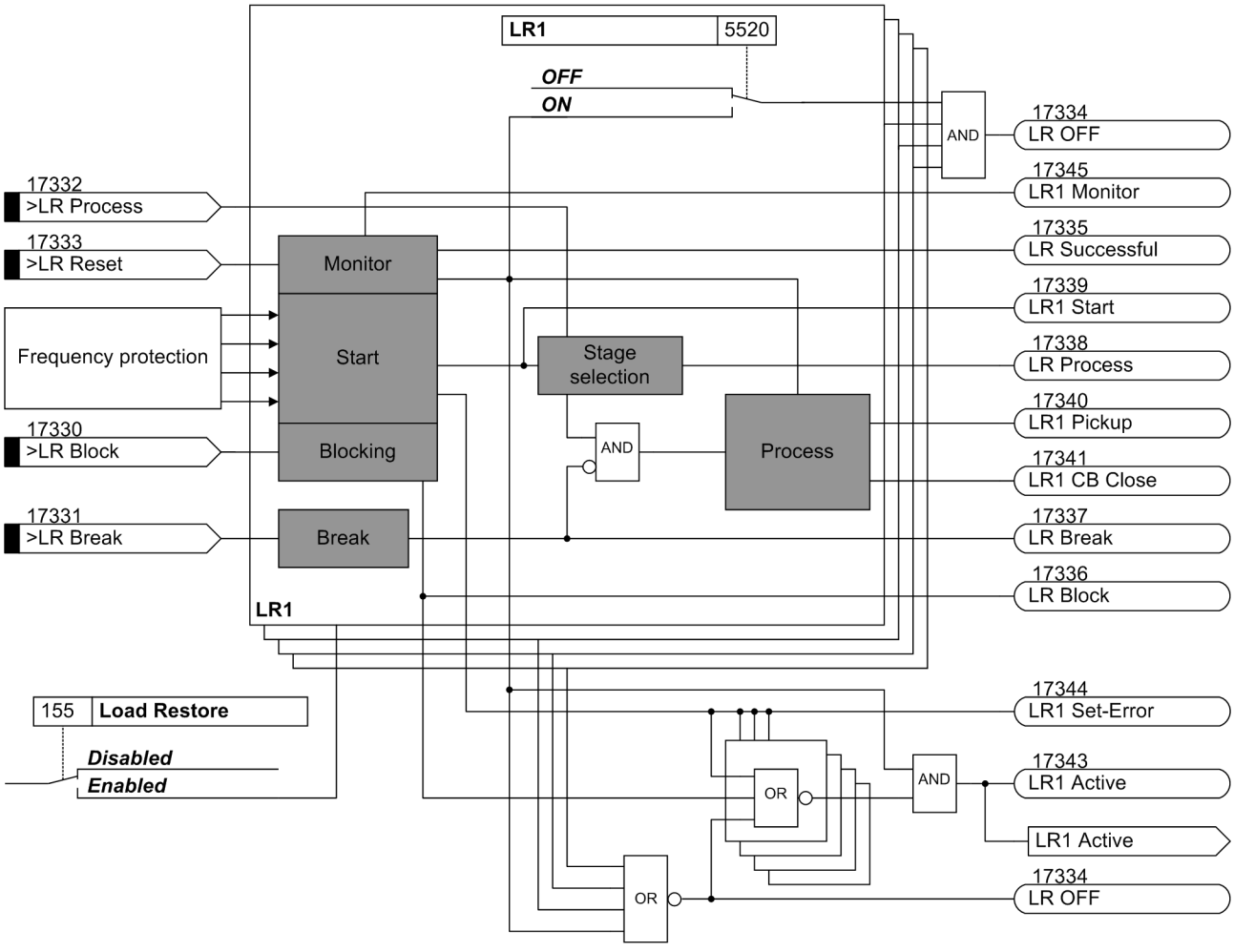
The binary input *>LR Break* breaks the load restoration process.

The binary input *>LR Reset* resets external blocking or a blocked monitoring.

Started elements are processed in descending order. The highest number element connects first. You may find an example in the instructions manual.

The Load Restoration can be applied across several 7RW80 devices. The Load Restoration across several devices can be coordinated using the CFC. The procedure is described in the instructions manual.

The following figure gives an overview of the load restoration's functionality.



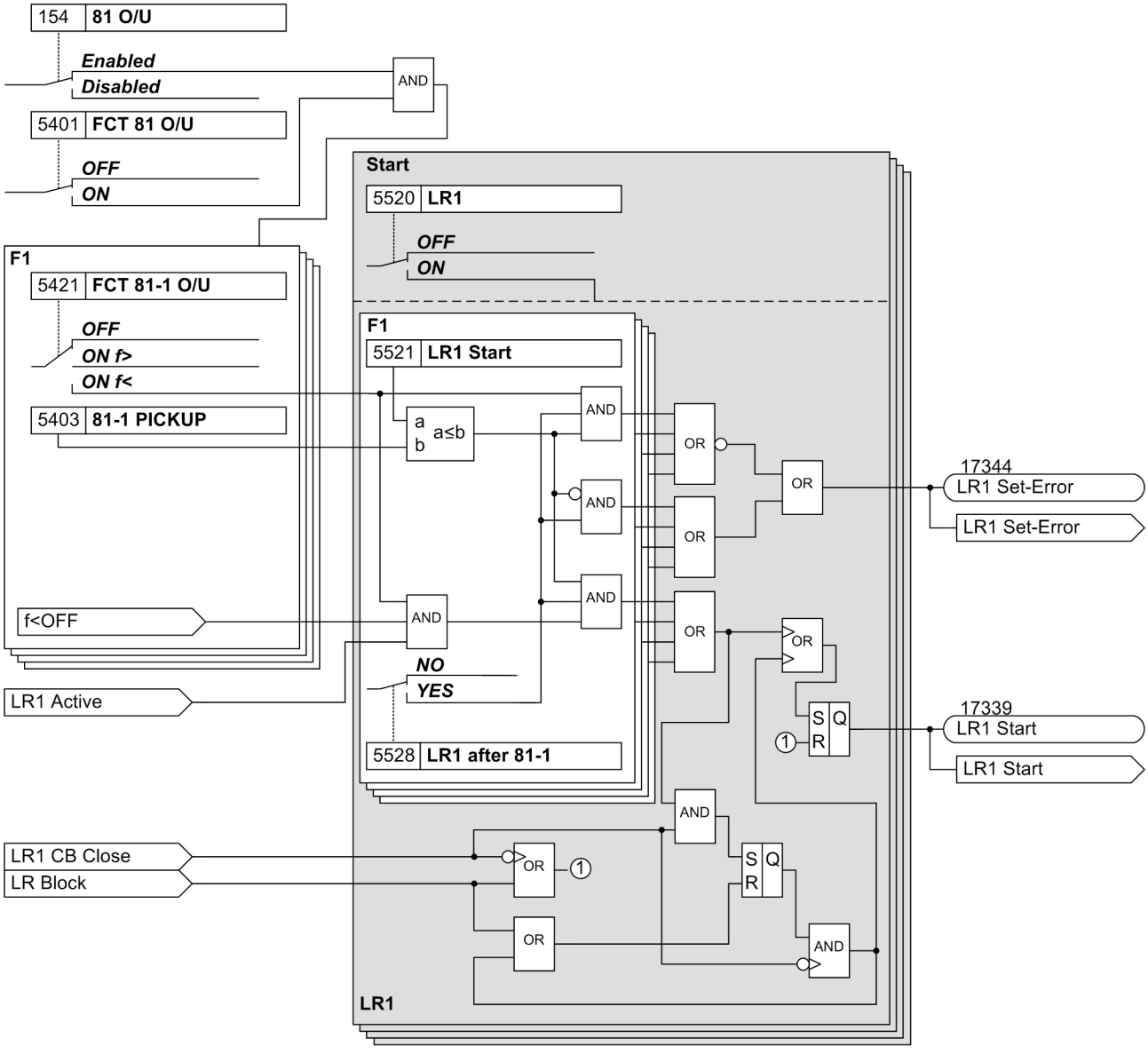
[7rw80-uebersicht-20100525, 1, en_US]

Figure 2-6 Load Restoration - Overview

Procedure

The start of a load restoration element is triggered by the tripping of the associated underfrequency element. Processing will terminate, if the restoration signal for the circuit breaker is issued or the function has been blocked. If the underfrequency trips again during the output of the restoration signal, the load restoration element will restart.

The following figure shows the interaction of underfrequency protection and load restoration.

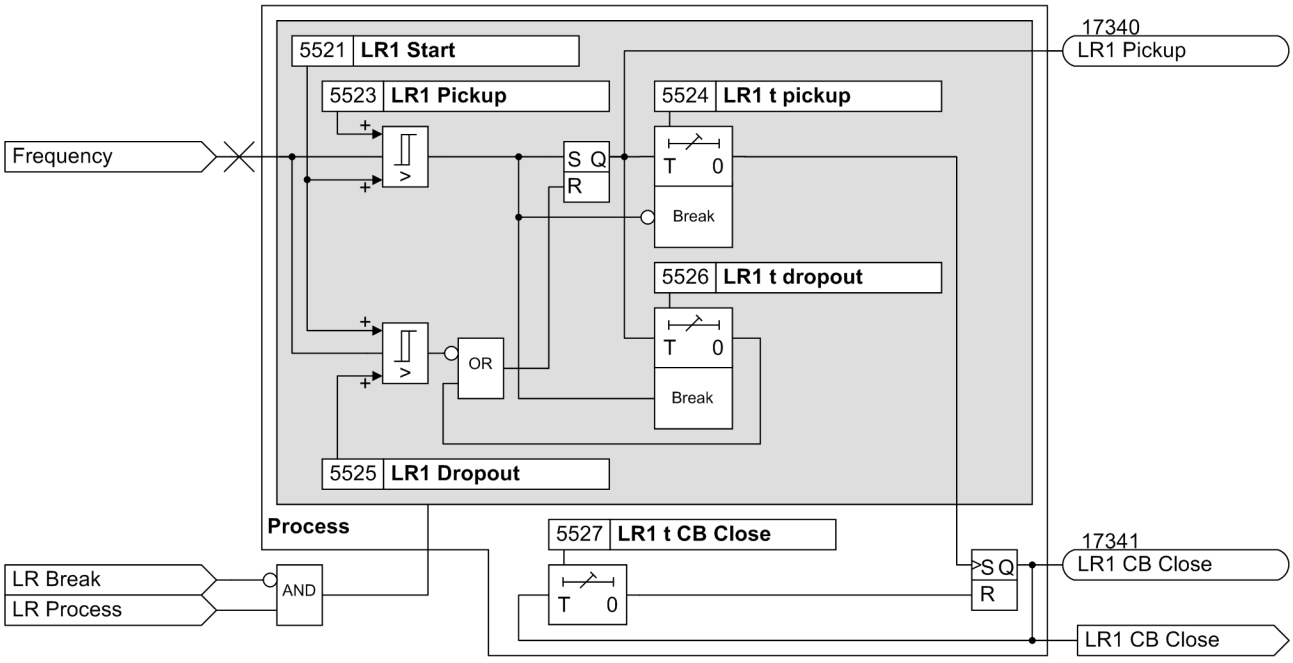


[7rw80-start-20100525, 1, en_US]

Figure 2-7 Load Restoration - Start

You can adjust the trip- and dropout time for every load restoration element. Furthermore, you can adjust the pickup- and dropout time as a difference to the starting frequency, which together form the threshold of the load restoration. The frequency must reach this threshold value of the set trip time, before the restoration signal for the circuit breaker is issued. If the frequency drops below the the set pickup threshold value during the set dropout time, the time for the pickup will be halted. If the frequency drops to a value below the dropout threshold value, pickup and dropout time will be reset. This takes into account that the frequency is not restored monotonously, but rather is subject to intermittent fluctuations.

The following figure shows the interaction of thresholds and timers.



[7rw80-prozess-20100525, 1, en_US]

Figure 2-8 Load Restoration - Sequence

Blocking and Monitoring

The load restoration can be blocked by:

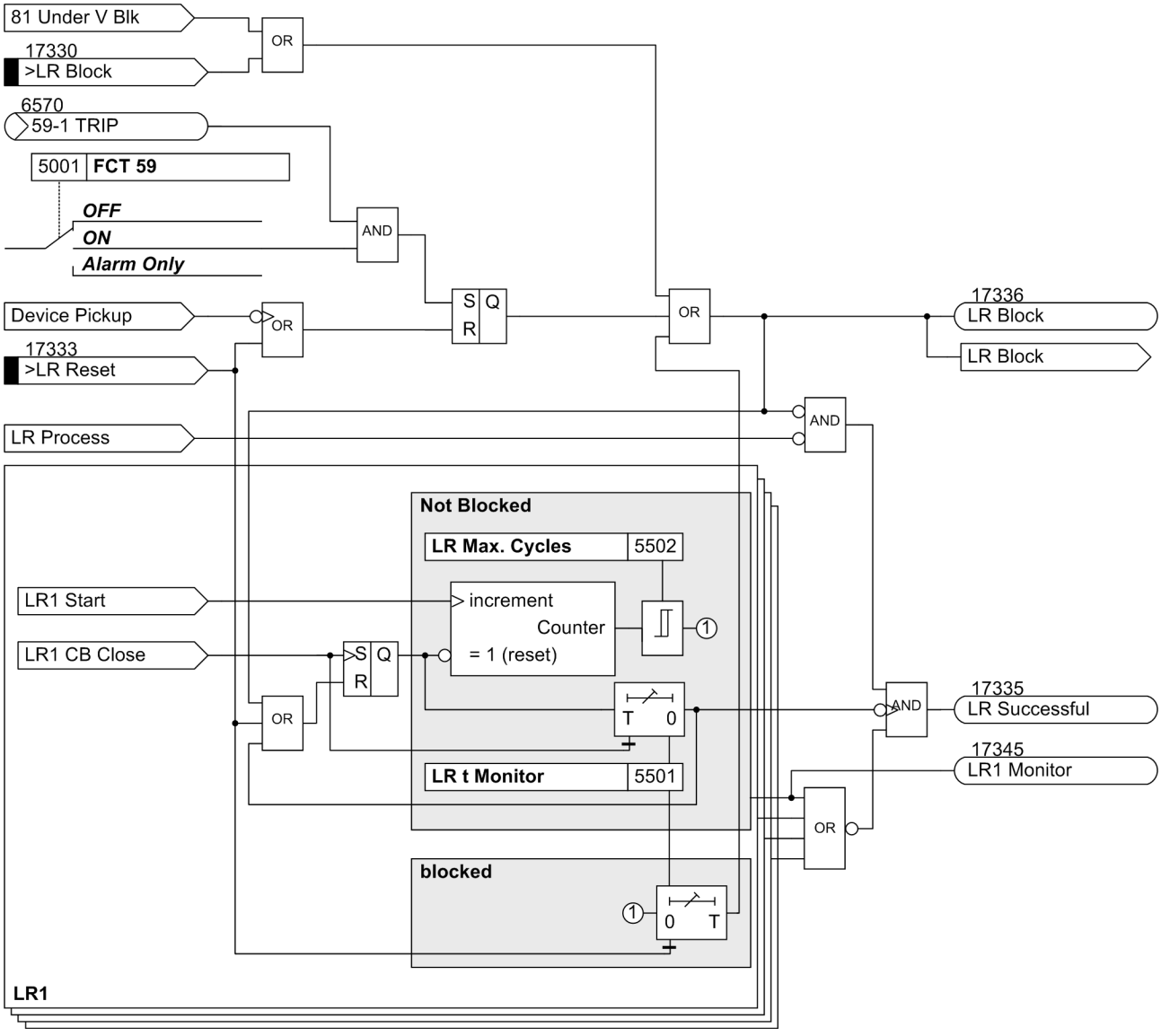
- Binary Input
- Tripping of another protective function of the device, which is not set to “Alarm Only”.
  An exception is the underfrequency protection. Tripping of a underfrequency element initiates the load restoration.
- Inaccurate or invalid frequency measurements at undervoltage

The blocking condition can be reset by a binary input or disappearing device pickup.

The number of restoration cycles is limited by a parameter. This prevents short-cyclical on- and off switching of the underfrequency protection and load restoration at major frequency fluctuations. If the number of restoration cycles exceeds the configured value, the load restoration will be blocked. The restoration cycle is time monitored. The monitoring time of load restoration cycles is configurable.

Pending power system/network faults are kept open during the restoration cycle.

The following figure shows the operation of the blocking and the monitoring parameters. The overvoltage function is an example, the same applies to other protection functions except for underfrequency.



[7rw80-block-monitor-20100508, 1, en_US]

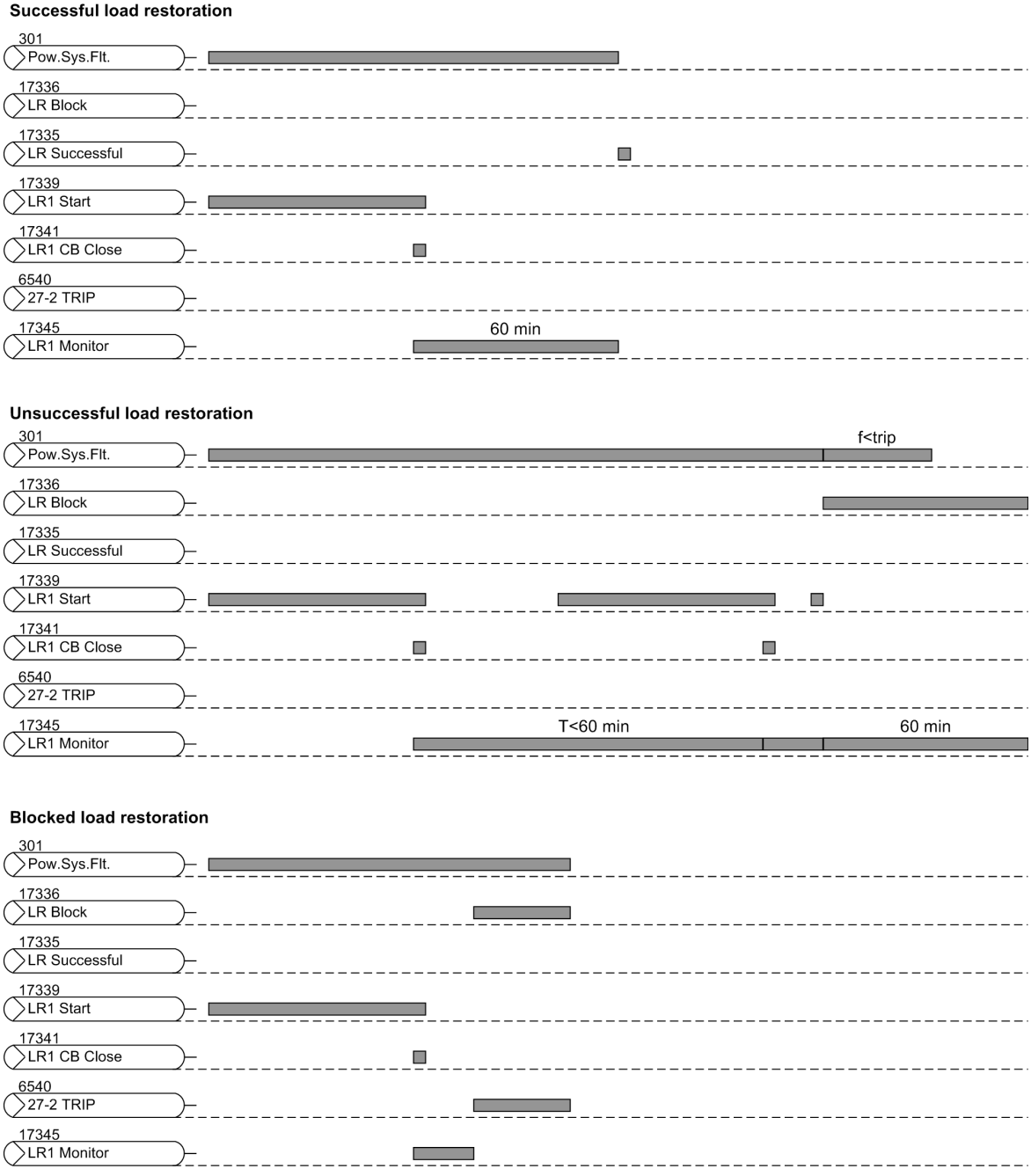
Figure 2-9 Load Restoration - Blocking and Monitoring

After the monitoring time of the restoration cycle has elapsed, the success of the load restoration will be evaluated.

Success basically depends on the following criteria:

- The load restoration is not blocked, e.g. by another protective function, binary input, undervoltage, monitoring
- The monitoring time of restoration cycles of every started load restoration elements has elapsed
- The maximum number of configured cycles was not exceeded
- All started load restoration elements are connected

To better illustrate the mode of operation, the following examples demonstrate different scenarios of the load restoration procedure.



[7rw80-monitor-log-bsp-20100525, 1, en_US]

Figure 2-10 Load Restoration – Blocking and Monitoring, Example

2.4.2 Setting Notes

General

The load restoration is active, if **`Load Restore`** = ***`Enabled`*** has been set at address 155 during configuration. If the function is not required ***`Disabled`*** is set.

The various elements of the load restoration are configured ***`ON`*** or ***`OFF`*** at addresses 5520, 5540, 5560 and 5580.

Pickup- and Dropout Values

At addresses 5521, 5541, 5561 and 5581 you configure the start frequency **LZx Start** for the elements. The start frequency must be adjusted to a value equal or higher than the tripping frequency of the underfrequency element.

At addresses 5523, 5543, 5563 and 5583 configure the pickup frequency **LRx Pickup** for the elements. The pickup frequency and the start frequency add up to the pickup threshold of the load restoration element.

At addresses 5524, 5544, 5564 and 5584 you configure the delay time **LRx t pickup** for the pickup of elements.

At addresses 5525, 5545, 5565 and 5585 you configure the dropout frequency **LRx Dropout** the elements. The dropout frequency and the start frequency add up to the dropout threshold of the load restoration element.

At addresses 5526, 5546, 5566 and 5586 you may configure the dropout time **LRx t dropout** for the elements.

At addresses 5527, 5547, 5567 and 5587 you may configure the close command duration of the circuit breaker **LRx t CB Close**.

The following example illustrates the interaction of the pickup- and dropout values of the load restoration elements and underfrequency elements.

The pickup threshold of the underfrequency elements 81-1, 81-2 and 81-3 are set to the following frequencies:

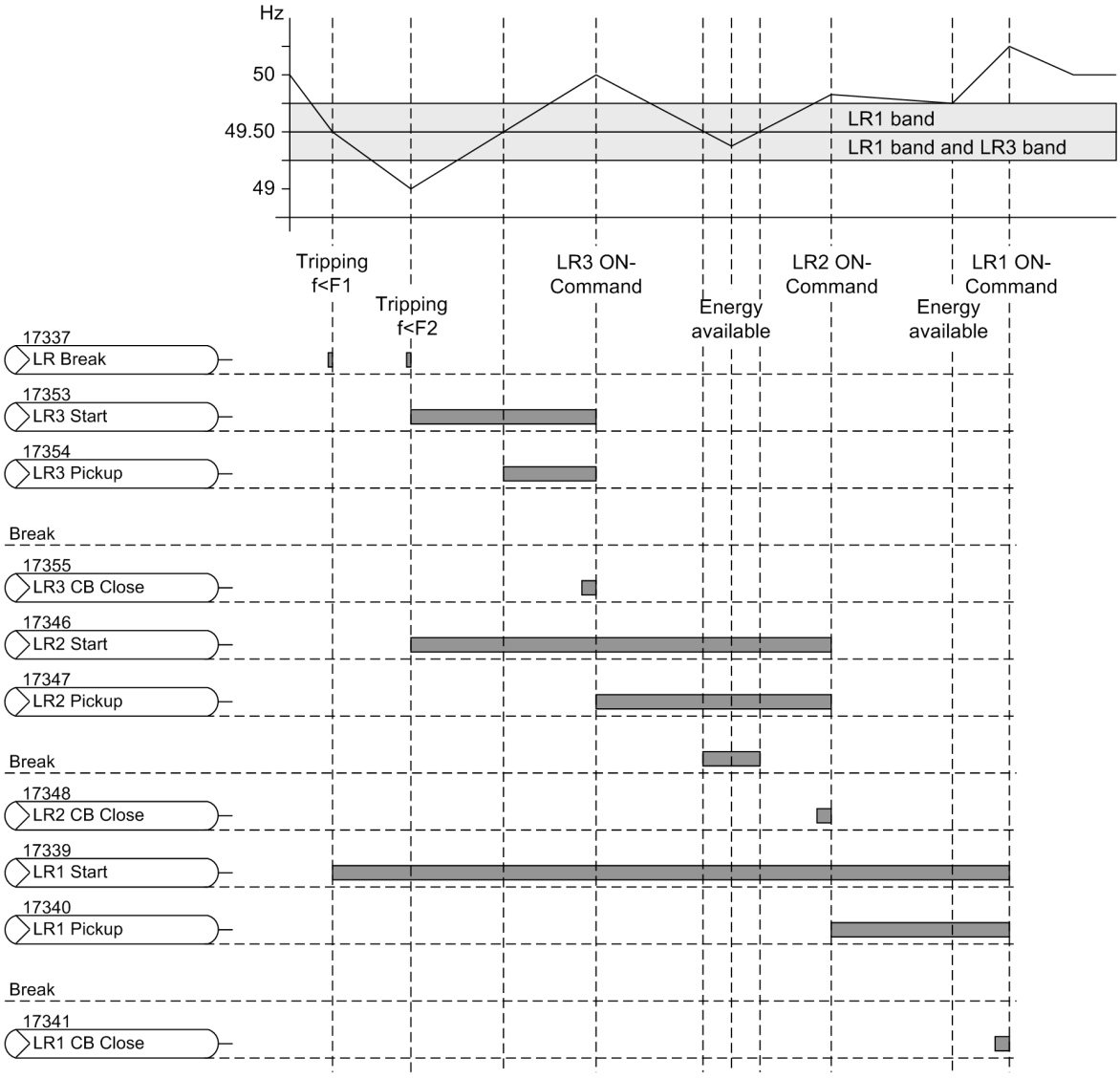
81-1 PICKUP 5403 = 49,5 Hz

81-2 PICKUP 5406 = 49 Hz

81-3 PICKUP 5409 = 47,5 Hz

Table 2-3 Settings Example

Parameter	LZ1	LZ2	LZ3
Start	**LR1 Start** 5521 = 49,5 Hz	**LR2 Start** 5541 = 49 Hz	**LR3 Start** 5561 = 49 Hz
Pickup	**LR1 Pickup** 5523 = 0,25 Hz	**LR2 Pickup** 5543 = 0,50 Hz	**LR3 Pickup** 5563 = 0,50 Hz
Dropout	**LR1 Dropout** 5525 = 0 Hz	**LR2 Dropout** 5545 = 0,25 Hz	**LR3 Dropout** 5565 = 0,25 Hz
Pickup Time	**LR1 t pickup** 5524 = 14 s	**LR2 t pickup** 5544 = 13 s	**LR3 t pickup** 5564 = 7 s
Dropout Time	**LR1 t dropout** 5526 = 10 s	**LR2 t dropout** 5546 = 10 s	**LR3 t dropout** 5566 = 10 s
CB Close time	**LR1 t CB Close** 5527 = 1 s	**LR2 t CB Close** 5547 = 1 s	**LR3 t CB Close** 5567 = 1s
Underfrequency elements	**LR1 after 81-1** 5528 = ***YES*** **LR1 after 81-2** 5529 = ***YES*** **LR1 after 81-3** 5530 = ***YES*** **LR1 after 81-4** 5531 = ***YES***	**LR2 after 81-1** 5548 = ***NO*** **LR2 after 81-2** 5549 = ***YES*** **LR2 after 81-3** 5550 = ***YES*** **LR2 after 81-4** 5551 = ***YES***	**LR3 after 81-1** 5568 = ***NO*** **LR3 after 81-2** 5569 = ***YES*** **LR3 after 81-3** 5570 = ***YES*** **LR3 after 81-4** 5571 = ***YES***



[7rw80-beispiel-20100525, 1, en_US]

Figure 2-11 Example for Load Restoration with 3 elements

In the above example the frequency initially drops below the pickup threshold of the underfrequency element 81-1. The element 81-1 trips.

Because of the configured settings (see *Table 2-3*) load restoration element LR1 is started with the tripping of 81-1. LR1 is at this point the only running/started element and is therefore processed immediately.

Afterwards the network frequency drops below the pickup threshold of the underfrequency element 81-2. Element 81-2 trips as well and initiates load restoration elements LR2 and LR3.

LR3 has at that point the highest number of all load restoration elements and is processed immediately. The processing of element LR1 is interrupted.

When the pickup frequency of 49.5 Hz is reached, load restoration element LR3 picks up. Once the frequency remains above the threshold during the pickup time of LR3, LR3 issues the CB Close command.

The pickup of the next restoration element LR2 will be processed immediately after the LR3 restoration CB Close signal.

During the pickup time of LR2 the network frequency drops briefly below the pickup threshold, but not below the dropout threshold of LR2. This stops the pickup of load restoration element LR2, but does not reset this procedure in the dropout delay time. When the frequency reaches the pickup threshold of LR2 (49.5 Hz) again, the pickup time of LR2 will be continued.

When pickup time has expired, the element LR2 initiates the load restoration.

Subsequently the pickup of load restoration LR1 is processed. When the pickup frequency of LR1 (49.75 Hz) is reached, LR1 picks up. LR1 initiates the restoration when pickup time has expired.

When the monitoring time has expired (address 5501 **LR t Monitor**), the message 17335 *LR Successful* is displayed (not shown in the figure).

Assignments to Frequency Elements

At addresses 5528 to 5531, 5548 to 5551, 5568 to 5571 and 5588 to 5591 you may assign the underfrequency elements, which trigger the load restoration element (when tripping).

Monitoring

At address 5501 **LR t Monitor** you may configure the monitoring time of the load restoration cycles.

At address 5502 **LR Max. Cycles** you may configure the maximum number of restoration cycles of the load restoration.

Load restoration across several devices

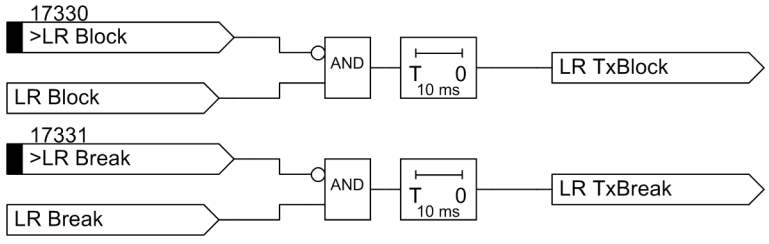
The Load Restoration can be applied across several 7RW80 devices. The Load Restoration across several devices can be coordinated using the CFC.

To ensure the correct restoration sequence between several v devices you must connect the output 17338 *LR Process* of the first restoring device with the input 17332 *>LR Process* of the other devices.

Furthermore you have to configure the user defined messages *LZ TxBlock* and *LZ TxPause* .

The output messages *LZ TxBlock* and *LZ TxPause* are connected to the according binary inputs of the opposite devices 17330 *>LR Block* and 17331 *>LR Break*.

In the CFC the following logic is applied:



[7rw80-lz-cfc-20100720, 1, en_US]

Figure 2-12 Load Restoration across several devices - CFC-Logic

NOTE

Use the fast CFC task level PLC1_BEARB.

2.4.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
5501	LR t Monitor	1 .. 3600 sec	3600 sec	Load restoration monitor time
5502	LR Max. Cycles	1 .. 10	2	Load restoration maximal no. of cycles
5520	LR1	ON OFF	OFF	Load restoration element 1
5520	LR1	ON OFF	OFF	Load restoration element 1
5521	LR1 Start	40.00 .. 60.00 Hz	49.50 Hz	Load restoration elem. 1 start frequency

Addr.	Parameter	Setting Options	Default Setting	Comments
5522	LR1 Start	50.00 .. 70.00 Hz	59.50 Hz	Load restoration elem. 1 start frequency
5523	LR1 Pickup	0.02 .. 2.00 Hz	0.04 Hz	Load restoration element 1 Pickup
5524	LR1 t pickup	0 .. 10800 sec	600 sec	Load restoration element 1 Pickup time
5525	LR1 Dropout	0.00 .. 2.00 Hz	0.02 Hz	Load restoration element 1 Dropout
5526	LR1 t dropout	0 .. 10800 sec	60 sec	Load restoration element 1 Dropout time
5527	LR1 t CB Close	0.01 .. 32.00 sec	1.00 sec	Load restoration element 1 CB Close time
5528	LR1 after 81-1	YES NO	NO	Load restoration element 1 after 81-1
5529	LR1 after 81-2	YES NO	NO	Load restoration element 1 after 81-2
5530	LR1 after 81-3	YES NO	NO	Load restoration element 1 after 81-3
5531	LR1 after 81-4	YES NO	NO	Load restoration element 1 after 81-4
5540	LR2	ON OFF	OFF	Load restoration element 2
5540	LR2	ON OFF	OFF	Load restoration element 2
5541	LR2 Start	40.00 .. 60.00 Hz	49.00 Hz	Load restoration elem. 2 start frequency
5542	LR2 Start	50.00 .. 70.00 Hz	59.00 Hz	Load restoration elem. 2 start frequency
5543	LR2 Pickup	0.02 .. 2.00 Hz	0.04 Hz	Load restoration element 2 Pickup
5544	LR2 t pickup	0 .. 10800 sec	600 sec	Load restoration element 2 Pickup time
5545	LR2 Dropout	0.00 .. 2.00 Hz	0.02 Hz	Load restoration element 2 Dropout
5546	LR2 t dropout	0 .. 10800 sec	60 sec	Load restoration element 2 Dropout time
5547	LR2 t CB Close	0.01 .. 32.00 sec	1.00 sec	Load restoration element 2 CB Close time
5548	LR2 after 81-1	YES NO	NO	Load restoration element 2 after 81-1
5549	LR2 after 81-2	YES NO	NO	Load restoration element 2 after 81-2
5550	LR2 after 81-3	YES NO	NO	Load restoration element 2 after 81-3
5551	LR2 after 81-4	YES NO	NO	Load restoration element 2 after 81-4
5560	LR3	ON OFF	OFF	Load restoration element 3
5560	LR3	ON OFF	OFF	Load restoration element 3

Addr.	Parameter	Setting Options	Default Setting	Comments
5561	LR3 Start	40.00 .. 60.00 Hz	47.50 Hz	Load restoration elem. 3 start frequency
5562	LR3 Start	50.00 .. 70.00 Hz	57.50 Hz	Load restoration elem. 3 start frequency
5563	LR3 Pickup	0.02 .. 2.00 Hz	0.04 Hz	Load restoration element 3 Pickup
5564	LR3 t pickup	0 .. 10800 sec	600 sec	Load restoration element 3 Pickup time
5565	LR3 Dropout	0.00 .. 2.00 Hz	0.02 Hz	Load restoration element 3 Dropout
5566	LR3 t dropout	0 .. 10800 sec	60 sec	Load restoration element 3 Dropout time
5567	LR3 t CB Close	0.01 .. 32.00 sec	1.00 sec	Load restoration element 3 CB Close time
5568	LR3 after 81-1	YES NO	NO	Load restoration element 3 after 81-1
5569	LR3 after 81-2	YES NO	NO	Load restoration element 3 after 81-2
5570	LR3 after 81-3	YES NO	NO	Load restoration element 3 after 81-3
5571	LR3 after 81-4	YES NO	NO	Load restoration element 3 after 81-4
5580	LR4	ON OFF	OFF	Load restoration element 4
5580	LR4	ON OFF	OFF	Load restoration element 4
5581	LR4 Start	40.00 .. 60.00 Hz	47.50 Hz	Load restoration elem. 4 start frequency
5582	LR4 Start	50.00 .. 70.00 Hz	57.50 Hz	Load restoration elem. 4 start frequency
5583	LR4 Pickup	0.02 .. 2.00 Hz	0.04 Hz	Load restoration element 4 Pickup
5584	LR4 t pickup	0 .. 10800 sec	600 sec	Load restoration element 4 Pickup time
5585	LR4 Dropout	0.00 .. 2.00 Hz	0.02 Hz	Load restoration element 4 Dropout
5586	LR4 t dropout	0 .. 10800 sec	60 sec	Load restoration element 4 Dropout time
5587	LR4 t CB Close	0.01 .. 32.00 sec	1.00 sec	Load restoration element 4 CB Close time
5588	LR4 after 81-1	YES NO	NO	Load restoration element 4 after 81-1
5589	LR4 after 81-2	YES NO	NO	Load restoration element 4 after 81-2
5590	LR4 after 81-3	YES NO	NO	Load restoration element 4 after 81-3
5591	LR4 after 81-4	YES NO	NO	Load restoration element 4 after 81-4

2.4.4 Information List

No.	Information	Type of Information	Comments
17330	>LR Block	SP	>Load restoration Block
17331	>LR Break	SP	>Load restoration break
17332	>LR Process	SP	>Load restoration Process
17333	>LR Reset	SP	>Load restoration Reset
17334	LR OFF	OUT	Load restoration is OFF
17335	LR Successful	OUT	Load restoration successful
17336	LR Block	OUT	Load restoration Block
17337	LR Break	OUT	Load restoration break
17338	LR Process	OUT	Load restoration Process
17339	LR1 Start	OUT	Load restoration element 1 Start
17340	LR1 Pickup	OUT	Load restoration element 1 Pickup
17341	LR1 CB Close	OUT	Load restoration element 1 CB Close
17343	LR1 Active	OUT	Load restoration element 1 Active
17344	LR1 Set-Error	OUT	Load restoration element 1 Setting Error
17345	LR1 Monitor	OUT	Load restoration element 1 monitor mode
17346	LR2 Start	OUT	Load restoration element 2 Start
17347	LR2 Pickup	OUT	Load restoration element 2 Pickup
17348	LR2 CB Close	OUT	Load restoration element 2 CB Close
17350	LR2 Active	OUT	Load restoration element 2 Active
17351	LR2 Set-Error	OUT	Load restoration element 2 Setting Error
17352	LR2 Monitor	OUT	Load restoration element 2 monitor mode
17353	LR3 Start	OUT	Load restoration element 3 Start
17354	LR3 Pickup	OUT	Load restoration element 3 Pickup
17355	LR3 CB Close	OUT	Load restoration element 3 CB Close
17357	LR3 Active	OUT	Load restoration element 3 Active
17358	LR3 Set-Error	OUT	Load restoration element 3 Setting Error
17359	LR3 Monitor	OUT	Load restoration element 3 monitor mode
17360	LR4 Start	OUT	Load restoration element 4 Start
17361	LR4 Pickup	OUT	Load restoration element 4 Pickup
17362	LR4 CB Close	OUT	Load restoration element 4 CB Close
17364	LR4 Active	OUT	Load restoration element 4 Active
17365	LR4 Set-Error	OUT	Load restoration element 4 Setting Error
17366	LR4 Monitor	OUT	Load restoration element 4 monitor mode

2.5 Supervision Functions

The device is equipped with extensive monitoring capabilities - both for hardware and software. In addition, the measured values are also constantly monitored for plausibility, therefore, the voltage transformer circuits are largely integrated into the monitoring.

2.5.1 Measurement Supervision

2.5.1.1 General

The device monitoring extends from the measuring inputs to the binary outputs. Monitoring checks the hardware for malfunctions and abnormal conditions.

Hardware and software monitoring described in the following are enabled continuously. Settings (including the possibility to activate and deactivate the monitoring function) refer to the monitoring of external transformer circuits.

2.5.1.2 Hardware Monitoring

Auxiliary and Reference Voltages

Failure of or switching off the supply voltage removes the device from operation and a message is immediately generated by a normally closed contact. Brief auxiliary voltage interruptions of less than 50 ms do not disturb the readiness of the device (for nominal auxiliary voltage > 110 VDC).

Buffer Battery

The buffer battery, which ensures operation of the internal clock and storage of counters and messages if the auxiliary voltage fails, is periodically checked for charge status. If it is less than an allowed minimum voltage, then the *Fail Battery* message is issued.

Memory Components

All working memories (RAMs) are checked during startup. If a malfunction occurs then, the starting sequence is interrupted and an LED blinks. During operation the memories are checked with the help of their checksum. For the program memory, the cross sum is formed cyclically and compared to the stored program cross sum.

For the settings memory, the cross sum is formed cyclically and compared to the cross sum that is freshly generated each time a setting process takes place.

If a fault occurs the processor system is restarted.

Scanning

Scanning and the synchronization between the internal buffer components are constantly monitored. If any deviations cannot be removed by renewed synchronization, then the processor system is restarted.

AD Transformer Monitoring

The digitized sampled values are being monitored in respect of their plausibility. If the result is not plausible, message 181 *Error A/D-conv.* is issued. The protection is blocked, thus preventing unwanted operation. Furthermore, a fault record is generated for recording of the internal fault.

2.5.1.3 Software Monitoring

Watchdog

For continuous monitoring of the program sequences, a time monitor is provided in the hardware (hardware watchdog) that expires upon failure of the processor or an internal program, and causes a complete restart of the processor system.

An additional software watchdog ensures that malfunctions during the processing of programs are discovered. This also initiates a restart of the processor system.

If such a malfunction is not cleared by the restart, an additional restart attempt is begun. After three unsuccessful restarts within a 30 second window of time, the device automatically removes itself from service and the red "Error" LED lights up. The readiness relay drops out and indicates „device malfunction" with its normally closed contact.

Offset Monitoring

This monitoring function checks all ring buffer data channels for corrupt offset replication of the analog/digital transformers and the analog input paths using offset filters. Possible offset errors are detected using DC filters, and the associated sampled values are corrected up to a specific limit. If this limit is exceeded, an indication is generated (191 *Error Offset*) and integrated into the warning group indication (160). As increased offset values impair the measurements, we recommend sending the device to the OEM plant for corrective action should this indication persist.

The Offset monitoring can be blocked via the binary input signal *>Blk.offset s.* (No. 17565).

2.5.1.4 Monitoring of the Transformer Circuits

Open circuits or short circuits in the secondary circuits of the voltage transformers, as well as faults in the connections (important during commissioning!), are detected and reported by the device. The measured quantities are periodically checked in the background for this purpose, as long as no system fault is present.

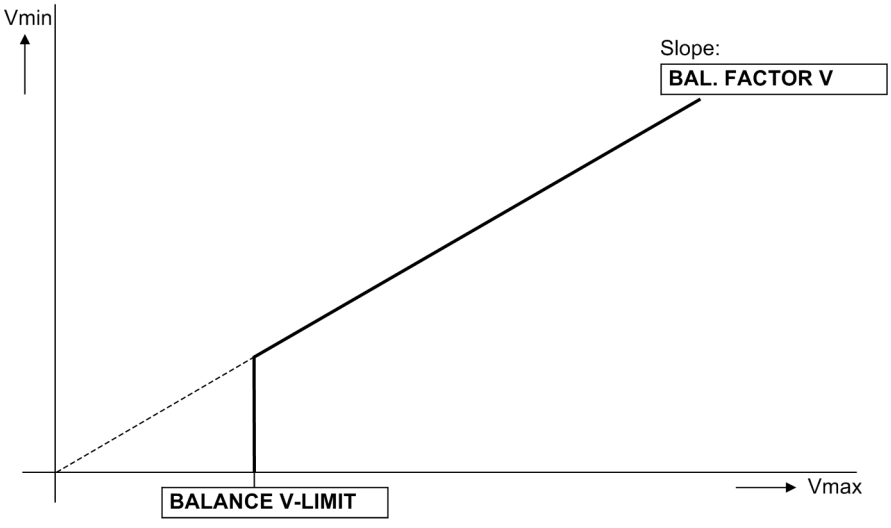
Voltage Symmetry

During normal system operation, balance among the voltages is expected. Since the phase-to-phase voltages are insensitive to ground faults, the phase-to-phase voltages are used for balance monitoring. If the device is connected to the phase-to-ground voltages, then the phase-to-phase voltages are calculated accordingly, whereas, if the device is connected to phase-to-phase voltages and the displacement voltage V_0, then the third phase-to-phase voltage is calculated accordingly. From the phase-to-phase voltages, the device generates the rectified average values and checks the balance of their absolute values. The smallest phase voltage is compared with the largest phase voltage.

Asymmetry is recognized if

$| V_{min} | / | V_{max} | <$ **BAL. FACTOR V** as long as $| V_{max} | >$ **BALANCE V-LIMIT**. Where V_{max} is the highest of the three voltages and V_{min} the smallest. The symmetry factor **BAL. FACTOR V** (address 8103) represents the allowable asymmetry of the conductor voltages while the limit value **BALANCE V-LIMIT** (address 8102) is the lower limit of the operating range of this monitoring (see Figure 2-70). Both parameters can be set. The dropout ratio is about 97%.

This fault is signalled after settable delay time with *Fail V balance*.



[dw_spannungssymmetrieueberwachung, 1, en_US]

Figure 2-13 Voltage symmetry monitoring

Phase sequence of the voltages

To detect swapped phase connections in the voltage input circuits, the direction of rotation of the phase-tophase voltages is checked. Therefore the sequence of the zero crossings of the currents (having the same sign) is checked.

Phase rotation of measurement quantities is checked by verifying the phase sequences. Here, the phase sequence supervision requires the phase-phase voltages V_{A2}, V_{B3}, V_{C1}.

Voltages: $\underline{V}_{A2}$ before $\underline{V}_{B3}$ before $\underline{V}_{C1}$

Verification of the voltage phase rotation is done when each measured voltage is at least

$|\underline{V}_{A2}|$, $|\underline{V}_{B3}|$, $|\underline{V}_{C1}| > 40$ V.

For abnormal phase sequences, the messages *Fail Ph. Seq. V* or are issued, along with the switching of this message *Fail Ph. Seq.*.

For applications in which an opposite phase sequence is expected, the protective relay should be adjusted via a binary input or a programmable setting **PHASE SEQ.** (Addresse 209). If the phase sequence is changed in the device, phases B and C internal to the relay are reversed, and the positive and negative sequence currents are thereby exchanged (see also Section *2.10.2 Setting Notes*). The phase-related messages, malfunction values, and measured values are not affected by this.

2.5.1.5 Broken Wire Monitoring of Voltage Transformer Circuits

Requirements

The measurement of all three phase-to-ground voltages is a requirement for the functionality. If only two phaseto- phase voltages were measured, it would not be possible to evaluate two of the required criteria.

Task

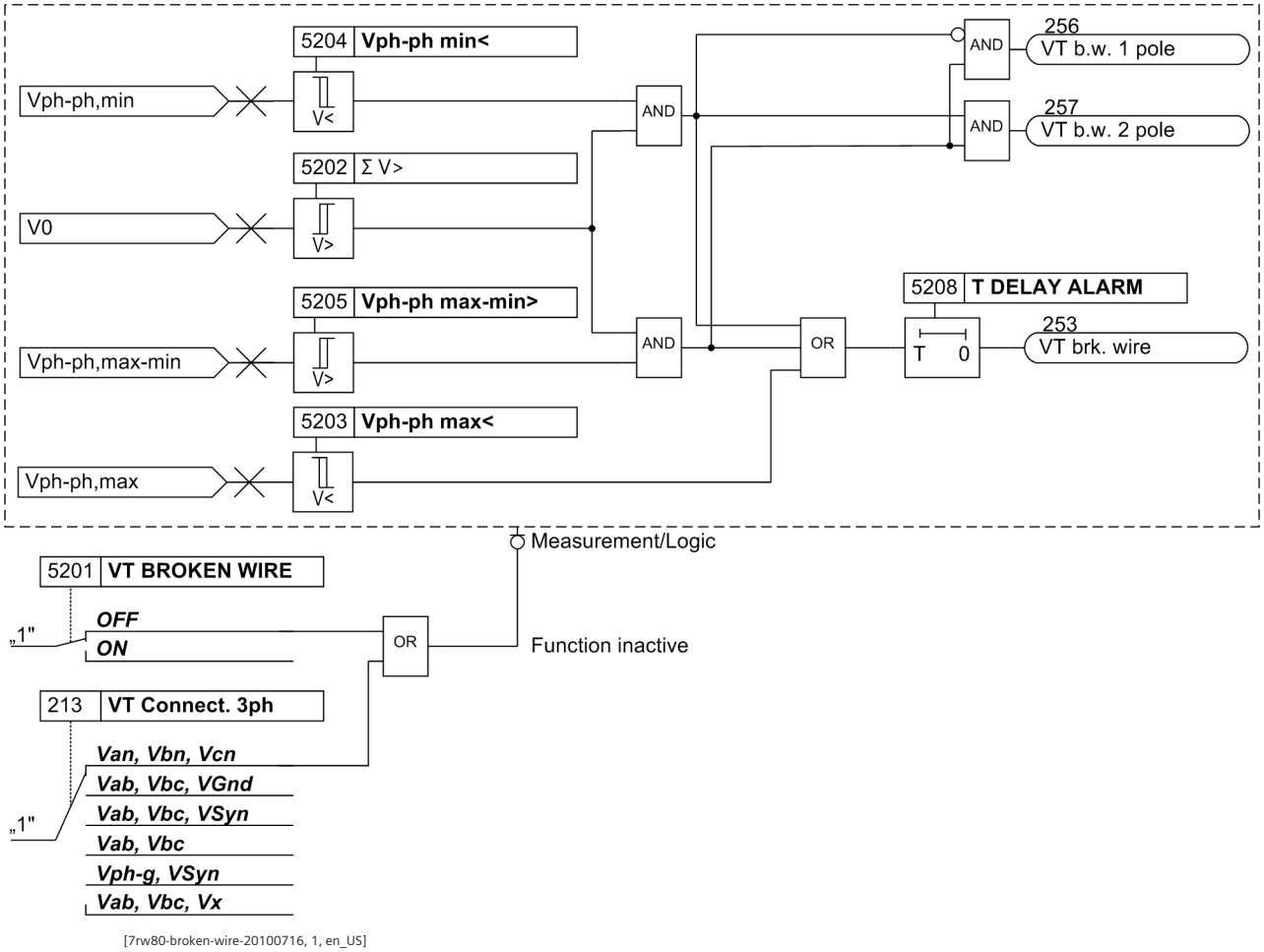
The “Broken Wire” monitoring function monitors the voltage transformer circuits of the secondary system with regard to failure. One distinguishes between single-phase and two-phase failures.

Mode of Operation / Logic

All three phase-to-ground voltages, the displacement voltage and the displacement voltage are measured. The required values are calculated for the respective criteria and eventually a decision is made. The resulting alarm message may be delayed. A blocking of the protection functions is however not effected.

The broken wire monitoring is also active during a fault. The function may be enabled or disabled.

The following logic diagram shows how the broken wire monitoring functions.



[7rw80-broken-wire-20100716, 1, en_US]

Figure 2-14 Logic diagram of the "Broken-wire" Monitoring

2.5.1.6 Setting Notes

Measured Value Monitoring

The sensitivity of the measured value monitor can be modified. Default values are set at the factory, which are sufficient in most cases. If especially high operating asymmetry in the voltages is to be expected for the application, or if it becomes apparent during operation that certain monitoring functions activate sporadically, then the setting should be less sensitive.

Address 8102 **BALANCE V-LIMIT** determines the limit voltage (phase-to-phase) above which the voltage symmetry monitor is effective. Address 8103 **BAL. FACTOR V** is the associated symmetry factor; that is, the slope of the symmetry characteristic curve. In address 5208 **T DELAY ALARM** you set the delay time of fault message no. 167 *Fail V balance*.

Measured value monitoring can be set to ***ON*** or ***OFF*** at address 8101 **MEASURE. SUPERV**.

2.5.1.7 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
5201	VT BROKEN WIRE	ON OFF	OFF	VT broken wire supervision
5202	Σ V>	1.0 .. 100.0 V	8.0 V	Threshold voltage sum
5203	Vph-ph max<	1.0 .. 100.0 V	16.0 V	Maximum phase to phase voltage
5204	Vph-ph min<	1.0 .. 100.0 V	16.0 V	Minimum phase to phase voltage
5205	Vph-ph max-min>	10.0 .. 200.0 V	16.0 V	Symmetry phase to phase voltages

Addr.	Parameter	Setting Options	Default Setting	Comments
5208	T DELAY ALARM	0.00 .. 32.00 sec	1.25 sec	Alarm delay time
8101	MEASURE. SUPERV	OFF ON	ON	Measurement Supervision
8102	BALANCE V-LIMIT	10 .. 100 V	50 V	Voltage Threshold for Balance Monitoring
8103	BAL. FACTOR V	0.58 .. 0.90	0.75	Balance Factor for Voltage Monitor

2.5.1.8 Information List

No.	Information	Type of Information	Comments
167	Fail V balance	OUT	Failure: Voltage Balance
171	Fail Ph. Seq.	OUT	Failure: Phase Sequence
176	Fail Ph. Seq. V	OUT	Failure: Phase Sequence Voltage
197	MeasSup OFF	OUT	Measurement Supervision is switched OFF
253	VT brk. wire	OUT	Failure VT circuit: broken wire
255	Fail VT circuit	OUT	Failure VT circuit
256	VT b.w. 1 pole	OUT	Failure VT circuit: 1 pole broken wire
257	VT b.w. 2 pole	OUT	Failure VT circuit: 2 pole broken wire
6509	>FAIL:FEEDER VT	SP	>Failure: Feeder VT
6510	>FAIL: BUS VT	SP	>Failure: Busbar VT

2.5.2 Trip Circuit Supervision 74TC

Devices 7RW80 are equipped with an integrated trip circuit supervision. Depending on the number of available binary inputs (not connected to a common potential), supervision with one or two binary inputs can be selected. If the allocation of the required binary inputs does not match the selected supervision type, then a message to this effect is generated (*74TC ProgFail*).

Applications

- When using two binary inputs, malfunctions in the trip circuit can be detected under all circuit breaker conditions.
- When only one binary input is used, malfunctions in the circuit breaker itself cannot be detected.

Prerequisites

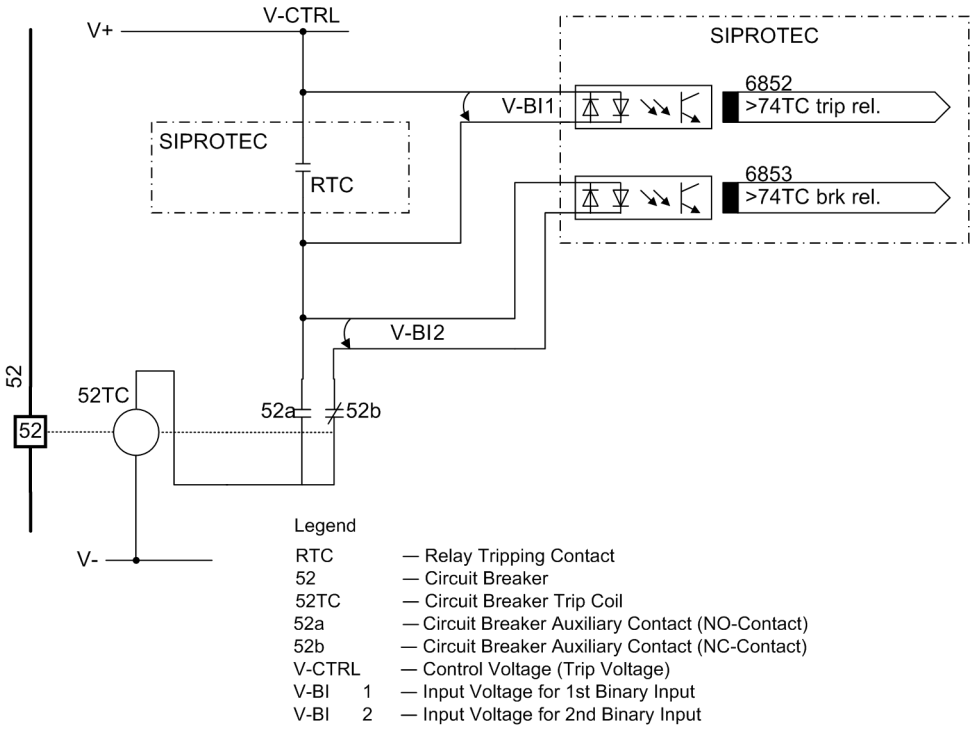
A requirement for the use of trip circuit supervision is that the control voltage for the circuit breaker is at least twice the voltage drop across the binary input ($V_{ct} > 2 \cdot V_{BImin}$).

Since at least 19 V are needed for the binary input, the supervision can only be used with a system control voltage of over 38 V.

2.5.2.1 Functional Description

Supervision with Two Binary Inputs

When using two binary inputs, these are connected according to *Figure 2-15*, parallel to the associated trip contact on one side, and parallel to the circuit breaker auxiliary contacts on the other.



[dw_prinzip-ausloesekreisueberwachung-2-binein, 1, en_US]

Figure 2-15 Principle of the trip circuit supervision with two binary inputs

Supervision with two binary inputs not only detects interruptions in the trip circuit and loss of control voltage, it also supervises the response of the circuit breaker using the position of the circuit breaker auxiliary contacts.

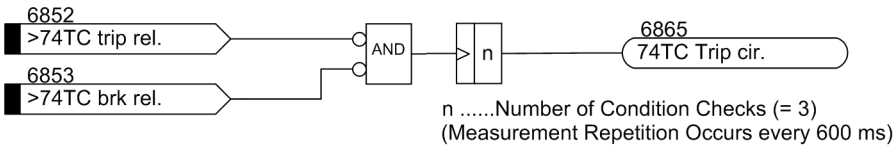
Depending on the conditions of the trip contact and the circuit breaker, the binary inputs are activated (logical condition "H" in *Table 2-4*), or not activated (logical condition "L").

In healthy trip circuits the condition that both binary inputs are not actuated (”L") is only possible during a short transition period (trip contact is closed but the circuit breaker has not yet opened). A continuous state of this condition is only possible when the trip circuit has been interrupted, a short-circuit exists in the trip circuit, a loss of battery voltage occurs, or malfunctions occur with the circuit breaker mechanism. Therefore, it is used as supervision criterion.

Table 2-4 Condition table for binary inputs, depending on RTC and CB position

No.	Trip contact	Circuit breaker	52a Contact	52b Contact	BI 1	BI 2
1	Open	Closed	Closed	Open	H	L
2	Open	Open	Open	Closed	H	H
3	Closed	Closed	Closed	Open	L	L
4	Closed	Open	Open	Closed	L	H

The conditions of the two binary inputs are checked periodically. A check takes place about every 600 ms. If three consecutive conditional checks detect an abnormality (after 1.8 s), an annunciation is reported (see *Figure 2-16*). The repeated measurements determine the delay of the alarm message and avoid that an alarm is output during short transition periods. After the malfunction in the trip circuit is cleared, the fault annunciation is reset automatically after the same time period.

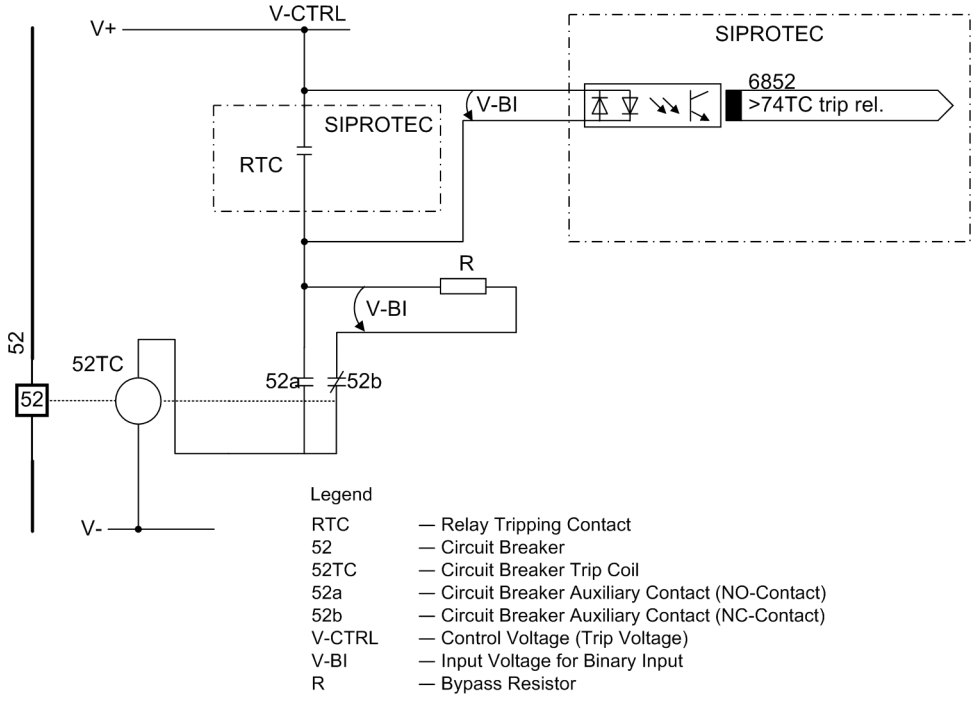


[dw_7sj6x_ausloesekreis_2_binaerein, 1, en_US]

Figure 2-16 Logic diagram of the trip circuit supervision with two binary inputs

Supervision with One Binary Input

The binary input is connected according to the following figure in parallel with the associated trip contact of the protection relay. The circuit breaker auxiliary contact is bridged with a bypass resistor R.



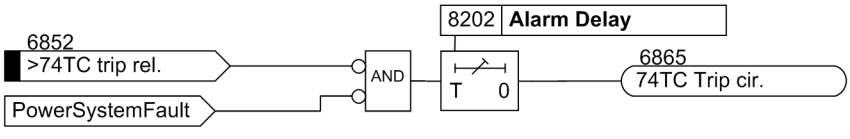
[dw_prinzip-ausloesekreisueberwachung-1-binein, 1, en_US]

Figure 2-17 Trip circuit supervision with one binary input

During normal operation, the binary input is activated (logical condition "H") when the trip contact is open and the trip circuit is intact, because the monitoring circuit is closed by either the 52a circuit breaker auxiliary contact (if the circuit breaker is closed) or through the bypass resistor R by the 52b circuit breaker auxiliary contact. Only as long as the trip contact is closed, the binary input is short circuited and thereby deactivated (logical condition "L").

If the binary input is continuously deactivated during operation, this leads to the conclusion that there is an interruption in the trip circuit or loss of control voltage.

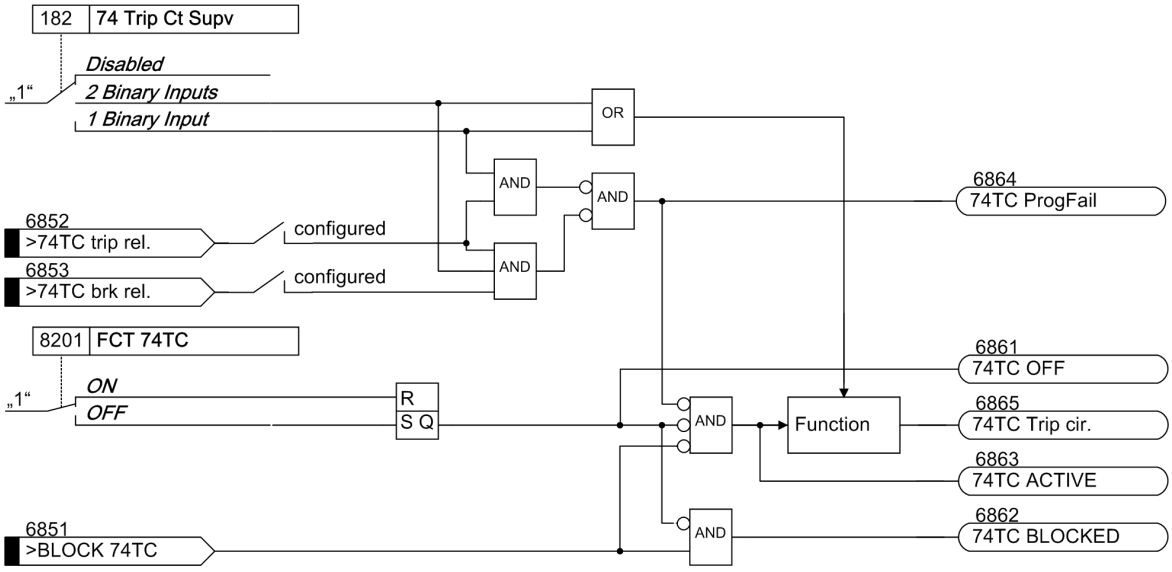
As the trip circuit supervision does not operate during system faults, the closed trip contact does not lead to a fault message. If, however, tripping contacts from other devices operate in parallel with the trip circuit, then the fault message must be delayed (see also *Figure 2-18*). The delay time can be set via parameter 8202 **`Alarm Delay`**. A message is only released after expiry of this time. After clearance of the fault in the trip circuit, the fault message is automatically reset.



[dw_7sj6x_ausloesekreis_1_binaerein, 1, en_US]

Figure 2-18 Logic diagram of trip circuit supervision with one binary input

The following figure shows the logic diagram for the message that can be generated by the trip circuit monitor, depending on the control settings and binary inputs.



[dw_7sj6x_ausloesekreis_meldelogik, 1, en_US]

Figure 2-19 Message logic for trip circuit supervision

2.5.2.2 Setting Notes

General

The function is only effective and accessible if address 182 (Section *2.1.1.2 Setting Notes*) was set to either ***2 Binary Inputs*** or ***1 Binary Input*** during configuration, the appropriate number of binary inputs has been configured accordingly for this purpose and the function **FCT 74TC** is ***ON*** at address 8201. If the allocation of the required binary inputs does not match the selected supervision type, a message to this effect is generated (*74TC ProgFail*). If the trip circuit monitor is not to be used at all, then ***Disabled*** is set at address 182.

In order to ensure that the longest possible duration of a trip command can be reliably bridged, and an indication is generated in case of an actual fault in the trip circuit, the indication regarding a trip circuit interruption is delayed. The time delay is set under address 8202 **Alarm Delay**.

Supervision with One Binary Input

Note: When using only one binary input (BI) for the trip circuit monitor, malfunctions, such as interruption of the trip circuit or loss of battery voltage are detected in general, but trip circuit failures while a trip command is active cannot be detected. Therefore, the measurement must take place over a period of time that bridges the longest possible duration of a closed trip contact. This is ensured by the fixed number of measurement repetitions and the time between the state checks.

When using only one binary input, a resistor R is inserted into the circuit on the system side, instead of the missing second binary input. Through appropriate sizing of the resistor and depending on the system conditions, a lower control voltage is mostly sufficient.

Information for dimensioning resistor R is given in the Chapter "Installation and Commissioning" under Configuration Notes in the Section "Trip Circuit Supervision".

2.5.2.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
8201	FCT 74TC	ON OFF	ON	74TC TRIP Circuit Supervision
8202	Alarm Delay	1 .. 30 sec	2 sec	Delay Time for alarm

2.5.2.4 Information List

No.	Information	Type of Information	Comments
6851	>BLOCK 74TC	SP	>BLOCK 74TC
6852	>74TC trip rel.	SP	>74TC Trip circuit superv.: trip relay
6853	>74TC brk rel.	SP	>74TC Trip circuit superv.: bkr relay
6861	74TC OFF	OUT	74TC Trip circuit supervision OFF
6862	74TC BLOCKED	OUT	74TC Trip circuit supervision is BLOCKED
6863	74TC ACTIVE	OUT	74TC Trip circuit supervision is ACTIVE
6864	74TC ProgFail	OUT	74TC blocked. Bin. input is not set
6865	74TC Trip cir.	OUT	74TC Failure Trip Circuit

2.5.3 Malfunction Responses of the Monitoring Functions

Im folgenden sind die Fehlerreaktionen der Überwachungseinrichtungen zusammengefasst.

2.5.3.1 Functional Description

Malfunction Responses

Depending on the type of malfunction discovered, an annunciation is sent, a restart of the processor system is initiated, or the device is taken out of service. After three unsuccessful restart attempts, the device is taken out of service. The operational readiness NC contact operates to indicate the device is malfunctioning. Also, the red LED ”ERROR" lights up on the front cover, if the internal auxiliary voltage is present, and the green ”RUN" LED goes out. If the internal auxiliary voltage fails, all LEDs are dark. *Table 2-5* provides a summary of the monitoring functions and the malfunction responses of the relay.

Table 2-5 Summary of malfunction responses by the protection relay

Monitoring	Possible Causes	Malfunction Response	Message (No.)	Output
AC/DC supply voltage loss	External (Nominal voltage) internal (power supply)	Device shutdown	All LEDs dark	DOK[2)] drops out
Buffer battery	Internal (buffer battery)	Message	*Fail Battery* (177)	
Hardware watchdog	Internal (processor failure)	Device shutdown[1)]	LED "ERROR"	DOK[2)] drops out
Software watchdog	Internal (processor failure)	Restart attempt [1)]	LED "ERROR"	DOK[2)] drops out
Working memory ROM	Internal (hardware)	Relay aborts restart, device shutdown	LED blinkt	DOK[2)] drops out
Program memory RAM	Internal (hardware)	During boot sequence	LED "ERROR"	DOK[2)] drops out
		Detection during operation: Restart attempt[1)]	LED "ERROR"	
Settings memory	Internal (hardware)	Restart attempt [1)]	LED "ERROR"	DOK[2)] drops out
Sampling frequency	Internal (hardware)	Device shutdown	LED "ERROR"	DOK[2)] drops out

Monitoring	Possible Causes	Malfunction Response	Message (No.)	Output
Error in the I/O-board	Internal (hardware)	Device shutdown	*I/O-Board error* (178), LED "ERROR"	DOK[2] drops out
Offset monitoring	Internal (hardware)	Device shutdown	*Error Offset* (191)	DOK[2] drops out
Voltage symmetry	External (power system or voltage transformer)	Message	*Fail V balance* (167)	As allocated
Voltage phase sequence	External (power system or connection)	Message	*Fail Ph. Seq. V* 176)	As allocated
Trip circuit monitoring	External (trip circuit or control voltage)	Message	*74TC Trip cir.* (6865)	As allocated
Secondary voltage transformer circuit monitoring	External (voltage transformer circuit interruption)	Message	*VT brk. wire* (253)	As allocated
Calibration data fault	Internal (hardware)	Message	*Alarm NO calibr* (193)	As allocated

[1] After three unsuccessful restart attempts, the device is shut down.

[2] DOK = "Device Okay" = Ready for service relay drops off, protection and control functions are blocked.

Group Alarms

Certain messages of the monitoring functions are already combined to group alarms. A listing of the group alarms and their composition is given in the Appendix *E.4 Group Indications*. In this case, it must be noted that message 160 *Alarm Sum Event* is only issued when the measured value monitoring functions (8101 **MEASURE. SUPERV**) are activated.

2.6 Flexible Protection Functions

The flexible protection function is applicable for a variety of protection principles. The user can create up to 20 flexible protection functions and configure them according to their function. Each function can be used either as an autonomous protection function, as an additional protective element of an existing protection function or as a universal logic, e.g. for monitoring tasks.

2.6.1 Functional Description

General

The function is a combination of a standard protection logic and a characteristic (measured quantity or derived quantity) that is adjustable via parameters. The characteristics listed in table 2-20 and the derived protection functions are available.

Table 2-6 Realisierbare Schutzfunktionen

Characteristic Group	Characteristic / Measured Quantity		Protective Function	ANSI-No.	Mode of Operation	
					3–phase	1–phase
Voltage	V	RMS value of fundamental component	Voltage protection Displacement voltage	27, 59, 59G	X	X
	V_{rms}	True RMS (r.m.s. value)	Voltage protection Displacement voltage	27, 59, 59G	X	X
	$3V_0$	Zero sequence system	Displacement voltage	59N	X	
	V_1	Positive-sequence component	Voltage protection	27, 59	X	
	V_2	Negative-sequence component	Voltage asymmetry	47	X	
	dV/dt	Voltage change	Voltage change protection		X	
Frequency	f	Frequency	Frequency protection	81U/O	without phase reference	
	df/dt	Frequency change	Frequency change protection	81R		
Binary input	–	Binary input	Direct coupling		without phase reference	

The maximum 20 configurable protection functions operate independently of each other. The following description concerns one function; it can be applied accordingly to all other flexible functions. The logic diagram *Figure 2-20* illustrates the description.

Functional Logic

The function can be switched ***OFF*** and ***ON*** or, it can be set to ***Alarm Only***. In this status, a pickup condition will neither initiate fault recording nor start the trip time delay. Tripping is thus not possible.

Changing the Power System Data 1 after flexible functions have been configured may cause these functions to be set incorrectly. Message (FNo.235.2128 *$00 inval.set*) reports this condition. The function is inactive in this case and function's setting has to be modified.

Blocking Functions

The function can be blocked via binary input (FNo. 235.2110 *>BLOCK $00*) or via local operating terminal (“Control”->“Tagging”->“Set”). Blocking will reset the function's entire measurement logic as well as all running times and indications. Blocking via the local operating terminal may be useful if the function is in a status of permanent pickup which does not allow the function to be reset.

In context with voltage-based characteristics, the function can be blocked if one of the measuring voltages fails. Recognition of this status is via auxiliary contacts of the voltage transformer CB (FNo. 6509 *>FAIL:FEEDER VT* and FNo. 6510 *>FAIL: BUS VT*). This blocking mechanism can be enabled or disabled

in the according parameters. The associated parameter **BLK.by Vol.Loss** is only available if the characteristic is based on a voltage measurement.

When using the flexible function for power protection or power monitoring, it will be blocked if currents fall below $0.03 \cdot I_{Nom}$.

Operating Mode, Measured Quantity, Measurement Method

The flexible function can be tailored to assume a specific protective function for a concrete application in parameters **OPERRAT. MODE**, **MEAS. QUANTITY**, **MEAS. METHOD** and **PICKUP WITH**. Parameter **OPERRAT. MODE** can be set to specify whether the function works ***3-phase***, ***1-phase*** oder ***no reference***, i.e. without a fixed phase reference. The three-phase method evaluates all three phases in parallel. This implies that threshold evaluation, pickup indications and trip time delay are accomplished selectively for each phase and parallel to each other.

When operating single-phase, the function employs a phase's measured quantity, which must be stated explicitly.

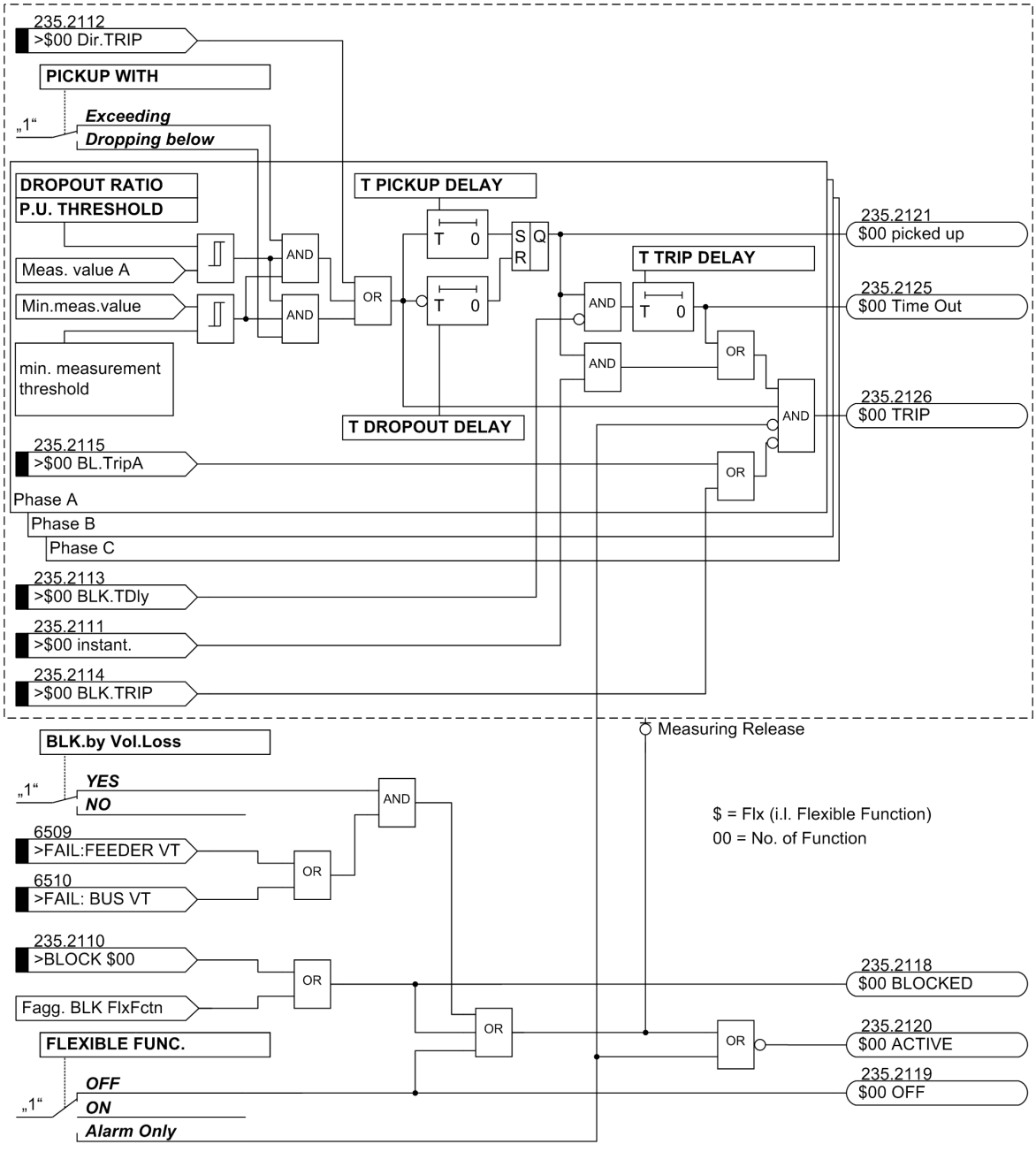
If the characteristic relates to the frequency or if external trip commands are used, the operating principle is without (fixed) phase reference. Additional parameters can be set to specify the used **MEAS. QUANTITY** and the **MEAS. METHOD**. The **MEAS. METHOD** determines for voltage measured values whether the function uses the RMS value of the fundamental component or the normal RMS value (true RMS) that evaluates also harmonics. All other characteristics use always the rms value of the fundamental component. Parameter **PICKUP WITH** moreover specifies whether the function picks up on exceeding the threshold (>-element) or on falling below the threshold (<-element).

Characteristic Curve

The function's characteristic curve is always “definite time”; this means that the time delay is not affected by the measured quantity.

Function Logic

The following figure shows the logic diagram of a three-phase function. If the function operates on one phase or without phase reference, phase selectivity and phase-specific indications are not relevant.



[7rw80-flex-fkt-210100716, 1, en_US]

Figure 2-20 Logic diagram of the flexible protection functions

The parameters can be set to monitor either exceeding or dropping below of the threshold. The configurable pickup time delay will be started once the threshold (>-element) has been exceeded. When the time delay has elapsed and the threshold is still violated, the pickup of the phase (e.g. no. 235.2122 *$00 pickup A*)and of the function (no. 235.2121 *$00 picked up*) is reported. If the pickup delay is set to zero, the pickup will occur simultaneously with the detection of the threshold violation. If the function is enabled, the pickup will start the trip time delay and the fault log. This is not the case if set to "Alarm only". If the threshold violation persists after the trip time delay has elapsed, the trip will be initiated upon its expiration (no. 235.2126 *$00 TRIP*). The timeout is reported via (no. 235.2125 *$00 Time Out*). Expiry of the trip time delay can be blocked via binary input (no. 235.2113 *>$00 BLK.TDly*). The time delay will not be started as long as the binary input is active; a trip can thus be initiated. The time delay is started after the binary input has dropped out and the pickup is still present. It is also possible to bypass the expiration of the time delay by activating binary input (no. 235.2111 *>$00 instant.*). The trip will be launched immediately when the pickup is

present and the binary input has been activated. The trip command can be blocked via binary inputs (no. 235.2115 *>$00 BL.TripA*) and (no. 235.2114 *>$00 BLK.TRIP*). The phase-selective blocking of the trip command is required for interaction with the inrush restraint (see "Interaction with other functions"). The function's dropout ratio can be set. If the threshold (>-element) is undershot after the pickup, the dropout time delay will be started. The pickup is maintained during that time, a started trip delay time continues to count down. If the trip time delay has elapsed while the dropout time delay is still during, the trip command will only be given if the current threshold is exceeded. The element will only drop out when the dropout time delay has elapsed. If the time is set to zero, the dropout will be initiated immediately once the threshold is undershot.

External Trip Commands

The logic diagram does not explicitly depict the external trip commands since their functionality is analogous. If the binary input is activated for external trip commands (no. 235.2112 *>$00 Dir.TRIP*), it will be logically treated as threshold overshooting, i.e. once it has been activated, the pickup time delay is started. If the pickup time delay is set to zero, the pickup condition will be reported immediately starting the trip time delay. Otherwise, the logic is the same as depicted in *Figure 2-20*.

Interaction with Other Functions

The pickup message of the flexible function is included in the general fault detection, and tripping in the general trip (see Chapter *2.11 Function Logic*). All functionalities linked to the general fault detection and general trip therefore also apply to the flexible function.

The trip commands by the flexible protection function are maintained after reset of the pickup for at least the configured minimum trip-command duration 210 **TMin TRIP CMD**.

2.6.2 Setting Notes

The setting of the functional scope determines the number of flexible protection functions to be used (see Section *2.1.1 Functional Scope*). If a flexible function in the functional scope is disabled (by removing the checkmark), this will result in losing all settings and configurations of this function or its settings will be reset to their default settings.

General

In the DIGSI setting dialog "General", parameter **FLEXIBLE FUNC.** can be set to ***OFF***, ***ON*** or ***Alarm Only***. If the function is enabled in operational mode ***Alarm Only***, no faults are recorded, no "Effective"indication is generated, no trip command issued and neither will the circuit-breaker protection be affected. Therefore, this operational mode is preferred when a flexible function is not required to operate as a protection function. Furthermore, the **OPERRAT. MODE** can be configured:

3-phase – functions evaluate the three-phase measuring system, i.e. all three phases are processed simultaneously.

1-phase functions evaluate only the individual measured value. This can be an individual phase value (e.g V_B) or V_x or a ground variable (V_N).

Setting ***no reference*** determines the evaluation of measured variables irrespective of a single or threeephase connection of voltage. *Table 2-6* provides an overview regarding which variables can be used in which mode of operation.

Measured Quantity

In the setting dialog "Measured Variable" the measured variables to be evaluated by the flexible protection functions can be selected, which may be a calculated or a directly measured variable. The setting options that can be selected here are dependant on the mode of measured-value processing as predefined in parameter **OPERRAT. MODE** (see the following table).

Table 2-7 Parameter **OPERRAT. MODE** and **MEAS. QUANTITY**

Parameter **OPERRAT. MODE** Setting	Parameter **MEAS. QUANTITY** Setting Options
1-phase 3-phase	***Voltage***
3-phase	***dV/dt rising*** ***dV/dt falling***
Without Reference	***Frequency*** ***df/dt rising*** ***df/dt falling*** ***Binray Input***

Measurement Process

The following table lists configurable measurement procedures depending on parameterized measured quantities.

Table 2-8 Parameter in the Setting Dialog "Measurement Procedure", Mode of Operation 3-phase

Parameter OPERRAT. MODE = *3-phase*	
Parameter **MEAS. QUANTITY** = ***Voltage***	
Parameter **MEAS. METHOD**	
Fundamental	Only the fundamental harmonic is evaluated, higher harmonics are suppressed. This is the standard measurement procedure of the protection functions. **Important**: The voltage threshold value is always parameterized as phase-to-phase voltage. If parameter **VOLTAGE SYSTEM** is selected as phase-to-ground, the voltage threshold will be devided by √3.
True RMS	The "true" RMS value is determined, i.e. higher harmonics are evaluated. **Important**: The voltage threshold value is always parameterized as phase-to-phase voltage. If parameter **VOLTAGE SYSTEM** is selected as phase-to-ground, the voltage threshold will be devided by √3.
Positive seq., ***Negative seq.***, ***Zero sequence***	In order to realize certain applications, the positive sequence system or negative sequence system can be configured as measurement procedure for example U2 (voltage asymmetry) Via the selection zero sequence system, additional zero sequence voltage functions can be realized that operate independent of the ground variable V_N, which are measured directly via transformers. Important: The voltage threshold is always parameterized according to the definition of the balanced components independently of parameter **VOLTAGE SYSTEM**.
Parameter **MEAS. QUANTITY** = ***Voltage***	
Parameter **VOLTAGE SYSTEM**	
Phase-Phase ***Phase-Ground***	If you have configured address 213 **VT Connect. 3ph** to ***Van, Vbn, Vcn*** or ***Vab, Vbc, VGnd***, you can select whether a 3- phase voltage function will evaluate the phase-to-ground voltage or the phase-to-phase voltages. When selecting phase-to-phase, these variables are derived from the phase-to-ground voltages. The selection is, for example, important for single-pole faults. If the faulty voltage drops to zero, the affected phase-to-ground voltage is zero, whereas the affected phase-to-phase voltages collapse to the size of a phase-to-ground voltage. With phase-to-phase voltage connections the parameter is hidden.

NOTE

With regard to the phase-selective pickup messages, a special behavior is observed in the three-phase voltage protection with phase-to-phase variables, because the phase-selective pickup message "Flx01 Pickup Lx" is allocated to the respective measured-value channel "Lx".

Single-phase faults:

If, for example, voltage V_A drops to such degree that voltages V_{AB} and V_A exceed their threshold values, the device indicates pickups “Flx01 Pickup A” and “Flx01 Pickup C”, because the undershooting was detected in the first and third measured-value channel.

Two-phase faults:

If, for example, voltage V_{AB} drops to such degree that its threshold value is reached, the device then indicates pickup "Flx01 Pickup A", because the undershooting was detected in the first measured-value channel.

Table 2-9 Parameter in the Setting Dialog "Measurement Procedure", Mode of Operation 1-phase

Parameter **OPERRAT. MODE** = ***1-phase***	
Parameter **MEAS. QUANTITY** = ***Voltage***	
Parameter **MEAS. METHOD**	
Fundamental	Only the fundamental harmonic is evaluated, higher harmonics are suppressed. This is the standard measurement procedure of the protection functions.
True RMS	The “True” RMS value is determined, i.e. higher harmonics are evaluated.
Parameter **MEAS. QUANTITY** = ***Voltage***	
Parameter **VOLTAGE**	
Va-n ***Vb-n*** ***Vc-n*** ***Va-b*** ***Vb-c*** ***Vc-a*** ***Vn*** ***Vx***	It is determined which voltage-measuring channel is evaluated by the function. When selecting phase-to-phase voltage, the threshold value must be set as a phase-to-phase value, when selecting a phase-to-ground variable as phase-toground voltage. The extent of the setting texts depends on the connection of the voltage transformer (see address213 **VT Connect. 3ph**).

Settings

The pickup thresholds, delay times and dropout ratios of the flexible protection function are set in the “Settings” dialog box in DIGSI.

The pickup threshold of the function is configured via parameter **P.U. THRESHOLD**. The TRIP-command delay time is set via parameter **T TRIP DELAY**. Both setting values must be selected according to the required application.

The pickup can be delayed via parameter **T PICKUP DELAY**. This parameter is usually set to zero (default setting) in protection applications, because a protection function should pick up as quickly as possible. A setting deviating from zero may be appropriate if a trip log is not desired to be started upon each short-term exceeding of the pickup threshold, for example, when a function is not used as a protection, but as a monitoring function.

The dropout of pickup can be delayed via parameter **T DROPOUT DELAY**. This setting is also set to zero by default (standard setting) A setting deviating from zero may be required if the device is utilized together with electro-magnetic devices with considerably longer dropout ratios than the digital protection device. When utilizing the dropout time delay, it is recommended to set it to a shorter time than the OFF-command delay time in order to avoid both times to “race”.

Parameter **BLK.by Vol.Loss** determines whether a function, with measured variable based on a voltage measurement (measured variables voltage), should be blocked in case of a measured voltage failure/loss of potential (set to ***YES***) or not (set to ***NO***).

The dropout ratio for the function can be set via the parameter **DROPOUT RATIO**. The standard dropout ratio of protection functions is 0.95 (default setting). If the dropout ratio is decreased, it would be sensible to test the pickup of the function regarding possible "chatter".

The dropout difference of the frequency elements is set under parameter **DO differential**. Usually, the default setting of 0.02 Hz can be retained. A higher dropout difference should be set in weak systems with larger, short-term frequency fluctuations to avoid chattering of the message.

The frequency change measured value (df/dt) works with a fixed dropout difference of 0.1 Hz/s.

The same applies to the voltage change (dU/dt) measurand. The permanent dropout difference here is 3 V/s.

Renaming Messages, Checking Configurations

After parameterization of a flexible function, the following steps should be noted:

- Open matrix in DIGSI
- Rename the neutral message texts in accordance with the application.
- Check configurations on contacts and in operation and fault buffer, or set them according to the requirements.

2.6.3 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under "Additional Settings".

Addr.	Parameter	Setting Options	Default Setting	Comments
0	FLEXIBLE FUNC.	OFF ON Alarm Only	OFF	Flexible Function
0	OPERRAT. MODE	3-phase 1-phase no reference	3-phase	Mode of Operation
0	MEAS. QUANTITY	Please select Voltage Frequency df/dt rising df/dt falling Binray Input dV/dt rising dV/dt falling	Please select	Selection of Measured Quantity
0	MEAS. METHOD	Fundamental True RMS Positive seq. Negative seq. Zero sequence Ratio I2/I1	Fundamental	Selection of Measurement Method
0	PICKUP WITH	Exceeding Dropping below	Exceeding	Pickup with

Addr.	Parameter	Setting Options	Default Setting	Comments
0	VOLTAGE	Please select Va-n Vb-n Vc-n Va-b Vb-c Vc-a Vn Vx	Please select	Voltage
0	VOLTAGE SYSTEM	Phase-Phase Phase-Ground	Phase-Phase	Voltage System
0	P.U. THRESHOLD	2.0 .. 260.0 V	110.0 V	Pickup Threshold
0	P.U. THRESHOLD	2.0 .. 200.0 V	110.0 V	Pickup Threshold
0	P.U. THRESHOLD	2.0 .. 260.0 V	110.0 V	Pickup Threshold
0	P.U. THRESHOLD	40.00 .. 60.00 Hz	51.00 Hz	Pickup Threshold
0	P.U. THRESHOLD	50.00 .. 70.00 Hz	61.00 Hz	Pickup Threshold
0	P.U. THRESHOLD	0.10 .. 20.00 Hz/s	5.00 Hz/s	Pickup Threshold
0	P.U. THRESHOLD	4 .. 100 V/s	60 V/s	Pickup Threshold
0	T TRIP DELAY	0.00 .. 3600.00 sec	1.00 sec	Trip Time Delay
0A	T PICKUP DELAY	0.00 .. 60.00 sec	0.00 sec	Pickup Time Delay
0A	T DROPOUT DELAY	0.00 .. 60.00 sec	0.00 sec	Dropout Time Delay
0A	BLK.by Vol.Loss	NO YES	YES	Block in case of Meas.-Voltage Loss
0A	DROPOUT RATIO	0.70 .. 0.99	0.95	Dropout Ratio
0A	DROPOUT RATIO	1.01 .. 3.00	1.05	Dropout Ratio
0	DO differential	0.02 .. 1.00 Hz	0.03 Hz	Dropout differential

2.6.4 Information List

No.	Information	Type of Information	Comments
235.2110	>BLOCK $00	SP	>BLOCK Function $00
235.2111	>$00 instant.	SP	>Function $00 instantaneous TRIP
235.2112	>$00 Dir.TRIP	SP	>Function $00 Direct TRIP
235.2113	>$00 BLK.TDly	SP	>Function $00 BLOCK TRIP Time Delay
235.2114	>$00 BLK.TRIP	SP	>Function $00 BLOCK TRIP
235.2115	>$00 BL.TripA	SP	>Function $00 BLOCK TRIP Phase A
235.2116	>$00 BL.TripB	SP	>Function $00 BLOCK TRIP Phase B
235.2117	>$00 BL.TripC	SP	>Function $00 BLOCK TRIP Phase C
235.2118	$00 BLOCKED	OUT	Function $00 is BLOCKED
235.2119	$00 OFF	OUT	Function $00 is switched OFF
235.2120	$00 ACTIVE	OUT	Function $00 is ACTIVE
235.2121	$00 picked up	OUT	Function $00 picked up
235.2122	$00 pickup A	OUT	Function $00 Pickup Phase A
235.2123	$00 pickup B	OUT	Function $00 Pickup Phase B
235.2124	$00 pickup C	OUT	Function $00 Pickup Phase C

No.	Information	Type of Information	Comments
235.2125	$00 Time Out	OUT	Function $00 TRIP Delay Time Out
235.2126	$00 TRIP	OUT	Function $00 TRIP
235.2128	$00 inval.set	OUT	Function $00 has invalid settings

2.7 Synchrocheck

When connecting two sections of a power system, the synchrocheck function verifies that the switching does not endanger the stability of the power system

Applications

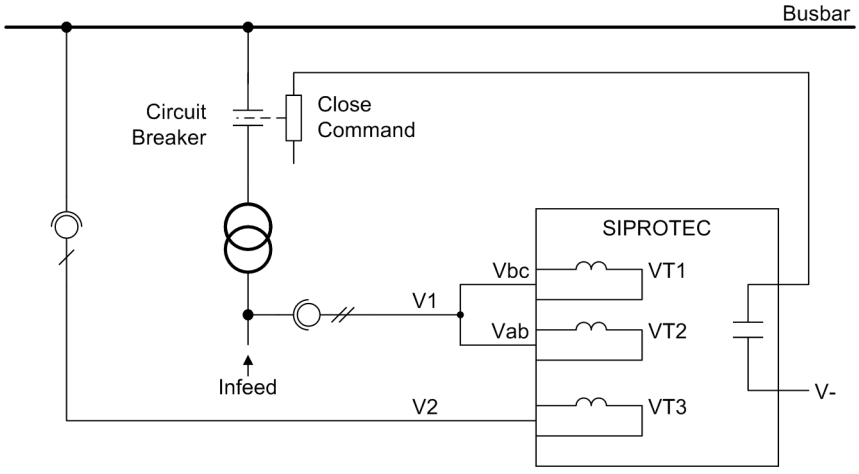
- Typical applications are, for example, the synchronization of a feeder and a busbar or the synchronization of two busbars via tie-breaker.

2.7.1 Allgemeines

Synchronous power systems exhibit small differences regarding frequency and voltage values. Before connection it is to be checked whether the conditions are synchronous or not. If the conditions are synchronous, the system is energized; if they are asynchronous, it is not. The circuit breaker operating time is not taken into consideration. The synchrocheck function is activated via address 161 ***SYNCHROCHECK***.

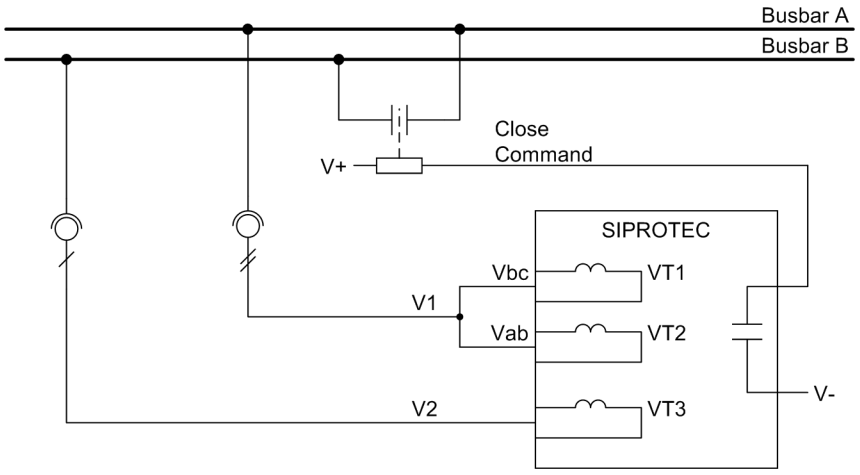
For comparing the two voltages of the sections of the power system to be synchronized, the synchrocheck function uses the reference voltage V_1 and an additional voltage to be connected V_2.

If a transformer is connected between the two voltage transformers as shown in the following example, its vector group can be adapted in the 7RW80 relay so that there is no external adjustment required.



[synchro-fkt-einspeis-061115, 1, en_US]

Figure 2-21 Infeed



[synchro-fkt-querkuppl-061115, 1, en_US]

Figure 2-22 Cross coupling

The synchrocheck function of the 7RW80 usually coordinates with the control function. Nevertheless, it is also possible to employ an external automatic reclosing system. In such a case, the signal exchange between the devices is to be accomplished via binary inputs and outputs.

The release command for closing under satisfied synchronism conditions can be deactivated via parameter 6113 **25 Synchron**. For special applications, the deactivated closing release can, however, be activated via a binary input (*>25 synchr.*) (see "De-energized Switching").

2.7.2 Functional Sequence

Validity Check of the Configuration

Already during startup of the device, a validation check of the configuration is performed. If there is a fault, the message *25 Set-Error* is output. after a measurement request there is a condition which is not plausible, the message *25 Set-Error* is output. The measurement is then not started.

Concerning the configuration, it is also checked if the substation parameter 213 is set to ***Vab, Vbc, VSyn*** or ***Vph-g, VSyn***. Furthermore, specific thresholds and settings of the function group are checked. If there is a condition which is not plausible, the error message *25 Set-Error* is output additionally. Please ensure in this case that address 6106 (threshold V_1, V_2 energized) is smaller than address 6103 (lower voltage limit **Vmin**). The synchrocheck function cannot be controlled via a binary input.

SYNC Error

The synchronization is not started if a voltage transformer failure (m.c.b. tripping) is communicated to the device via the binary input 6509 *>FAIL:FEEDER VT* or 6510 *>FAIL: BUS VT*. The message *25 Sync. Error* is output. In this case, the synchronization can be controlled directly via a binary input.

In case of a protection pickup, the complete synchronization process is reset instantaneously.

Release

The synchrocheck function only operates if it receives a measurement request. This request may be issued by the internal control function, the automatic reclosing function or externally via a binary input, e.g. from an external automatic reclosing system.

Before a release for closing is granted, the following conditions are checked:

- Is the reference voltage V_1 above the setting value **Vmin** but below the maximum voltage **Vmax**?
- Is the voltage V_2 to be synchronized above the setting value **Vmin**, but below the maximum voltage **Vmax**?
- Is the voltage difference $V_2 - V_1$ within the permissible limit **dV SYNCHK V2>V1**?

- Is the voltage difference $V_1 - V_2$ within the permissible limit **dV SYNCHK V2<V1**?
- Are the two frequencies f_1 and f_2 within the permissible operating range $f_{Nom} \pm 3$ Hz?
- Is the frequency difference $f_2 - f_1$ within the permissible limit **df SYNCHK f2>f1**?
- Is the frequency difference $f_1 - f_2$ within the permissible limit **df SYNCHK f2<f1**?
- Is the angle difference $\alpha_2 - \alpha_1$ within the permissible limit **dα SYNCHK α2>α1**?
- Is the angle difference $\alpha_1 - \alpha_2$ within the permissible limit **dα SYNCHK α2<α1**?

If there is a condition which is not plausible, the message *25 Sync. Error* is output and the measurement is not started. the conditions are plausible, the measurement is started (message*25-1 meas.*) and the configured release conditions are checked.

Each condition which is met is indicated explicitly (messages *25 Vdiff ok*, *25 fdiff ok*, *25 αdiff ok*). Conditions which are not met are also indicated explicitly, e.g. when the voltage difference (messages *25 V2>V1*, *25 V2<V1*), frequency difference (messages „25 f2>f1“, „25 f2<f1“) or angle difference (messages *25 α2>α1*, *25 α2<α1*) is outside the limit values. The precondition for these messages is that both voltages are within the operating range of the synchrocheck function (see “Operating Range”).

If the conditions are met, the synchrocheck function issues a release signal for closing the relay (*25 CloseRelease*). This release signal is only available for the configured duration of the CLOSE command and is processed by the device's function control as CLOSE command to the circuit breaker (see also margin heading “Interaction with Control”). However, the message *25 Synchron* is applied as long as the synchronous conditions are met.

The measurement of the the synchronism conditions can be confined to the a maximum monitoring time **T-SYN. DURATION**. If the conditions are not met within **T-SYN. DURATION**, the release is cancelled (message *25 MonTimeExc*). A new synchronization can only be performed if a new measurement request is received.

Operating Range

The operating range of the synchrocheck function is defined by the configured voltage limits **Vmin** and **Vmax** as well as the fixed frequency band $f_{Nom} \pm 3$ Hz

If the measurement is started and one of or both voltages are outside the operating range or one of the voltages leaves the operating range, this is indicated by corresponding messages (*25 f1>>, 25 f1<<, 25 V1>>, 25 V1<<*).

Measured Values

The measured values of the synchrocheck function are displayed in separate windows for primary, secondary and percentaged measured values. The measured values are displayed and updated only while the synchrocheck function is requested.

The following is displayed:

- Value of the reference voltage V_1
- Value of the voltage to be synchronized V_2
- Frequency values f_1 and f_2
- Differences of voltage, frequency and angle.

2.7.3 De-energized Switching

Connecting two components of a power system is also possible if at least one of the components is de-energized and if the measured voltage is greater than the threshold 6106 **V>**. With a multi-phase connection on the side V_1, all connected voltages must have a higher value than the threshold **V>** so that the side V_1 is considered as being energized. With a single-phase connection, of course, only the one voltage has to exceed the threshold value.

Besides the release under synchronous conditions, the following additional release conditions can be selected for the check:

SYNC V1>V2< =	Release on the condition that component V_1 is energized and component V_2 is de-energized.
SYNC V1<V2> =	Release on the condition that component V_1 is de-energized and component V_2 is energized.
SYNC V1<V2< =	Release on the condition that component V_1 and component V_2 are de-energized.

Each of these conditions can be enabled or disabled individually via parameters or binary inputs; combinations are thus also possible (e.g. release if **SYNC V1>V2<** or **SYNC V1<V2>** are fulfilled).

For that reason synchronization with the use of the additional parameter 6113 **25 Synchron** (configured to ***NO***) can also be used for the connection of a ground electrode. In such a case, connection is only permissible when there is no voltage on the load side.

The threshold below which a power system component is considered as being de-energized is defined by parameter **V<**. If the measured voltage exceeds the threshold **V>**, a power system component is considered as being energized. With a multi-phase connection on the side V_1, all connected voltages must have a higher value than the threshold **V>** so that the side V_1 is considered as being energized. With a single-phase connection, of course, only the one voltage has to exceed the threshold value.

Before granting a release for connecting the energized component V_1 and the de-energized component V_2, the following conditions are checked:

- Is the reference voltage V_1 above the setting value **Vmin** and **V>** but below the maximum voltage **Vmax**?
- Is the voltage to be synchronized V_2 below the setting value **V<**?
- Is the frequency f_1 within the permissible operating range $f_{Nom} \pm 3$ Hz?

After successful completion of the checks, the release is granted.

For connecting the de-energized component 1 to the energized component 2 or the de-energized component 1 to the de-energized component 2, the conditions to be fulfilled correspond to those stated above.

The associated messages indicating the release via the corresponding condition are as follows: *25 V1> V2<*, *25 V1< V2>* and *25 V1< V2<*.

Via the binary inputs *>25 V1>V2<*, *>25 V1<V2>* and *>25 V1<V2<*, the release conditions can also be issued externally, provided the synchronization is controlled externally.

The parameter **TSUP VOLTAGE** (address 6111) can be set to configure a monitoring time which requires the additional release conditions stated above to be present for de-energized connection before connection is allowed.

2.7.4 Direct Command / Blocking

Parameter 6110 **Direct CO** can be set to grant a release without performing any checks. In this case, connection is allowed immediately when initiating the synchrocheck function. It is obviously not reasonable to combine **Direct CO** with other release conditions.

If the synchrocheck function fails, a direct command may be issued or not, depending on the type of failure (also see "Plausibility Check" and "SYNC Error").

Via the binary input *>25direct CO*, this release can also be granted externally.

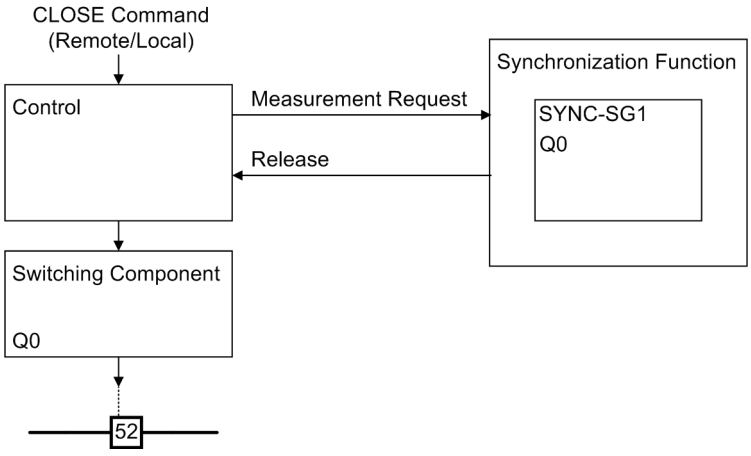
Blocking the entire synchrocheck function is possible via the binary input *>BLK 25-1*. The message signaling this condition is output via *25-1 BLOCK*. With the blocking, the measurement is terminated and the entire function is reset. A new measurement can only be performed with a new measurement request.

Via the binary input *>BLK 25 CLOSE* it is possible to block only the release signal for closing (*25 CloseRelease*). When the blocking is active, measurement continues. The blocking is indicated by the message *25 CLOSE BLK*. When the blocking is reset and the release conditions are still fulfilled, the release signal for closing is issued.

2.7.5 Interaction with Control and External Control

With Control

Basically, the synchrocheck function interacts with the device control. The switchgear component to be synchronized is selected via a parameter. If a CLOSE command is issued, the control takes into account that the switchgear component requires synchronization. The control sends a measurement request (*25 Measu. req.*) to the synchrocheck function which is then started. Having completed the check, the synchrocheck function issues the release message (*25 CloseRelease*) to which the control responds by terminating the switching operation either positively or negatively.

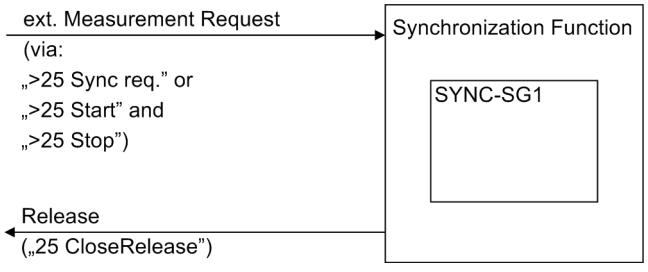


[dw_zusam-wirk-steuer-synchro-fkt, 1, en_US]

Figure 2-23 Interaction of control and synchrocheck function

With External Control

As another option, the synchrocheck function can be activated via external measurement requests via binary inputs. If the start is effected via the pulse start signal *>25 Start*, the corresponding stop signal *>25 Stop* must always be generated, too. Having completed the check, the synchrocheck function issues the release message (see the following figure). Measurement is terminated as soon as the measurement request is reset via the binary input. In this case, there is no need to configure a control device to be synchronized.



[dw_zusam-wirk-synchro-fkt-mit-ext-anst, 1, en_US]

Figure 2-24 Interaction of synchrocheck function and external control

2.7.6 Setting Notes

General

The synchronization function can only operate if **25 Function 1** with ***SYNCHROCHECK*** was enabled at address 161 during configuration of the functional scope (see Section *2.1.1.2 Setting Notes*). If this function is not required, then ***Disabled*** is set.

While setting the Power System Data 1 (see Section *Voltage Connection (Power System), Page 29*) the device was already provided with data relevant for the measured values and the operating principle of the synchronization function. This concerns the following parameters:

202 **Vnom PRIMARY** primary nominal voltage of the voltage transformers V_1 (phase-to-phase) in kV;

203 **Vnom SECONDARY** secondary nominal voltage of the voltage transformers V_1 phase-to-phase) in V;

213 **VT Connect. 3ph** specifies how the voltage transformers are connected.

When using the synchronization function the setting ***Vab, Vbc, VSyn*** is used if two phase-to-phase voltages are open delta-connected to the device. You can use any phase-to-phase voltage as the reference voltage V_{SYN}

Use the setting ***Vph-g, VSyn*** if only phase-to-ground voltages are available. One of these voltages is connected to the first voltage transformer; the reference voltage V_{SYN} is connected to the third voltage transformer. V_1 at the first voltage transformer and V_2 at the third voltage transformer must belong to the same voltage type (VAN or VBN or VCN).

Connection examples are given under side heading "Voltage Connections" and in the Appendix *C Connection Examples*).

If you have set ***Vab, Vbc, VSyn*** or ***Vph-g, VSyn***, the zero sequence voltage can not be determined. *Table 2-1* in Section *Voltage Connection (Power System), Page 29* provides information about the consequences of the different voltage connection types.

The operating range of the synchronization function (f_{Nom} ± 3 Hz) refers to the nominal frequency of the power system, address 214 **Rated Frequency**.

The corresponding messages of the SYNC function group are pre-allocated for IEC 60870–5–103 (VDEW).

Selecting the SYNC function group in DIGSI opens a dialog box with tabs in which the individual parameters for synchronization can be set.

General Settings

The general thresholds for the synchronizing function are set at addresses 6101 to 6112.

Address 6101 **Synchronizing** allows you to switch the entire SYNC function group ***ON*** or ***OFF***. If switched off, the synchrocheck does not verify the synchronization conditions and release is not granted.

Parameter 6102 **SyncCB** is used to select the switchgear component to which the synchronization settings are applied. Select the option ***none*** to use the function as external synchronizing feature. It will then be triggered via binary input messages.

Addresses 6103 **Vmin** and 6104 **Vmax** set the upper and lower limits for the operating voltage range for V_1 or V_2 and thus determine the operating range for the synchronization function. Values outside this range will be signaled.

Address 6105 **V<** indicates the voltage threshold below which the feeder or the busbar can safely be considered switched off (for checking a de-energized feeder or busbar).

Address 6106 **V>** indicates the voltage threshold above which the feeder or busbar can safely be considered energized (for checking an energized feeder or busbar). It must be set below the anticipated operational undervoltage.

The setting for the mentioned voltage values is made in secondary volts. When using DIGSI for configuration, these values can also be entered as primary values. Depending on the connection of the voltages these are phase-to-earth voltages or phase-to-phase voltages.

Addresses 6107 to 6110 are set to specify the release conditions for the voltage check: Where

6107 **SYNC V1<V2>** = component V_1 must be de-energized, component V_2 must be energized (connection when reference is de-energized, dead line);

6108 **SYNC V1>V2<** = component V_1 must be energized, component V_2 must be de-energized (connection when feeder is de-energized, dead bus);

6109 **SYNC V1<V2<** = component V_1 and component V_2 must both be de-energized (connection when reference and feeder are de-energized, dead bus / dead line);

6110 **Direct CO** = connection released without checks.

The possible release conditions are independent of each other and can be combined. It is not recommended to combine **Direct CO** with other release conditions.

Parameter **TSUP VOLTAGE** (address 6111) can be set to configure a monitoring time which requires above stated release conditions to be present for at least de-energized switching before connection is allowed. The preset value of 0.1 s accounts for transient responses and can be applied without modification.

Release via synchrocheck can be limited to a configurable synchronous monitoring time **SYN. DURATION** (address 6112). The configured conditions must be fulfilled within this time period. Otherwise release is not granted and the synchronizing function is terminated. If this time is set to ∞, the conditions will be checked until they are fulfilled.

For special applications (e.g. connecting a ground switch) parameter 6113 **25 Synchron** allows enabling/ disabling the connection release when the conditions for synchronism are satisfied.

Power System Data

The system related data for the synchronization function are set at addresses 6121 to 6125.

The parameter **Balancing V1/V2** (address 6121) can be set to account for different VT ratios of the two parts of the power system (see example in *Figure 2-25*).

If a transformer is located between the system parts to be synchronized, its vector group can be accounted for by angle adjustment so that no external adjusting measures are required. Parameter **ANGLE ADJUSTM.** (address 6122) is used to this end.

The phase angle from V_1 to V_2 is evaluated positively.

Example:

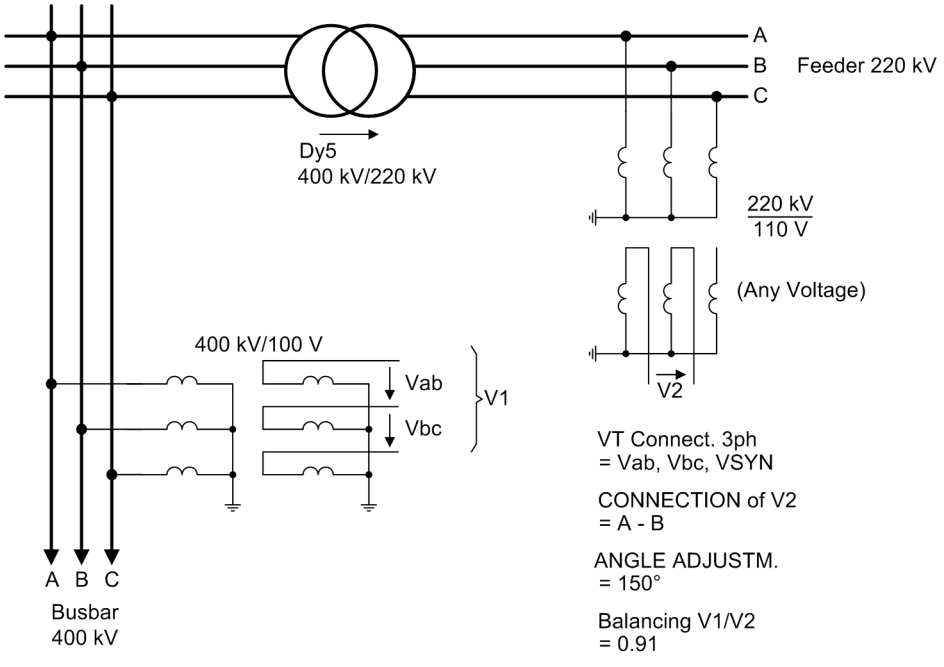
Busbar	400 kV primary; 100 V secondary
Feeder	220 kV primary; 110 V secondary
Transformer	400 kV/220 kV; vector group Dy(n)5

The transformer vector group is defined from the high side to the low side. In the example, the reference voltage transformers (V_1) are the ones of the transformer high side, i.e. the setting angle is 5 x 30° (according to vector group), that is 150°:

Address 6122 **ANGLE ADJUSTM.** = ***150°***.

The reference voltage transformers supply 100 V secondary for primary operation at nominal value while the feeder transformer supplies 110 V secondary. Therefore, this difference must be balanced:

Address 6121 **Balancing V1/V2** = 100 V/110 V = ***0.91***.



[ss-spg-ueber-trafo-gemess-061115, 1, en_US]

Figure 2-25 Busbar voltage measured across the transformer

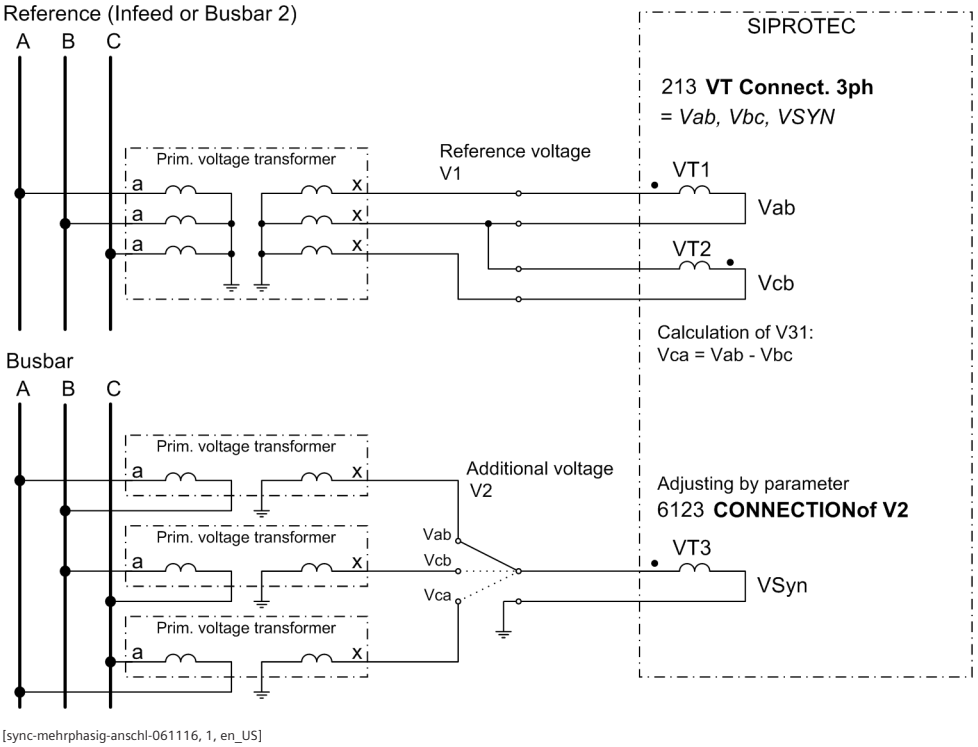
Voltage Connections

The 7RW80 provides **two** voltage inputs for connecting the voltage V_1 and **one** voltage input for connecting the voltage V_2 (see the following examples).

If two phase-to-phase voltages are open delta-connected to side V_1 as reference voltage, a phase-to-phase voltage must be connected and configured for the additional voltage V_2 to be synchronized.

To correctly compare the phase-to-phase reference voltage V_1 with the additional voltage V_2, the device needs to know the connection type of voltage V_2. That is the task of parameter **CONNECTIONof V2** (parameter 6123).

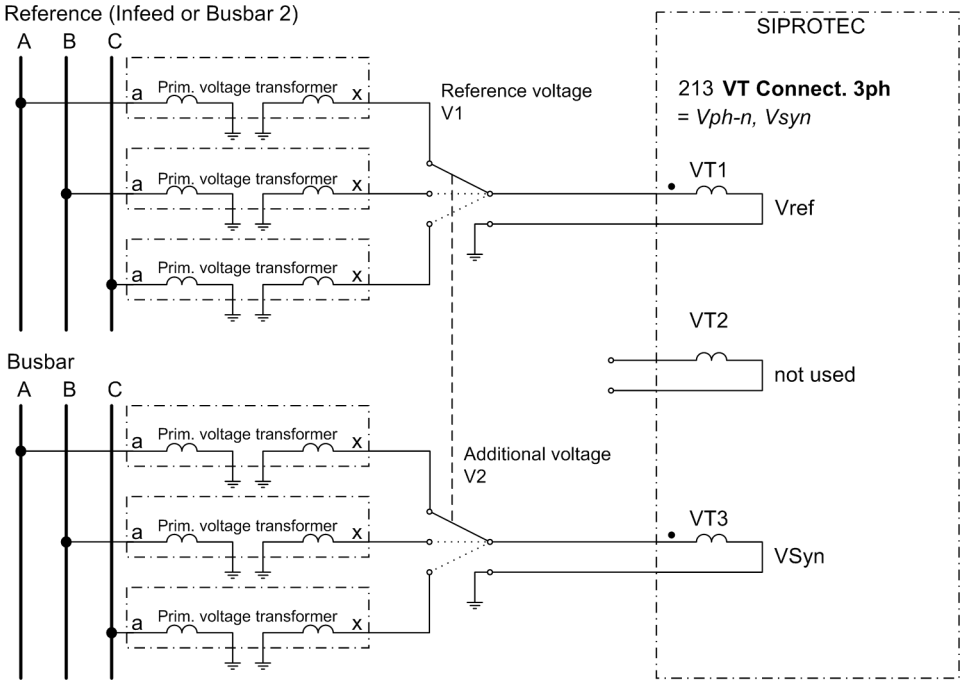
For the device to perform the internal conversion to primary values, the primary rated transformer voltage of the measured quantity V_2 must be entered via parameter 6125 **VT Vn2, primary**, primary if a transformer is located between the system parts to be synchronized.



[sync-mehrphasig-anschl-061116, 1, en_US]

Figure 2-26 Phase-to-phase voltage connection (open-delta connection)

If only phase-to-ground voltages are available, the reference voltage V_1 is connected to the first voltage transformer and the additional voltage V_2 to the third voltage transformer.



[sync-1phasig-anschl-le-061116, 1, en_US]

Figure 2-27 Phase-to-ground voltage connection

Voltage Difference

The parameters 6150 **dV SYNCHK V2>V1** and 6151 **dV SYNCHK V2<V1** can be set to adjust the permissible voltage differences asymmetrically. The availability of two parameters enables an asymmetrical release to be set.

Frequency Difference

The parameters 6152 **df SYNCHK f2>f1** and 6153 **df SYNCHK f2<f1** determine the permissible frequency differences. The availability of two parameters enables an asymmetrical release to be set.

Operating Range

The parameters 6154 **dα SYNCHK α2>α1** and 6155 **dα SYNCHK α2<α1** delimit the operating range for switching under synchronous system conditions. The availability of two parameters enables an asymmetrical release range to be set.

2.7.7 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under "Additional Settings".

Addr.	Parameter	Setting Options	Default Setting	Comments
6101	Synchronizing	ON OFF	OFF	Synchronizing Function
6102	SyncCB	(Einstellmöglichkeiten anwendungsabhängig)	none	Synchronizable circuit breaker
6103	Vmin	20 .. 125 V	90 V	Minimum voltage limit: Vmin
6104	Vmax	20 .. 140 V	110 V	Maximum voltage limit: Vmax
6105	V<	1 .. 60 V	5 V	Threshold V1, V2 without voltage
6106	V>	20 .. 140 V	80 V	Threshold V1, V2 with voltage

Addr.	Parameter	Setting Options	Default Setting	Comments
6107	SYNC V1<V2>	YES NO	NO	ON-Command at V1< and V2>
6108	SYNC V1>V2<	YES NO	NO	ON-Command at V1> and V2<
6109	SYNC V1<V2<	YES NO	NO	ON-Command at V1< and V2<
6110A	Direct CO	YES NO	NO	Direct ON-Command
6111A	TSUP VOLTAGE	0.00 .. 60.00 sec	0.10 sec	Supervision time of V1>;V2> or V1<;V2<
6112	SYN. DURATION	0.01 .. 1200.00 sec	30.00 sec	Maximum duration of synchronism-check
6113A	25 Synchron	YES NO	YES	Switching at synchronous condition
6121	Balancing V1/V2	0.50 .. 2.00	1.00	Balancing factor V1/V2
6122A	ANGLE ADJUSTM.	0 .. 360 °	0 °	Angle adjustment (transformer)
6123	CONNECTIONof V2	A-B B-C C-A	A-B	Connection of V2
6125	VT Vn2, primary	0.10 .. 800.00 kV	20.00 kV	VT nominal voltage V2, primary
6150	dV SYNCHK V2>V1	0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6151	dV SYNCHK V2<V1	0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6152	df SYNCHK f2>f1	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6153	df SYNCHK f2<f1	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6154	dα SYNCHK α2>α1	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6155	dα SYNCHK α2<α1	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1

2.7.8 Information List

No.	Information	Type of Information	Comments
170.0001	>25-1 act	SP	>25-group 1 activate
170.0043	>25 Sync requ.	SP	>25 Synchronization request
170.0049	25 CloseRelease	OUT	25 Sync. Release of CLOSE Command
170.0050	25 Sync. Error	OUT	25 Synchronization Error
170.0051	25-1 BLOCK	OUT	25-group 1 is BLOCKED
170.2007	25 Measu. req.	SP	25 Sync. Measuring request of Control
170.2008	>BLK 25-1	SP	>BLOCK 25-group 1
170.2009	>25direct CO	SP	>25 Direct Command output
170.2011	>25 Start	SP	>25 Start of synchronization
170.2012	>25 Stop	SP	>25 Stop of synchronization
170.2013	>25 V1>V2<	SP	>25 Switch to V1> and V2<

No.	Information	Type of Information	Comments
170.2014	>25 V1<V2>	SP	>25 Switch to V1< and V2>
170.2015	>25 V1<V2<	SP	>25 Switch to V1< and V2<
170.2016	>25 synchr.	SP	>25 Switch to Sync
170.2022	25-1 meas.	OUT	25-group 1: measurement in progress
170.2025	25 MonTimeExc	OUT	25 Monitoring time exceeded
170.2026	25 Synchron	OUT	25 Synchronization conditions okay
170.2027	25 V1> V2<	OUT	25 Condition V1>V2< fulfilled
170.2028	25 V1< V2>	OUT	25 Condition V1<V2> fulfilled
170.2029	25 V1< V2<	OUT	25 Condition V1<V2< fulfilled
170.2030	25 Vdiff ok	OUT	25 Voltage difference (Vdiff) okay
170.2031	25 fdiff ok	OUT	25 Frequency difference (fdiff) okay
170.2032	25 αdiff ok	OUT	25 Angle difference (alphadiff) okay
170.2033	25 f1>>	OUT	25 Frequency f1 > fmax permissible
170.2034	25 f1<<	OUT	25 Frequency f1 < fmin permissible
170.2035	25 f2>>	OUT	25 Frequency f2 > fmax permissible
170.2036	25 f2<<	OUT	25 Frequency f2 < fmin permissible
170.2037	25 V1>>	OUT	25 Voltage V1 > Vmax permissible
170.2038	25 V1<<	OUT	25 Voltage V1 < Vmin permissible
170.2039	25 V2>>	OUT	25 Voltage V2 > Vmax permissible
170.2040	25 V2<<	OUT	25 Voltage V2 < Vmin permissible
170.2050	V1 =	MV	V1 =
170.2051	f1 =	MV	f1 =
170.2052	V2 =	MV	V2 =
170.2053	f2 =	MV	f2 =
170.2054	dV =	MV	dV =
170.2055	df =	MV	df =
170.2056	dα =	MV	dalpha =
170.2090	25 V2>V1	OUT	25 Vdiff too large (V2>V1)
170.2091	25 V2<V1	OUT	25 Vdiff too large (V2<V1)
170.2092	25 f2>f1	OUT	25 fdiff too large (f2>f1)
170.2093	25 f2<f1	OUT	25 fdiff too large (f2<f1)
170.2094	25 α2>α1	OUT	25 alphadiff too large (a2>a1)
170.2095	25 α2<α1	OUT	25 alphadiff too large (a2<a1)
170.2096	25 FG-Error	OUT	25 Multiple selection of func-groups
170.2097	25 Set-Error	OUT	25 Setting error
170.2101	25-1 OFF	OUT	Sync-group 1 is switched OFF
170.2102	>BLK 25 CLOSE	SP	>BLOCK 25 CLOSE command
170.2103	25 CLOSE BLK	OUT	25 CLOSE command is BLOCKED

2.8 24 Overexcit. Protection (Volt/Hertz)

Overexcitation protection is used to detect inadmissibly high induction in generators and transformers, especially in power station unit transformers. The protection must intervene when the limit value for the protected object (e.g. unit transformer) is exceeded. The transformer is endangered, for example, if the power station block is disconnected from the system from full-load, and if the voltage regulator either does not operate or does not operate sufficiently fast to control the associated voltage rise. Similarly a decrease in frequency (speed), e.g. in island systems, can lead to an inadmissible increase in induction.

An increase in induction above the rated value quickly saturates the iron core and causes large eddy current losses.

2.8.1 Functional Description

Measurement Method

The overexcitation protection feature servers to measure the voltage V/frequency f, ratio f, which is proportional to the B induction and puts it in relation to the B_N nominal induction. In this context, both voltage and frequency are related to nominal values of the object to be protected (generator, transformer).

$$B \sim \frac{V}{f}$$

[uebereregungsschutz-020827-ho, 1, en_US]

$$\frac{B}{B_{N\,Mach}} = \frac{\frac{V}{V_{N\,Mach}}}{\frac{f}{f_N}} \hat{=} \frac{V}{f} \qquad \text{(simplified notation)}$$

[uebereregungsschutz2-020827-ho, 1, en_US]

The calculation is based on the maximum of the three phase-to-phase voltages. The frequency range monitored extends from 25 Hz to 70 Hz.

Voltage Transformer Adaptation

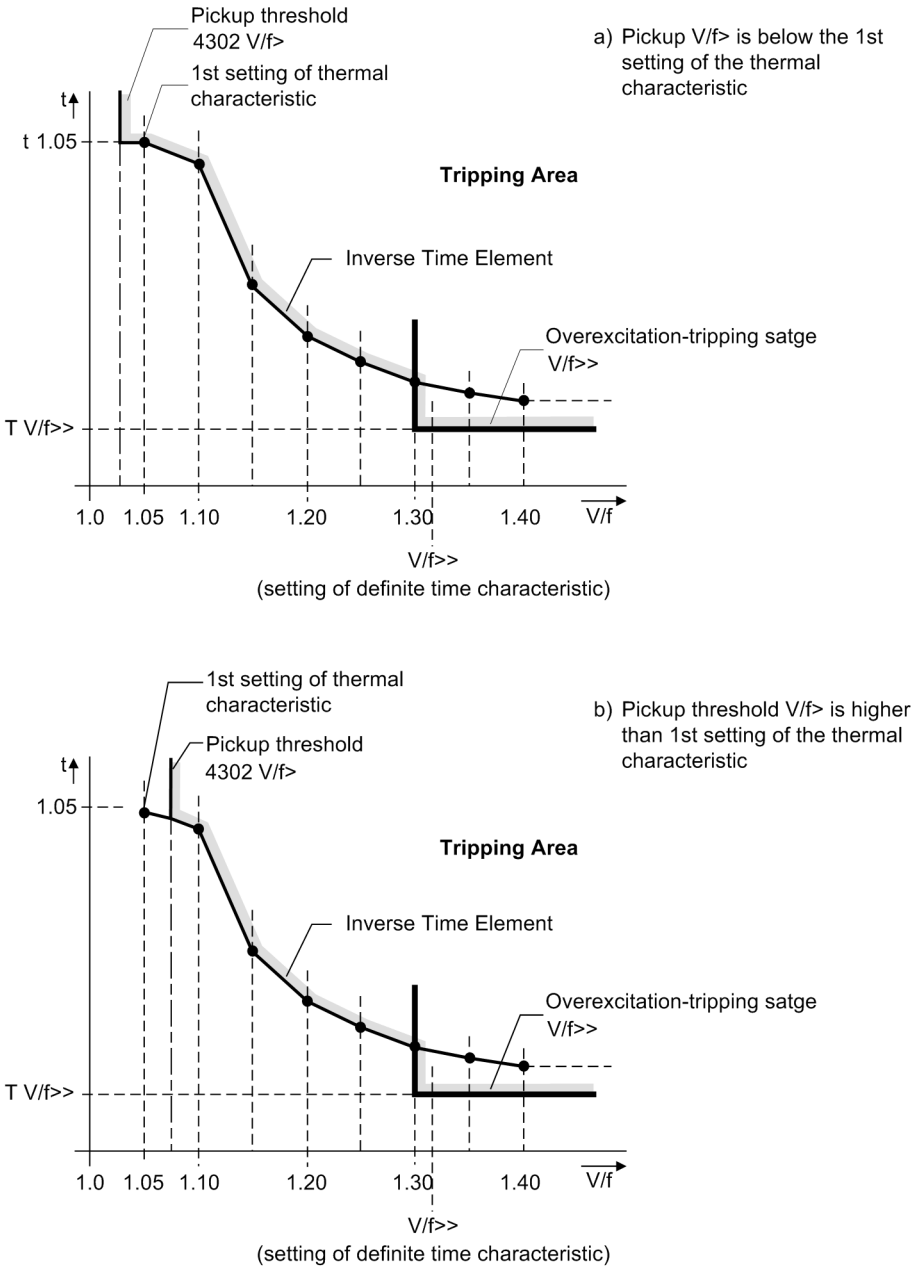
Any deviation between the primary nominal voltage of the voltage transformers and of the protected object is compensated by an internal correction factor ($V_{Nom\,prim}/V_{Nom\,Mach}$). For this reason pickup values and characteristic do not need to be converted to secondary values. However the system primary nominal transformer voltage and the nominal voltage of the object to be protected must be entered correctly (see Sections *2.1.3 Power System Data 1* and *2.1.6 Power System Data 2*).

Characteristics

Overexcitation protection includes two time graded characteristics and one thermal characteristic for approximate modeling of the heating of the protection object due to overexcitation. As soon as a first pickup threshold (warning element 4302 **24-1 PICKUP**) has been exceeded, a 4303 **24-1 DELAY** time element is started. On its expiry a warning message is transmitted. At the same time a counter switching is activated when the pickup threshold is exceeded. This weighted counter is incremented in accordance with the current V/f value resulting in the trip time for the parametrized characteristic. A trip signal is transmitted as soon as the trip counter state has been reached.

The trip signal is retracted as soon as the value falls below the pickup threshold and the counter is decremented in accordance with a parametrizable cool-down time.

The thermal characteristic is specified by 8 value pairs for overexcitation V/f (related to nominal values) and trip time t. In most cases, the specified characteristic for standard transformers provides sufficient protection. If this characteristic does not correspond to the actual thermal behavior of the object to be protected, any desired characteristic can be implemented by entering customer-specific trip times for the specified V/f overexcitation values. Intermediate values are determined by a linear interpolation within the device.

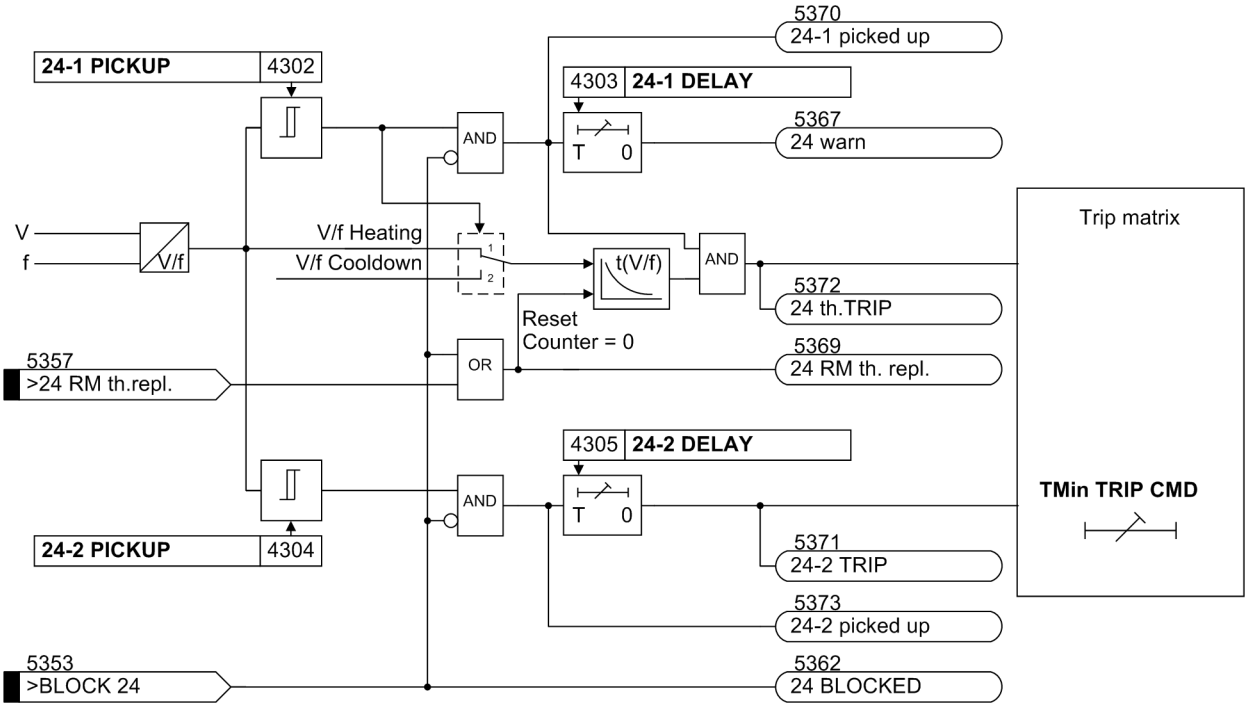


[ausloesebereich-des-uebererregungsschutz-020827-ho, 1, en_US]

Figure 2-28 Tripping Range of the Overexcitation Protection

The characteristic resulting from the device default settings is shown in the Technical Data Section Overexcitation Protection. *Figure 2-28* illustrates the behaviour of the protection on the assumption that within the framework of configuration the setting for the pickup threshold (parameter 4302 **24-1 PICKUP**) was chosen higher or lower than the first setting value of the thermal characteristic.

The following figure shows the logic diagram for overexcitation protection. The counter can be reset to zero by means of a blocking input or a reset input.



[logikdiagramm-des-uebererregungsschutzes-020827-ho, 1, en_US]

Figure 2-29 Logic diagram of the Overecxitation protection

2.8.2 Setting Notes

General

Overecxitation Protection is only in effect and accessible if address 143 **24 V/f** is set to ***Enabled*** during configuration of protective functions. If the function is not required ***Disabled*** is set. Under address 4301 **FCT 24 V/f** the function can be turned ***ON*** or ***OFF***.

Overexcitation protection measures the voltage/frequency quotient which is proportional to the induction B. The protection must intervene when the limit value for the protected object (e.g. unit transformer) is exceeded. The transformer is for example endangered if the power station block is switched off at full-load operation and the voltage regulator does not respond fast enough or not at all to avoid related voltage increase.

Similarly a decrease in frequency (speed), e.g. in island systems, can lead to an inadmissible increase in induction.

In this way the V/f protection monitors the correct functioning both of the voltage regulator and of the speed regulation, in all operating states.

Independent Elements

The limit-value setting at address 4302 **24-1 PICKUP** is based on the induction limit value relation to the nominal induction (B/B_N) as specified by the manufacturer of the object to be protected.

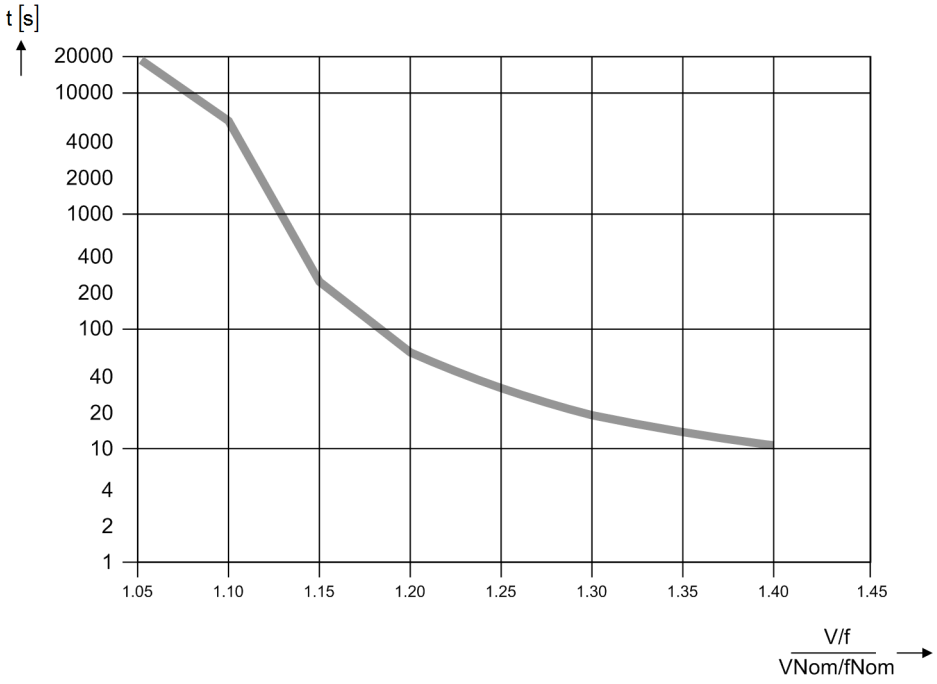
A pickup message is transmitted as soon as the induction limit value V/f at address 4302 is exceeded. A warning message is transmitted after expiry of the corresponding 4303 **24-1 DELAY** time delay.

The 4304 **24-2 PICKUP**, 4305 **24-2 DELAY** trip element characteristic serves to rapidly switch off particularly strong overexcitations.

The time set for this purpose is an additional time delay which does not include the operating time (measuring time, drop-out time).

Thermal Characteristic

A thermal characteristic is superimposed on the trip element characteristic. For this purpose, the temperature rise created by the overexcitation is approximately modeled. Not only the already mentioned pickup signal is generated on transgression of the V/f induction limit set at address 4302, but in addition a counter is activated additionally which causes the tripping after a length of time corresponding to the set characteristic.



[thermische-ausloesekennlinie-020827-ho, 1, en_US]

Figure 2-30 Thermal tripping time characteristic (with presettings)

The characteristic of a Siemens standard transformer was selected as a default setting for the parameters 4306 to 4313. If the protection object manufacturer did not provide any information, the preset standard characteristic should be used. Otherwise, any trip characteristic can be specified entering parameters point-bypoint over a maximum of 7 straight lengths. To do this, the trip times t of the overexcitation values V/f = 1.05; 1.10; 1.15; 1.20; 1.25; 1.30; 1.35 and 1.40 are read out from predefined characteristic and entered at the addresses 4306 **24-t(V/f=1.05)** to 4313 **24-t(V/f=1.40)** 24-t(V/f=1.40). The protection device interpolates linearly between the points.

Limitation

The heating model of the object to be protected is limited to a 150 % overshoot of the trip temperature.

Cooling time

Tripping by the thermal image drops out by the time of the pickup threshold dropout. However, the counter content is counted down to zero with the cooldown time parametrized at address 4314 **24 T COOL DOWN**. In this context this parameter is defined as the time required by the thermal image to cool down from 100 % to 0 %.

Voltage Transformer Adaptation

Any deviation between primary nominal voltage of the voltage transformers and of the object to be protected is compensated by an internal correction factor ($V_{Nom\ prim}/V_{Nom\ Mach}$). For this it is necessary that the relevant parameters 202 **Vnom PRIMARY** and 1101 **FullScaleVolt.** have been entered correctly in accordance with Section *2.1.3.2 Setting Notes* and *2.1.6.2 Setting Notes*.

2.8.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
4301	FCT 24 V/f	OFF ON	OFF	24 Overexcit. Protection (Volt/ Hertz)
4302	24-1 PICKUP	1.00 .. 1.20	1.10	24-1 V/f Pickup
4303	24-1 DELAY	0.00 .. 60.00 sec	10.00 sec	24-1 V/f Time Delay
4304	24-2 PICKUP	1.00 .. 1.40	1.40	24-2 V/f Pickup
4305	24-2 DELAY	0.00 .. 60.00 sec	1.00 sec	24-2 V/f Time Delay
4306	24-t(V/f=1.05)	0 .. 20000 sec	20000 sec	24 V/f = 1.05 Time Delay
4307	24-t(V/f=1.10)	0 .. 20000 sec	6000 sec	24 V/f = 1.10 Time Delay
4308	24-t(V/f=1.15)	0 .. 20000 sec	240 sec	24 V/f = 1.15 Time Delay
4309	24-t(V/f=1.20)	0 .. 20000 sec	60 sec	24 V/f = 1.20 Time Delay
4310	24-t(V/f=1.25)	0 .. 20000 sec	30 sec	24 V/f = 1.25 Time Delay
4311	24-t(V/f=1.30)	0 .. 20000 sec	19 sec	24 V/f = 1.30 Time Delay
4312	24-t(V/f=1.35)	0 .. 20000 sec	13 sec	24 V/f = 1.35 Time Delay
4313	24-t(V/f=1.40)	0 .. 20000 sec	10 sec	24 V/f = 1.40 Time Delay
4314	24 T COOL DOWN	0 .. 20000 sec	3600 sec	24 Time for Cooling Down

2.8.4 Information List

No.	Information	Type of Informa-tion	Comments
5353	>BLOCK 24	SP	>BLOCK 24
5357	>24 RM th.repl.	SP	>24 Reset memory of thermal replica V/f
5361	24 OFF	OUT	24 is swiched OFF
5362	24 BLOCKED	OUT	24 is BLOCKED
5363	24 ACTIVE	OUT	24 is ACTIVE
5367	24 warn	OUT	24 V/f warning element
5369	24 RM th. repl.	OUT	24 Reset memory of thermal replica V/f
5370	24-1 picked up	OUT	24-1 V/f> picked up
5371	24-2 TRIP	OUT	24-2 TRIP of V/f>> element
5372	24 th.TRIP	OUT	24 TRIP of th. element
5373	24-2 picked up	OUT	24-2 V/f>> picked up

2.9 Jump of Voltage Vector

Consumers with their own generating plant, for example, feed power directly into a network. The incoming feeder line is usually the technical and legal ownership boundary between the network operator and these consumers/ producers. A failure of the input feeder line, for example, due to a three-pole automatic reclosure, can result in a deviation of the voltage or frequency at the feeding generator which is a function of the overall power balance. When the incoming feeder line is switched on again after the dead time, asynchronous conditions may prevail that cause damage to the generator or the gear train between generator and drive.

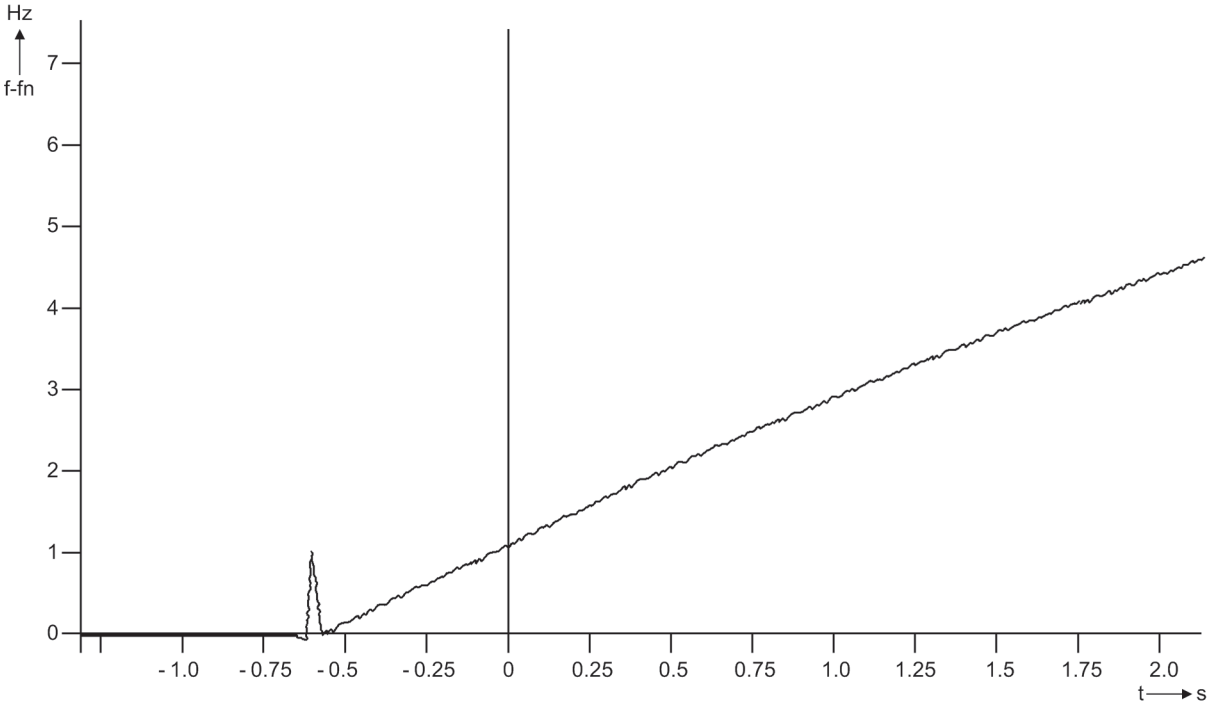
One way to identify an interruption of the incoming feeder is to monitor the phase angle in the voltage. If the incoming feeder fails, the abrupt current interruption causes a phase angle jump in the voltage. This jump is detected by means of a delta process. As soon as a preset threshold is exceeded, an opening command for the generator or bus-tie coupler circuit-breaker is issued.

This means that the vector jump function is mainly used for network decoupling.

2.9.1 Functional Description

Frequency Behaviour on Load Shedding

The following figure shows the evolution of the frequency when a load is disconnected from a generator. Opening of the generator circuit breaker causes a phase angle jump that can be observed in the frequency measurement as a frequency jump. The generator is accelerated in accordance with the power system conditions.



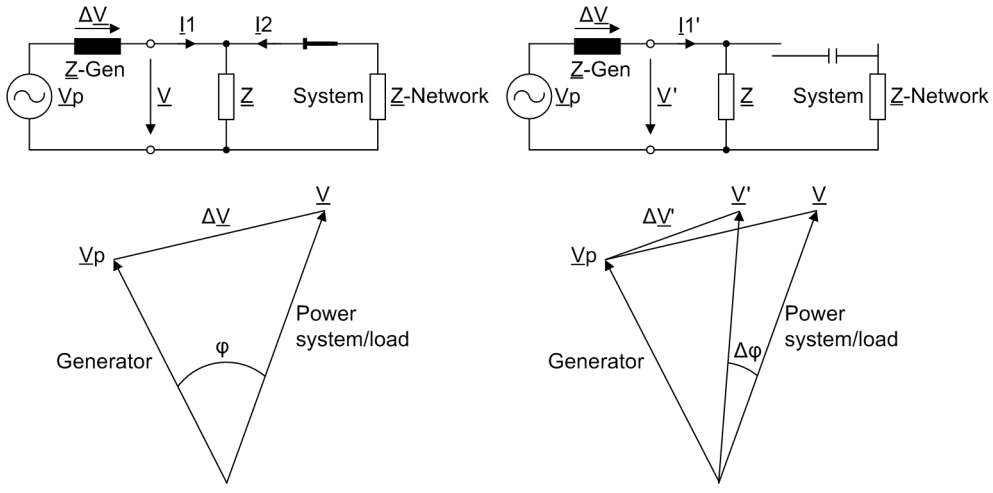
[veraenderung-der-frequenz-nach-lastabschaltg-020904-ho, 1, en_US]

Figure 2-31 Change of the Frequency after Disconnection of a Load (Fault recording with the SIPROTEC 4 device – the figure shows the deviation from the nominal frequency)

Measuring principle

For a three phase voltage connection, the vector of the positive sequence system voltage is calculated . For a single-phase connection, the connected single-phase voltage is evaluated. The phase angle change of the voltage vector is determined over a delta interval of 2 cycles. The presence of a phase angle jump indicates an abrupt change of current flow. The basic principle is shown in *Figure 2-32*. The diagram on the left shows the

steady state, and the diagram on the right the vector change following a load shedding. The vector jump is clearly visible.



[spannungszeiger-nach-entlastung-020904-ho, 1, en_US]

Figure 2-32 Voltage Vector Following Load Shedding

The function features a number of additional measures to avoid spurious tripping, such as:

- Correction of steady-state deviations from rated frequency
- Frequency operating range limited to f_{Nom} ± 3 Hz
- Detection of internal scanning frequency changeover (Scanning frequency adjustment)
- Minimum voltage for enabling
- Blocking on voltage connection or disconnection

Logic

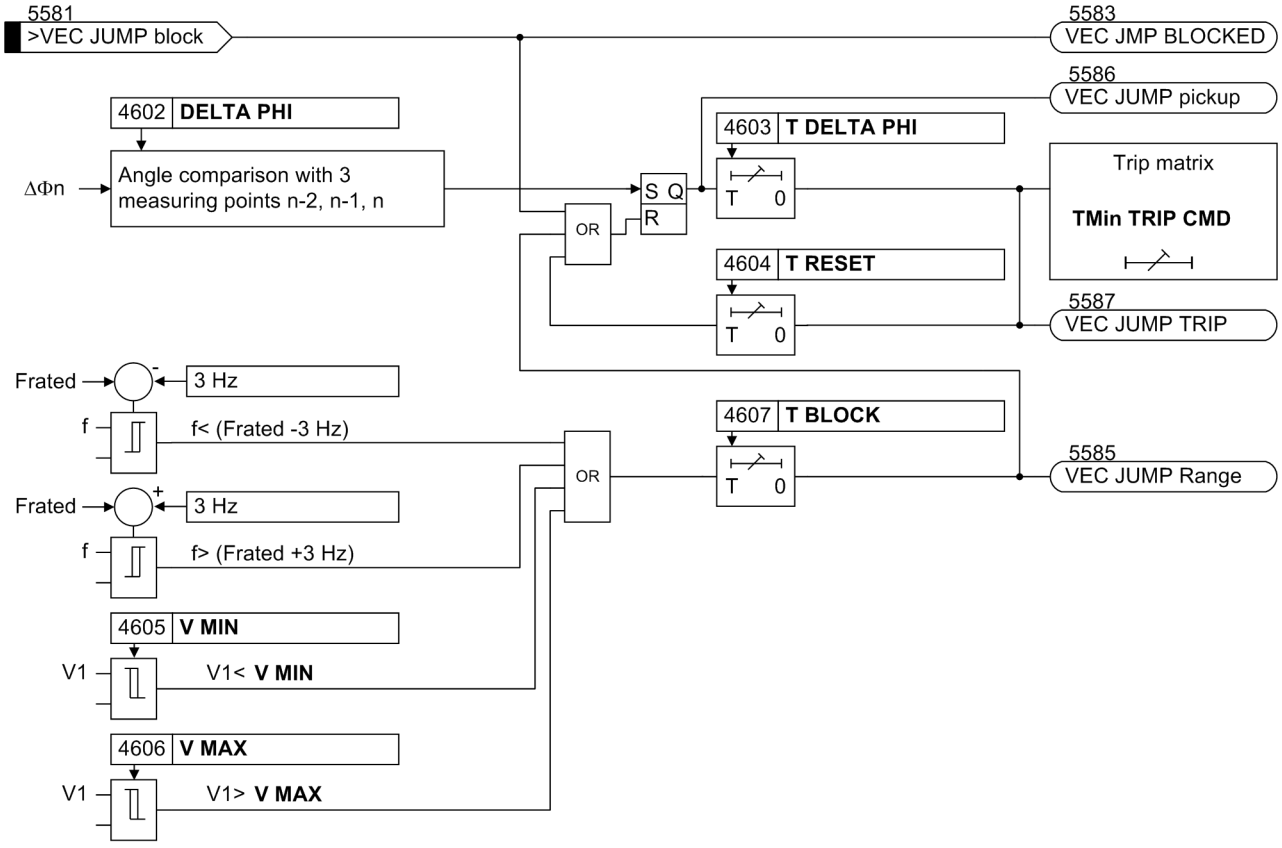
The logic is shown in *Figure 2-33*. The phase angle comparison determines the angle difference, and compares it with the set value. If this value is exceeded, the vector jump is stored in a RS flip-flop. Trippings can be delayed by the associated time delay.

The stored pickup can be reset via a binary input, or automatically by a timer (address 4604 **T RESET**).

The vector jump function becomes ineffective on exiting the admissible frequency band. The same applies for the voltage. In such a case the limiting parameters are **V MIN** and **V MAX**.

If the frequency or voltage range is not maintained, the logic generates a logical 1, and the reset input is continuously active. The result of the vector jump measurement is suppressed. If, for instance, the voltage is connected, and the frequency range is correct, the logical 1 changes to 0. The timer **T BLOCK** with reset delay keeps the reset input active for a certain time, thus preventing a pickup caused by the vector jump function.

If a short-circuit causes the voltage to drop abruptly to a low value, the reset input is immediately activated to block the function. The vector jump function is thus prevented from causing a trip.



[logikdiagramm-der-vektorsprungerfassung-020827-ho, 1, en_US]

Figure 2-33 Logic diagram of the vector jump detection

2.9.2 Setting Notes

General

The vector jump protection is only effective and available if address 146 **VECTOR JUMP** is set to ***Enabled*** during configuration.

Under address 4601 **VECTOR JUMP** the function can be turned ***ON*** or ***OFF***.

Pickup Values

The value to be set for the vector jump (address 4602 **DELTA PHI**) depends on the feed and load conditions. Abrupt active power changes cause a jump of the voltage vector. The value to be set must be established in accordance with the particular power system. This can be done on the basis of the simplified equivalent circuit of the diagram "Voltage Vector Following Load Shedding" in the Functional Description section, or using network calculation software.

If a setting is too sensitive, the protection function is likely to perform a network decoupling every time loads are connected or disconnected. Therefore the default setting is **10°**.

The admissible voltage operating range can be set at addresses 4605 for **V MIN** and 4606 for **V MAX**. The setting values for **V MIN** and **V MAX** always refer to phase-phase voltages. With a single-phase connection they refer to the phase-to-ground voltage of the selected connection. Setting range limits are to some extent a matter of the utility's policy. The value for **V MIN** should be below the admissible level of short voltage dips for which network decoupling is desired. The default setting is ***80*** % of the nominal voltage. For **V MAX** the maximum admissible voltage must be selected. This will be in most cases ***130*** % of the nominal voltage.

Time Delays

The time delay **T DELTA PHI** (address 4603) should be left at zero, unless you wish to transmit the trip indication with a delay to a logic (CFC), or to leave enough time for an external blocking to take effect.

After expiry of the timer **T RESET** (address 4604), the protection function is automatically reset. The reset time depends on the decoupling policy. It must have expired before the circuit breaker is reclosed. Where the automatic reset function is not used, the timer is set to ∞. The reset signal must come in this case from the binary input (circuit breaker auxiliary contact).

The timer **T BLOCK** with reset delay (address 4607) helps to avoid overfunctioning when voltages are connected or disconnected. Normally the default setting need not be changed. Any change can be performed with the DIGSI communication software (advanced parameters). It must be kept in mind that **T BLOCK** should not be set less than the measuring window for vector jump measurement (150 ms).

2.9.3 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under "Additional Settings".

Addr.	Parameter	Setting Options	Default Setting	Comments
4601	VECTOR JUMP	OFF ON	OFF	Jump of Voltage Vector
4602	DELTA PHI	2 .. 30 °	10 °	Jump of Phasor DELTA PHI
4603	T DELTA PHI	0.00 .. 60.00 sec	0.00 sec	T DELTA PHI Time Delay
4604	T RESET	0.10 .. 60.00 sec	5.00 sec	Reset Time after Trip
4605A	V MIN	10.0 .. 125.0 V	80.0 V	Minimal Operation Voltage V MIN
4606A	V MAX	10.0 .. 170.0 V	130.0 V	Maximal Operation Voltage V MAX
4607A	T BLOCK	0.00 .. 60.00 sec	0.15 sec	Time Delay of Blocking

2.9.4 Information List

No.	Information	Type of Information	Comments
5581	>VEC JUMP block	SP	>BLOCK Vector Jump
5582	VEC JUMP OFF	OUT	Vector Jump is switched OFF
5583	VEC JMP BLOCKED	OUT	Vector Jump is BLOCKED
5584	VEC JUMP ACTIVE	OUT	Vector Jump is ACTIVE
5585	VEC JUMP Range	OUT	Vector Jump not in measurement range
5586	VEC JUMP pickup	OUT	Vector Jump picked up
5587	VEC JUMP TRIP	OUT	Vector Jump TRIP

2.10 Phase Rotation

A phase rotation function via binary input and parameter is implemented in 7RW80 devices.

Applications

- Phase rotation ensures that all protective and monitoring functions operate correctly even with anti-clockwise rotation, without the need for two phases to be reversed.

2.10.1 Functional Description

General

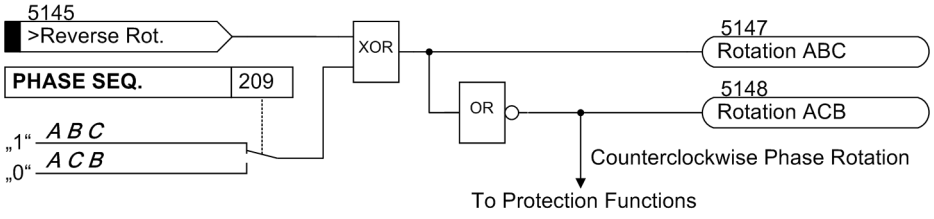
Various functions of the 7RW80 only operate correctly if the phase rotation of the voltages is known. Among these functions are undervoltage protection (based only on positive sequence voltages) and measured value monitors.

If an "acb" phase rotation is normal, the appropriate setting is made during configuration of the Power System Data.

If the phase rotation can change during operation (e.g. the direction of a motor must be routinely changed), then a changeover signal at the routed binary input for this purpose is sufficient to inform the protective relay of the phase rotation reversal.

Logic

Phase rotation is permanently established at address 209 **PHASE SEQ.** (Power System Data). Via the exclusive- OR gate the binary input *>Reverse Rot.* inverts the sense of the phase rotation applied with setting.



[dw_meldelogikdrehfeldumschaltung, 1, en_US]

Figure 2-34 Message logic of the phase rotation reversal

Influence on Protective and Monitoring Functions

The swapping of phases directly impacts the calculation of positive and negative sequence quantities, as well as phase-to-phase voltages via the subtraction of one phase-to-ground voltage from another and vice versa. Therefore, this function is vital so that phase detection messages, fault values, and operating measurement values are not correct. As stated before, this function influences the voltage protection, flexible protection functions and some of the monitoring functions that issue messages if the defined and calculated phase rotations do not match.

2.10.2 Setting Notes

Setting the Function Parameter

The normal phase sequence is set at 209 (see Section *2.1.3 Power System Data 1*). If, on the system side, phase rotation is reversed temporarily, then this is communicated to the protection device using the binary input *>Reverse Rot.* (5145).

2.11 Function Logic

The function logic coordinates the execution of protection and auxiliary functions, it processes the resulting decisions and information received from the system. This includes in particular:

Fault Detection / Pickup Logic

Processing Tripping Logic

2.11.1 Pickup Logic of the Entire Device

General Device Pickup

The pickup signals for all protection functions in the device are connected via an OR logic and lead to the general device pickup. 4 It is initiated by the first function to pick up and drop out when the last function drops out. As a consequence, the following message is reported: 501 *Relay PICKUP*.

The general pickup is a prerequisite for a number of internal and external consequential functions. The following are among the internal functions controlled by general device pickup:

- Start of a trip log: From general device pickup to general device dropout, all fault messages are entered in the trip log.
- Initialization of Oscillographic Records: The storage and maintenance of oscillographic values can also be made dependent on the general device pickup.

Exception: Apart from the settings ***ON*** or ***OFF***, some protection functions can also be set to ***Alarm Only***. With setting ***Alarm Only*** no trip command is given, no trip log is created, fault recording is not initiated and no spontaneous fault annunciations are shown on the display.

External functions may be controlled via an output contact. Examples are:

- Automatic reclosing devices,
- Starting of additional devices, or similar.

2.11.2 Tripping Logic of the Entire Device

General Tripping

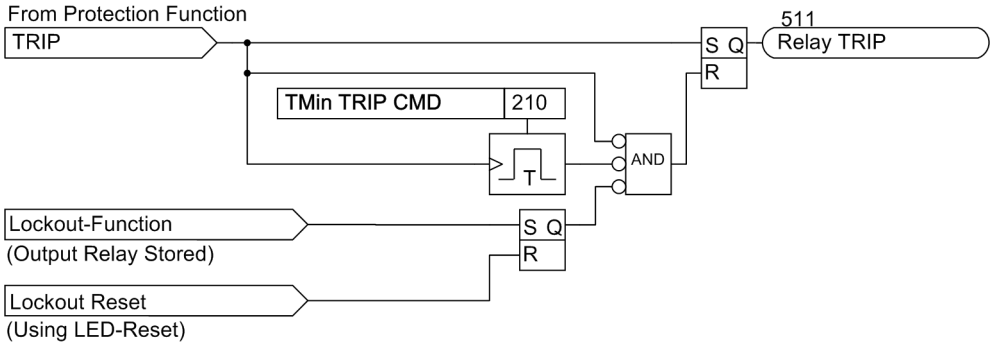
The trip signals for all protective functions are connected by OR and generate the message 511 *Relay TRIP*.

This message can be configured to an LED or binary output, just as the individual tripping messages can.

Terminating the Trip Signal

Once the trip command is output by the protection function, it is recorded as message *Relay TRIP* (see *Figure 2-35*). At the same time, the minimum trip command duration **TMin TRIP CMD** is started. This ensures that the command is transmitted to the circuit breaker for a sufficient amount of time, even if the function which issued the trip signal drops out quickly. The trip commands can be terminated first when the last protection function has dropped out (no function is in pickup mode) AND the minimum trip signal duration has expired.

Finally, it is possible to latch the trip signal until it is manually reset (lockout function). This allows the circuit-breaker to be locked against reclosing until the cause of the fault has been clarified and the lockout has been manually reset. The reset takes place either by pressing the LED reset key or by activating an appropriately allocated binary input (*>Reset LED*). A precondition, of course, is that the circuit-breaker close coil – as usual – remains blocked as long as the trip signal is present, and that the trip coil current is interrupted by the auxiliary contact of the circuit breaker.



[dw_7sj6x-abst-ausloesekommando, 1, en_US]

Figure 2-35 Terminating the Trip Signal

2.11.3 Setting Notes

Trip Signal Duration

The minimum trip command duration **`TMin TRIP CMD`** was described already in Section *2.1.3 Power System Data 1*. This setting applies to all protective functions that initiate tripping.

2.12 Auxiliary Functions

The general functions of the device are described in chapter "Auxililary Functions".

2.12.1 Message Processing

After the occurrence of a system fault, data regarding the response of the protective relay and the measured values are saved for future analysis. For this reason the device is designed to perform message processing.

Applications

- LED Display and Binary Outputs (Output Relays)
- Information via Display Field or Personal Computer
- Information to a Control Center

Prerequisites

The SIPROTEC 4 System Description provides a detailed description of the configuration procedure (see */1/ SIPROTEC 4 System Description*).

2.12.1.1 LED Displays and Binary Outputs (Output Relays)

Important events and conditions are displayed, using LEDs at the front panel of the relay. The device furthermore has output relays for remote indication. All LEDs and binary outputs indicating specific messages can be freely configured. The relay is delivered with a default setting. The Appendix of this manual deals in detail with the delivery status and the allocation options.

The output relays and the LEDs may be operated in a latched or unlatched mode (each may be individually set).

The latched conditions are protected against loss of the auxiliary voltage. They are reset:

- On site by pressing the LED key on the relay,
- Remotely using a binary input configured for that purpose,
- Using one of the serial interfaces,
- Automatically at the beginning of a new pickup.

State indication messages should not be latched. Also, they cannot be reset until the criterion to be reported has reset. This applies to messages from monitoring functions, or similar.

A green LED displays operational readiness of the relay ("RUN"), and cannot be reset. It goes out if the self-check feature of the microprocessor recognizes an abnormal occurrence, or if the auxiliary voltage is lost.

When auxiliary voltage is present, but the relay has an internal malfunction, then the red LED ("ERROR") lights up and the processor blocks the relay.

2.12.1.2 Information on the Integrated Display (LCD) or Personal Computer

Events and conditions can be read out on the display at the front cover of the relay. Using the front PC interface or the port B at the botton, a personal computer can be connected, to which the information can be sent.

The relay is equipped with several event buffers, for operational messages, circuit breaker statistics, etc., which are protected against loss of the auxiliary voltage by a buffer battery. These messages can be displayed on the LCD at any time by selection via the keypad or transferred to a personal computer via the serial service or PC interface. Readout of messages during operation is described in detail in the SIPROTEC 4 System Description.

Classification of Messages

The messages are categorized as follows:

- Operational messages (event log); messages generated while the device is operating: Information regarding the status of device functions, measured data, power system data, control command logs etc.
- Fault indications; these are indications of the last 25 network faults that were processed by the device.
- Messages of "statistics"; they include a counter for the trip commands initiated by the device and possibly reclose commands.

A complete list of all message and output functions that can be generated by the device with the maximum functional scope can be found in the appendix. All functions are associated with an information number (FNo). There is also an indication of where each message can be sent to. If functions are not present in a not fully equipped version of the device, or are configured to ***Disabled***, then the associated indications cannot appear.

Operational Messages (Buffer: Event Log)

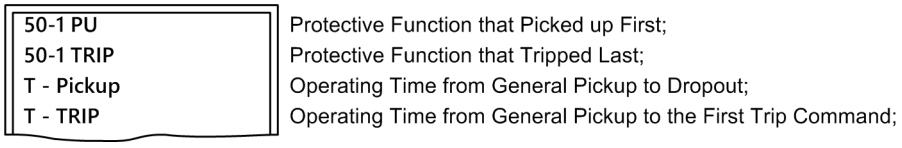
The operational messages contain information that the device generates during operation and about operational conditions. Up to 200 operational messages are recorded in chronological order in the device. New messages are appended at the end of the list. If the memory is used up, then the oldest message is scrolled out of the list by a new message.

Fault Messages (Buffer: Trip Log)

After a fault on the system, for example, important information about the progression of the fault can be retrieved, such as the pickup of a protective element or the initiation of a trip signal. The start of the fault is time stamped with the absolute time of the internal system clock. The progress of the disturbance is output with a relative time referred to the instant of fault detection, so that the duration of the fault until tripping and up to reset of the trip command can be ascertained. The resolution of the time information is 1 ms.

Spontaneous Displays on the Device Front

After occurrence of a fault, the most important fault data is output automatically on the device display, without any further operating actions. It is displayed after a general device pickup in the sequence shown in the following figure.



[dw_display-spontanmeldungen, 1, en_US]

Figure 2-36 Display of spontaneous messages in the HMI

Retrievable Messages

The messages for the last eight network faults can be retrieved and read out. The definition of a network fault is such that the time period from fault detection up to final clearing of the disturbance is considered to be one network fault. Within a network fault, several fault messages can occur (from the first pickup of a protective function to the last dropout of a protective function). Each fault event represents a network fault.

In total 600 indications can be recorded. Oldest data are erased for newest data when the buffer is full.

General Interrogation

The general interrogation which can be retrieved via DIGSI enables the current status of the SIPROTEC 4 device to be read out. All messages requiring general interrogation are displayed with their present value.

Spontaneous Messages

The spontaneous messages displayed using DIGSI reflect the present status of incoming information. Each new incoming message appears immediately, i.e. the user does not have to wait for an update or initiate one.

2.12.1.3 Information to a Control Center

Stored information can additionally be transferred to a central control and storage device if the relay is connected to such a device via port B. Transmission is possible via various transmission protocols.

2.12.2 Statistics

The number of trips initiated by the 7RW80 and the operating hours under load are counted. An additional counter enables the tripping of the count of the hours, in which the circuit breaker is positioned in condition “open”.

The counter and memory levels are secured against loss of auxiliary voltage.

During the first start of the protection device the statistical values are pre-defined to zero.

2.12.2.1 Functional Description

Number of Trips

In order to count the number of trips of 7RW80, the 7RW80 relay has to be informed of the position of the circuit breaker auxiliary contacts via binary inputs. Hereby, it is necessary that the internal pulse counter *#of TRIPs=* is allocated in the matrix to a binary input that is controlled by the circuit breaker OPEN position. The pulse count value "Number of TRIPs CB" can be found in the "Statistics" group if the option "Measured and Metered Values Only" was enabled in the configuration matrix.

Operating Hours

Moreover, the operating hours are summed (device operating time).

Hours Meter "CB open"

A counter can be implemented as CFC application which, similarly to the operating hours counter, counts the hours in the condition “circuit breaker open”. The universal hours counter is connected to a corresponding binary input and starts counting if the respective binary input is active. The counter can be set or reset. A CFC application example for such a counter is available on the Internet (SIPROTEC Download Area).

2.12.2.2 Setting Notes

Reading/Setting/Resetting Counters

The SIPROTEC 4 System Description provides a description of how to read out the statistical counters via the device front panel or DIGSI. Setting or resetting of these statistical counters takes place under the menu item **MESSAGES** —> **STATISTICS** by overwriting the counter values displayed.

2.12.2.3 Information List

No.	Information	Type of Information	Comments
-	#of TRIPs=	PMV	Number of TRIPs=
409	>BLOCK Op Count	SP	>BLOCK Op Counter
1020	Op.Hours=	VI	Counter of operating hours

2.12.3 Measurement

A series of measured values and the values derived from them are constantly available for call up on site, or for data transfer.

Applications

- Information on the actual status of the system
- Conversion of secondary values to primary values and percentages

Prerequisites

Except for secondary values, the device is able to indicate the primary values and percentages of the measured values.

A precondition correct display of the primary and percentage values is the complete and correct entry of the nominal values for the instrument transformers and the protected equipment as well as current and voltage transformer ratios in the ground paths when configuring the device. The following table shows the formulas which are the basis for the conversion of secondary values to primary values and percentages.

Measured values which cannot be calculated due to the selected voltage connection are shown as dots.

2.12.3.1 Display of Measured Values

Table 2-10 Conversion formulae between secondary values and primary/percentage values

Measured Values	sekun-dary	primary	%
V_A, V_B, V_C, V_0, V_1, V_2, V_{syn}	$V_{Ph\text{-}N\ sec.}$	$\frac{\text{Vnom PRIMARY}}{\text{Vnom SECONDARY}} \cdot U_{PhNsec}$	$\frac{V_{prim}}{\text{FullScaleVolt.}/(\sqrt{3})}$
V_{A-B}, V_{B-C}, V_{C-A}	$V_{Ph\text{-}Ph\ sec.}$	$\frac{\text{Vnom PRIMARY}}{\text{Vnom SECONDARY}} \cdot V_{Ph\text{-}Ph\ sec}$	$\frac{V_{prim}}{\text{FullScaleVolt.}}$
V_N	$V_{N\ sec.}$	$\text{Vph/Vdelta} \cdot \frac{\text{Vnom PRIM}}{\text{Vnom SEC}} \cdot V_{N\ sec}$	$\frac{V_{prim}}{\sqrt{3} \cdot \text{FullScaleVolt.}}$
V_x	$V_{x\ sec.}$	$\frac{\text{VXnom PRIMARY}}{\text{VXnom SECONDARY}} \cdot V_X$	$\frac{V_{prim}}{\text{V REF 100\% PRIM}}$
Frequency Protection	f in Hz	f in Hz	$\frac{\text{f in Hz}}{f_{Nom}} \cdot 100$

Table 2-11 Legende zu den Umrechnungsformeln

Parameter	Adresse
Vnom PRIMARY	202
Vnom SECONDARY	203
Vph / Vdelta	206
FullScaleVolt.	1101

Depending on the type of device ordered and the device connections, some of the operational measured values listed below may not be available.

The phase–to–ground voltages are either measured directly, if the voltage inputs are connected phase–to–ground, or they are calculated from the phase–to–phase voltages V_{A-B} and V_{B-C} and the displacement voltage V_N.

The displacement voltage V_N is either measured directly or calculated from the phase-to-ground voltages:

$$V_N = \frac{3 \cdot V_0}{V_{ph}/V_{delta}} \quad \text{with} \quad 3\underline{V_0} = (\underline{V_{A-G}} + \underline{V_{B-G}} + \underline{V_{C-G}})$$

V_{ph}/V_{delta} = Transformation adjustment for ground input voltage (setting 0206A)

[verlagerungsspannunguen-020315-wlk, 1, en_US]

Please note that value V_0 is indicated in the operational measured values.

The calculation of the operational measured values is also performed during a fault. The values are updated in intervals of > 0.3 s and < 1 s.

2.12.3.2 Transfer of Measured Values

Measured values can be transferred via the interfaces to a central control and storage unit.
The measuring range in which these values are transmitted depend on the protocol and, if necessary, additional settings.

Protocol	Transmittable measuring range, format
IEC 60870-5-103	0 to 240 % of the measured value.
IEC 61850	The primary operational measured values are transmitted. The measured values as well as their unit format are set out in detail in manual PIXIT 7SJ. The measured values are transmitted in “Float” format. The transmitted measuring range is not limited and corresponds to the operational measurement.
PROFIBUS, Modbus, DNP 3.0	The unit format of the measured values on the device side is at first automatically generated by means of the selected nominal values of current and voltage within the system data. The current unit format can be determined in DIGSI or at the device via Menu Operational Values. The user can select via DIGSI which operational measured values (primary, secondary or percentage) must be transmitted. The measured values are always transmitted as 16-bit values including sign (range ± 32768). The user can define the scaling of the operational measured value to be transmitted. This will result in the respective transmittable measuring range. For further details, please refer to the descriptions and protocol profiles.

2.12.3.3 Information List

No.	Information	Type of Information	Comments
621	Va =	MV	Va
622	Vb =	MV	Vb
623	Vc =	MV	Vc
624	Va-b=	MV	Va-b
625	Vb-c=	MV	Vb-c
626	Vc-a=	MV	Vc-a
627	VN =	MV	VN
629	V1 =	MV	V1 (positive sequence)
630	V2 =	MV	V2 (negative sequence)
632	Vsync =	MV	Vsync (synchronism)
644	Freq=	MV	Frequency
765	V/f =	MV	(V/Vn) / (f/fn)
766	V/f th=	MV	Calculated temperature (V/f)
832	Vo =	MV	Vo (zero sequence)
30800	VX =	MV	Voltage VX
30801	Vph-n =	MV	Voltage phase-neutral

2.12.4 Min/Max Measurement Setup

Minimum and maximum values are calculated by the 7RW80. Time and date of the last update of the values can also be read out.

2.12.4.1 Functional Description

Minimum and Maximum Values

The minimum and maximum values for the three phase-to-ground voltages $V_{x\text{-}N}$, the three phase-to-phase voltages V_{xy}, the positive sequence component V_1, the displacement voltage V_0 and the frequency are calculated as primary values (including the date and time they were last updated).

The minimum and maximum values can be reset at any time via binary inputs or by using the integrated control panel or the DIGSI software. Additionally, the reset can be carried out cyclically, starting at a preset point of time.

2.12.4.2 Setting Notes

Minimum and Maximum Values

The tracking of minimum and maximum values can be reset automatically at a programmable point in time. To select this feature, address 8311 **MinMax cycRESET** should be set to ***YES***. The point in time when reset is to take place (the minute of the day in which reset will take place) is set at address 8312 **MiMa RESET TIME**. The reset cycle in days is entered at address 8313 **MiMa RESETCYCLE**, and the beginning date of the cyclical process, from the time of the setting procedure (in days), is entered at address 8314 **MinMaxRES.START**.

2.12.4.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
8311	MinMax cycRESET	NO YES	YES	Automatic Cyclic Reset Function
8312	MiMa RESET TIME	0 .. 1439 min	0 min	MinMax Reset Timer
8313	MiMa RESETCYCLE	1 .. 365 Days	7 Days	MinMax Reset Cycle Period
8314	MinMaxRES.START	1 .. 365 Days	1 Days	MinMax Start Reset Cycle in

2.12.4.4 Information List

No.	Information	Type of Information	Comments
-	ResMinMax	IntSP_Ev	Reset Minimum and Maximum counter
397	>V MiMaReset	SP	>V MIN/MAX Buffer Reset
398	>VphphMiMaRes	SP	>Vphph MIN/MAX Buffer Reset
399	>V1 MiMa Reset	SP	>V1 MIN/MAX Buffer Reset
407	>Frq MiMa Reset	SP	>Frq. MIN/MAX Buffer Reset
859	Va-nMin=	MVT	Va-n Min
860	Va-nMax=	MVT	Va-n Max
861	Vb-nMin=	MVT	Vb-n Min
862	Vb-nMax=	MVT	Vb-n Max
863	Vc-nMin=	MVT	Vc-n Min
864	Vc-nMax=	MVT	Vc-n Max
865	Va-bMin=	MVT	Va-b Min
867	Va-bMax=	MVT	Va-b Max
868	Vb-cMin=	MVT	Vb-c Min

No.	Information	Type of Information	Comments
869	Vb-cMax=	MVT	Vb-c Max
870	Vc-aMin=	MVT	Vc-a Min
871	Vc-aMax=	MVT	Vc-a Max
872	Vn Min =	MVT	V neutral Min
873	Vn Max =	MVT	V neutral Max
874	V1 Min =	MVT	V1 (positive sequence) Voltage Minimum
875	V1 Max =	MVT	V1 (positive sequence) Voltage Maximum
882	fmin=	MVT	Frequency Minimum
883	fmax=	MVT	Frequency Maximum

2.12.5 Set Points for Measured Values

SIPROTEC devices facilitate the setting of limit values for some measured and metered values. If any of these limit values is reached, exceeded or fallen below during operation, the device issues an alarm which is indicated in the form of an operational message. This can be allocated to LEDs and/or binary outputs, transferred via the interfaces and linked in DIGSI CFC. The limit values can be configured via DIGSI CFC and allocated via the DIGSI device matrix.

Applications

- This monitoring program works with multiple measurement repetitions and a lower priority than the protection functions. Therefore, it may not pick up if measured values are changed spontaneously in the event of a fault, before a pickup or tripping of the protection function occurs. This monitoring program is therefore absolutely unsuitable for blocking protection functions.

2.12.5.1 Setting Notes

Setpoints for Measured Values

Setting is performed in the DIGSI configuration Matrix under **Settings**, **Masking I/O (Configuration Matrix)**. Apply the filter "Measured and Metered Values Only" and select the configuration group "Set Points (MV)".

Here you can insert new limit values via the Information Catalog which are subsequently linked to the measured value to be monitored using CFC.

This view also allows you to change the default settings of the limit values under **Properties**.

The settings for limit values must be in percent and usually refer to nominal values of the device.

For more details, see the SIPROTEC 4 System Description and the DIGSI CFC Manual.

2.12.6 Set Points for Statistic

2.12.6.1 Functional Description

For the statistical counters, setpoints may be entered and a message is generated as soon as they are reached. The message can be allocated to both output relays and LEDs.

2.12.6.2 Setting Notes

Setpoints for the Statistical Counter

The setting of threshold values for the statistical counters takes place in DIGSI under **Messages → Statistics** in the sub-menu **Threshold Values for Statistics**. Double-click to display the corresponding contents in another window. By overwriting the previous value the settings can be changed (please refer to the SIPROTEC 4 System Description).

2.12.6.3 Information List

No.	Information	Type of Information	Comments
-	OpHour>	LV	Operating hours greater than
272	SP. Op Hours>	OUT	Set Point Operating Hours

2.12.7 Energy Metering

Die Energiezähler werden über Binäreingangsimpulse gemessen.

2.12.7.1 Setting Notes

Setting of parameter for meter resolution

Parameter 8315 **MeterResolution** allows increasing the resolution of the energy metered values by the ***Factor 10*** or ***Factor 100*** compared to the ***Standard*** setting.

2.12.7.2 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
8315	MeterResolution	Standard Factor 10 Factor 100	Standard	Meter resolution

2.12.7.3 Information List

No.	Information	Type of Information	Comments
-	Meter res	IntSP_Ev	Reset meter
888	Wp(puls)	PMV	Pulsed Energy Wp (active)
889	Wq(puls)	PMV	Pulsed Energy Wq (reactive)

2.12.8 Commissioning Aids

In test mode or during commissioning, the device information transmitted to a central or storage device can be influenced. There are tools available for testing the system interface (port B) and the binary inputs and outputs of the device.

Applications

- Test Mode
- Commissioning

Prerequisites

In order to be able to use the commissioning aids described in the following, the device must be connected to a control center via port B.

2.12.8.1 Functional Description

Influencing Information to the Control Center During Test Mode

Some of the available protocols allow for identifying all messages and measured values transmitted to the control center with "Test Mode" as the message cause while the device is tested on site. This identification

prevents the message from being incorrectly interpreted as resulting from an actual fault. Moreover, a transmission block can be set during the test so that no messages are transferred to the control center.

This can be implemented via binary inputs, using the interface on the device front and a PC.

The SIPROTEC 4 System Description states in detail how to activate and deactivate test mode and blocked data transmission.

Testing the Connection to a Control Center

Via the DIGSI device control it can be tested whether messages are transmitted correctly.

A dialog box shows the display texts of all messages which were allocated to the system interface (port B) in the DIGSI matrix. In another column of the dialog box, a value for the messages to be tested can be defined (e.g. message ON / message OFF). After having entered password no. 6 (for hardware test menus), the corresponding message is issued and can be read out in the event log of the SIPROTEC 4 device and in the substation control center.

The procedure is described in detail in Chapter "Mounting and Commissioning".

Checking the Binary Inputs and Outputs

The binary inputs, outputs, and LEDs of a SIPROTEC 4 device can be individually and precisely controlled in DIGSI. This feature can be used, for example, to verify control wiring from the device to substation equipment (operational checks), during start-up.

A dialog box shows all binary inputs and outputs as well as LEDs of the device with their present status. The operating equipment, commands, or messages that are configured (masked) to the hardware components are also displayed. After having entered password no. 6 (for hardware test menus), it is possible to switch to the opposite status in another column of the dialog box. Thus, you can energize every single output relay to check the wiring between protected device and the system without having to create the alarm allocated to it.

The procedure is described in detail in Chapter "Mounting and Commissioning".

Creating Oscillographic Recordings for Tests

During commissioning, energization sequences should be carried out to check the stability of the protection also during closing operations. Oscillographic event recordings contain the maximum information on the behavior of the protection.

Along with the capability of storing fault recordings via pickup of the protection function, the 7RW80 also has the capability of capturing the same data when commands are given to the device via the service program DIGSI, the serial interface, or a binary input. For the latter, event *>Trig.Wave.Cap.* must be allocated to a binary input. Triggering for the oscillographic recording then occurs, for instance, via the binary input when the protection object is energized.

An oscillographic recording that is triggered externally (that is, without a protective element pickup) are processed by the device as a normal oscillographic record. For each oscillographic record a fault record is created which is given its individual number to ensure that assignment can be made properly. However, these oscillographic recordings are not displayed in the fault log buffer in the display as they are no network fault events.

The procedure is described in detail in Chapter "Mounting and Commissioning".

2.13 Breaker Control

A control command function is integrated in the SIPROTEC 4 7RW80 to coordinate the operation of circuit breakers and other equipment in the power system.

Control commands can originate from four command sources:

- Local control at the device's operator panel
- Operation using DIGSI
- Remote control via network control center or substation controller (e.g. SICAM)
- Automatic functions (e.g., via binary input)

Switchgear with single and multiple busbars are supported. The number of switchgear devices to be controlled is limited only by the number of binary inputs and outputs. Interlocking checks ensure high security against maloperation and a multitude of switchgear types and operating modes are available.

2.13.1 Control Device

Switchgear can also be controlled via the device's operator panel, DIGSI or a connection to the substation control equipment.

Applications

- Switchgear with single and double busbars

Prerequisites

The number of switchgear devices to be controlled is limited by the
– existing binary inputs
– existing binary outputs.

2.13.1.1 Functional Description

Operation Using the Device's Operator Panel

For controlling the device, there are two independent colored keys located below the graphic display. If you are somewhere in the menu system outside the control submenu, you can return to the control mode via one of these keys.

Then, select the switchgear to be operated with the help of the navigation keys. The switching direction is determined by operating the **I** or **O** pushbutton. The selected switching direction is displayed flashing in the bottom line of the following security prompt.

Password and security prompts prevent unintended switching operations. With **ENTER** the entries are confirmed.

Cancellation is possible at any time before the control command is issued or during switch selection via the **ESC** key.

Command end, feedback or any violation of the interlocking conditions are indicated.

For further information on the device operation, please refer to Section *2.14 Notes on Device Operation*.

Operation using DIGSI

Switchgear can be controlled via the operator control interface with a PC using the DIGSI software. The procedure to do so is described in the SIPROTEC 4 System Description (Control of Switchgear).

Operation Using the System Interface

Switchgear can be controlled via the serial system interface and a connection to the substation control equipment. For that it is necessary that the required periphery is physically existing in the device as well as in the

substation. Furthermore, certain settings for the serial interface need to be made in the device (see SIPROTEC 4 System Description).

2.13.1.2 Informationsübersicht

No.	Information	Type of Informa-tion	Comments
-	52Breaker	CF_D12	52 Breaker
-	52Breaker	DP	52 Breaker
-	Disc.Swit.	CF_D2	Disconnect Switch
-	Disc.Swit.	DP	Disconnect Switch
-	GndSwit.	CF_D2	Ground Switch
-	GndSwit.	DP	Ground Switch
31000	Q0 OpCnt=	VI	Q0 operationcounter=
31001	Q1 OpCnt=	VI	Q1 operationcounter=
31008	Q8 OpCnt=	VI	Q8 operationcounter=

2.13.2 Types of Commands

In conjunction with the power system control several command types can be distinguished for the device:

2.13.2.1 Functional Description

Commands to the Process

These are all commands that are directly output to the switchgear to change their process state:

- Switching commands for controlling the circuit breakers (not synchronized), disconnectors and ground electrodes
- Step commands, e.g. raising and lowering transformer LTCs
- Set-point commands with configurable time settings, e.g. to control Petersen coils

Internal / Pseudo Commands

They do not directly operate binary outputs. They serve to initiate internal functions, simulate changes of state, or to acknowledge changes of state.

- Manual overriding commands to manually update information on process-dependent objects such as annunciations and switching states, e.g. if the communication with the process is interrupted. Manually overridden objects are flagged as such in the information status and can be displayed accordingly.
- Tagging commands (for "setting") of the information value of internal objects, for example switching authority (remote/local), settings group switching, data transmission block and deleting/presetting metered values.
- Acknowledgment and resetting commands for setting and resetting internal buffers or data states.
- Information status command to set/reset the additional information "information status" of a process object, such as:
  - Input blocking
  - Output blocking

2.13.3 Command Sequence

Safety mechanisms in the command sequence ensure that a command can only be released after a thorough check of preset criteria has been successfully concluded. Standard Interlocking checks are provided for each

individual control command. Additionally, user-defined interlocking conditions can be programmed separately for each command. The actual execution of the command is also monitored afterwards. The overall command task procedure is described in brief in the following list:

2.13.3.1 Functional Description

Check Sequence

Please observe the following:

- Command Entry, e.g. using the keypad on the local user interface of the device
  - Check Password → Access Rights
  - Check Switching Mode (interlocking activated/deactivated) → Selection of Deactivated interlocking Recognition.
- User configurable interlocking checks
  - Switching Authority
  - Device Position Check (set vs. actual comparison)
  - Interlocking, Zone Controlled (logic using CFC)
  - System Interlocking (centrally, using SCADA system or substation controller)
  - Double Operation (interlocking against parallel switching operation)
  - Protection Blocking (blocking of switching operations by protective functions).
- Fixed Command Checks
  - Internal Process Time (software watch dog which checks the time for processing the control action between initiation of the control and final close of the relay contact)
  - Setting Modification in Process (if setting modification is in process, commands are denied or delayed)
  - Operating equipment enabled as output (if an operating equipment component was configured, but not configured to a binary input, the command is denied)
  - Output Block (if an output block has been programmed for the circuit breaker, and is active at the moment the command is processed, then the command is denied)
  - Board Hardware Error
  - Command in Progress (only one command can be processed at a time for one operating equipment, object-related Double Operation Block)
  - 1-of-n-check (for schemes with multiple assignments, such as relays contact sharing a common terminal a check is made if a command is already active for this set of output relays).

Monitoring the Command Execution

The following is monitored:

- Interruption of a command because of a Cancel Command
- Runtime Monitor (feedback message monitoring time)

2.13.4 Switchgear Interlocking

System interlocking is executed by the user-defined logic (CFC).

2.13.4.1 Functional Description

Interlocking checks in a SICAM / SIPROTEC 4 system are normally divided in the following groups:

- System interlocking relies on the system data base in the substation or central control system.
- Bay interlocking relies on the object data base (feedbacks) of the bay unit.
- Cross-bay interlocking via GOOSE messages directly between bay units and protection relays (with IEC61850: The inter-relay communication with GOOSE is performed via the EN100 module)

The extent of the interlocking checks is determined by the configuration of the relay. To obtain more information about GOOSE, please refer to the SIPROTEC 4 System Description.

Switching objects that require system interlocking in a central control system are assigned to a specific parameter inside the bay unit (via configuration matrix).

For all commands, operation with interlocking (normal mode) or without interlocking (Interlocking OFF) can be selected:

- For local commands, by activation of "Normal/Test"-key switch,
- For automatic commands, via command processing. by CFC and deactivated interlocking recognition,
- For local / remote commands, using an additional interlocking disable command, via Profibus.

Interlocked / Non-Interlocked Switching

The configurable command checks in the SIPROTEC 4 devices are also called "standard interlocking". These checks can be activated via DIGSI (interlocked switching/tagging) or deactivated (non-interlocked).

Deactivated interlock switching means the configured interlocking conditions are not checked in the relay.

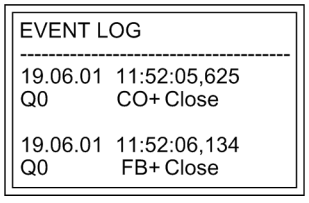
Interlocked switching means that all configured interlocking conditions are checked within the command processing. If a condition is not fulfilled, the command will be rejected by a message with a minus added to it (e.g. “CO–”), immediately followed by a message.

The following table shows the possible types of commands in a switching device and their corresponding annunciations. For the device the messages designated with *) are displayed in the event logs, for DIGSI they appear in spontaneous messages.

Type of Command	Command	Cause	Message
Control issued	Switching	CO	CO +/–
Manual tagging (positive / negative)	Manual tagging	MT	MT+/–
Information state command, input blocking	Input blocking	ST	ST+/– *)
Information state command, output blocking	Output blocking	ST	ST+/– *)
Cancel command	Cancel	CA	CA+/–

The "plus" appearing in the message is a confirmation of the command execution. The command execution was as expected, in other words positive. The minus sign means a negative confirmation, the command was rejected. Possible command feedbacks and their causes are dealt with in the SIPROTEC 4 System Description. The following figure shows operational indications relating to command execution and operation response information for successful switching of the circuit breaker.

The check of interlocking can be programmed separately for all switching devices and tags that were set with a tagging command. Other internal commands such as manual entry or abort are not checked, i.e. carried out independent of the interlocking.



[dw_display_LS-betriebsmeldung, 1, en_US]

Figure 2-37 Example of an operational annunciation for switching circuit breaker 52 (Q0)

Standard Interlocking (default)

The standard interlockings contain the following fixed programmed tests for each switching device, which can be individually enabled or disabled using parameters:

- Device Status Check (set = actual): The switching command is rejected, and an error indication is displayed if the circuit breaker is already in the set position. (If this check is enabled, then it works whether interlocking, e.g. zone controlled, is activated or deactivated.) This condition is checked in both interlocked and non-interlocked status modes.
- System Interlocking: To check the power system interlocking, a local command is transmitted to the central unit with Switching Authority = LOCAL. A switching device that is subject to system interlocking cannot be switched by DIGSI.
- Zone Controlled / Bay Interlocking: Logic links in the device which were created via CFC are interrogated and considered during interlocked switching.
- Blocking by Protection: Switch-ON commands are rejected with interlocked switches, as soon as one of the protection functions of the unit has opened a fault case. The OPEN-command, by contrast, can always be executed.
- Double Operation Block: Parallel switching operations are interlocked against one another; while one command is processed, a second cannot be carried out.
- Switching Authority LOCAL: A control command from the user interface of the device (command with command source LOCAL) is only allowed if the Key Switch (by configuration) is set to LOCAL.
- Switching Authority DIGSI: Switching commands that are issued locally or remotely via DIGSI (command with command source DIGSI) are only allowed if remote control is admissible for the device (by configuration). If a DIGSI-PC communicates with the device, it deposits here its virtual device number (VD). Only commands with this VD (when Switching Authority = REMOTE) will be accepted by the device. Remote switching commands will be rejected.
- Switching authority REMOTE: A remote switch command (command with source REMOTE) is only allowed if remote control is enabled at the device (by configuration).

Control Logic using CFC

For bay interlocking, a release logic can be created using CFC. Via specific release conditions the information "released" or "bay interlocked" are available (e.g. object "52 Close" and "52 Open" with the data values: ON/OFF).

Switching Authority

The interlocking condition "Switching Authority" serves for determining the switching authority. It enables the user to select the authorized command source. For devices with operator panel, the following switching authority ranges are defined in the following priority sequence:

- LOCAL
- DIGSI
- REMOTE

The "Switching authority" object serves for interlocking or enabling LOCAL control but not REMOTE or DIGSI commands. With a 7RW80, the switching authority can be changed between "REMOTE" and "LOCAL" on the operator panel after having entered the password or by means of CFC also via binary inputs and a function key.

The "Switching authority DIGSI" is used for interlocking and allows commands to be initiated using DIGSI. Commands are allowed for both a remote and a local DIGSI connection. When a (local or remote) DIGSI PC logs on to the device, it enters its Virtual Device Number (VD). The device only accepts commands having that VD (with switching authority = OFF or REMOTE). When the DIGSI PC logs off, the VD is cancelled.

Commands are checked for their source SC and the device settings, and compared to the information set in the objects "Switching authority" and "Switching authority DIGSI".

Configuration

Switching authority available	y/n (create appropriate object)
Switching authority available DIGSI	y/n (create appropriate object)
Specific device (e.g. switching device)	Switching authority LOCAL (check for Local status): y/n

Specific device (e.g. switching device)	Switching authority REMOTE (check for LOCAL, REMOTE, or DIGSI commands: y/n

Table 2-12 Interlocking logic

Current Switching Authority Status	Switching	Command Issued with SC[3]=LOCAL	Command Issued from SC=LOCAL or REMOTE	Command issued from SC=DIGSI
LOCAL	not registered	Allowed	Interlocked [2] - "switching authority LOCAL"	Interlocked "DIGSI not registered"
LOCAL	Checked	Allowed	Interlocked [2] - "switching authority LOCAL"	Interlocked [2] - "switching authority LOCAL" „verriegelt, da VORORT–Steuerung"
REMOTE	Not checked	Interlocked [1] - "switching authority REMOTE"	Allowed	Interlocked "DIGSI not registered"
REMOTE	Checked	Interlocked [1] - "switching authority DIGSI"	Interlocked [2] - "switching authority DIGSI"	Allowed

[1] also "Allowed" for: "switching authority LOCAL (check for Local status): is not marked

[2] also "Allowed" for: "Switching authority REMOTE (check for LOCAL, REMOTE, or DIGSI status): is not marked"

[3] SC = Source of command

SC = Auto SICAM:

Commands that are initiated internally (command processing in the CFC) are not subject to switching authority and are therefore always "allowed".

Switching Mode

The switching mode determines whether selected interlocking conditions will be activated or deactivated at the time of the switching operation.

The following switching modes (local) are defined:

- Local commands (SC = LOCAL)
  - interlocked (normal), or
  - non-interlocked switching.

With a 7RW80, the switching mode can be changed between "locked" and "unlocked" on the operator panel after having entered the password or by means of CFC also via binary inputs and a function key.

The following switching modes (remote) are defined:

- Remote or DIGSI commands (SC = LOCAL, REMOTE, or DIGSI)
  - interlocked, or
  - non-interlocked switching. Here, deactivation of interlocking is accomplished via a separate command.
  - For commands from CFC (SC = AUTO SICAM), please observe the notes in the CFC manual (component: BOOL to command).

Zone Controlled / Field Interlocking

Zone controlled / field interlocking (e.g. via CFC) includes the verification that predetermined switchgear position conditions are satisfied to prevent switching errors (e.g. disconnector vs. ground switch, ground switch only if no voltage applied) as well as verification of the state of other mechanical interlocking in the switchgear bay (e.g. High Voltage compartment doors).

Interlocking conditions can be programmed separately, for each switching device, for device control CLOSE and/or OPEN.

The enable information with the data "switching device is interlocked (OFF/NV/FLT) or enabled (ON)" can be set up,

- directly, using a single point or double point indication or internal indication (marking), or
- by means of a control logic via CFC.

When a switching command is initiated, the actual status is scanned cyclically. The assignment is done via "Release object CLOSE/OPEN".

System Interlocking

Substation Controller (System interlocking) involves switchgear conditions of other bays evaluated by a central control system.

Double Activation Blockage

Parallel switching operations are interlocked. As soon as the command has arrived all command objects subject to the interlocking are checked to know whether a command is being processed. While the command is being executed, interlocking is enabled for other commands.

Blocking by Protection

The pickup of protective elements blocks switching operations. Protective elements are configured, separately for each switching component, to block specific switching commands sent in CLOSE and TRIP direction.

When enabled, "Block CLOSE commands" blocks CLOSE commands, whereas "Block TRIP commands" blocks TRIP signals. Switching operations in progress will immediately be aborted by the pickup of a protective element.

Device Status Check (set = actual)

For switching commands, a check takes place whether the selected switching device is already in the set/desired position (set/actual comparison). This means, if a circuit breaker is already in the CLOSED position and an attempt is made to issue a closing command, the command will be refused, with the operating message "set condition equals actual condition". If the circuit breaker / switchgear device is in the intermediate position, then this check is not performed.

Bypassing Interlockings

Bypassing configured interlockings at the time of the switching action happens device-internal via interlocking recognition in the command job or globally via so-called switching modes.

- SC=LOCAL
  - The user can switch between the modes “interlocked“ or “non-interlocked“ (bypassed) in the operator panel after entering the password or using CFC via binary input and function key.
- REMOTE and DIGSI
  - Commands issued by SICAM or DIGSI are unlocked via a global switching mode REMOTE. A separate request must be sent for the unlocking. The unlocking applies only for one switching operation and for commands caused by the same source.
  - Job order: command to object "Switching mode REMOTE", ON
  - Job order: switching command to "switching device"
- Command via CFC (automatic command, SC=Auto SICAM):
  - Behavior configured in the CFC block ("BOOL to command").

2.13.5 Command Logging

During the processing of the commands, independent of the further message routing and processing, command and process feedback information are sent to the message processing center. These messages contain information on the cause. With the corresponding allocation (configuration) these messages are entered in the event list, thus serving as a report.

Prerequisites

A listing of possible operating messages and their meaning as well as the command types needed for tripping and closing of the switchgear or for raising and lowering of transformer taps are described in the SIPROTEC 4 System Description.

2.13.5.1 Functional Description

Acknowledgment of Commands to the Device Front

All messages with the source of command LOCAL are transformed into a corresponding response and shown in the display of the device.

Acknowledgment of commands to Local / Remote / DIGSI

The acknowledgment of messages with source of command Local/ Remote/DIGSI are sent back to the initiating point independent of the routing (configuration on the serial digital interface).

The acknowledgment of commands is therefore not executed by a response indication as it is done with the local command but by ordinary command and feedback information recording.

Monitoring of Feedback Information

The processing of commands monitors the command execution and timing of feedback information for all commands. At the same time the command is sent, the monitoring time is started (monitoring of the command execution). This time controls whether the device achieves the required final result within the monitoring time. The monitoring time is stopped as soon as the feedback information arrives. If no feedback information arrives, a response **Timeout command monitoring time** appears and the process is terminated.

Commands and information feedback are also recorded in the event list. Normally the execution of a command is terminated as soon as the feedback information (**FB+**) of the relevant switchgear arrives or, in case of commands without process feedback information, the command output resets and a message is output.

The "plus" sign appearing in a feedback information confirms that the command was successful. The command was as expected, in other words positive. The "minus" is a negative confirmation and means that the command was not executed as expected.

Command Output and Switching Relays

The command types needed for tripping and closing of the switchgear or for raising and lowering of transformer taps are described in the configuration section of the SIPROTEC 4 System Description */1/ SIPROTEC 4 System Description*.

2.14 Notes on Device Operation

The operation of the 7RW80 slightly differs from the other SIPROTEC 4 devices. These differences are described in the following. General information regarding the operation and configuration of SIPROTEC 4 devices is set out in the SIPROTEC 4 System Description.

2.14.1 Different operation

Pushbuttons of the Control Panels

Pushbutton	Funktion/Bedeutung
Enter	Confirming entries and navigating forward in the menus
Esc	Navigating to the main menu (where necessary, press repeatedly), navigating backwards in the menus, discarding entries
	Testing the LEDs Resetting the LED memory and binary outputs
Fn	Function key Fn for displaying the assignment of the function keys. If several function keys have been assigned, a second page is displayed for the assignment when leafing through, if required. Combined pushbutton with numeric keys for a faster navigation (e.g. Fn + 1 operational messages) Navigation to the main menu with Fn in combination with the numeric key 0.
.	For setting the contrast, keep the pushbutton pressed for about 5 seconds. Set the contrast in the menu with the scrolling keys (downward: less contrast, upward: more contrast).

Entry of Negative Signs

Only a few parameters can reach a negative value, i.e. a negative sign can only be entered for these.

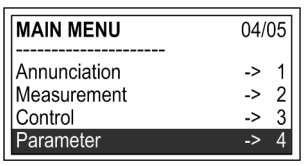
If a negative sign is permissible, the prompt -/+ --> v/^ appears in the bottom line when changing the parameter. The sign can be determined via the scrolling keys: downward = negative sign, upward = positive sign.

Display

The SIPROTEC 4 System Description applies to devices with a 4-line ASCII display. Apart from that there are devices with a graphical display and a size of 30 lines. The 7RW80 uses the outputs of the graphical display, but with 6 lines. Therefore, the representation might differ from the representations in the System Description.

The basic differences of the device with regard to the representation are the following:

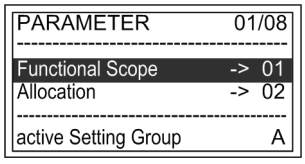
The current selection is indicated by inverse representation (not by the prefix >)



[grundbild-hauptmenue-20070404, 1, en_US]

Figure 2-38 Inverse representation of the current selection

In part, the sixth line is used for representing e.g. the active parameter group.



[grundbild-parameter-20070404, 1, en_US]

Figure 2-39 Representation of the active parameter group (line 6)

3 Mounting and Commissioning

This chapter is intended for experienced commissioning staff. He must be familiar with the commissioning of protection and control systems, the management of power systems and the safety rules and regulations. Hardware adjustments to the power system data might be necessary. The primary tests require the protected object (line, transformer, etc.) to carry load.

3.1 Mounting and Connections

General

WARNING

Warning of improper transport, storage, installation or assembly of the device.

Failure to observe these precautions can result in death, personal injury, or serious material damage.

- ✧ Trouble-free and safe use of this device depends on proper transport, storage, installation, and assembly of the device according to the warnings in this device manual.
- ✧ Of particular importance are the general installation and safety regulations for work in a high-voltage environment (for example, ANSI, IEC, EN, DIN, or other national and international regulations). These regulations must be observed.

3.1.1 Configuration Information

Prerequisites

For installation and connections the following conditions must be met:

The rated device data have been checked as recommended in the SIPROTEC 4 System Description. It has been verified that these data comply with the power system data.

General Diagrams

Block diagrams for the terminal assignment of the 7RW80 are shown in Appendix *B Terminal Assignments*. Connection examples for the current and voltage transformer circuits are provided in Appendix *C Connection Examples*.

Voltage Connection Examples

Connection examples for voltage transformers are provided in Appendix *C Connection Examples*. It must be checked that the configuration of the **Power System Data 1** (Section *Voltage Connection (Power System), Page 29*) corresponds with the connections.

The normal connection is set at address 213 **VT Connect. 3ph** = ***Van, Vbn, Vcn***.

When connecting an open delta winding of the voltage transformer set, address 213 **VT Connect. 3ph** must be set to ***Vab, Vbc, VGnd***.

Another example shows the connection mode 213 = ***Vab, Vbc, Vx***. The voltage connected to the third transformer Vx is only used by the flexible protection functions.

Binary Inputs and Outputs

The configuration options of the binary in- and outputs, i.e. the procedure for the individual adaptation to the plant conditions, are described in the SIPROTEC 4 System Description. The connections to the plant are dependent on this configuration. The presettings of the device are listed in Appendix *D Default Settings and Protocol-dependent Functions*. Please also check that the labeling strips on the front panel correspond to the configured message functions.

Setting Group Change

If binary inputs are used to switch setting groups, please observe the following:

- Two binary inputs must be dedicated to the purpose of changing setting groups when four groups are to be switched. One binary input must be set for *>Set Group Bit0*, the other input for *>Set Group Bit1*. If either of these input functions is not assigned, then it is considered as not controlled.
- For the control of 2 setting groups one binary input is sufficient, namely *>Set Group Bit0*, since the non-assigned binary input *>Set Group Bit1* is then regarded as not connected.
- The control signals must be permanently active so that the selected setting group is and remains active.

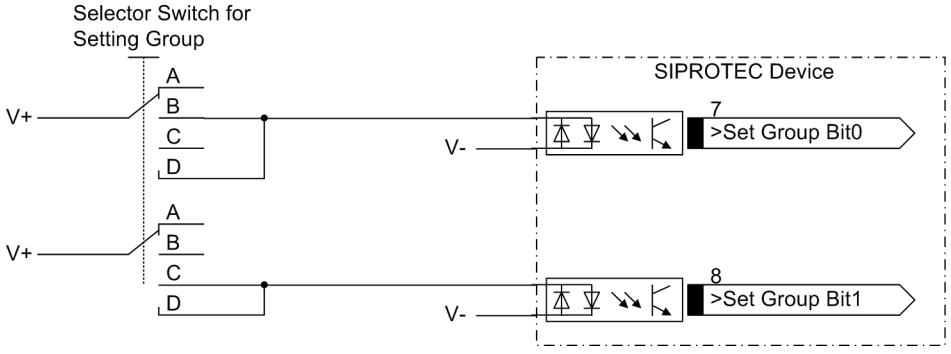
The following table shows the allocation of the binary inputs to the setting groups A to D and a simplified connection diagram for the two binary inputs is illustrated in the following figure. The figure illustrates an example in which both Set Group Bits 0 and 1 are configured to be controlled (actuated) when the associated binary input is energized (high).

Where:

no =	not energized or not connected
yes =	energized

Table 3-1 Changing setting groups using binary inputs

Binary Input		Active Group
>Param.Wahl1	**>Param. Wahl2**	
no	no	Group A
yes	no	Group B
no	yes	Group C
yes	yes	Group D



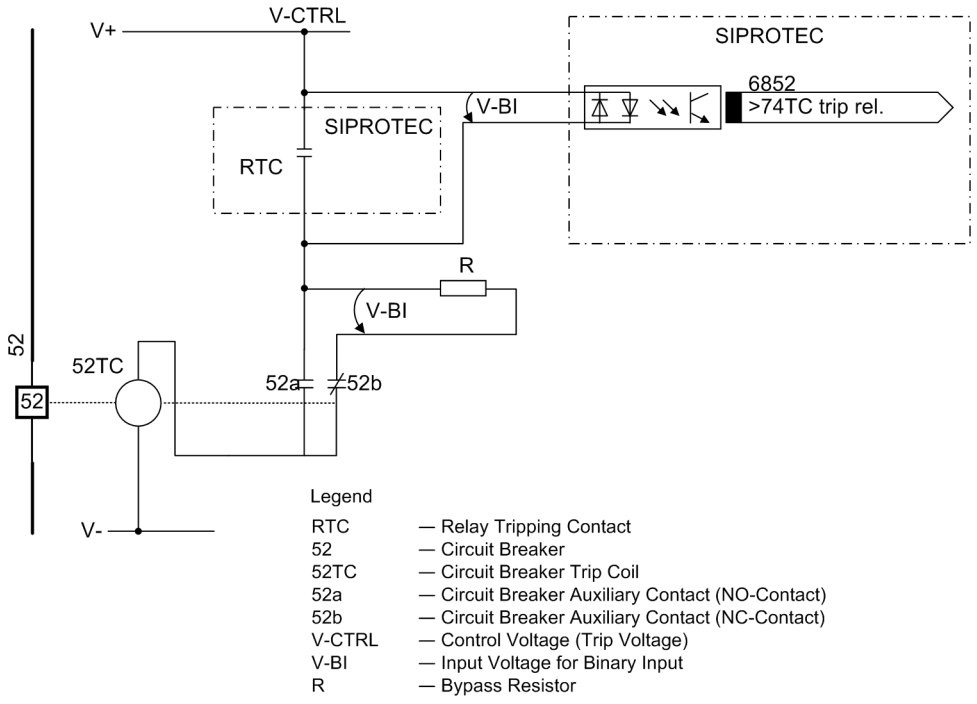
[dw_einstellgruppenumschaltung-ueber-binaere, 1, en_US]

Figure 3-1 Connection diagram (example) for setting group switching using binary inputs

Trip Circuit Supervision 74TC

It must be noted that two binary inputs or one binary input and one bypass resistor R must be connected in series. The pick-up threshold of the binary inputs must therefore be substantially below half the rated control DC voltage.

If **one** binary input is used, a bypass resistor R must be used (see following figure). The resistor R is inserted into the circuit of the 52b circuit breaker auxiliary contact to facilitate the detection of a malfunction also when the 52a circuit breaker auxiliary contact is open and the trip contact has dropped out. The value of this resistor must be such that in the circuit breaker open condition (therefore 52a is open and 52b is closed), the circuit breaker trip coil (52TC) is no longer energized and binary input (BI1) is still energized if the command relay contact is open.



[dw_prinzip-ausloesekreisueberwachung-1-binein, 1, en_US]

Figure 3-2 Trip circuit supervision with one binary input

This results in an upper limit for the resistance dimension, R_{max} and a lower limit R_{min}, from which the optimal value of the arithmetic mean R should be selected:

$$R = \frac{R_{max} + R_{min}}{2}$$

[formel-mittelwert-r-260602-kn, 1, en_US]

In order that the minimum voltage for controlling the binary input is ensured, R_{max} is derived as:

$$R_{max} = \left(\frac{V_{CTR} - V_{BI\ min}}{I_{BI\ (High)}}\right) - R_{CBTC}$$

[formel-rmax-260602-kn, 1, en_US]

So the circuit breaker trip coil does not remain energized in the above case, R_{min} is derived as:

$$R_{min} = R_{CBTC} \cdot \left(\frac{V_{CTR} - V_{CBTC\ (LOW)}}{V_{CBTC\ (LOW)}}\right)$$

[formel-rmin-260602-kn, 1, en_US]

$I_{BI\ (HIGH)}$	Constant current with activated BI (= 0.4 mA)
$V_{BI\ min}$	Minimum control voltage for BI (= 19 V at delivery setting for nominal voltages of 24 V/ 48 V; 88 V at delivery setting for nominal voltages of 60 V/ 110 V/ 125 V/ 220 V/ 250 V)
V_{CTR}	Control voltage for trip circuit
R_{CBTC}	Ohmic resistance of the circuit breaker coil
$V_{CBTC(LOW)}$	Maximum voltage on the circuit breaker coil that does not lead to tripping

If the calculation has the result $_{max} < R_{min}$, the calculation has to be repeated with the next smaller threshold $V_{BI\ min}$. This threshold is determined via the parameters 220 **Threshold BI 1** to 226 **Threshold BI 7**. The settings ***Thresh. BI 176V***, ***Thresh. BI 88V***, ***Thresh. BI 19V*** are possible.

For the power consumption of the resistance:

$$P_R = I^2 \cdot R = \left(\frac{V_{CTR}}{R + R_{CBTC}}\right)^2 \cdot R$$

[formel-leistungvon-r-260602-kn, 1, en_US]

Example

$I_{BI\ (HIGH)}$	0.4 mA (SIPROTEC 4 7RW80)
$V_{BI\ min}$	19 V at delivery setting for nominal voltages of 24 V/ 48 V; 88 V at delivery setting for nominal voltages of 60 V/ 110 V/ 125 V/ 220 V/ 250 V
V_{CTR}	110 V (from the system / trip circuit)
R_{CBTC}	500 Ω (from the system / trip circuit)
$V_{CBTC\ (LOW)}$	2 V (from the system / trip circuit)

$$R_{max} = \left(\frac{110\ V\ - 19\ V}{0.4\ mA}\right) - 500\ \Omega = 227\ k\Omega$$

[fo_r-max-bsp, 1, en_US]

$$R_{min} = \left(\frac{110\ V - 2\ V}{2\ V}\right) \cdot 500\ \Omega = 27\ k\Omega$$

[beispiel-rmin-20061211, 1, en_US]

$$R = \frac{R_{max} + R_{min}}{2} = 127\ k\Omega$$

[fo_r-mittelwertbsp, 1, en_US]

$$P_R = \left(\frac{110\ V}{127\ k\Omega + 0.5\ k\Omega}\right)^2 - 127\ k\Omega \geq 95\ mW$$

[fo_leistung-r, 1, en_US]

3.1.2 Hardware Modifications

3.1.2.1 Disassembly

Work on the Printed Circuit Boards

NOTE

Before carrying out the following steps, make sure that the device is not operative.

NOTE

Apart from the communication modules and the fuse, there are no further components that can be configured or operated by the user inside the device. Any service activities exceeding the installation or exchange of communication modules must only be carried out by Siemens personnel

For preparing the workplace, a pad suitable for electrostatic sensitive devices (ESD) is required.
Additionally, the following tools are required:

- a screwdriver with a 5 mm to 6 mm (0.20 – 0.24 in) wide blade,
- a Philips screwdriver size 1,
- a 5 mm (0.20 in) socket or nut driver.

In order to disassemble the device, first remove it from the substation installation. To do so, perform the steps stated in Sections Panel Flush Mounting, Panel Surface Mounting or Cubicle Mounting in reverse order.

NOTE

The following must absolutely be observed:

Disconnect the communication connections at the device bottom (ports A and B). If this is not observed, the communication lines and/or the device might be destroyed.

NOTE

To use the device, all terminal blocks must be plugged in.

CAUTION

Mind electrostatic discharges

Failure to observe these precautions can result in personal injury or material damage.

✧ Any electrostatic discharges while working at the electronics block are to be avoided. We recommend ESD protective equipment (grounding strap, conductive grounded shoes, ESD-suitable clothing, etc.). Alternatively, an electrostatic charge is to be discharged by touching grounded metal parts.

NOTE

In order to minimize the expenditure for reconnecting the device, remove the completely wired terminal blocks from the device. Use a screwdriver (DIN 4 x 0.8) to carefully bend the left and right spring clips outwards. Then carefully pull out the terminal block. When reinstalling the device, carefully insert the terminal block into the spring clips. Both spring clips must engage clearly audible. (Sections Panel Flush Mounting, Panel Surface Mounting or Cubicle Mounting).

In order to install or exchange communication modules or to replace the fuse, proceed as follows:

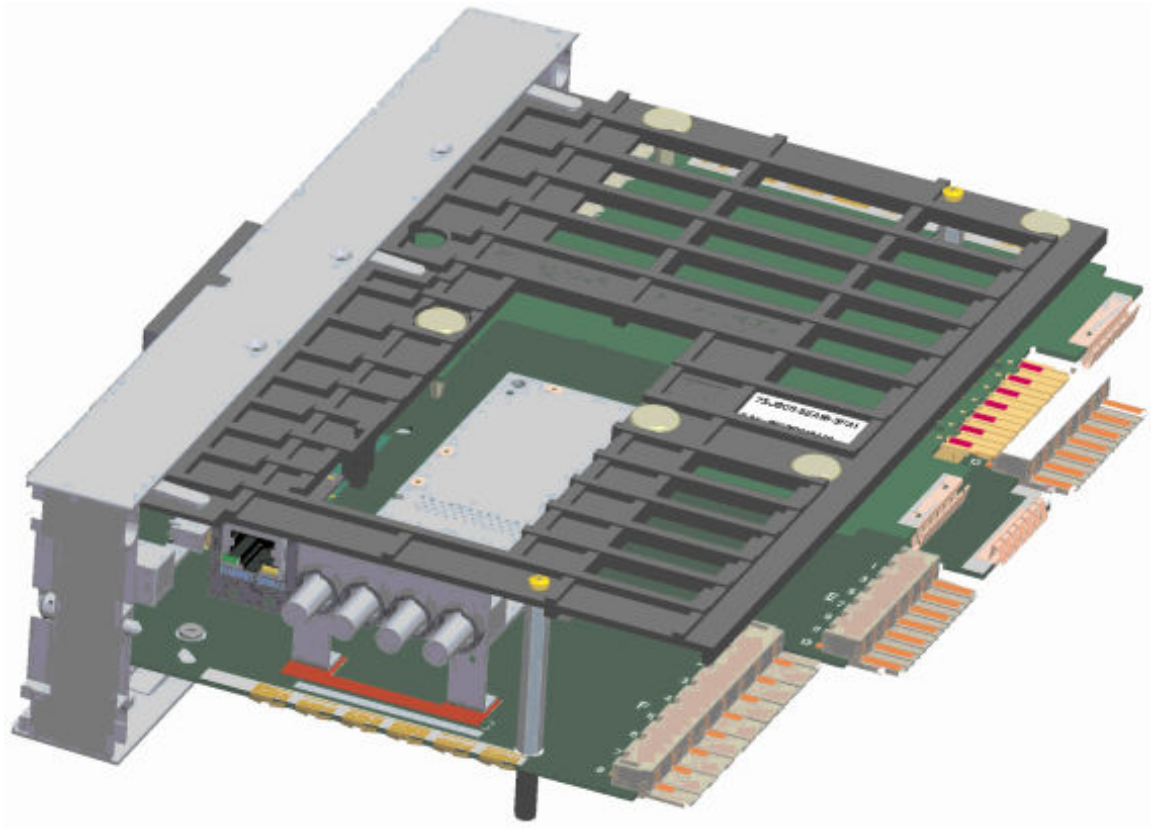
Remove the two covers at the top and bottom. Thus, 1 housing screw each at the top and bottom becomes accessible. First, only unscrew the bottom housing screw so far that its tip no longer looks out of the thread of the mounting bracket (the housing screws are captive, they remain in the front cover even when unscrewed).

Unscrew all screws that fasten any existing communication modules in the module cover on the bottom side of the device. Also unscrew the 4 countersunk screws that fasten the module cover on the bottom side of the device. Carefully pull the entire module cover out of the device.

Only now completely unscrew the two housing screws at the top and bottom in the cover and carefully remove the complete electronics block from the housing (*Figure 3-3*).

NOTE

If you have not removed the terminal blocks from the rear panel, much more force is required for removing and reinstalling the electronics block, which might lead to the damaging of the device. Therefore, we absolutely recommend to remove the terminal blocks before removing the electronics block.

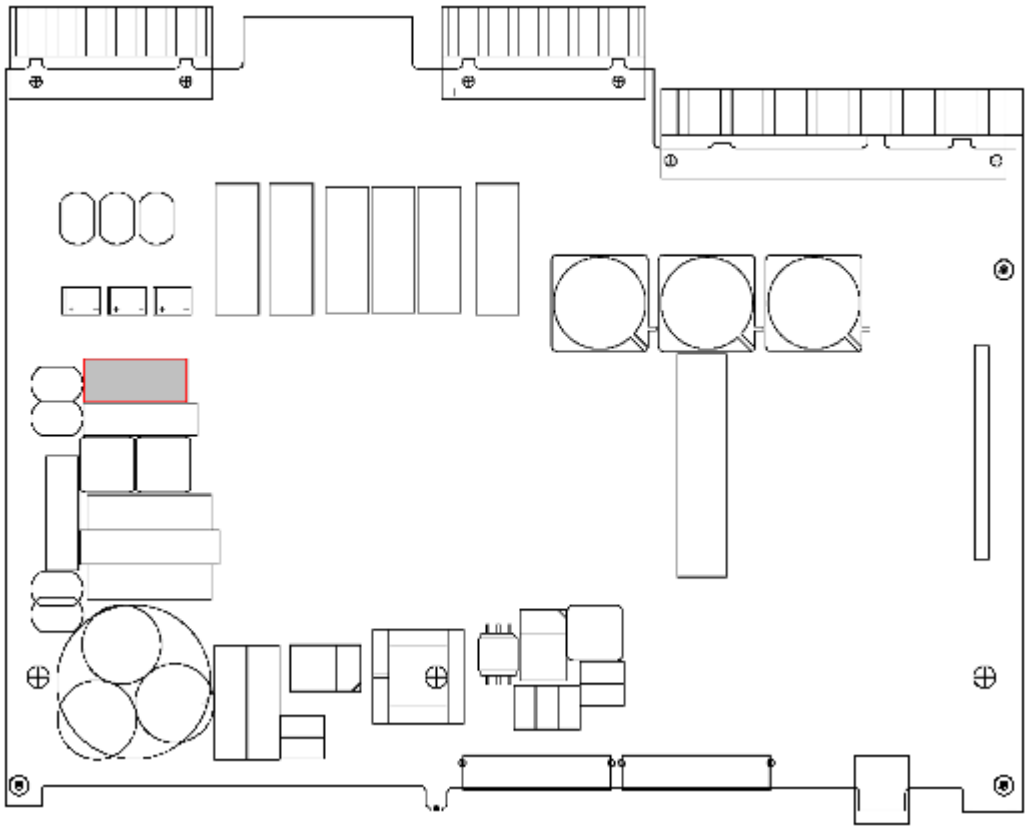


[einschub-7sj80-20071107, 1, --_--]

Figure 3-3 Electronics block without housing

Replacing the Fuse

The fuse holder is located at the edge of the basic I/O board close to the power supply connection.



[7sx80-fuse-basic-io-080408, 1, en_US]

Figure 3-4 Placing the fuse

Remove the defective fuse. Insert the new fuse with the following technical data into the fuse holder:

5 mm x 20 mm (0.20 * 0.79 in) safety fuse

T characteristic

2.0 A nominal current

250 V nominal voltage

Switching capability 1500 VA/ DC 300 V

Only UL-approved fuses may be used.

This data applies to all device types (24 V/48 V and 60 V – 250 V).

Make sure that the defective fuse has not left any obvious damage on the device. If the fuse trips again after reconnection of the device, refrain from any further repairs and send the device to Siemens for repair.

The device can now be reassembled again (see Section Reassembly).

Disposal of Old Equipment and Batteries (Applicable only for European Union and Countries with a Recycling System)

The disposal of our products and possible recycling of their components after decommissioning has to be carried out by an accredited recycling company, or the products/components must be taken to applicable collection points. Such disposal activities must comply with all local laws, guidelines and environmental specifications of the country in which the disposal is done. For the European Union the sustainable disposal of electronic scrap is defined in the respective regulation for "waste electrical and electronic equipment" (WEEE).

The crossed-out wheelie bin on the products, packaging and/or accompanying documents means that used electrical and electronic products and batteries must not be mixed with normal household waste.

According to national legislation, penalties may be charged for incorrect disposal of such waste.

By disposing of these products correctly you will help to save valuable resources and prevent any potential negative effects on human health and the environment.

NOTE

Our products and batteries must not be disposed of as household waste. For disposing batteries it is necessary to observe the local national/international directives.

Disposal of Mobile Storage Devices (e.g. USB Sticks and Memory Cards)

When disposing of/transferring mobile storage devices, using the **format** or **delete** functions only changes the file management information and does not completely delete the data from your mobile storage device. When disposing of or transferring a mobile storage device, Siemens strongly recommends physically destroying it or completely deleting data from the mobile storage device by using a commercially available computer data erasing software.

REACH/RoHS Declaration

You can find our current **REACH/RoHS** declarations at:
https://www.siemens.com/global/en/home/products/energy/ecotransparency/ecotransparency-downloads.html

NOTE

You can find more information about activities and programs to protect the climate at the EcoTransparency website:
https://www.siemens.com/global/en/home/products/energy/ecotransparency.html

3.1.2.2 Connections of the Voltage Terminals

Fixing Elements

The fixing elements for the voltage transformer connection are part of the voltage terminal (housing side). They have a stress-crack- and corrosion-resistant alloy. The head shape of the terminal screw allows for using a flat screwdriver (4.0 mm x 0.8 mm / 0.16 in x 0.031 in) or a crosstip screwdriver (PZ1). PZ1 is recommended.

Cable Lugs and Wire Cross-sections

The connection mode available is the connection as single cable. As single cables, solid conductors as well as stranded conductors with or without conductor sleeves can be used. We recommend using twin cable end sleeves when connecting two single cables. We recommend the twin cable end sleeves of the series PN 966 144 from Tyco Electronics.

When connecting single cables, the following cross-sections are allowed:

Cable cross-sections:	AWG 20-14 (0.5 mm^2 to 2.0 mm^2)
Connector sleeve with plastic collar	L = 12 mm (0.47 in)
Stripping length: (when used without conductor sleeve)	12 mm (0.47 in) Only copper cables may be used.

With terminal points lying one below the other you may connect single conductors and jumpers (Order No. C53207-A406-D194-1) together. Please make sure that neighboring jumpers are built in/connected alternately.

Mechanical Requirements

The fixing elements and the connected components are designed for the following mechanical requirements:

Permissible tightening torque at the terminal screw	1.0 Nm (8.85 lb.in)

Permissible traction per connected conductor	50 N based on IEC 60947-1 (VDE 660, Part 100)

3.1.2.3 Interface Modules

General

The 7RW80 relay is supplied with preconfigured interfaces according to the ordering version. You do not have to make any adaptations to the hardware (e.g. plugging in jumpers) yourself, except for the installation or replacement of communication modules.

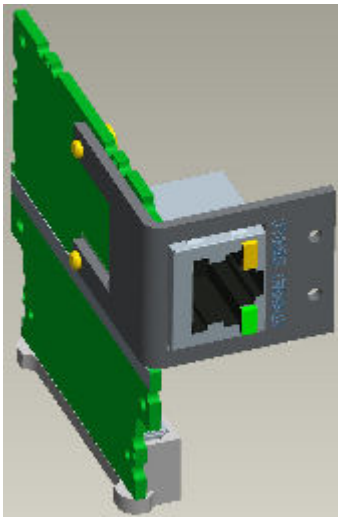
The use of the interface modules RS232, RS485 and optical can be defined via the parameter 617 **`ServiProt (CM)`**. This parameter is only visible if the 11th digit of the ordering number was selected to be 1 for RS232, 2 for RS485 or 3 for optical.

Installation or Replacement of the Ethernet Interface Module

The following requirement must be fulfilled:

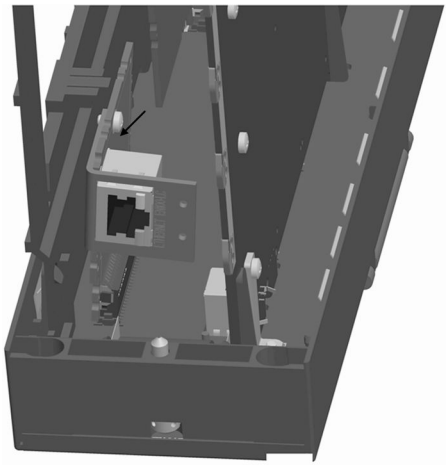
There is no SIPROTEC 4 communication module mounted yet. Otherwise, this has to be removed before actually installing the Ethernet interface module (see below).

The Ethernet interface module is inserted in the respective slot, most suitably from the open bottom, i.e. above the back of the battery case. A supporting frame is placed over the modular plug. The narrow spacer lies at edge of the printed circuit board. The module is attached to the 50-pole plug connector of the CPU module slightly inclined to the basic I/O board. The supporting plate is slightly pulled outwards in this area. The module can now be inserted vertically up to the stop. Then, the supporting plate is pressed against in the area of the locking latch until the upper edge of the printed circuit board of the Ethernet interface module snaps into the locking latch.



[com-modul-mit-stuetz-20100716, 1, --_--]

Figure 3-5 Ethernet interface with support frame



[en100-lc_schraeg-20071107, 1, --_--]

Figure 3-6 Installation of the Ethernet interface

Now, a SIPROTEC 4 communication module can be installed (see Section Installation or Replacement of a SIPROTEC 4 Communication Module). Otherwise, the device can be reassembled again (see Section Reassembly).

Installation or Replacement of a SIPROTEC 4 Communication Module

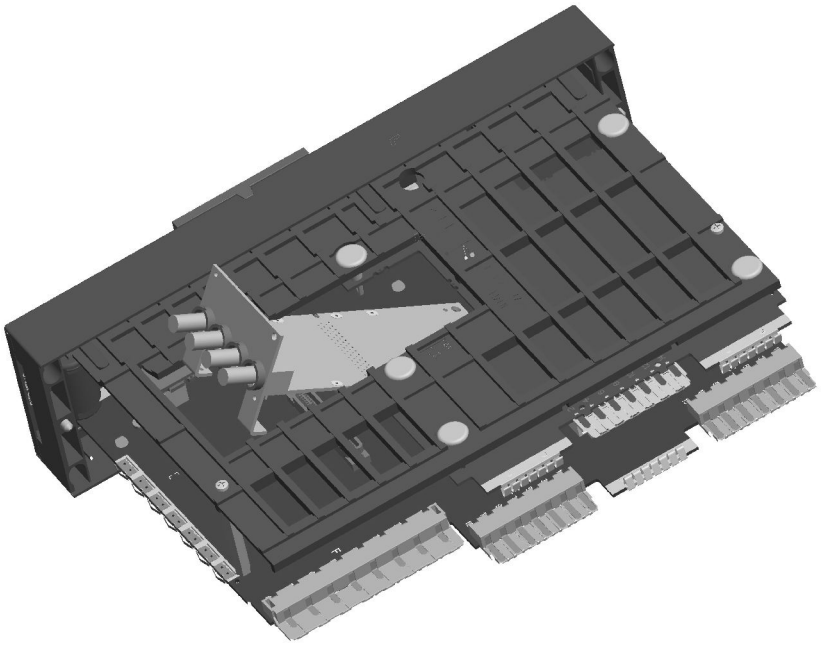
The following description assumes the normal case that a SIPROTEC 4 communication module which has not yet been existing is retrofitted.

If a SIPROTEC 4 communication module has to be removed or replaced, the steps are to be performed in reverse order.

NOTE

The installation can only be performed alone or after the installation of the Ethernet module.

The SIPROTEC 4 communication module is inserted via the large window in the plastic supporting plate. The direction of insertion is not arbitrary. The module is held at its mounting bracket. The opposite end of the module is inserted with the same orientation in the window opening, under the supporting plate and any existing extension I/O. The module bracket is turned towards the Ethernet module locking latch at the supporting plate. Thus, even the longest connection elements of the communication module can be moved in this space between the lower supporting plate reinforcement and the locking latch in the direction of the transformer module. The mounting bracket of the module is now drawn up to the stop in the direction of the lower supporting plate reinforcement. Thus, the 60-pin plug connector on the module and the basic I/O board are aligned on top of each other. The alignment has to be checked via the opening at the bottom of the rack. Attach the module's mounting rail from the back side of the basic I/O using 2 M 2.5 screws.



[com-modul-20071107, 1, --_--]

Figure 3-7 Installation of a SIPROTEC 4 communication module

The device can now be reassembled again (see Section Reassembly).

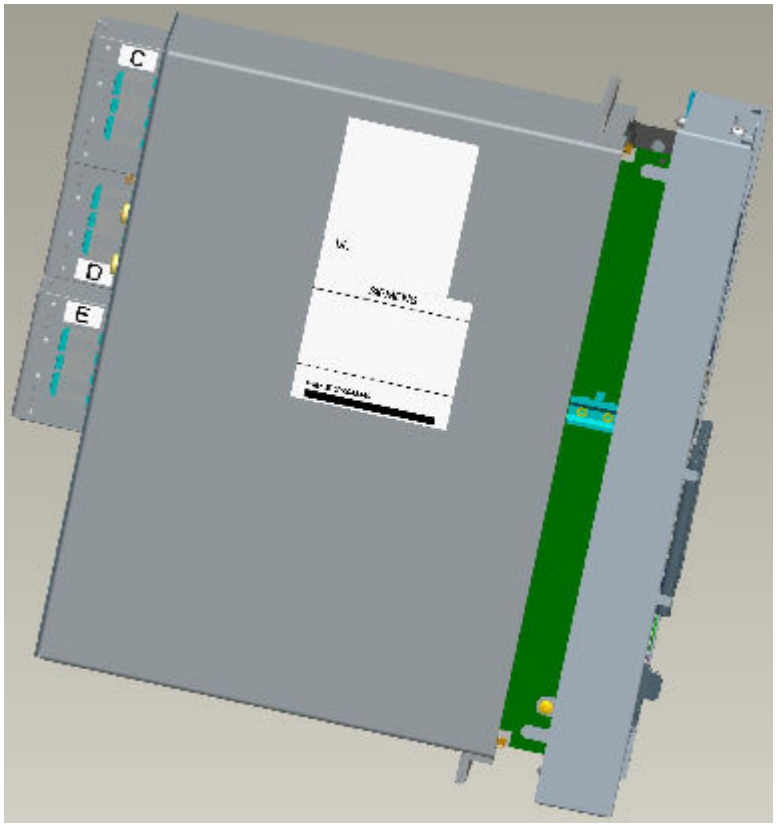
3.1.2.4 Reassembly

The reassembly of the device is performed in the following steps:

Carefully insert the complete electronics block into the housing. Please observe the following:

The connections of the communication modules point at the bottom of the housing.

Insert the electronics block into the housing, until the supporting part rests against the front edge of the housing. Press the left housing wall slightly out and insert the electronics block carefully further into the housing. When the front edge of the housing and the inside of the front plate touch, center the front plate by carful lateral movements. This makes sure that the front plate encloses/surrounds the housing. The electronics block can only be inserted centered up to the end stop.



[einschub-mit-stuetz-20100716, 1, --_--]

Figure 3-8 Reassembly of Device

Fix the front cover to the housing with the two medium screws at the top and bottom of the front cover. The two covers can be inserted again either now or after the reinstallation of the device. Now install the device in accordance with the Sections Panel Flush Mounting, Panel Surface Mounting or Cubicle Mounting.

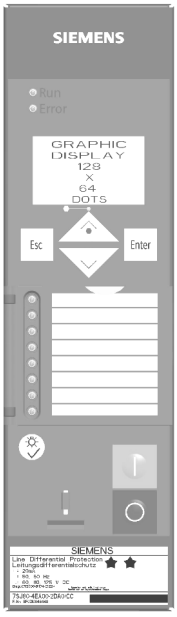
NOTE

Insert the voltage terminal blocks again and lock them in place!

3.1.3 Installation

3.1.3.1 General

The 7RW80 relay has a housing size 1/6. The housing has 2 covers and 4 fixing holes each at the top and bottom (see *Figure 3-9* and *Figure 3-10*).



[front-7sj80-mit-abdeckungen-20071107, 1, --_--]

Figure 3-9 Housing with covers

[front-7sj80-ohne-abdeckungen-20071107, 1, --_--]

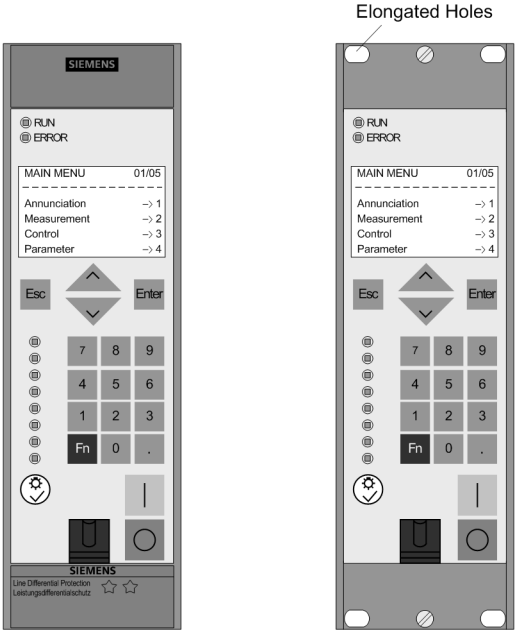
Figure 3-10 Housing with fixing holes (without covers)

3.1.3.2 Panel Flush Mounting

The housing (housing size $^1/_6$) has 2 covers and 4 fixing holes.

- Remove the 2 covers at the top and bottom of the front cover. Thus, 4 elongated holes are revealed in the mounting bracket and can be accessed.
- Insert the device into the panel cut-out and fasten it with four screws. For dimensional drawings, refer to Section *4.12 Dimensions*.
- Mount the 2 covers again.

- Connect a solid low-ohmic protective and operational ground to the grounding terminal of the device. The cross-section of the cable used must correspond to the maximum connected cross-section but must be at least 2.5 mm² (Grounding area > M4, grounding area to be lacquer-free).
- Connections are to be established via the screw terminals on the rear panel of the device in accordance with the circuit diagram. The details on the connection technique for the communication modules at the bottom of the device (port A and port B) in accordance with the SIPROTEC 4 System Description and the details on the connection technique for the voltage terminals on the rear of the device in Section "Connections of the Voltage Terminals" must be strictly observed.



[schalttafeleinbau-7sj80-1-6tel-gehaeuse-20070107, 1, en_US]

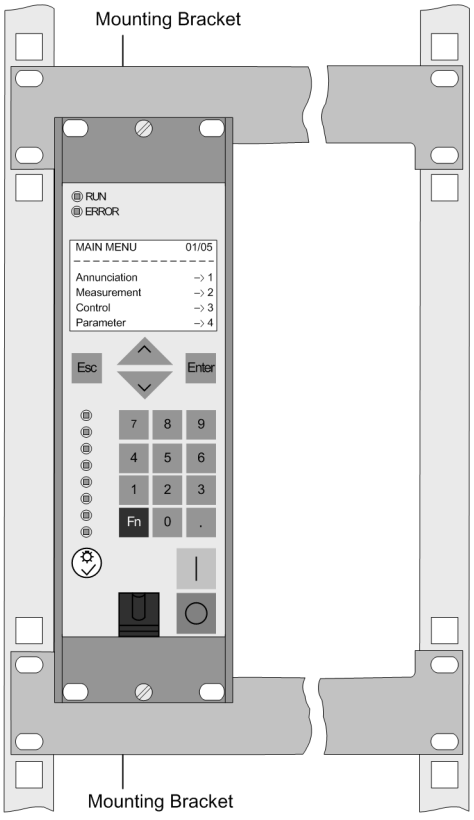
Figure 3-11 Panel flush mounting of a 7RW80

3.1.3.3 Cubicle Mounting

To install the device in a rack or cubicle, two mounting brackets are required. The ordering codes are stated in Appendix, Section *A Ordering Information and Accessories*.

The housing (housing size $^1/_6$) has 2 covers and 4 fixing holes.

- Loosely screw the two angle rails into the rack or cubicle with 4 screws each.
- Remove the 2 covers at the top and bottom of the front cover. Thus, 4 elongated holes are revealed in the mounting bracket and can be accessed.
- Secure the device to the angle rails with 4 screws.
- Mount the 2 covers again.
- Tighten the 8 screws of the the angle rails in the rack or cubicle.
- Connect a solid low-ohmic protective and operational ground to the grounding terminal of the device. The cross-section of the cable used must correspond to the maximum connected cross-section but must be at least 2.5 mm² (Grounding area > M4, grounding area to be lacquer-free).
- Connections are to be established via the screw terminals at the rear panel of the device in accordance with the circuit diagram. The details on the connection technique for the communication modules on the bottom of the device (port A and port B) in accordance with the SIPROTEC 4 System Description and the details on the connection technique for the voltage terminals at the rear of the device in Section "Connections of the Voltage Terminals" must be strictly observed.



[montage-7sj8x-einsechstel-gehaeuse-20070117, 1, en_US]

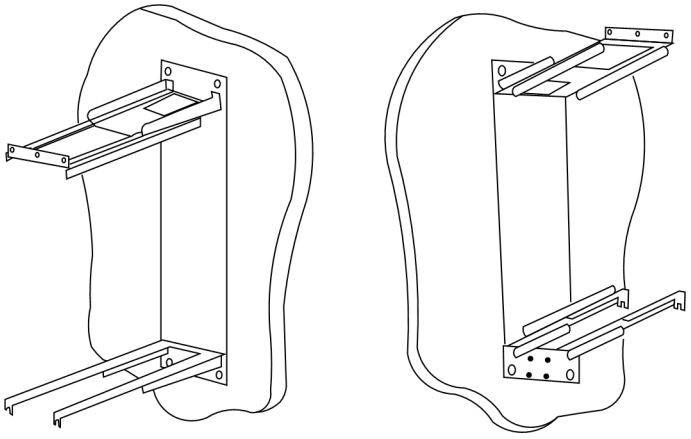
Figure 3-12 Example installation of a 7RW80 in a rack or cubicle

3.1.3.4 Panel Surface Mounting

When ordering the device as surface-mounting case (9th digit of the ordering number= B), the mounting frame shown below is part of the scope of delivery.

For installation, proceed as follows:

- Drill the holes for the mounting frame into the control panel.
- Fasten the mounting frame with 4 screws to the control panel (the continuously open side of the mounting frame is intended for the cable harnesses and can point at the top or bottom according to customer specification).
- Loosen the terminal blocks for the wiring, wire the terminal blocks and then click them in again.
- Connect a solid low-ohmic protective and operational ground to the grounding terminal of the device. The cross-section of the cable used must correspond to the maximum connected cross-section but must be at least 2.5 mm^2 (Grounding area > M4, grounding area to be lacquer-free).
- Connections are to be established via the screw terminals on the rear panel of the device in accordance with the circuit diagram. The details on the connection technique for the communication modules at the bottom of the device (port A and port B) in accordance with the SIPROTEC 4 System Description and the details on the connection technique for the voltage terminals on the rear of the device in Section “Connections of the Voltage Terminals” must be strictly observed.
- Insert the device into the mounting frame (make sure that no cables are jammed).
- Secure the device to the mounting frame with 4 screws. For dimensional drawings, refer to the Technical Data, Section *4.12 Dimensions*.



[montagehalterung-20070116, 1, en_US]

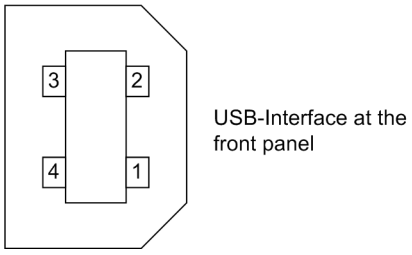
Figure 3-13 Mounting rails for panel surface mounting

3.2 Checking Connections

3.2.1 Checking the Data Connections of the Interfaces

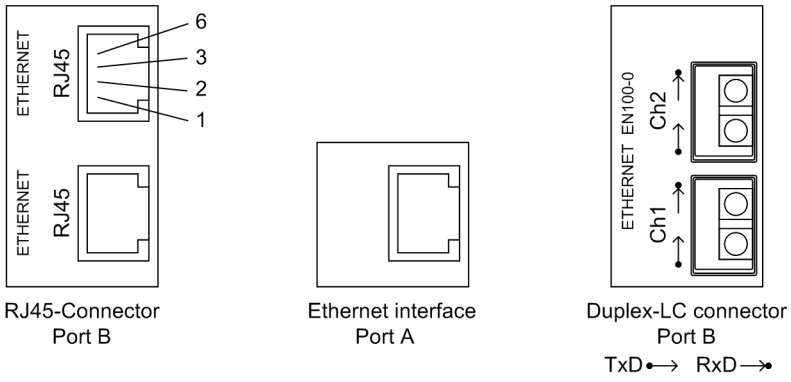
Pin Assignment

The following tables show the pin assignment of the various interfaces. The position of the connections can be seen in the following figures.



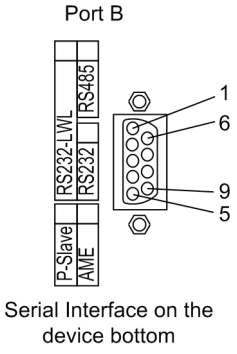
[usb-schnittst-auf-geraetefrontseite-20070111, 1, en_US]

Figure 3-14 USB interface



[ethernet-anschlussbuchsen-101103-kn, 1, en_US]

Figure 3-15 Ethernet connections at the device bottom



[dsub-buchsen-20070111, 1, en_US]

Figure 3-16 Serial interface at the device bottom

USB Interface

The USB interface can be used to establish a connection between the protection device and your PC. For the communication, the Microsoft Windows USB driver is used which is installed together with DIGSI (as of version V4.82). The interface is installed as a virtual serial COM port. We recommend the use of standard USB cables with a maximum length of 5 m/16 ft.

Table 3-2 Assignment of the USB socket

Pin-No.	1	2	3	4	Housing
USB	VBUS (unused)	D-	D+	GND	Shield

Connections at port A

If the interface is used for communication with the device, the data connection is to be checked.

Table 3-3 Assignment of the port A socket

Pin-No.	Ethernet interface
1	Tx+
2	Tx-
3	Rx+
4	—
5	—
6	Rx-
7	—
8	—

Connections at port B

When a serial interface of the device is connected to a control center, the data connection must be checked. A visual check of the assignment of the transmit and receive channels is important. With RS232 and fiber optic interfaces, each connection is dedicated to one transmission direction. For that reason the data output of one device must be connected to the data input of the other device and vice versa.

Table 3-4 Belegung der Buchsen Port B

Pin-No.	RS232	RS485	Profibus DP, RS485	Modbus RS485 DNP3.0 RS485	Ethernet EN 100	IEC 60870–5–103 redundant
1	Shield (electrically connected with shield shroud)				Tx+	B/B' (RxD/TxD-P)
2	RxD	–	–	–	Tx–	A/A' (RxD/TxD-N)
3	TxD	A/A' (RxD/TxD-N)	B/B' (RxD/TxD-P)	A	Rx+	–
4	–	–	CNTR-A (TTL)	RTS (TTL level)	—	–
5	GND	C/C' (GND)	C/C' (GND)	GND1	—	–
6	–	–	+5 V ((max. load <100 mA)	VCC1	Rx–	–
7	$\overline{\text{RTS}}$	– [1)]	–	–	—	–
8	$\overline{\text{CTS}}$	B/B' (RxD/TxD-P)	A/A' (RxD/TxD-N)	B	—	–
9	–	–	–	–	not available	not available

[1)] Pin 7 also carries the RTS signal with RS232 level when operated as RS485 interface. Pin 7 must therefore not be connected!

With data cables, the connections are designated according to DIN 66020 and ISO 2110:

- TxD = Data output
- RxD = Data input
- $\overline{\text{RTS}}$ = Request to send
- $\overline{\text{CTS}}$ = Clear to send
- GND = Signal/Chassis Ground

The cable shield is to be grounded at **both ends**. For extremely EMC-prone environments, the GND may be connected via a separate individually shielded wire pair to improve immunity to interference.

Fiber-optic Cables

WARNING

Laser Radiation! Class 1

✧ Do not look directly into the fiber-optic elements!

Signals transmitted via optical fibers are unaffected by interference. The fibers guarantee electrical isolation between the connections. Transmit and receive connections are represented by symbols.

The standard setting of the character idle state for the optical fiber interface is “Light off”. If the character idle state is to be changed, use the operating program DIGSI as described in the SIPROTEC 4 System Description.

3.2.2 Checking the System Connections

WARNING

Warning of dangerous voltages

Non-observance of the following measures can result in death, personal injury or substantial property damage.

✧ Therefore, only qualified people who are familiar with and adhere to the safety procedures and precautionary measures should perform the inspection steps.

CAUTION

Take care when operating the device without a battery on a battery charger.

Non-observance of the following measures can lead to unusually high voltages and consequently, the destruction of the device.

✧ Do not operate the device on a battery charger without a connected battery. (For limit values see also Technical Data, Section *4.1 General Device Data*).

Before the device is energized for the first time, it should be in the final operating environment for at least 2 hours to equalize the temperature, to minimize humidity and to avoid condensation. Connections are checked with the device at its final location. The plant must first be switched off and grounded.

Proceed as follows for checking the system connections:

- Circuit breakers for the auxiliary power supply and the measuring voltage must be opened.
- Check the continuity of all voltage transformer connections against the system and connection diagrams:
  - Are the voltage transformers grounded properly?
  - Are the polarities of the voltage transformer connections the same and correct?
  - Is the phase assignment of the voltage transformers correct?
  - Is the polarity for the voltage input V_3 correct (if used e.g. for broken delta winding or busbar voltage)?
- If test switches are used for the secondary testing of the device, their functions must also be checked.

- Connect an ammeter in the supply circuit of the power supply. A range of about 2.5 A to 5 A for the meter is appropriate.
- Switch on m.c.b. for auxiliary voltage (supply protection), check the voltage level and, if applicable, the polarity of the voltage at the device terminals or at the connection modules.
- The current input should correspond to the power input in neutral position of the device. The measured steady state current should be insignificant. Transient movement of the ammeter merely indicates the charging current of capacitors
- Apply voltage to the power supply
- Close the protective switches for the voltage transformers.
- Verify that the voltage phase rotation at the device terminals is correct.
- Open the protective switches for the voltage transformers and the power supply.
- Check the trip and close circuits to the power system circuit breakers.
- Verify that the control wiring to and from other devices is correct.
- Check the signaling connections.
- Switch the mcb back on.

3.3 Commissioning

WARNING

Warning of dangerous voltages when operating an electrical device

Non-observance of the following measures can result in death, personal injury or substantial property damage.

- ✧ Only qualified people shall work on and around this device. They must be thoroughly familiar with all warnings and safety notices in this instruction manual as well as with the applicable safety steps, safety regulations, and precautionary measures.
- ✧ Before making any connections, the device must be grounded at the protective conductor terminal.
- ✧ Hazardous voltages can exist in all switchgear components connected to the power supply and to measurement and test circuits.
- ✧ Hazardous voltages can be present in the device even after the power supply voltage has been removed (capacitors can still be charged).
- ✧ After switching off the auxiliary voltage, wait a minimum of 10 seconds before reconnecting this voltage so that steady conditions can be established.
- ✧ The limit values given in Technical Data (Chapter 4) must not be exceeded, neither during testing nor during commissioning.

When testing the device with secondary test equipment, make sure that no other measurement quantities are connected and that the trip and close circuits to the circuit breakers and other primary switches are disconnected from the device.

DANGER

Hazardous voltages during interruptions in secondary circuits of current transformers

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

- ✧ Short-circuit the current transformer secondary circuits before current connections to the device are opened.

Switching operations have to be carried out during commissioning. A prerequisite for the prescribed tests is that these switching operations can be executed without danger. They are accordingly not intended for operational checks.

WARNING

Warning of dangers evolving from improper primary tests

Non-observance of the following measures can result in death, personal injury or substantial property damage.

- ✧ Primary tests are only allowed to be carried out by qualified personnel, who are familiar with the commissioning of protection systems, the operation of the plant and the safety rules and regulations (switching, grounding, etc.).

3.3.1 Test Mode and Transmission Block

Activation and Deactivation

If the device is connected to a central or main computer system via the SCADA interface, then the information that is transmitted can be influenced. This is only possible with some of the protocols available (see Table "Protocol- dependent functions" in the Appendix *D.6 Protocol-dependent Functions*).

If the **test mode** is switched on, the messages sent by a SIPROTEC 4 device to the main system has an additional test bit. This bit allows the messages to be recognized as not resulting from actual faults. Furthermore, it can be determined by activating the **transmission block** that no annunciations are transmitted via the system interface during test mode.

The SIPROTEC 4 System Manual describes in detail how to activate and deactivate the test mode and blocked data transmission. Please note that when DIGSI is being used for device editing, the program must be in the **online** operating mode for the test features to be used.

3.3.2 Testing the System Interface

Prefacing Remarks

If the device features a system interface and this is used to communicate with the control center, the DIGSI device operation can be used to test if messages are transmitted correctly. This test option should however definitely not be used while the device is in "real" operation.

DANGER

Danger evolving from operating the equipment (e.g. circuit breakers, disconnectors) by means of the test function

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

✧ Equipment used to allow switching such as circuit breakers or disconnectors is to be checked only during commissioning. Do not under any circumstances check them by means of the test function during "real" operation by transmitting or receiving messages via the system interface.

NOTE

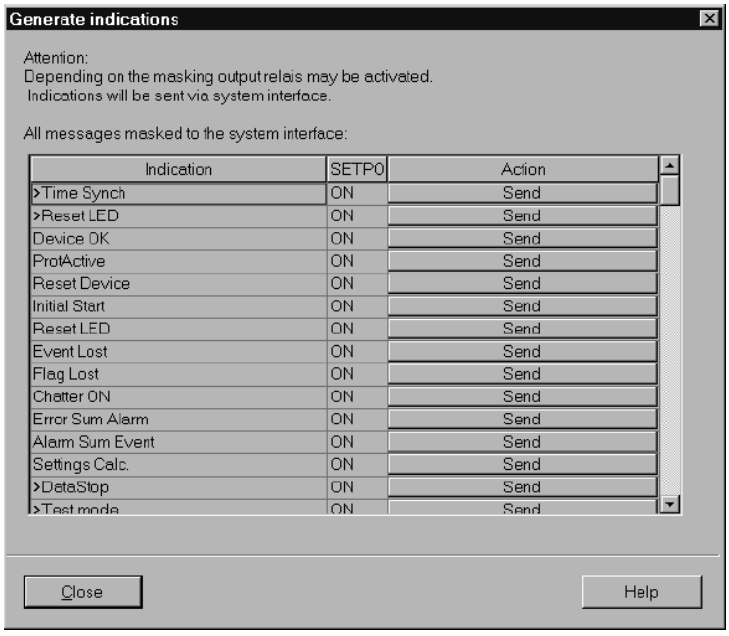
After termination of the system interface test the device will reboot. Thereby, all annunciation buffers are erased. If required, these buffers should be extracted with DIGSI prior to the test.

The interface test is carried out using DIGSI in the Online operating mode:

- Open the **Online** directory by double-clicking; the operating functions for the device appear.
- Click on **Test**; the function selection appears in the right half of the screen.
- Double-click **Generate Indications** in the list view. The **Generate Indications** dialog box opens (see following figure).

Structure of the Test Dialog Box

In the column **Indication** the display texts of all indications are displayed which were allocated to the system interface in the matrix. In the column **SETPOINT Status** the user has to define the value for the messages to be tested. Depending on annunciation type, several input fields are offered (e.g. message *ON* / message *OFF*). By clicking on one of the fields you can select the desired value from the pull-down menu.



[sc_schnittstelle-testen, 1, en_US]

Figure 3-17 System interface test with the dialog box: Creating messages - example

Changing the Operating State

When clicking one of the buttons in the column **Action** for the first time, you will be prompted for the password no. 6 (for hardware test menus). After correct entry of the password, individual annunciations can be initiated. To do so, click on the button **Send** on the corresponding line. The corresponding message is issued and can be read out either from the event log of the SIPROTEC 4 device or from the substation control system.

As long as the window is open, further tests can be performed.

Test in Message Direction

For all information that is transmitted to the central station, test the options in the list which appears in **SETPOINT Status**:

- Make sure that each checking process is carried out carefully without causing any danger (see above and refer to DANGER!)
- Click on Send in the function to be tested and check whether the transmitted information reaches the central station and shows the desired reaction. Data which are normally linked via binary inputs (first character ">") are likewise indicated to the central power system with this procedure. The function of the binary inputs itself is tested separately.

Exiting the Test Mode

To end the System Interface Test, click on **Close**. The device is briefly out of service while the start-up routine is executed. The dialog box closes.

Test in Command Direction

The information transmitted in command direction must be indicated by the central station. Check whether the reaction is correct.

3.3.3 Configuring Communication Modules

Required Settings in DIGSI 4

The following applies in general:

In the case of a first-time installation or replacement of a communication module, the ordering number (MLFB) does not need to be changed. The ordering number can be retained. Thus, all previously created parameter sets remain valid for the device.

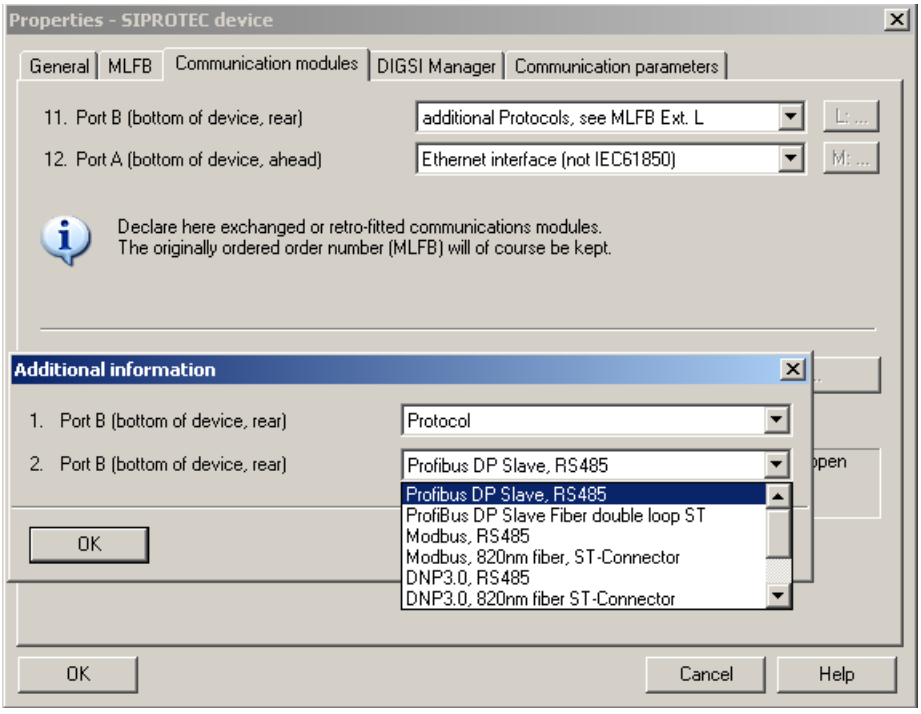
Changes in the DIGSI Manager

In order that the protection device can access the new communication module, a change has to be made in the parameter set within the DIGSI Manager.

Select the SIPROTEC device in **DIGSI 4 Manager project** and choose the menu entry **Edit > Object Properties** to open the dialog **Properties – SIPROTEC 4 Device** (see the following figure).

Select an Interfac for **11. Port B (on back of device bottom)** and for **12. Port A (on front of device bottom)** in the properties box **Communications modules**. For Profibus DP, Modbus or DNP3.0, the entry **additional Protocols, see MLFB Ext L** has to be selected.

For port B, click **L...** and select the type of communication protocol in the dialog **Additional information**



[sx80-komm-prot-l-071112, 1, en_US]

Figure 3-18 DIGSI 4.3: Profibus DP protocol selection (example)

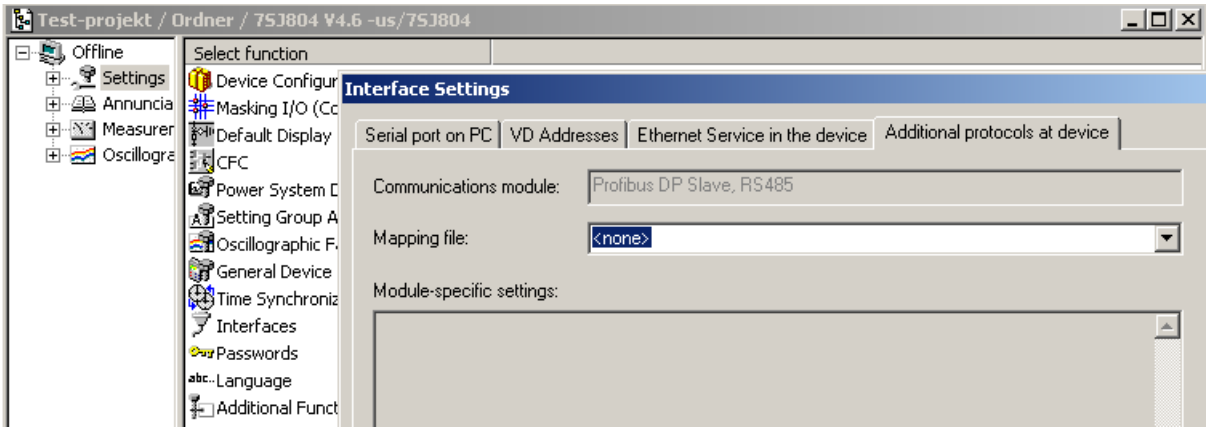
Mapping File

For Profibus DP, Modbus and DNP3.0, a matching bus mapping has to be selected.

For the selection of the mapping file please open the SIPROTEC device in DIGSI and choose **Settings** > **Interfaces** (see *Figure 3-19*).

The dialog **Interface Settings** shows under **Additional protocols at device** the following:

- Display of the selected communication module
- Selection **Mapping file**, listing all Profibus DP, Modbus, DNP3.0 and VDEW Redundant mapping files available for the respective device type, with their names and reference to the corresponding bus mapping document
- Edit field **Module-specific settings** for changing the bus-specific parameters



[auswahl-mapping-071122, 1, en_US]

Figure 3-19 DIGSI 4.3: Selection of a mapping file and setting of bus-specific parameters

NOTE

If the mapping file assignment for a SIPROTEC device has been changed, this is usually connected with a change of the allocations of the SIPROTEC objects to the system interface.

After having selected a new mapping file, please check the allocations to "Target system interface" or "Source system interface" in the **DIGSI allocation matrix**.

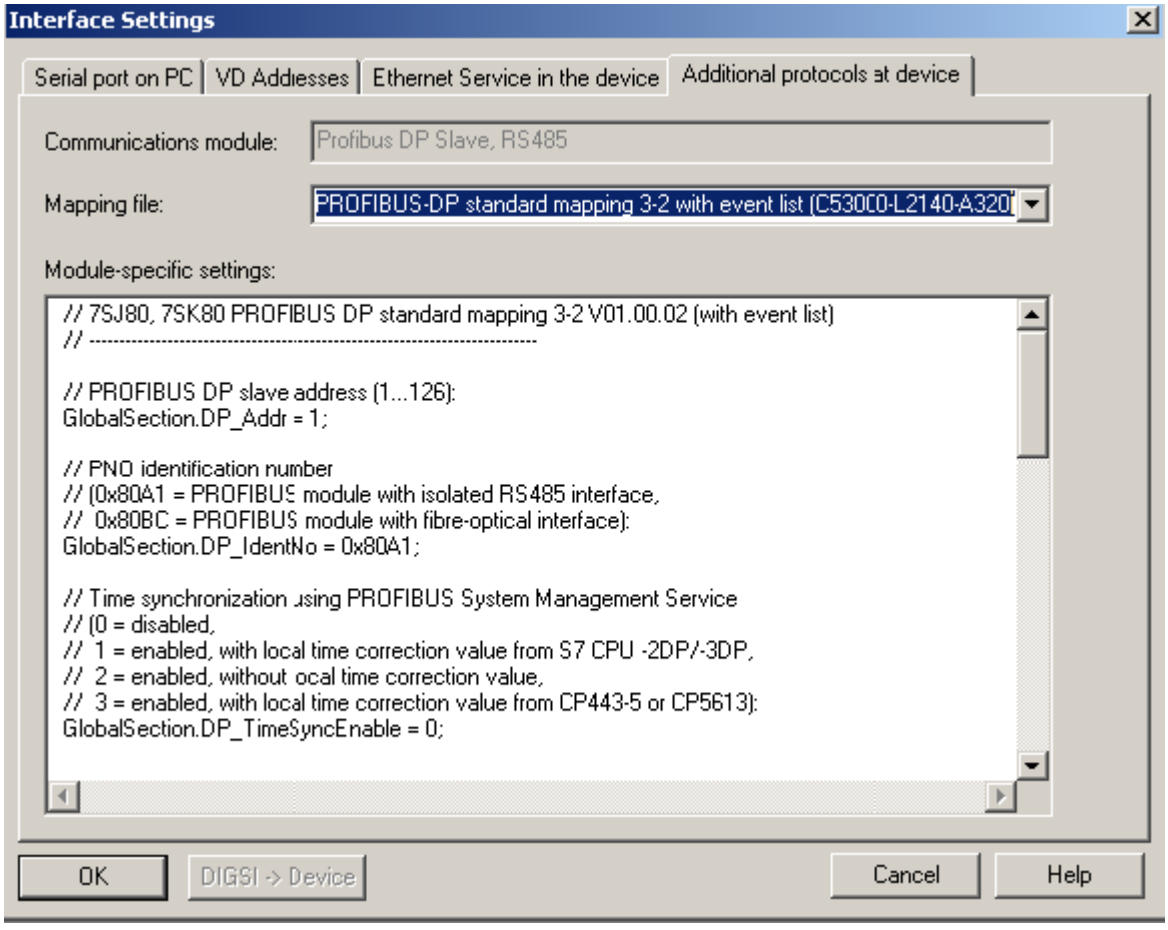
Edit Field "Module-specific settings"

Change only the numbers in the lines not starting with "//" and observe the semicolon at the end of the lines in the field **Module-specific settings**.

Further changes in the field might lead to an error message when closing the dialog box **Interface settings**.

Select the bus mapping corresponding to your requirements. The documentation of the individual bus mappings is available on the Internet (www.siprotec.com in the download area).

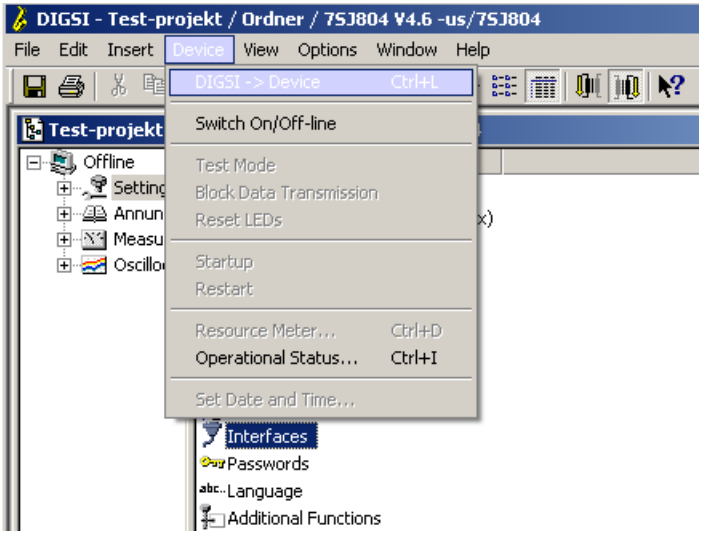
After having selected the bus mapping, the area of the mapping file in which you can make device-specific settings appears in the window (see *Figure 3-20*). The type of this setting depends of the protocol used and is described in the protocol documentation. Please only perform the described changes in the settings window and confirm your entries with "OK".



[modulspez-071122, 1, en_US]

Figure 3-20 Module-specific settings

Transfer the data to the protection device (see the following figure).



[daten-uebertragen-071122, 1, en_US]

Figure 3-21 Transmitting data

Terminal Test

The system interface (EN 100) is preassigned with the default value zero and the module is thus set to DHCP mode. The IP address can be set in the DIGSI Manager (Object properties... / Communication parameters / System interface [Ethernet]).

The Ethernet interface is preassigned with the following IP address and can be changed on the device at any time (DIGSI device processing / Parameters / Interfaces / Ethernet service):

IP address: 192.168.100.10

Network mask: 255.255.255.0

The following restrictions must be observed:

For subnet mask: 255.255.255.0 the IP bandwidth 192.168.64.xx is not available

For subnet mask 255.255.255.0, the IP-Band 192.168.1.xx is not available

For subnet mask: 255.255.0.0 the IP bandwidth 192.168.xx.xx is not available

For subnet mask: 255.0.0.0 the IP band 192.xx.xx.xx is not available.

3.3.4 Checking the Status of Binary Inputs and Outputs

Prefacing Remarks

The binary inputs, outputs, and LEDs of a SIPROTEC 4 device can be individually and precisely controlled in DIGSI. This feature is used to verify control wiring from the device to plant equipment (operational checks) during commissioning. This test option should however definitely not be used while the device is in “real” operation.

DANGER

Danger evolving from operating the equipment (e.g. circuit breakers, disconnectors) by means of the test function

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

✧ Equipment used to allow switching such as circuit breakers or disconnectors is to be checked only during commissioning. Do not under any circumstances check them by means of the test function during real operation by transmitting or receiving messages via the system interface.

NOTE

After finishing the hardware tests, the device will reboot. Thereby, all annunciation buffers are erased. If required, these buffers should be read out with DIGSI and saved prior to the test.

The hardware test can be carried out using DIGSI in the Online operating mode:

- Open the **Online** directory by double-clicking; the operating functions for the device appear.
- Click on **Test**; the function selection appears in the right half of the screen.
- Double-click in the list view on **Hardware Test**. The dialog box of the same name opens (see the following figure).

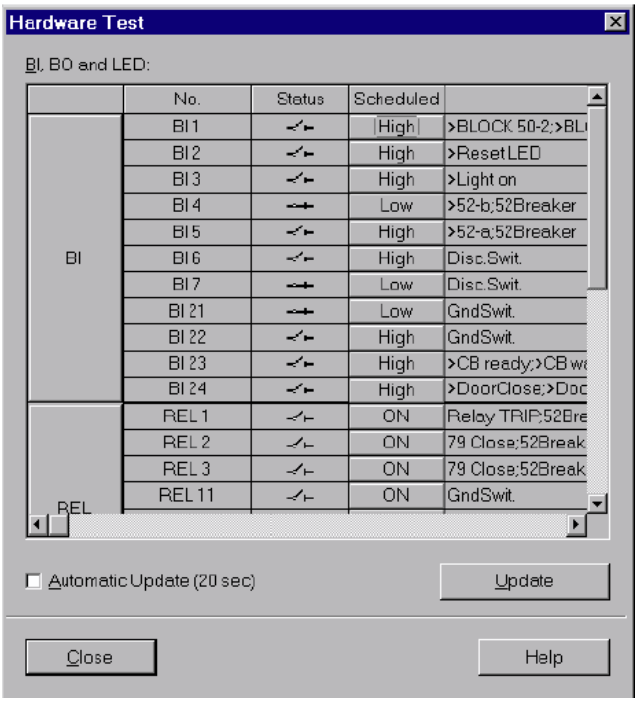
Structure of the Test Dialog Box

The dialog box is classified into three groups: **BI** for binary inputs, **REL** for output relays, and **LED** for lightemitting diodes. On the left of each of these groups is an accordingly labeled button. By double-clicking a button, information regarding the associated group can be shown or hidden.

In the column **Status** the present (physical) state of the hardware component is displayed. Indication is made by symbols. The physical actual states of the binary inputs and outputs are indicated by an open or closed switch symbol, the LEDs by a dark or illuminated LED symbol.

The opposite state of each element is displayed in the column **Scheduled**. The display is made in plain text.

The right-most column indicates the commands or messages that are configured (masked) to the hardware components.



[ein-ausgabe-testen-110402-wlk, 1, en_US]

Figure 3-22 Test of the binary inputs/outputs — example

Changing the Operating State

To change the status of a hardware component, click on the associated button in the **Scheduled** column.

Password No. 6 (if activated during configuration) will be requested before the first hardware modification is allowed. After entry of the correct password a status change will be executed. Further status changes remain possible while the dialog box is open.

Test of the Output Relays

Each individual output relay can be energized allowing to check the wiring between the output relay of the 7RW80 and the system, without having to generate the message that is assigned to the relay. As soon as the first status change for any one of the output relays is initiated, all output relays are separated from the internal device functions, and can only be operated by the hardware test function. This for example means that a switching command coming from a protection function or a control command from the operator panel to an output relay cannot be executed.

Proceed as follows in order to check the output relay:

- Ensure that the switching of the output relay can be executed without danger (see above under DANGER!).
- Each output relay must be tested via the corresponding **Scheduled**-cell in the dialog box.
- Finish the testing (see margin title below “Exiting the Test Mode”), so that during further testings no unwanted switchings are initiated.

Test of the Binary Inputs

To test the wiring between the plant and the binary inputs of the 7RW80 the condition in the plant which initiates the binary input must be generated and the response of the device checked.

To do so, the dialog box **Hardware Test** must be opened again to view the physical state of the binary inputs. The password is not yet required.

Proceed as follows in order to check the binary inputs:

- Activate each of function in the system which causes a binary input to pick up.
- Check the reaction in the **Status** column of the dialog box. To do so, the dialog box must be updated. The options may be found below under the margin heading “Updating the Display”.
- Finish the testing (see margin heading below “Exiting the Test Mode”).

If ,however, the effect of a binary input must be checked without carrying out any switching in the plant, it is possible to trigger individual binary inputs with the hardware test function. As soon as the first state change of any binary input is triggered and the password No. 6 has been entered, all binary inputs are separated from the plant and can only be activated via the hardware test function.

Test of the LEDs

The LEDs may be tested in a similar manner to the other input/output components. As soon as the first state change of any LED has been triggered, all LEDs are separated from the internal device functionality and can only be controlled via the hardware test function. This means e.g. that no LED is illuminated anymore by a protection function or by pressing the LED reset button.

Updating the Display

As the **Hardware Test** dialog opens, the operating states of the hardware components which are current at this time are read in and displayed.

An update is made:

- for each hardware component, if a command to change the condition is successfully performed,
- for all hardware components if the **Update** button is clicked,
- for all hardware components with cyclical updating (cycle time is 20 seconds) if the **Automatic Update (20sec)** field is marked.

Exiting the Test Mode

To end the hardware test, click on **Close**. The dialog box is closed. The device becomes unavailable for a brief start-up period immediately after this. Then all hardware components are returned to the operating conditions determined by the plant settings.

3.3.5 Testing User-Defined Functions

CFC Logic

The device has a vast capability for allowing functions to be defined by the user, especially with the CFC logic. Any special function or logic added to the device must be checked.

Of course, general test procedures cannot be given. Configuration of these functions and the target conditions must be actually known beforehand and tested. Possible interlocking conditions of switching devices (circuit breakers, disconnectors, ground switch) are of particular importance. They must be observed and tested.

3.3.6 Voltage and Phase Rotation Testing

The connections of the voltage transformers are tested using primary quantities. The line is energized and will remain in this state during the measurements.

If measurement circuits are connected correctly, all Measured Value Monitoring of the device will stay inactive. If an element detects a problem, the causes which provoked it may be viewed in the Event Log. If voltage sum errors are found, check the matching factors.

Messages from the symmetry monitoring could occur because there actually are asymmetrical conditions in the network. If these asymmetrical conditions are normal service conditions, the corresponding monitoring functions should be made less sensitive.

Voltage Values

The voltages can be seen in the display field at the front of the device or the operator interface via a PC. They can be compared to the quantities measured by an independent source, as primary and secondary quantities.

If the measured values are implausible, the connection must be checked and corrected after the line has been isolated. The measurements must then be repeated.

Phase Rotation

The phase rotation must correspond to the configured phase rotation, in general a clockwise phase rotation. If the system has an anti-clockwise phase rotation, this must have been considered when the power system data was set (address 209 **PHASE SEQ.**). If the phase rotation is incorrect, the alarm *Fail Ph. Seq.* (FNo 171) is generated. The measured value phase allocation must be checked

Voltage Transformer Miniature Circuit Breaker (VT mcb)

The VT mcb of the feeder (if used) must be opened. The measured voltages in the operational measured values appear with a value close to zero (small measured voltages are of no consequence).

Check in the spontaneous annunciations that the VT mcb trip was entered (annunciation *>FAIL:FEEDER VT* "ON" in the spontaneous annunciations). Beforehand it has to be assured that the position of the VT mcb is connected to the device via a binary input.

Close the VT mcb again: The above messages appear under the spontaneous messages as "OFF", i.e. *>FAIL:FEEDER VT* "OFF".

If one of the events does not appear, the connection and allocation of these signals must be checked.

If the *ON*-state and *OFF*–state are swapped, the contact type (H–active or L–active) must be checked and remedied.

3.3.7 Polarity Check for Voltage Input V_3

Depending on the application of the voltage measuring input V_3 of a 7RW80, a polarity check may be necessary. If no measuring voltage is connected to this input, this section is irrelevant.

If input V_3 is used for the measurement of the **displacement voltage** V_N (Power System Data 1 address 213 **VT Connect. 3ph** = ***Vab, Vbc, VGnd***), the polarity is checked together with the current input I_N/I_{Ns} (see further below).

If the input V_3 is used for measuring a voltage for **synchrocheck** (Power System Data 1, address 213 **VT Connect. 3ph** = ***Vab, Vbc, VSyn*** or ***Vph-g, VSyn***), the following is to be observed:

- The single-phase voltage V_2 to be synchronized must be connected to input V_3.
- The correct polarity is to be checked as follows using the synchrocheck function:

The device must provide the synchrocheck function which is to be configured in address 161 = **25 Function 1** = ***SYNCHROCHECK***.

The voltage V_2 to be synchronized must be set correctly in address 6123 **CONNECTIONof V2**.

If a transformer is located between the measuring points of the reference voltage V_1 and the voltage to be synchronized V_2, its phase rotation must be taken into consideration. For this purpose, a corresponding angle is entered in address 6122 **ANGLE ADJUSTM.**, in the direction of the busbar seen from the feeder. An example is shown in Section *2.7 Synchrocheck*.

If necessary different transformation ratios of the transformers on the busbar and the feeder may have to be considered under address **Balancing V1/V2**.

The synchrocheck function must be activated at address 6101 **Synchronizing** = ***ON***.

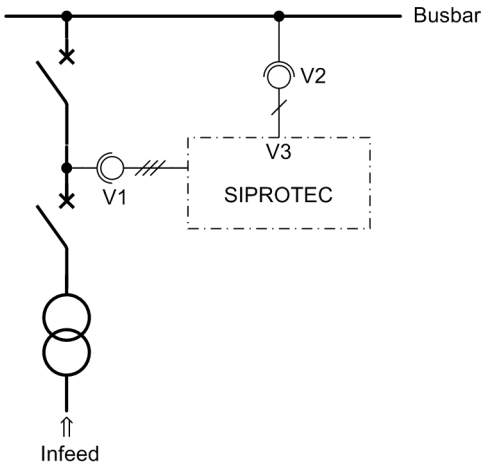
A further aid for checking the connections are the messages 170.2090 *25 V2>V1*, 170.2091 *25 V2<V1*, 170.2094 *25 α2>α1* and 170.2095 *25 α2<α1* in the spontaneous messages.

- Circuit breaker is open. The feeder is de-energized. The circuit breakers of both voltage transformer circuits must be closed.
- For the synchrocheck, the program **Direct CO** is set to ***YES*** (address 6110); the other programs (addresses 6107 to 6109) are set to ***NO***.
- Via a binary input (170.0043 *>25 Sync requ.*) a measurement request is entered. The synchrocheck must release closing (message 170.0049 *25 CloseRelease*). If not, check all relevant parameters again (synchrocheck configured and enabled correctly, see Sections *2.1.1 Functional Scope* and *2.7 Synchrocheck*).
- Set address 6110 **Direct CO** to ***NO***.
- Then the circuit breaker is closed while the line isolator is open (see *Figure 3-23*). Thus, both voltage transformers receive the same voltage.
- For the synchrocheck, the program **25 Function 1** is set to ***SYNCHROCHECK*** (address 161)
- Via a binary input (170.0043 *>25 Sync requ.*) a measurement request is entered. The synchrocheck must release closing (message 170.0049 *25 CloseRelease*).
- If not, first check whether one of the aforesaid messages 170.2090 *25 V2>V1* or 170.2091 *25 V2<V1* or 170.2094 *25 α2>α1* or 170.2095 *25 α2<α1* is available in the spontaneous messages.

  The message *25 V2>V1* or *25 V2<V1* indicates that the magnitude adaption is incorrect. Check address 6121 **Balancing V1/V2** and recalculate the adaptation factor.

  The message *25 α2>α1* or *25 α2<α1* indicates that the phase relation of the busbar voltage does not match the setting under address **CONNECTIONof V2** (see Section *2.7 Synchrocheck*). When measuring via a transformer, address 6122 **ANGLE ADJUSTM.** must also be checked; this must adapt the vector group. If these are correct, there is probably a reverse polarity of the voltage transformer terminals for V1.
- For the synchrocheck, the program **SYNC V1>V2<** is set to ***YES*** (address 6108)
- Open the VT mcb of the busbar voltage.
- Via a binary input (170.0043 *>25 Sync requ.*) a measurement request is entered. There is no close release. If there is, the VT mcb for the busbar voltage is not allocated. Check whether this is the required state, alternatively check the binary input *>FAIL: BUS VT* (6510).
- Close the VT mcb of the busbar voltage again.
- Open the circuit breaker.
- For the synchrocheck, the program **SYNC V1<V2>**is set to ***YES*** (address 6107) and **SYNC V1>V2<** is set to ***NO*** (address 6108).
- Via a binary input (170.0043 *>25 Sync requ.*) a measurement request is entered. The synchrocheck must release closing (message 170.0049 *25 CloseRelease*). Otherwise check all voltage connections and the corresponding parameters again thoroughly as described in Section*2.7 Synchrocheck*.
- Open the VT mcb of the feeder voltage.
- Via a binary input (170.0043 *>25 Sync requ.*) a measurement request is entered. No close release is given.
- Close the VT mcb of the busbar voltage again.

Addresses 6107 to 6110 must be restored as they were changed for the test. If the allocation of the LEDs or signal relays was changed for the test, this must also be restored.



[messspan-synch-kontr-20070716, 1, en_US]

Figure 3-23 Measuring voltages for synchrocheck

3.3.8 Trip/Close Tests for the Configured Operating Devices

Control by Local Command

If the configured operating devices were not switched sufficiently in the hardware test already described, all configured switching devices must be switched on and off from the device via the integrated control element. The feedback information of the circuit breaker position injected via binary inputs is read out at the device and compared with the actual breaker position.

The switching procedure is described in the SIPROTEC 4 System Description. The switching authority must be set according to the command source used. The switching mode can be selected from interlocked and noninterlocked switching. Please note that non-interlocked switching can be a safety hazard.

Control by Protective Functions

For OPEN-commands sent to the circuit breaker please take into consideration that if the external automatic reclosure function is used a TRIP-CLOSE test cycle is initiated.

DANGER

A test cycle successfully started by the automatic reclosure function can lead to the closing of the circuit breaker !

Non-observance of the following statement will result in death, severe personal injury or substantial property damage.

✧ Be fully aware that OPEN-commands sent to the circuit breaker can result in a trip-close-trip event of the circuit breaker by an external reclosing device.

Control from a Remote Control Center

If the device is connected to a remote substation via a system interface, the corresponding switching tests may also be checked from the substation. Please also take into consideration that the switching authority is set in correspondence with the source of commands used.

3.3.9 Creating Oscillographic Recordings for Tests

General

In order to be able to test the stability of the protection during switchon procedures also, switchon trials can also be carried out at the end. Oscillographic records obtain the maximum information about the behaviour of the protection.

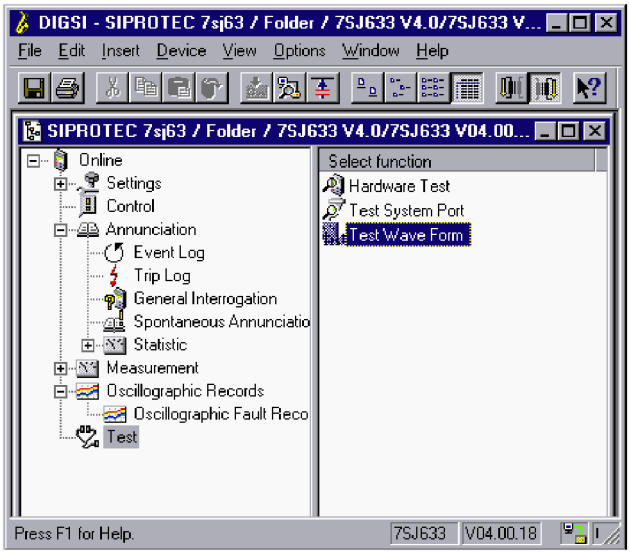
Requirements

To be able to trip an oscillographic recording, parameter **`Osc Fault Rec.`** must be configured to Enabled in the **Functional Scope**. Apart from the capability of storing fault recordings via pickup of the protection function, the 7RW80 also has the capability of initiating a measured value recording via the operator program DIGSI, the serial interface or binary input. In the latter case, the information *`>Trig.Wave.Cap.`* must be allocated to a binary input. Triggering for the oscillographic recording then occurs, for instance, via the binary input when the protection object is energized.

Those that are externally triggered (that is, without a protective element pickup) are processed by the device as a normal oscillographic record. For each oscillographic record a fault record is created which is given its individual number to ensure that assignment can be made properly. However, these recordings are not displayed in the fault indication buffer, as they are not fault events.

Triggering Oscillographic Recording

To trigger test measurement recording with DIGSI, click on **Test** in the left part of the window. Double click the entry T**est Wave Form** in the list of the window.



[digsi-fenster-testmessschrieb-starten-260602-kn, 1, en_US]

Figure 3-24 Start oscillographic recording with DIGSI

Oscillographic recording is started immediately. During recording, a report is given in the left part of the status bar. Bar segments additionally indicate the progress of the procedure.

The SIGRA or the Comtrade Viewer program is required to view and analyse the oscillographic data.

3.4 Final Preparation of the Device

Firmly tighten all screws. Tighten all terminal screws, including those that are not used.

CAUTION

Inadmissable Tightening Torques

Non–observance of the following measure can result in minor personal injury or property damage.

✧ The tightening torques must not be exceeded as the threads and terminal chambers may otherwise be damaged!

The settings should be checked again, if they were changed during the tests. Check if all protection, control and auxiliary functions to be found with the configuration parameters are set correctly (Section *2.1.1 Functional Scope*, Functional Scope) and all desired functions are set to ***ON***. Keep a copy of all setting values on a PC.

Check the internal clock of the device. If necessary, set or synchronize the clock if it is not automatically synchronized. For assistance, refer to the SIPROTEC 4 System Description.

The annunciation buffers are deleted under **MAIN MENU** → **Annunciations** → **Set/Reset**, so that future information will only apply to actual events and states (see also SIPROTEC 4 System Description). The counters in the switching statistics should be reset to the values that were existing prior to the testing (see also SIPROTEC 4 System Description).

Reset the counter of the operational measured values (e.g. operation counter, if available) under **MAIN MENU** → **Measured Values** → **Reset** (also see SIPROTEC 4 System Description).

Press the **ESC** key (several times if necessary), to return to the default display. The default display appears in the display box (e.g. the display of operational measured values).

Clear the LEDs on the front panel of the device by pressing the **LED** key, so that they show only real events and states in the future. In this context, also output relays probably memorized are reset. Pressing the LED key also serves as a test for the LEDs on the front panel because they should all light when the button is pushed. Any LEDs that are lit after the clearing attempt are displaying actual conditions.

The green “RUN” LED must light up, whereas the red “ERROR” must not light up.

Close the protective switches. If test switches are available, then these must be in the operating position.

The device is now ready for operation.

4 Technical Data

4.1 General Device Data

4.1.1 Analog Inputs

Voltage Inputs

Nominal frequency	f_{Nom}	50 Hz or 60 Hz (adjustable)
Operating range frequency (not dependent on the nominal frequency		25 Hz to 70 Hz
Nominal Voltage		34 V – 225 V (adjustable) for connection of phase-to-ground voltages 34 V – 200 V (adjustable) for connection of phase-to-phase voltages
Measuring Range		0 V to 200 V
Burden	at 100 V	approx. 0.005 VA
Overload capacity in the voltage path		
– Thermal (rms)		230 V continuous

4.1.2 Auxiliary voltage

Direct Voltage

Voltage supply via an integrated converter		
Nominal auxiliary DC voltage V_{Aux}	DC 24 V to 48 V	DC 60 V to 250 V
Permissible voltage ranges	DC 19 V to 60 V	DC 48 V to 300 V
Overvoltage category, IEC 60255-27	III	
AC ripple voltage peak to peak, IEC 60255-11	15 % of auxiliary voltage	

Power input	Quiescent	Energized
7RW80	approx. 5 W	approx. 12 W
Bridging time for failure/short-circuit, IEC 60255–11	≥ 50 ms at V ≥ 110 V	
	≥ 10 ms at V < 110 V	

Alternating Voltage

Voltage supply via an integrated converter		
Nominal auxiliary AC voltage V_{Aux}	AC 115 V	AC 230 V
Permissible voltage ranges	AC 92 V to 132 V	AC 184 V to 265 V
Overvoltage category, IEC 60255-27	III	

Power input (at AC 115 V/230 V)	< 15 VA
Bridging time for failure/short-circuit	≥ 10 ms at V = 115 V/230 V

4.1.3 Binary Inputs and Outputs

Binary Inputs

Variant	Quantity
7RW801	3 (configurable)
7RW802	7 (configurable)

DC nominal voltage range	24 V to 250 V	
Current Consumption (independent of the control voltage)	approx. 0.4 mA	
Pickup time Response time of the binary output after trigger signal via binary input	approx. 3 ms approx. 9 ms	
Dropout time Response time of the binary output after trigger signal via binary input	approx. 4 ms approx. 5 ms	
Secured switching thresholds	(adjustable)	
for Nominal Voltages	DC 24 V to 125 V	V high > DC 19 V V low < DC 10 V
for Nominal Voltages	DC 110 V to 250 V	V high > DC 88 V V low < DC 44 V
for Nominal Voltages	DC 220 V and 250 V	V high > DC 176 V V low < DC 88 V
Maximum Permissible Voltage	DC 300 V	
Impulse Filter on Input	220 V coupled above 220nF at a recovery time between two switching operations ≥ 60 ms	

Output Relays

Signal-/Command Relay, Alarm Relay		
Quantity and data	According to the order variant (allocatable)	
Order variant	NO contact	NO/NC selectable
7RW801	3	2 (+ 1 life contact not allocatable)
7RW802	6	2 (+ 1 life contact not allocatable)
Switching capability CLOSE	1000 W / 1000 VA	
Switching capability TRIP	40 W or 30 VA at L/R ≤ 40 ms	
Switching voltage AC and DC	250 V	
adm. current per contact (continuous)	5 A	
adm. current per contact (close and hold)	30 A for 1 s (NO contact)	
Interference suppression capacitor at the relay contacts 2,2 nF, 250 V, Ceramic	Frequency	Impedance
	50 Hz	$1.4 \cdot 10^6\ \Omega \pm 20\ \%$
	60 Hz	$1.2 \cdot 10^6\ \Omega \pm 20\ \%$

4.1.4 Communication Interfaces

User Interface

Terminal	Front side, non-isolated, USB type B socket for connecting a personal computer Operation from DIGSI V4.82 via USB 2.0 full speed (PELV)
Operation	with DIGSI
Transmission speed	up to 12 Mbit/s max.
Bridgeable distance	5 m

Port A

Ethernet electrical for DIGSI or SICAM I/O Unit 7XV5673	
Operation	with DIGSI
Terminal	Front case bottom, mounting location "A", RJ45 socket 100BaseT according to IEEE802.3 LED yellow: 10-/100 MBit/s (on/off) LED green: connection/no connection (on/off)
Test voltage (PELV)	500 V; 50 Hz
Transmission speed	10/100 MBit/s
Bridgeable distance	20 m

Port B

IEC 60870-5-103 single	
RS232/RS485/FO depending on the order variant	Isolated interface for data transfer to a control center
RS232	
Terminal	Back case bottom, mounting location "B", 9- pin DSUB socket
Test voltage (PELV)	500 V; 50 Hz
Transmission speed	min. 1,200 Bd, max. 115,000 Bd; factory setting 9,600 Bd
Bridgeable distance	15 m
RS485	
Terminal	Back case bottom, mounting location "B", 9- pin DSUB socket
Test voltage (PELV)	500 V; 50 Hz
Transmission speed	min. 1,200 Bd, max. 115,000 Bd; factory setting 9,600 Bd
Bridgeable distance	max. 1 km
Fiber optic cable (FO)	
FO connector type	ST connector
Terminal	Back case bottom, mounting location "B"
Optical wavelength	λ = 820 nm
Laser Class 1 according to EN 60825-1/-2	When using glass fiber 50 µm/125 µm or glass fiber 62.5 µm/125 µm
Permissible optical signal attenuation	max. 8 dB, with glass fiber 62.5/125 µm
Bridgeable distance	max. 1.5 km
Character idle state	Configurable; factory setting “Light off”
Profibus RS485 (DP)	
Terminal	Back case bottom, mounting location "B”, 9- pin DSUB socket
Test voltage (PELV)	500 V; 50 Hz
Transmission speed	Up to 1.5 MBd
Bridgeable distance	1 000 m (3 300 ft) at ≤ 93.75 kBd 500 m (1 600 ft) at ≤ 187.5 kBd 200 m (660 ft) at ≤ 1.5 MBd

Profibus FO (DP)	
FO connector type	ST connector Double ring
Terminal	Back case bottom, mounting location "B"
Transmission speed	up to 1.5 MBd
Recommended:	> 500 kBd with normal casing
Optical wavelength	λ = 820 nm
Laser Class 1 according to EN 60825-1/-2	When using glass fiber 50/125 µm or glass fiber 62.5/125 µm
Permissible optical signal attenuation	max. 8 dB, with glass fiber 62.5/125 µm
Bridgeable distance	max. 1.5 km
DNP3.0 /MODBUS RS485	
Terminal	Back case bottom, mounting location "B", 9- pin DSUB socket
Test voltage (PELV)	500 V; 50 Hz
Transmission speed	up to 19,200 Bd
Bridgeable distance	max. 1 km
DNP3.0 /MODBUS FO	
FO connector type	ST connector transmitter/receiver
Terminal	Back case bottom, mounting location "B"
Transmission speed	up to 19,200 Bd
Optical wavelength	λ = 820 nm
Laser Class 1 according to EN 60825-1/-2	When using glass fiber 50 µm/125 µm or glass fiber 62.5/125 µm
Permissible optical signal attenuation	max. 8 dB, with glass fiber 62.5/125 µm
Bridgeable distance	max. 1.5 km
Ethernet electrical (EN 100) for DIGSI and IEC61850	
Terminal	Back case bottom, mounting location "B", 2 x RJ45 socket 100BaseT according to IEEE802.3
Test voltage (with regard to the socket) (PELV)	500 V; 50 Hz
Transmission speed	100 MBit/s
Bridgeable distance	20 m
Ethernet optical (EN 100) for DIGSI and IEC61850	
Terminal	Back case bottom, mounting location "B", Duplex-LC, 100BaseF according to IEEE802.3
Transmission speed	100 MBit/s
Optical wavelength	1300 nm
Bridgeable distance	max. 2 km (1.24 mi)

4.1.5 Electrical Tests

Regulations

Standards:	IEC 60255 IEEE Std C37.90, see individual functions VDE 0435 for more standards see also individual functions

Insulation Test

Standards:	IEC 60255-27 and IEC 60870-2-1
Voltage test (routine test) of all circuits except auxiliary voltage, binary inputs and communication ports	2.5 kV, 50 Hz
Voltage test (routine test) of auxiliary voltage and binary inputs	DC 3.5 kV
Voltage test (routine test) of isolated communication ports only (A and B)	500 V, 50 Hz
Impulse voltage test (type test) of all process circuits (except for communication ports) against the internal electronics	6 kV (peak value); 1.2 µs/50 µs; 0.5 J; 3 positive and 3 negative impulses at intervals of 1 s
Impulse voltage test (type test) of all process circuits against each other (except for communication ports) and against the PE terminal of class III	5 kV (peak value); 1.2 µs/50 µs; 0.5 J; 3 positive and 3 negative impulses at intervals of 1 s

EMC Tests for Immunity (Type Tests)

Standards:		IEC 60255-26, (product standard) IEC/EN 61000-6-2 VDE 0435 For more standards see also individual functions
Immunity to damped oscillatory waves IEC 60255-22-1 IEC 61000-4-18		2.5 kV (Peak); 100 kHz and 1 MHz; τ = 15 ms; 400 Surges per s; Test duration 2 s; R_i = 200 Ω
Electrostatic discharge, Class IV EN 61000-6-2, IEC 60255-22-2		8 kV contact discharge; 15 kV air discharge, both polarities; 150 pF; R_i = 330 Ω, rating criteria B
Radio frequency electromagnetic field, amplitude-modulated, Class III EN 61000-6-2, IEC 60255-22-3		10 V/m; 80 MHz to 2.7 GHz 80 % AM; 1 kHz
Fast transient bursts, Class IV EN 61000-6-2, IEC 60255-22-4		4 kV; 5 ns/50 ns; 5 kHz; 1 min. test length, rating criteria B
High energy surge voltages (SURGE), Installation Class III, EN 61000-6-2, IEC 60255-22-5		Impulse: 1.2 µs/50 µs, rating criteria B
	Auxiliary voltage	common mode: 4 kV; 12 Ω; 9 µF diff. mode: 1 kV; 2 Ω; 18 µF
	Measuring inputs, binary inputs and relay outputs	common mode: 4 kV; 42 Ω; 0.5 µF diff. mode: 1 kV; 42 Ω; 0.5 µF

Immunity to Conducted Disturbance by RF fields, injected Current EN 61000-6-2, IEC 60255-22-6	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz; 27 Mhz and 68 MHz spot freq. Dwell time > 10 sec.
Power system frequency magnetic field EN 61000-6-2, IEC 61000-4-8	30 A/m continuous; 300 A/m and 1000 V/m for 3 s;
Radiated Electromagnetic Interference IEEE Std C37.90.2	20 V/m; 80 MHz to 1 GHz; 80 % AM; 1 kHz 35 V/m pulsed, 50% duty cycle 1 Hz rep. rate
Power frequency on binary input ports IEC 60255-26, IEC 61000-4-16	Common mode Zone A and B: 300 Veff (220 Ω, 0.47 µF) Differential Mode Zone B: 100 Veff (100 Ω, 0.047 µF) testet with 3.9 KΩ termination resistor
Ripple on d.c. input power port inmunity test, IEC 61000-4-17	15 % of nominal auxiliary voltage
Gradual shutdown / start-up for d.c. power supply IEC 60255-26	Shut-down ramp: 60 s Power off: 5 min. Start-up ramp: 60 s

EMC Tests for Noise Emission (Type Test)

Standard:	EN 61000-6-4 /01.07 + A1 EN 55011 /11.2009 + A1 class A
Radio noise voltage to lines, only auxiliary voltage IEC/CISPR 16-2-1	150 kHz to 30 MHz Limit Class A
Interference field strength IEC/CISPR 16-2-3	30 MHz bis 1000 MHz Limit Class A 1 GHz to 6 GHz Limit Class A
Harmonic currents on the network lead at AC 230 V IEC 61000-3-2	Device is to be assigned Class D (applies only to devices with > 50 VA power consumption)
Voltage dips, interruptions and fluctuations IEC 60255-11, IEC 61000-4-29	Tolerate Voltage interruptions < 60 ms for the nominal auxiliary voltage.

4.1.6 Mechanical Tests

Vibration and Shock Stress during Steady-State Operation

Standards:	IEC 60255-21 and IEC 60068
Oscillation IEC 60255-21-1, Class 2; IEC 60068-2-6	Sinusoidal 10 Hz to 60 Hz: ±0,075 mm amplitude; 60 Hz bis 150 Hz: 1g acceleration frequency sweep rate 1 octave/min 20 cycles in 3 orthogonal axes.
Shock IEC 60255-21-2, Class 1; IEC 60068-2-27	Semi-sinusoidal acceleration, duration 11 ms, each 3 shocks in both directions of the 3 axes
Seismic Vibration IEC 60255-21-3, Class 2; IEC 60068-3-3	Sinusoidal 1 Hz to 8 Hz: ±7,5 mm amplitude (horizontal axis) 1 Hz to 8 Hz: ±3,5 mm amplitude (vertical axis) 8 Hz to 35 Hz: 2 g acceleration (horizontal axis) 8 Hz to 35 Hz: 1 g acceleration (vertical axis) Frequency sweep 1 octave/min 1 cycle in 3 orthogonal axes

Vibration and Shock Stress during Transport

Standards:	IEC 60255-21 and IEC 60068
Oscillation IEC 60255-21-1, Class 2; IEC 60068-2-6	Sinusoidal 5 Hz to 8 Hz: ±7.5 mm amplitude; 8 Hz to 150 Hz: 2 g acceleration frequency sweep 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, Class 1; IEC 60068-2-27	Semi-sinusoidal 15 g acceleration, duration 11 ms, each 3 shocks (in both directions of the 3 axes)
Continuous Shock IEC 60255-21-2, Class 1; IEC 60068-2-29	Semi-sinusoidal 10 g acceleration, duration 16 ms, each 1000 shocks (in both directions of the 3 axes)

4.1.7 Climatic Stress Tests

Temperatures

Standards:	IEC 60255-1, IEC 60068-2-1/2, IEC 60068-2-78, IEC 60068-2-30
Type test (in acc. with IEC 60068-2-1 and -2, Test Bd for 16 h)	–25 °C to +85 °C oder –13 °F to +185 °F
Damp heat, steady state - Test Cab IEC 60255-1 and IEC 60068-2-78.	40 °C, 93 % RH, 56 days
Damp heat, cyclic - Test Db IEC 60255-1 and IEC 60068-2-30	25 °C to/down 40 °C in 3 hr., > 93 % RH, dwell time 9 hr. 6 cycles
Permissible temporary operating temperature (tested for 96 h)	–20 °C to +70 °C oder –4 °F to +158 °F (clearness of the display may be impaired from +55 °C or +131 °F)
Recommended for permanent operation (in acc. with IEC 60255-6)	–5 °C to +55 °C or +23 °F to +131 °F
Limit temperatures for storage	–25 °C to +55 °C or –13 °F to +131 °F
Limit temperatures for transport	–25 °C to +70 °C or –13 °F to +158 °F
Storage and transport with factory packaging	

Humidity

Permissible humidity	Mean value per year ≤ 75 % relative humidity; on 56 days of the year up to 93 % relative humidity; condensation must be avoided!
Siemens recommends that all devices be installed such that they are not exposed to direct sunlight, nor subject to large fluctuations in temperature that may cause condensation to occur.	

4.1.8 Service Conditions

The protective device is designed for use in an industrial environment and an electrical utility environment. Proper installation procedures should be followed to ensure electromagnetic compatibility (EMC).

In addition, the following is recommended:

- All contacts and relays that operate in the same cubicle, cabinet, or relay panel as the numerical protective device should, as a rule, be equipped with suitable surge suppression components.
- For substations with operating voltages of 100 kV and above, all external cables should be shielded with a conductive shield grounded at both ends. For substations with lower operating voltages, no special measures are normally required.
- Do not withdraw or insert individual modules or boards while the protective device is energized. In withdrawn condition, some components are electrostatically endangered; during handling the ESD standards (for **E**lectrostatic **S**ensitive **D**evices) must be observed. They are not endangered when inserted into the case.

4.1.9 Constructive Design

Case	7XP20
Dimensions	see dimensional drawings, Section *4.12 Dimensions*

Device	Case	Size	Weight
7RW80**-*B	for panel surface mounting	1/6	4.5 kg (9.9 lb)
7RW80**-*E	for panel flush mounting	1/6	4 kg (8.8 lb)

Protection type acc. to IEC 60529	
For equipment in the surface-mounting case	IP 50
For equipment in flush mounting case	Front IP 51 Rear IP 50
For operator protection	IP 2x for current terminal IP 2x for voltage terminal
Degree of pollution, IEC 60255-27	2

4.1.10 UL certification conditions

The data in the following table apply to the device variants 7RW801 and 7RW802.

Output Relays	DC 24 V	5 A General Purpose
	DC 48 V	0,8 A General Purpose
	DC 240 V	0,1 A General Purpose
	AC 240 V	5 A General Purpose
	AC 120 V	1/3 hp
	AC 250 V	1/2 hp
	B300, R300	
Voltage Inputs	Input voltage range	300 V

Battery	Servicing of the circuitry involving the batteries and replacement of the lithium batteries shall be done by a trained technician. Replace Battery with VARTA or Panasonic Cat. Nos. CR 1/2 AA or BR 1/2 AA only. Use of another Battery may present a risk of fire or explosion. See manual for safety instructions. Caution: The battery used in this device may present a fire or chemical burn hazard if mistreated. Do not recharge, disassemble, heat above 100 °C (212 °F) or incinerate. Dispose of used battery promptly. Keep away from children.	
Climatic Stress Tests	Surrounding air temperature	tsurr: max. 70 °C (158 °F), normal operation
Design	Field Wires of Control Circuits shall be separated from other circuits with respect to the end use requirements!	
	Type 1 if mounted into a door or front cover of an enclosure.	

4.2 Voltage Protection

Setting Ranges / Increments

Undervoltages 27-1, 27-2, 27-Vp<		
Measured quantity used with three-phase connection	- Positive sequence system of voltages - Smallest phase-to-phase voltages - Smallest phase-to-ground voltage	
Measured quantity used with single-phase connection	Single-phase phase-to-ground or phase-to-phase voltage	
Connection of phase-to-ground voltages - Bewertung Leiter-ground voltages - Evaluation of phase-to-phase voltages - Evaluation of positive-sequence system	 10 V to 120 V 10 V to 210 V 10 V to 210 V	 Increment 1 V Increment 1 V Increment 1 V
Connection of phase-to-phase voltages	10 V to 120 V	Increment 1 V
Connection: single-phase	10 V to 120 V	Increment 1 V
Dropout ratio r for 27-1, 27-2[1)]	1.01 to 3.00	Increment 0.01
Dropout threshold for (r · 27-1) or (r · 27-2) or (r · 27-Vp<)	max.130 V for phase-to-phase voltage max. 225 V for phase-to-ground voltage Minimum hysteresis 0.6 V	
Time delays 27-1 DELAY, 27-2 DELAY, 27 T Vp<	0.00 s to 100.00 s oder ∞ (disabled)	Increment 0.01 s
Overvoltages 59-1, 59-2, 59-Vp>		
Measured quantity used with three-phase connection	- Positive sequence system of the voltages - Negative sequence system of the voltages - Largest phase-to-phase voltage - Largest phase-to-ground voltage	
Measured quantity used with single-phase connection	Connected single-phase phase-togroundvoltage or phase-to-phase voltage	
Connection of phase-to-ground voltages - Evaluation of phase-to-ground voltages - Evaluation of phase-to-phase voltages - Evaluation of positive-sequence system - Evaluation of negative-sequence system	 20 V to 150 V 20 V to 260 V 20 V to 150 V 2 V to 150 V	 Increment 1 V Increment 1 V Increment 1 V Increment 1 V
Connection of phase-to-phase voltages - Evaluation of phase-to-phase voltages - Evaluation of positive-sequence system - Evaluation of negative-sequence system	 20 V to 150 V 20 V to 150 V 2 V to 150 V	 Increment 1 V Increment 1 V Increment 1 V
Connection: single-phase	20 V to 150 V	Increment 1 V
Dropout ratio r for 59-1, 59-2[1)]	0.90 to 0.99	Increment 0.01 V
Dropout threshold for (r · 59-1) or (r · 59-2) or (r · 59-Vp>)	max. 150 V for phase-to-phase voltage max. 260 V for phase-to-ground voltage Minimum hysteresis 0.6 V	
Time delays 59-1 DELAY, 59-2 DELAY, 59 T Vp>	0.00 s to 100.00 s or ∞ (disabled)	Increment 0.01 s
[1)] $r = V_{dropout}/V_{pickup}$		

Times

Pickup Times	
Undervoltage 27-1, 27-2, 27-1 V_1, 27-2 V_1, 27-Vp< - Overvoltage 59-1, 59-2, 59-Vp> - Overvoltage 59-1 V_1, 59-2 V_1, 59-1 V_2 , 59-2 V_2, 59-Vp> V_1, 59-Vp> V_2	approx. 50 ms approx. 50 ms approx. 60 ms
Dropout Times	
- Undervoltage 27-1, 27-2, 27-1 V_1, 27-2 V_1, 27-Vp> - Overvoltage 59-1, 59-2, 59-Vp> - Overvoltage 59-1 V_1, 59-2 V_1, 59-1 V_2 , 59-2 V_2, 59-Vp> V_1, 59-Vp> V_2	approx. 50 ms approx. 50 ms approx. 60 ms

Tolerances

Pickup Voltage Limits	3 % of setting value or 1 V
Delay times T	1 % of setting value or. 10 ms

Influencing Variables

Auxiliary DC voltage in range $0.8 \leq V_{Aux}/V_{AuxNom} \leq 1{,}15$	1 %
Temperature in range –5 °C (23 °F) ≤ Θ_{amb} ≤ 55 °C (131 °F)	0.5 %/10 K
Frequency in the range of 25 Hz to 70 Hz	
Frequency in the range of $0.95 \leq f/f_{Nom} \leq 1.05$ (f_{Nom} = 50 Hz or 60 Hz)	1 %
Frequency outside range $0.95 \leq f/f_{Nom} \leq 1.05$	Increased tolerances
Harmonics - up to 10 % 3rd harmonic - up to 10 % 5th harmonic	 1 % 1 %

4.3 Frequency Protection 81 O/U

Setting Ranges / Increments

Setting Ranges / Increments	4; each can be set to f> or f<	
Pickup values f> or f< for f_{Nom} = 50 Hz	40.00 Hz to 60.00 Hz	Increments 0.01 Hz
Pickup values f> or f< for f_{Nom} = 60 Hz	50.00 Hz to 70.00 Hz	Increments 0.01 Hz
Dropout threshold = |pickup threshold - dropout threshold|	0.02 Hz to 1.00 Hz	Increments 0.01 Hz
Time delays T	0.00 s to 100.00 s or ∞ (disabled)	Increments 0.01 s
Undervoltage blocking with three-phase connection: Positive sequence component V_1 with single-phase connection ("Vphn, Vsyn"): single-phase Phase-to-ground voltage	10 V to 150 V	Increments 1 V

Times

Pickup times f>, f<	approx. 100 ms at f_{Nom} = 50 Hz approx. 80 ms at f_{Nom} = 60 Hz
Dropout times f>, f<	approx. 100 ms at f_{Nom} = 50 Hz approx. 80 ms at f_{Nom} = 60 Hz

Dropout Difference

Δf = I pickup value - dropout value I	0.02 Hz to 1 Hz

Dropout Ratio

Dropout Ratio for Undervoltage Blocking	approx. 1.05

Tolerances

Pickup frequencies 81/O or 81U	≤ 5 mHz Tolerance (at V = V_{Nom}, f_{Nom} - 0.5 Hz < f < f_{Nom} + 0.5 Hz) < 15 mHz Tolerance (at V = V_{Nom}, f_{Nom} - 5 Hz < f < f_N - 0.5 Hz) < 15 mHz Tolerance (at V = V_{Nom}, f_{Nom} + 0.5 Hz < f < f_{Nom} + 5 Hz)
Undervoltage blocking	3 % of setting value or 1 V
Time delays 81/O or 81/U	1 % of setting value or 10 ms

Influencing Variables

Power supply direct voltage in range 0.8 ≤ V_{PS}/V_{PSNom} ≤ 1.15	1 %
Temperature in range 23 °F (-5 °C) ≤ Θ_{amb} ≤ 131 °F (55 °C)	0,5 %/10 K
Harmonics - up to 10 % 3rd harmonic - up to 10 % 5th harmonic	 1 % 1 %

4.4 Load Restoration

Setting Ranges / Increments

Setting Ranges / Increments	4	
Start threshold with f_{Nom} = 50 Hz	40.00 Hz to 60.00 Hz	Increments 0.01 Hz
Start threshold with f_{Nom} = 60 Hz	50.00 Hz to 70.00 Hz	Increments 0.01 Hz
Pickup Threshold = |Start threshold – Pickup threshold|	0.02 Hz to 2.00 Hz	Increments 0.01 Hz
Dropout Threshold = |Start threshold – Dropout threshold|	0.00 Hz to 2.00 Hz	Increments 0.01 Hz
Delay times T Pickup and Dropout	0 s to 10800 s	Increments 1 s
Delay times T CB-Close command	0.01 s to 32.00 s	

Times

Pickup times	approx. 100 ms at f_{Nom} = 50 Hz approx. 80 ms at f_{Nom} = 60 Hz
Dropout Times	approx. 100 ms at f_{Nom} = 50 Hz approx. 80 ms at f_{Nom} = 60 Hz

Tolerances

Pickup frequencies	15 mHz (with $U = U_{Nom}$, $f = f_{Nom} \pm 5$ Hz)
Undervoltage blocking	3 % of setting value or 1 V
Time delays	1 % of setting value or 10 ms

Influencing Variables

Power supply direct voltage in range $0.8 \leq V_{Aux}/V_{AuxNom} \leq 1.15$	1 %
Temperature in the Range 23.00 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131.00 °F (55 °C)	0.5 %/10 K
Oberschwingungen - up to 10 % 3rd harmonic - up to 10 % 5th harmonic	 1 % 1 %

4.5 Flexible Protection Functions

Measured Values / Modes of Operation

Three-phase	V, $3V_0$, V1, V2, dV/dt
Single-phase	V, V_N,V_x
Without fixed phase reference	f, df/dt, binary input
Measurement method for V	Fundamental, r.m.s. value (true RMS), positive sequence system, negative sequence system, zero sequence system
Pickup on	exceeding threshold value or falling below threshold value

Setting Ranges / Increments

Pickup thresholds:			
Voltage V, V_1, V_2, $3V_0$		2.0 V to 260.0 V	Increments 0.1 V
Displacement voltage V_0		2.0 V to 200.0 V	Increments 0.1 V
Frequency	for f_{Nom} = 50 Hz for f_{Nom} = 60 Hz	40.0 Hz to 60.0 Hz 50.0 Hz to 70.0 Hz	Increments 0.01 Hz Increments 0.01 Hz
Frequency change df/dt		0.10 Hz/s to 20.00 Hz/s	Increments 0.01 Hz/s
Voltage change dV/dt		4 V/s to 100 V/s	Increments 1 V/s
Dropout ratio > element		1.01 to 3.00	Increments 0.01
Dropout ratio < element		0.70 to 0.99	Increments 0.01
Dropout difference f		0.02 Hz to 1.00 Hz	Increments 0.01 Hz
Pickup delay (standard)		0.00 s to 60.00 s	Increments 0.01 s
Command delay time		0.00 s to 3,600.00 s	Increments 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments 0.01 s

Fixed Dropout Difference

Dropout difference df/dt	0.1 Hz/s
Dropout difference dV/dt	3 V/s

Times

Pickup times:	
Voltage (phase quantities) for 2 times the setting value for 10 times the setting value	 approx. 30 ms approx. 20 ms
Voltage (symmetrical components) for 2 times the setting value for 10 times the setting value	 approx. 40 ms approx. 30 ms
Frequency	approx. 100 ms
Frequency change for 1.25 times the setting value	approx. 220 ms
Voltage change dV/dt for 2 times the setting value	approx. 220 ms
Binary input	approx. 20 ms

Dropout times:	
Voltage (phase quantities)	< 20 ms
Current, voltage (symmetrical components)	< 30 ms
Frequency	< 100 ms
Frequency change	< 200 ms
Voltage change	< 200 ms
Binary input	< 10 ms

Tolerances

Pickup thresholds:	
Voltage	3% of setting value or 0,2 V
Voltage (symmetrical components)	4% of setting value or 0,2 V
Voltage change dV/dt	5 % of setting value or 2 V/s
Frequency	15 mHz
Frequency change	5% of setting value or 0,05 Hz/s
Times	1% of setting value or 10 ms

Influencing Variables for Pickup Values

Auxiliary DC voltage in range $0.8 \leq V_{Aux}/V_{AuxNom} \leq 1,15$	1 %
Temperature in range –5 °C (23 °F) $\leq \Theta_{amb} \leq$ 55 °C (131 °F)	0.5 %/10 K
Frequency in the range of 25 Hz to 70 Hz	
Frequency in the range of $0.95 \leq f/f_{Nom} \leq 1.05$ (f_{Nom} = 50 Hz or 60 Hz)	1 %
Frequency outside range $0.95 \leq f/f_{Nom} \leq 1.05$	Increased tolerances
Harmonics - up to 10 % 3rd harmonic - up to 10 % 5th harmonic	 1 % 1 %

4.6 Synchrocheck 25

Modes of Operation

- Synchrocheck

Additional Release Conditions

- Live bus / dead line, - Dead bus / live line, - Dead bus and dead line - Bypassing

Voltages

Maximum operating voltage V_{max}	20 V to 140 V (phase-to-phase)	Increments 1 V
Minimum operating voltage V_{min}	20 V to 125 V (phase-to-phase)	Increments 1 V
V< for dead line V> for live line	1 V to 60 V (phase-to-phase) 20 V to 140 V (phase-to-phase)	Increments 1 V Increments 1 V
Primary transformer rated voltage V2N	0.10 kV to 800.00 kV	Increments 0.01 kV
Tolerances	2 % of pickup value or 2 V	
Dropout Ratios	approx. 0.9 (V>) or 1.1 (V<)	

Permissible Difference

Voltages differences V2>V1; V2<V1 Tolerance	0.5 V to 50.0 V (phase-tophase) 1 V	Increments 0.1 V
Frequency Difference f2>f1; f2<f1 Tolerance	0.01 Hz to 2.00 Hz 20 mHz	Increments 0.01 Hz
Angle Difference α2 > α1; α2 < α1	2° to 80°	Increments 1°
Tolerance	2°	
Max. angle error	5° for Δf ≤ 1 Hz 10° for Δf >1 Hz	

Matching

Vector group matching via angle	0° to 360°	Increments 1°
Different voltage transformer V1/V2	0.50 to 2.00	Increments 0.01

Times

Minimum Measuring Time	approx. 80 ms	
Maximum duration $T_{SYN\ DURATION}$	0.01 s to 1200.00 s or ∞ (disabled)	Increments 0.01 s
Monitoring Time $T_{SUP\ VOLTAGE}$	0.00 s to 60.00 s	Increments 0.01 s
Tolerance of all times	1 % of setting value or 10 ms	

Measured Values of the Synchronism and Voltage Check

Reference voltage V1 - Range - Tolerance [1)]	in kV primary, in V secondary or in % V_{Nom} 10 % to 120 % of V_{Nom} ≤ 1 % of measured value, or 0,5 % V_{Nom}

Voltage to be synchronized V2 - Range - Tolerance [1)]	in kV primary, in V secondary or in % V_{Nom} 10 % to 120 % of V_{Nom} ≤ 1 % of measured value, or 0,5 % V_{Nom}
Frequency of the voltage V1 - Range - Tolerance [1)]	f1 in Hz f_{Nom} ± 5 Hz 20 mHz
Frequency of the voltage V2 - Range - Tolerance [1)]	f2 in Hz f_{Nom} ± 5 Hz 20 mHz
Voltage difference V2-V1 - Range - Tolerance [1)]	in kV primary, in V secondary or in % V_N 10 % bis 120 % of V_N ≤ 1 % of measured value, or 0,5 % V_N
Frequency difference f2-f1 - Range - Tolerance [1)]	in mHz f_{Nom} ± 5 Hz 20 mHz
Angle difference λ2-λ1 - Range - Tolerance [1)]	in ° 0 to 180° 0,5°
[1)] at nominal frequency	

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Setting Ranges / Increments

Pickup threshold of the warning stage $\frac{V/V_N}{f/f_N}$	1.00 to 1.20	Increments 0.01
Pickup threshold of the stage characteristic $\frac{V/V_N}{f/f_N}$	1.00 to 1.40	Increments 0.01
Delay times T V/f>, T V/f>> (Alarm and stage characteristic)	0.00 s to 60.00 s or ∞ (inactive)	Increments 0.01 s
Characteristic value pairs V/f	1.05/1,10/1,15/1,20/1.25/1,30/1.35/1.40	
Associated time delay for t (V/f) thermal replica	0 s to 20 000 s	Increments 1 s
Cooling time T_{COOL}	0 s to 20 000 s	Increments 1 s

Times

Alarm and stage characteristic	
Pickup times for 1.1 · Setting value	approx. 90 ms
Dropout Times	approx. 60 ms

Dropout Ratios

Pickup, Tripping	approx. 0.98

Tripping Characteristic

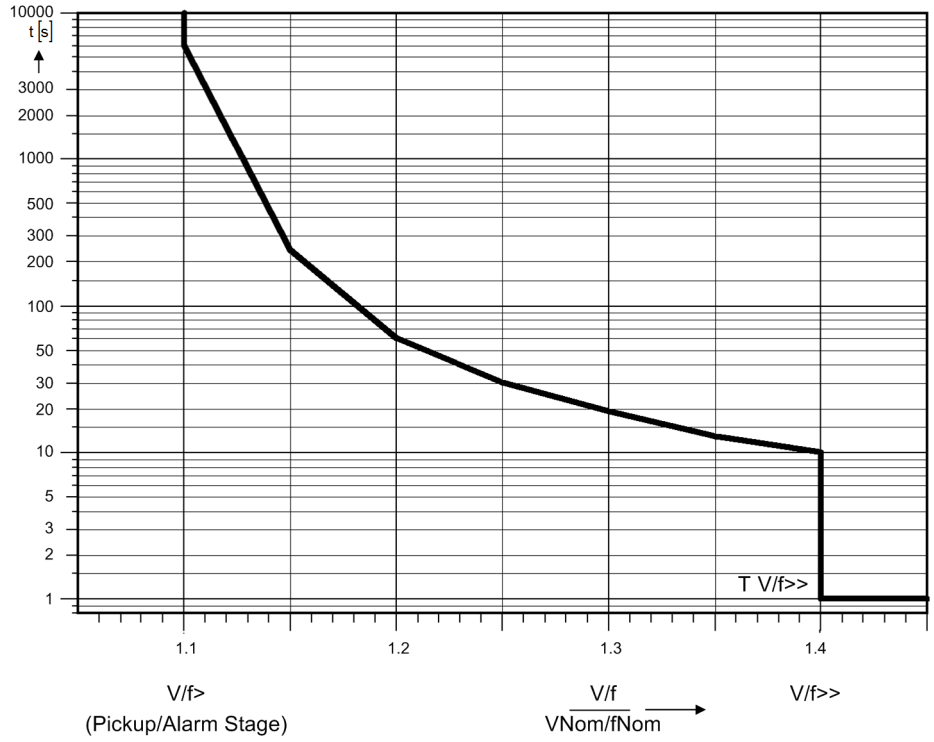
Thermal Replica (Presetting and stage characteristic)	see *Figure 4-1*

Tolerances

Pickup on V/f	3 % of setting value
Delay times T (Alarm and stage characteristic)	1 % of setting value or 10 ms
Thermal replica (time characteristic)	5 %, related to V/f ±600 ms

Influencing Variables

Power supply direct voltage in range $0.8 \le V_{Aux}/V_{AuxNom} \le 1.15$	≤ 1 %
Temperature in the Range 23.00 °F (–5 °C) ≤ Θ_{amb}≤ 131.00 °F (55 °C)	≤ 0.5 %/10 K
Harmonics - up to 10 % 3rd harmonic - up to 10 % 5th harmonic	 ≤ 1 % ≤ 1 %



[resultierende-ausloesekennlinie-aus-therm-020830-ho, 1, en_US]

Figure 4-1 Resulting Tripping Characteristic from Thermal Replica and Stage Characteristic of the Overexcitation Protection (Default Setting)

4.8 Jump of Voltage Vector

Setting Ranges / Increments

Element Δφ	2° to 30°	Increments 1°
Delay times T	0.00 to 60.00 s or ∞ (inactive)	Increments 0.01 s
Reset Time T_{Reset}	0.00 to 60.00 s or ∞ (inactive)	Increments 0.00 s
Undervoltage Blocking	10.0 to 125.0 V	Increments 0.1 V

Times

Pickup Times Δφ	approx. 75 ms
Dropout Times Δφ	approx. 75 ms

Dropout Ratios

–	–

Tolerances

Jump of Phasor	2° at $V > 0.5\ V_N$
Undervoltage Blocking	1 % of setting value or 0.5 V
Delay times T	1 % of setting value or 10 ms

Influencing Variables

Power supply direct voltage in range $0.8 \le V_{Aux}/V_{AuxNom} \le 1.15$	≤ 1 %
Temperature in the Range 23.00 °F (–5 °C) ≤ Θ_{amb}≤ 131.00 °F (55 °C)	≤ 0.5 %/10 K
Frequency in Range $0.95 \le f/f_{Nom} \le 1.05$	≤ 1 %
Harmonics - up to 10 % 3nd harmonic - up to 10 % 5th harmonic	 ≤ 1 % ≤ 1 %

4.9 User-defined Functions (CFC)

Function Blocks and Their Possible Assignments to Task Levels

Function block	Explanation	Task level			
		MW_ BEARB	PLC1_ BEARB	PLC_ BEARB	SFS_ BEARB
ABSVALUE	Magnitude Calculation	X	—	—	—
ADD	Addition	X	X	X	X
ALARM	Alarm	X	X	X	X
AND	AND - Gate	X	X	X	X
BLINK	Blink block	X	X	X	X
BOOL_TO_CO	Boolean to Control (conversion)	—	X	X	—
BOOL_TO_DI	Boolean to Double Point (conversion)	—	X	X	X
BOOL_TO_IC	Bool to Internal SI, Conversion	—	X	X	X
BUILD_DI	Create Double Point Annunciation	—	X	X	X
CMD_CANCEL	Cancel command	X	X	X	X
CMD_CHAIN	Switching Sequence	—	X	X	—
CMD_INF	Command Information	—	—	—	X
COMPARE	Metered value comparison	X	X	X	X
CONNECT	Connection	—	X	X	X
COUNTER	Counter	X	X	X	X
DI_GET_STATUS	Decode status of double-point indication	X	X	X	X
DI_SET_STATUS	Generate double-point indication with status	X	X	X	X
D_FF	D- Flipflop	—	X	X	X
D_FF_MEMO	Status Memory for Restart	X	X	X	X
DI_TO_BOOL	Double Point to Boolean (conversion)	—	X	X	X
DINT_TO_REAL	Adaptor	X	X	X	X
DIST_DECODE	Convert double-point indication with status into four single-point indications with status	X	X	X	X
DIV	Division	X	X	X	X
DM_DECODE	Decode Double Point	X	X	X	X
DYN_OR	Dynamic OR	X	X	X	X
INT_TO_REAL	Conversion	X	X	X	X
IO_UNIT	SICAM I/O Unit		X	X	
LIVE_ZERO	Live-zero, non-linear Curve	X	—	—	—
LONG_TIMER	Timer (max.1193h)	X	X	X	X
LOOP	Feedback Loop	X	X	—	X
LOWER_SETPOINT	Lower Limit	X	—	—	—
MUL	Multiplication	X	X	X	X
MV_GET_STATUS	Decode status of a value	X	X	X	X
MV_SET_STATUS	Set status of a value	X	X	X	X
NAND	NAND - Gate	X	X	X	X
NEG	Negator	X	X	X	X
NOR	NOR - Gate	X	X	X	X

Function block	Explanation	Task level			
		MW_ BEARB	PLC1_ BEARB	PLC_ BEARB	SFS_ BEARB
OR	OR - Gate	X	X	X	X
REAL_TO_DINT	Adaptor	X	X	X	X
REAL_TO_INT	Conversion	X	X	X	X
REAL_TO_UINT	Conversion	X	X	X	X
RISE_DETECT	Edge detector	X	X	X	X
RS_FF	RS- Flipflop	—	X	X	X
RS_FF_MEMO	RS- Flipflop with status memory	—	X	X	X
SQUARE_ROOT	Root Extractor	X	X	X	X
SR_FF	SR- Flipflop	—	X	X	X
SR_FF_MEMO	SR- Flipflop with status memory	—	X	X	X
ST_AND	AND gate with status	X	X	X	X
ST_NOT	Inverter with status	X	X	X	X
ST_OR	OR gate with status	X	X	X	X
SUB	Substraction	X	X	X	X
TIMER	Timer	—	X	X	—
TIMER_SHORT	Simple timer	—	X	X	—
UINT_TO_REAL	Conversion	X	X	X	X
UPPER_SETPOINT	Upper Limit	X	—	—	—
X_OR	XOR - Gate	X	X	X	X
ZERO_POINT	Zero Supression	X	—	—	—

General Limits

Description	Limit	Comment
Maximum number of all CFC charts considering all task levels	32	If the limit is exceeded, the device rejects the parameter set with an error message, restores the last valid parameter set and restarts using that parameter set.
Maximum number of all CFC charts considering one task level	16	When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.
Maximum number of all CFC inputs considering all charts	400	When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.
Maximum number of reset-resistant flipflops D_FF_MEMO	350	When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.

Device-Specific Limits

Description	Limit	Comment
Maximum number of synchronous changes of chart inputs per task level	165	When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.
Maximum number of chart outputs per task level	150	

Additional Limits

Additional limits [1] for the following CFC blocks:		
Task Level	**Maximum Number of Modules in the Task Levels**	
	TIMER[2] [3]	TIMER_SHORT[2] [3]
MW_BEARB	—	—
PLC1_BEARB	15	30
PLC_BEARB		
SFS_BEARB	—	—

[1] When the limit is exceeded, an error message is iisued by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.

[2] The following condition applies for the maximum number of timers: (2 · number of TIMER + number of TIMER_SHORT) < 30. TIMER and TIMER_SHORT hence share the available timer resources within the frame of this inequation. The limit does not apply to the LONG_TIMER.

[3] The time values for the blocks TIMER and TIMER_SHORT must not be selected shorter than the time resolution of the device of 10 ms, as then, the blocks will not then start with the starting pulse.

Maximum Number of TICKS in the Task Levels

Task level	Limit in TICKS [1]
MW_BEARB (measured value processing)	10000
PLC1_BEARB (slow PLC processing)	12000
PLC_BEARB (fast PLC processing)	600
SFS_BEARB (interlocking)	10000

[1] When the sum of TICKS of all blocks exceeds the limits mentioned before, an error message is output in the CFC.

Processing Times in TICKS for the Individual Elements

Individual element		Number of TICKS
Block, basic requirement		5
Each input from the 3rd additional input on for generic modules		1
Combination with input signal border		6
Combination with output signal border		7
Additionally for each chart		1
Arithmetic	ABS_VALUE	5
	ADD	26
	SUB	26
	MUL	26
	DIV	54
	SQUARE_ROOT	83
Base logic	AND	5
	CONNECT	4
	DYN_OR	6
	NAND	5
	NEG	4
	NOR	5
	OR	5
	RISE_DETECT	4
	X_OR	5

Individual element		Number of TICKS
Information status	SI_GET_STATUS	5
	CV_GET_STATUS	5
	DI_GET_STATUS	5
	MV_GET_STATUS	5
	SI_SET_STATUS	5
	DI_SET_STATUS	5
	MV_SET_STATUS	5
	ST_AND	5
	ST_OR	5
	ST_NOT	5
Memory	D_FF	5
	D_FF_MEMO	6
	RS_FF	4
	RS_FF_MEMO	4
	SR_FF	4
	SR_FF_MEMO	4
Control commands	BOOL_TO_CO	5
	BOOL_TO_IC	5
	CMD_INF	4
	CMD_INF_EXE	4
	CMD_CHAIN	34
	CMD_CANCEL	3
	LOOP	8
Type converter	BOOL_TO_DI	5
	BUILD_DI	5
	DI_TO_BOOL	5
	DM_DECODE	8
	DINT_TO_REAL	5
	DIST_DECODE	8
	UINT_TO_REAL	5
	REAL_TO_DINT	10
	REAL_TO_UINT	10
Comparison	COMPARE	12
	LOWER_SETPOINT	5
	UPPER_SETPOINT	5
	LIVE_ZERO	5
	ZERO_POINT	5
Metered value (counter)	COUNTER	6
Time and clock pulse	TIMER	5
	TIMER_LONG	5
	TIMER_SHORT	8
	ALARM	21
	BLINK	11
Other	IO_UNIT	17

Routable in Matrix

In addition to the defined preassignments, indications and measured values can be freely routed to buffers, preconfigurations can be removed.

4.10 Auxiliary Functions

Operational Measured Values

Voltages (phase-to-ground) V_{A-N}, V_{B-N}, V_{C-N} Voltages (phase-to-phase) V_{A-B}, V_{B-C}, V_{C-A}, V_{SYN} V_N, V_{ph-N}, V_x or V_0 Positive sequence component V_1 Negative sequence component V_2		in kV primary, in V secondary or in % V_{Nom}
	Range Tolerance [1]	10 % to 120 % V_{Nom} 1,5 % of measured value or 0,5 % V_N
Frequenz f		in Hz
	Range Tolerance [1]	f_{Nom} ± 5 Hz 20 mHz
Synchronization Function		see section (Synchronization Function)
[1] at nominal frequency		

Min / Max Report

Report of Measured Values	with date and time
Reset automatic	Time of day adjustable (in minutes, 0 to 1439 min) Time frame and starting time adjustable (in days, 1 to 365 days, and ∞)
Manual Reset	Using binary input Using keypad Via communication
Min/Max Values for Voltages	V_{A-N}; V_{B-N}; V_{C-N}; V_1 (Positive Sequence Component); V_{A-B}; V_{B-C}; V_{C-A}

Broken-wire Monitoring of Voltage Transformer Circuits

suited for 1- or 2-pole broken-wire detection of voltage transformer circuits; only for connection of phase-ground voltages

Fault Logging

Recording of indications of the last 25 power system faults
Recording of indications of the last 3 power system ground faults

Time Allocation

Resolution for Event Log (Operational Annunciations)	1 ms
Resolution for Trip Log (Fault Annunciations)	1 ms
Maximum Time Deviation (Internal Clock)	0.01 %
Battery	Lithium battery 3 V/1 Ah, Typ CR 1/2 AA Message “Battery Fault” for insufficient battery charge

Local Measured Values Monitoring

Voltage Asymmetry	V_{max}/V_{min} > balance factor, for V > V_{Grenz}
Voltage phase sequence	Clockwise (ABC) / counter-clockwise (ACB)

Fault Recording

maximum of 8 fault records saved; memory maintained by buffer battery in the case of auxiliary voltage failure	
Recording time	5 s per fault record, in total up to 18 s at 50 Hz (max. 15 s at 60 Hz)
Intervals at 50 Hz Intervals at 60 Hz	1 instantaneous value each per 1.0 ms 1 instantaneous value each per 0.83 ms

Statistics

Stored number of trips	Up to 9 digits

Operating Hours Counter

Display Range	Up to 7 digits

Trip Circuit Supervision

With one or two binary inputs

Commissioning Aids

- Phase rotation field check - Operational measured values - Circuit breaker test by means of control function - Creation of a test measurement report - Creation of messages

Clock

Time synchronization		Binary input Communication
Modes of operation for time tracking		
No.	Mode of operation	Explanations
1	Internal	Internal synchronization using RTC (presetting)
2	IEC 60870-5-103	External synchronization using port B (IEC 60870-5-103)
3	Pulse via binary input	External synchronization with pulse via binary input
4	Fieldbus (DNP, Modbus)	External synchronization using field bus
5	SNTP (IEC 61850)	External synchronization using port B (IEC 61850)

Setting Group Change Option of the Functional Settings

Number of Available Setting Groups	4 (parameter group A, B, C and D)
Switchover Performed	using the keypad DIGSI using the front PC port Protocol using port B Binary Input

IEC 61850 GOOSE (inter-relay communication)

The GOOSE communication service of IEC 61850 is qualified for switchgear interlocking The runtime of GOOSE messages with the protection relay picked up depends on the number of connected IEC 61850 clients.

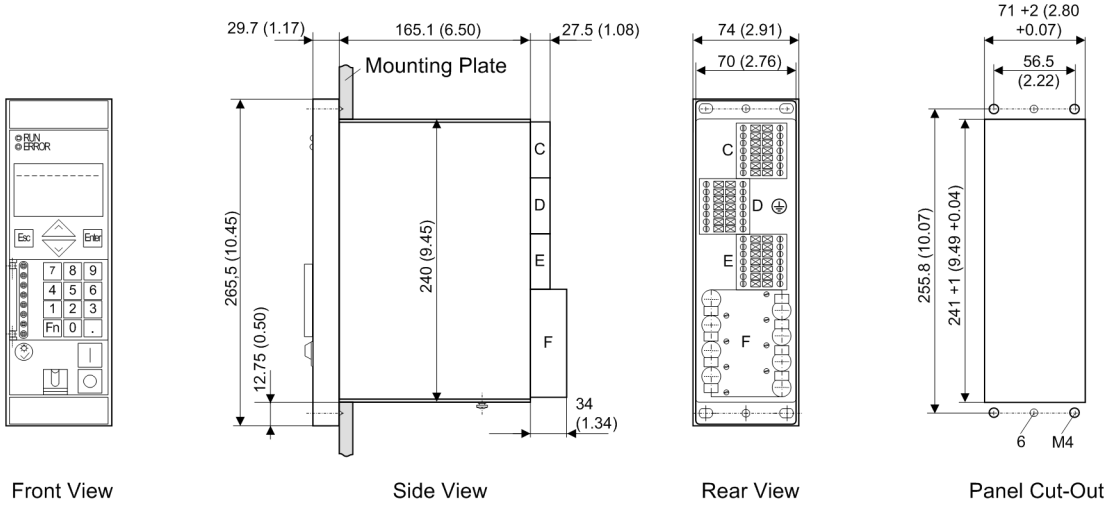
As from version V4.6 of the devices, applications with protective functions have to be checked with regard to their required runtime. In individual cases, the manufacturer has to be consulted with regard to the requirements to ensure that the application functions safely.

4.11 Switching Device Control

Number of Controlled Switching Devices	Depends on the number of binary inputs and outputs available
Interlocking	Freely programmable interlocking
Messages	Single command / double command
Control Commands	Single command / double command
Switching Command to Circuit Breaker	1-, 1½ - and 2-pole
Programmable Logic Controller	PLC logic, graphic input tool
Local Control	Control via menu control assignment of function keys
Remote Control	Using Communication Interfaces Using a substation automation and control system (e.g. SICAM) Using DIGSI (e.g. via Modem)

4.12 Dimensions

4.12.1 Panel Flush and Cubicle Mounting (Housing Size 1/6)



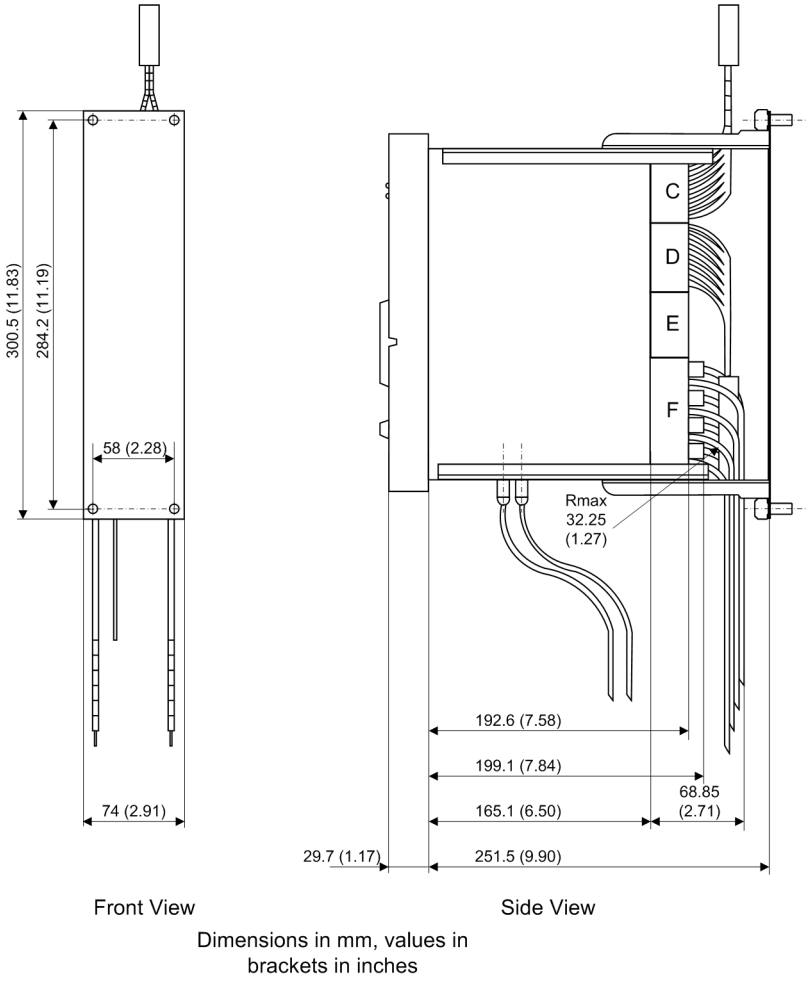
[abmess-sechstel-gehaeuse-7sx80-060606, 1, en_US]

Figure 4-2 Dimensional drawing of a 7RW80 for panel flush or cubicle mounting (housing size $^1/_6$)

Note: A set of mounting brackets (consisting of upper and lower mounting rail) (order no. C73165-A63-D200-1) is required for cubicle mounting. When using the Ethernet interface, it may be necessary to rework the lower mounting rail.

Provide for sufficient space at the device bottom side or below the device to accommodate the cables of the communication modules.

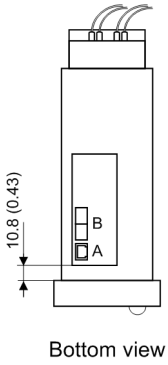
4.12.2 Panel Surface Mounting (Housing Size 1/6)



[abmess-sechstel-gehaeuse-aufbau-7sx80-060606, 1, en_US]

Figure 4-3 Dimensional drawing of a 7RW80 for panel surface mounting (housing size $^1/_6$)

4.12.3 Bottom view



[ansicht-unten-sechstel-gehaeuse-7sx80-070914, 1, en_US]

Figure 4-4 Bottom view of a 7RW80 (housing size $^1/_6$)

A Ordering Information and Accessories

A.1 Ordering Information 7RW80 V4.6

Voltage and Frequency Protection						6	7		8	9	10	11	12		13	14	15	16		Supplementary		
	7	**R**	**W**	**8**	**0**		0	–						–		D			+	L	0	

Number of Binary Inputs and Outputs	**Pos. 6**
Housing 1/6 19" 3x V, 3 BI, 5 BO (2 changeover contacts), 1 Life Status Contact	1
Housing 1/6 19" 3 x V, 7 BI, 8 BO (2 changeover contacts), 1 Life Status Contact	2

Auxiliary voltage (power supply, pilot voltage)	**Pos. 8**
DC 24 / 48 V	1
DC 60 V / 110 V / 125 V / 220 V / 250 V, AC 115 V, AC 230 V	5

Construction	**Pos. 9**
Surface-mounting case, screw-type terminals	B
Flush mounting case, screw-type terminals	E

Region-specific Default / Language Settings and Function Versions	**Pos. 10**
Region DE, IEC, German language (language can be changed, standard front panel	A
Region world, IEC/ANSI, English language (GB) (language can be changed), standard front panel	B
Region US, ANSI, English language (US) (language can be changed), US front panel	C
Region FR, IEC/ANSI, French language (language can be changed), standard front panel	D
Region world, IEC/ANSI, Spanish language (language can be changed), standard front panel	E
Region world, IEC/ANSI, Italian language (language can be changed), standard front panel	F
Region RUS, IEC/ANSI, Russian language (language can be changed), standard front panel	G
Region CHN, IEC/ANSI, Chinese language (language cannot be changed), standard front panel Chinese	K

Port B (bottom side of device, rear)	**Pos. 11**
Not installed	0
IEC60870-5-103 or DIGSI4/Modem, electrical RS232	1
IEC60870-5-103 or DIGSI4/Modem, electrical RS485	2
IEC60870-5-103 or DIGSI4/Modem, optical 820nm, ST-connector	3
For further interface options see Additional Information in the following	9

Additional information for additional ports (bottom side of device, rear, port B)	**Zusatz**
Profibus DP Slave, electrical RS485	+ L 0 A
Profibus DP Slave, 820 nm, optical, double ring, ST-connector	+ L 0 B
Modbus electrical RS485	+ L 0 D
Modbus, optical 820 nm, ST–connector	+ L 0 E
DNP3.0, electrical RS485	+ L 0 G
DNP3.0, optical 820 nm, ST–connector	+ L 0 H
IEC 61850 100 Mbit Ethernet, electrical, double, RJ45 connector	+ L 0 R
IEC 61850 100 Mbit Ethernet optical, double, LC duplex connector	+ L 0 S

Converter	Order Number	Use
SIEMENS OLM[1)]	6GK1502–2CB10	For single ring
SIEMENS OLM[1)]	6GK1502–3CB10	For double ring

[1)] The converter requires an operating voltage of DC 24 V. If the available operating voltage is > DC 24 V the additional power supply 7XV5810–0BA00 is required.

Port A (bottom side of device, front)	Pos. 12
Not installed	0
with Ethernet port (DIGSI port, not IEC61850), RJ45 connector	6

Measuring/Fault Recording	Pos. 13
With fault recording and min/max values for voltage	1

Functions			Pos. 15
Description	ANSI-Nr.	Description	
Voltage and Frequency Protection	27/59	Under/Overvoltage	A
	64/59N	Displacement Voltage	
	81 U/O	Under/Overfrequency, f< ,f>	
	47	Phase Rotation	
	74TC	Trip Circuit Supervision	
	86	Lock out	
	—	Cold load pickup (dynamic setting changes) Monitoring Functions Breaker control Flexible protection functions (parameters from voltage), Frequency change and Voltage change protection	
Voltage and Frequency Protection Load Restoration	27/59	Under/Overvoltage	B
	64/59N	Displacement Voltage	
	81 U/O	Under/Overfrequency, f< ,f>	
	—	Load Restoration	
	47	Phase Rotation	
	74TC	Trip Circuit Supervision	
	86	Lock out	
	—	Cold load pickup (dynamic setting changes) Monitoring Functions Breaker control Flexible protection functions (parameters from voltage), Frequency change and Voltage change protection	
Voltage and Frequency Protection Synchrocheck	27/59	Under/Overvoltage	C
	81 U/O	Under/Overfrequency, f< ,f>	
	25	Synchrocheck	
	47	Phase Rotation	
	74TC	Trip Circuit Supervision	
	86	Lock out	
	—	Cold load pickup (dynamic setting changes) Monitoring Functions Breaker control Flexible protection functions (parameters from voltage), Frequency change and Voltage change protection	
Voltage and Frequency Protection Overexcitation Protection, Jump of Voltage Vector	27/59	Under/Overvoltage	D
	64/59N	Displacement Voltage	
	81 U/O	Under/Overfrequency, f< ,f>	
	24	Overexcitation Protection	
		Jump of Voltage Vector	

Functions			Pos. 15
	47	Phase Rotation	
	74TC	Trip Circuit Supervision	
	86	Lock out	
	—	Cold load pickup (dynamic setting changes) Monitoring Functions Breaker control Flexible protection functions (parameters from voltage), Frequency change and Voltage change protection	
Voltage, Frequency Protection, Overexcitation Protection, Jump of Voltage Vector Load Restoration, Synchrocheck	27/59	Under/Overvoltage	E
	81U/O	Under/Overfrequency, f< ,f>	
	24	Overexcitation Protection	
	—	Jump of Voltage Vector	
	—	Load Restoration	
	25	Synchrocheck	
	47	Phase Rotation	
	74TC	Trip Circuit Supervision	
	86	Lock out	
	— -	Cold load pickup (dynamic setting changes) Monitoring Functions Breaker control Flexible protection functions (parameters from voltage), Frequency change and Voltage change protection	

A.2 Accessories

Exchangeable interface modules

Name	Order number
RS232	C53207-A351-D641-1
RS485	C53207-A351-D642-1
FO 820 nm	C53207-A351-D643-1
Profibus DP RS485	C53207-A351-D611-1
Profibus DP double ring	C53207-A351-D613-1
Modbus RS 485	C53207-A351-D621-1
Modbus 820 nm	C53207-A351-D623-1
DNP 3.0 RS 485	C53207-A351-D631-1
DNP 3.0 820 nm	C53207-A351-D633-1
Ethernet electrical (EN 100)	C53207-A351-D675-2
Ethernet optical (EN 100), 4 ST connectors	C53207-A351-D678-1
	C53207-A351-D688-1
Ethernet port electrical at port A	C53207-A351-D151-1

RS485 FO converter

RS485 FO converter	Order No.
820 nm, FC–Connector	7XV5650-0AA00
820 nm, with ST-Connector	7XV5650-0BA00

Mounting Rail for 19"-Racks

Name	Order Number
Mounting Rail Set	C73165-A63-D200-1

Battery

Lithium battery 3 V/1 Ah, type CR 1/2 AA	Order No.
VARTA	6127 101 301
Panasonic	BR-1/2AA

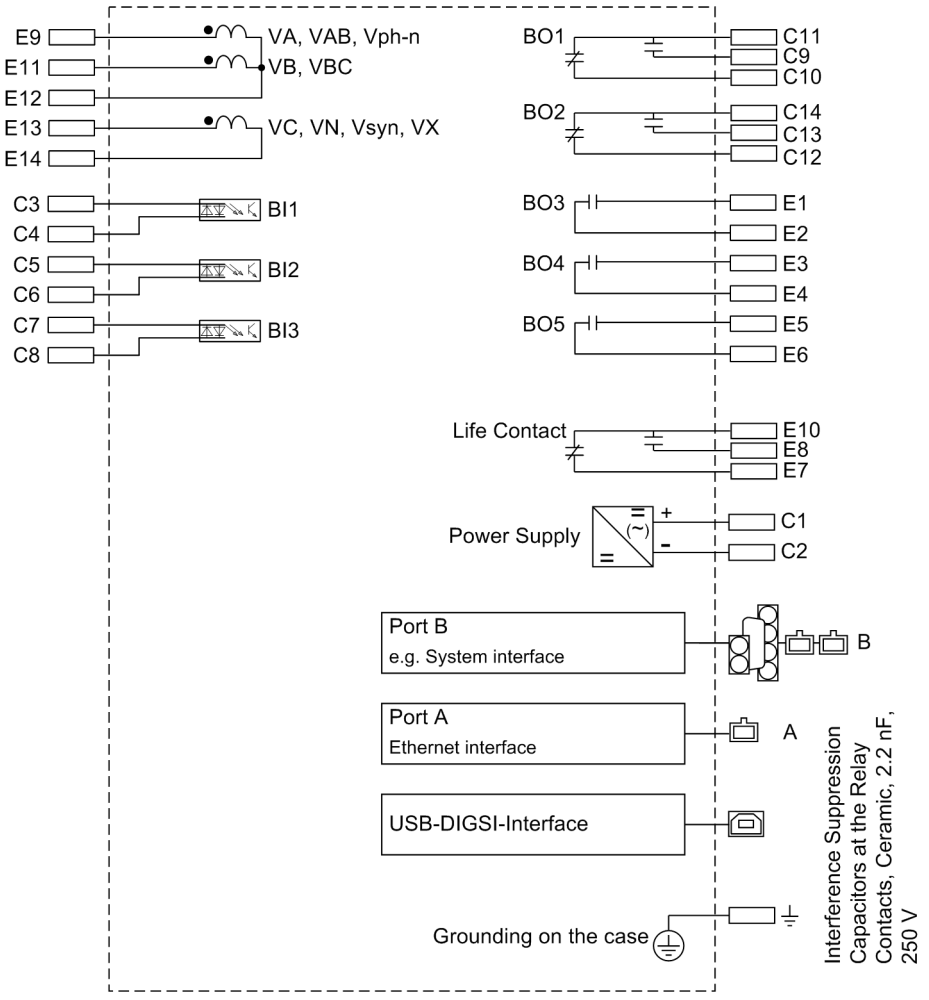
Terminals

Terminals Voltage terminal block C or block E	C53207-A406-D181-1
Voltage terminal block D (inverse print)	C53207-A406-D182-1
Voltage terminal short circuit links, 6 pieces	C53207-A406-D194-1

B Terminal Assignments

B.1 7RW80 — Housing for Panel Flush Mounting or Cubicle Mounting

7RW801*

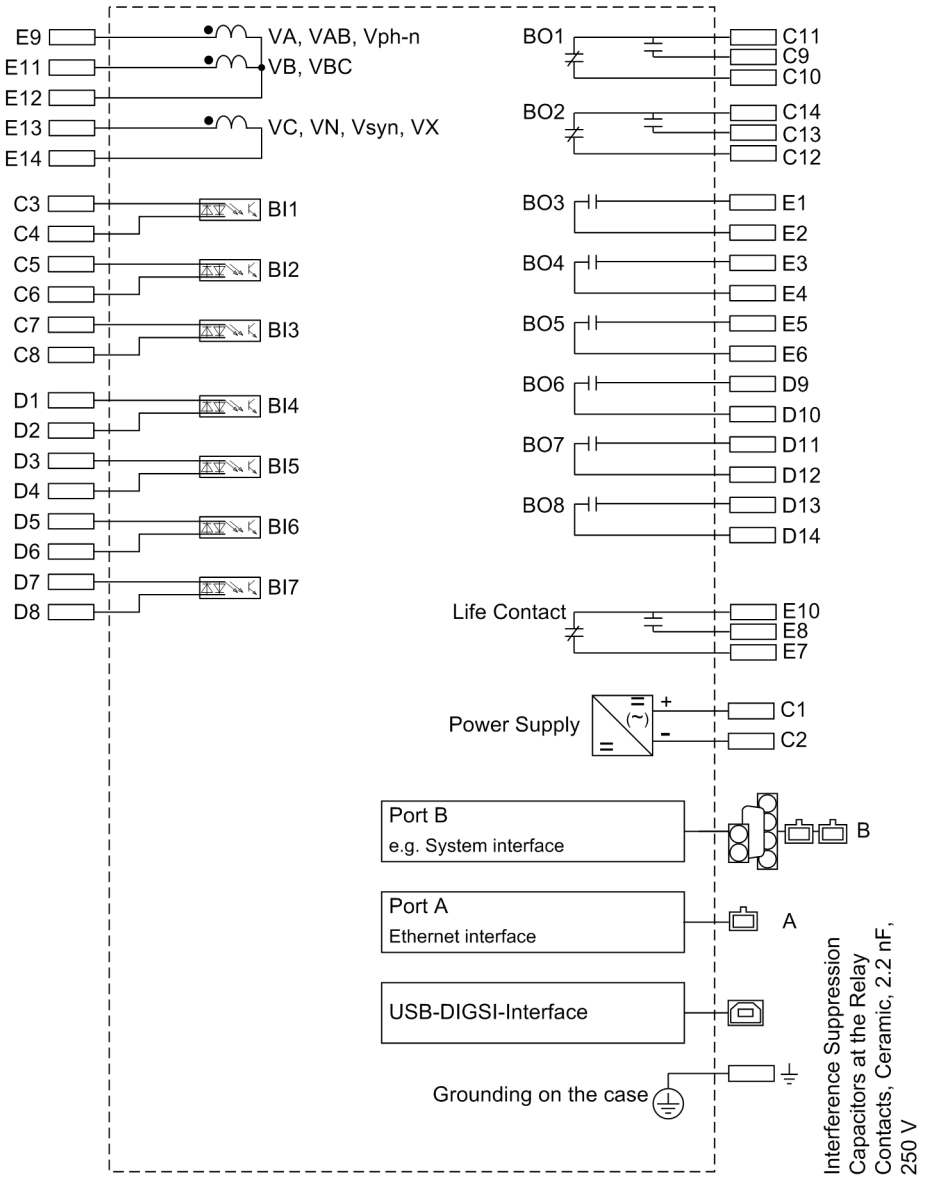


[kl-uebers-7rw80-1, 1, en_US]

Figure B-1 General diagram 7RW801

B.2 7RW80 — Housing for panel surface mounting

7RW802

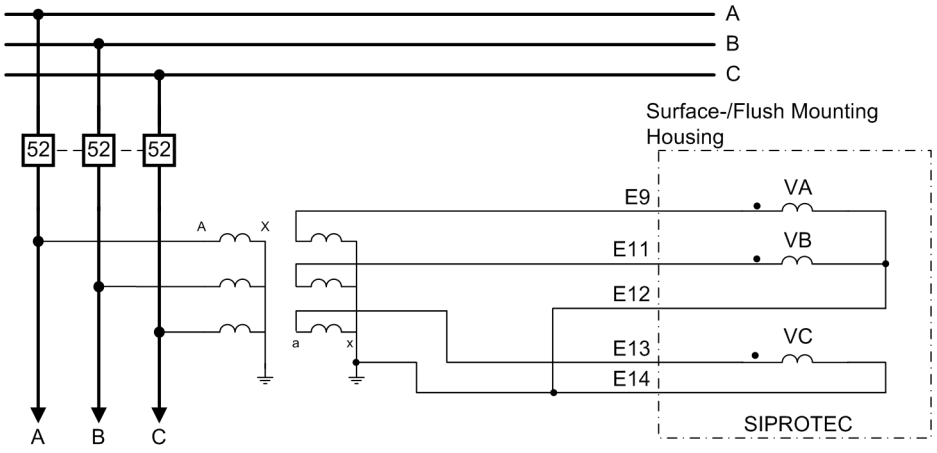


[kl-uebers-7rw80-2, 1, en_US]

Figure B-2 General diagram 7RW802

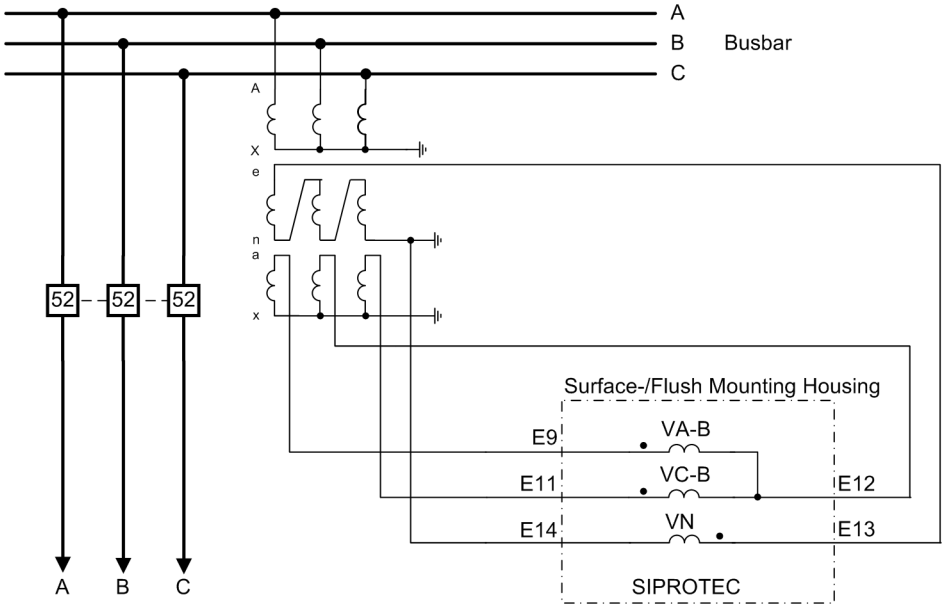
C Connection Examples

C.1 Connection Examples for Voltage Transformers



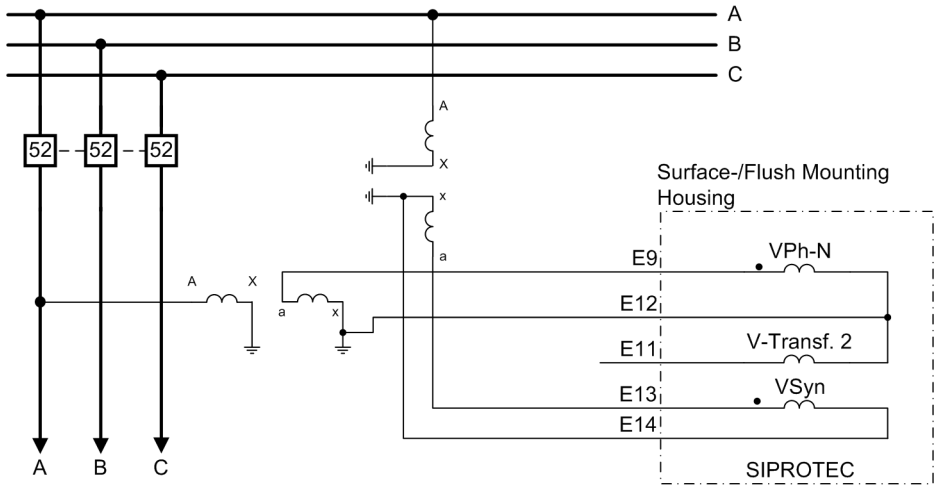
[anschl-u1e-u2e-u3e-abgang-20070129, 1, en_US]

Figure C-1 Example for connection type "VAN, VBN, VCN" load-side voltage connection



[anschl-u12-u23-ue-20070129, 1, en_US]

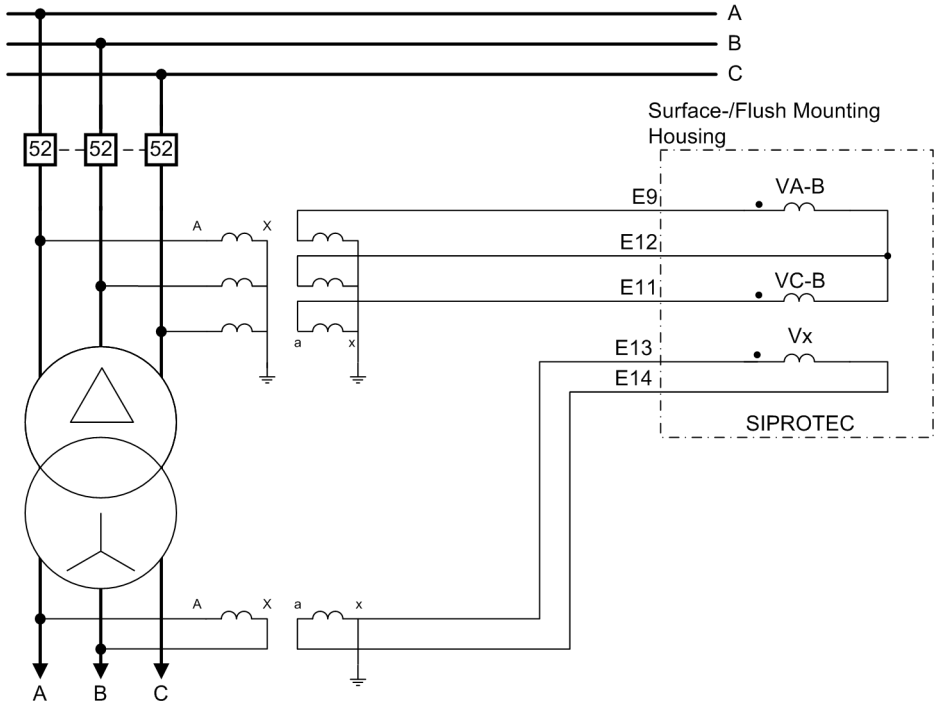
Figure C-2 Voltage transformer connections to two voltage transformers (phase-to-phase voltages) and broken delta winding (da-dn) – appropriate for all networks



[anschl-uph-usyn-20070129, 1, en_US]

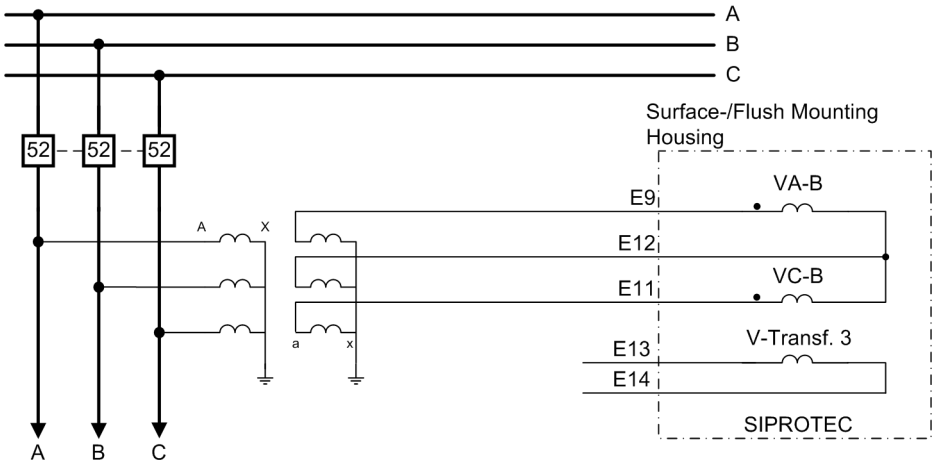
Figure C-3 Example for connection type "Vph-n, Vsyn"

The connection can be established at any one of the three phases. The phase must be the same for Vph-n and Vsyn.



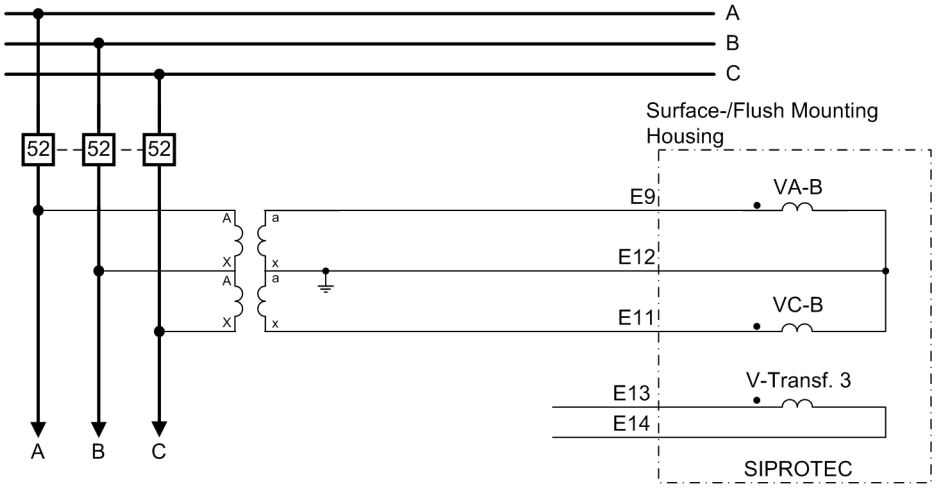
[anschl-u12-u23-ux-20070129, 1, en_US]

Figure C-4 Example for connection type "VAB, VBC, Vx"



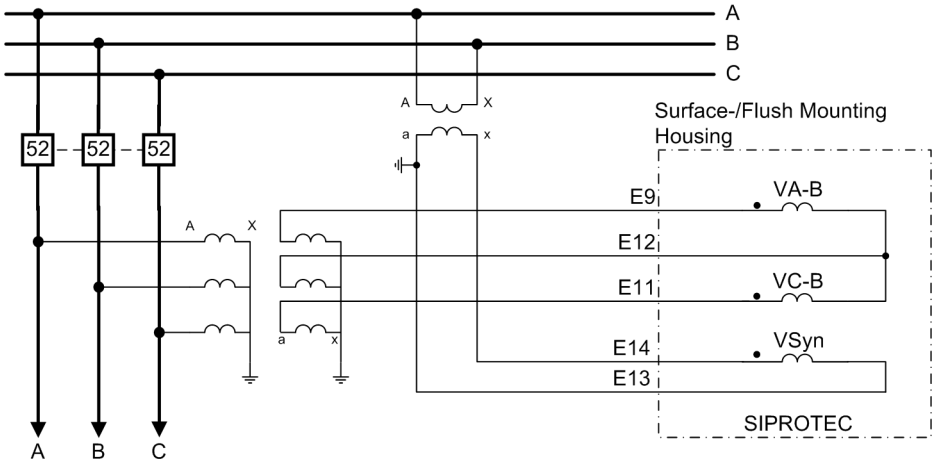
[anschl-u12-u23-20070129, 1, en_US]

Figure C-5 Example for connection type "VAB, VBC"



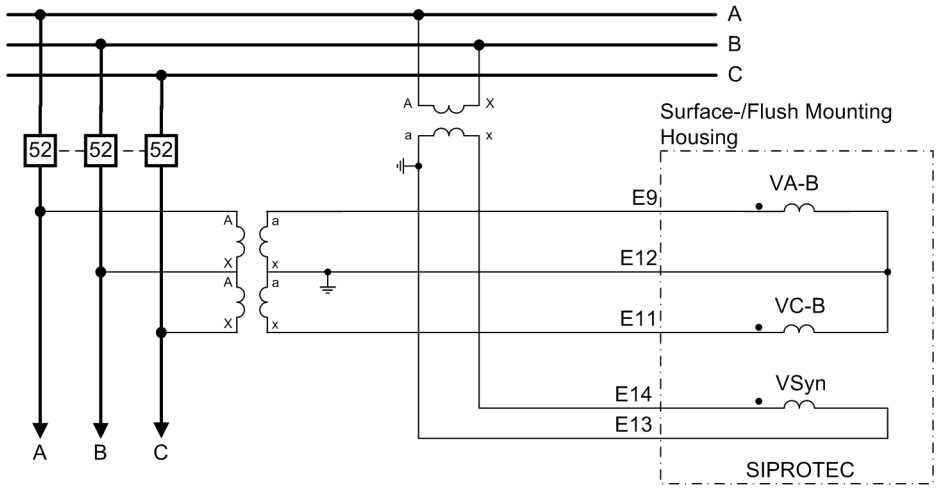
[anschl-u12-u23-v-schalt-20070129, 1, en_US]

Figure C-6 Example for connection type "VAB, VBC" with phase voltage connection as open-delta connection



[anschl-u12-u23-usyn-20070129, 1, en_US]

Figure C-7 Example for connection type "VAB, VBC, VSYN"



[anschl-u12-u23-usyn-v-schalt-20070129, 1, en_US]

Figure C-8 Example for connection type "VAB, VBC, VSYN" with phase voltage connection as open-delta connection

D Default Settings and Protocol-dependent Functions

D.1 LEDs

Table D-1 Preset LED displays

LEDs	Default function	Function No.	Description
LED1	Relay TRIP	511	Relay GENERAL TRIP command
LED2	Not configured	1	No Function configured
LED3	Not configured	1	No Function configured
LED4	Not configured	1	No Function configured
LED5	Not configured	1	No Function configured
LED6	Fail V balance	167	Failure: Voltage Balance
	Fail Ph. Seq. V	176	Failure: Phase Sequence Voltage
	VT brk. wire	253	Failure VT circuit: broken wire
LED7	Not configured	1	No Function configured
LED8	Brk OPENED		Breaker OPENED

D.2 Binary Input

Table D-2 Binary input presettings for all devices and ordering variants

Binary Input	Default function	Function No.	Description
BE1	nicht vorbelegt	-	-
BE2	>52-b	4602	>52-b contact (OPEN, if bkr is closed)
BE3	>52-a	4601	>52-a contact (OPEN, if bkr is open)

Table D-3 Further binary input presettings for 7RW802*

Binary Input	Default function	Function No.	Description
BE4	nicht vorbelegt	-	-
BE5	nicht vorbelegt	-	-
BE6	nicht vorbelegt	-	-
BE7	nicht vorbelegt	-	-

D.3 Binary Output

Table D-4 Output Relay Presettings for All Devices and Ordering Variants

Binary Output	Default function	Function No.	Description
BA1	Relay TRIP	511	Relay GENERAL TRIP command
	52Breaker		52 Breaker
BA2	52Breaker		52 Breaker
BA3	52Breaker		52 Breaker
BA4	Fail V balance	167	Failure: Voltage Balance
	Fail Ph. Seq. V	176	Failure: Phase Sequence Voltage
	VT brk. wire	253	Failure VT circuit: broken wire
BA5	Relay PICKUP	501	Relay PICKUP

Table D-5 Further Output Relay Presettings for 7RW802*

Binary Output	Default function	Function No.	Description
BA6	nicht vorbelegt	-	-
BA7	nicht vorbelegt	-	-
BA8	nicht vorbelegt	-	-

D.4 Function Keys

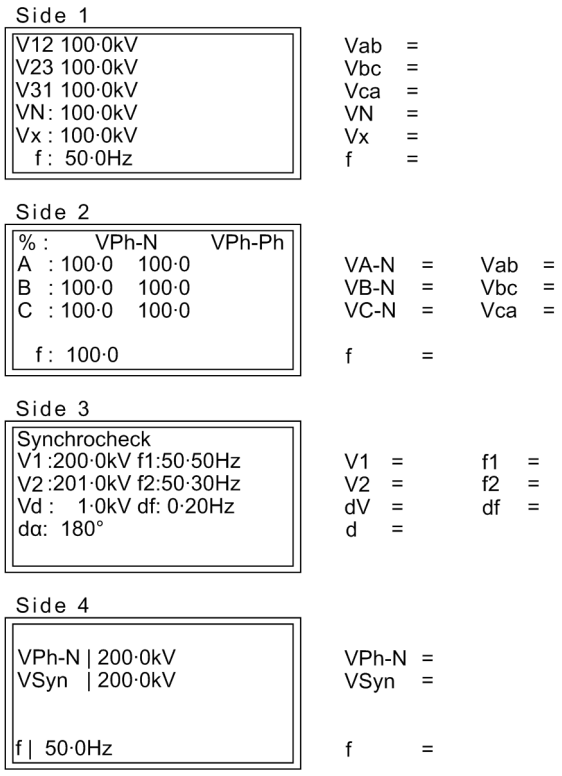
Table D-6 Applies to All Devices and Ordered Variants

Function Keys	Default function
F1	Display of the operational indications
F2	Display of the primary operational measured values
F3	Display of the last fault log buffer
F4	not pre-assigned
F5	not pre-assigned
F6	not pre-assigned
F7	not pre-assigned
F8	not pre-assigned
F9	not pre-assigned

D.5 Default Display

The start page of the default display, which will open after device startup, can be selected via parameter 640 **`Start image DD`**.

6–line Display



[display-alle-20100517, 1, en_US]

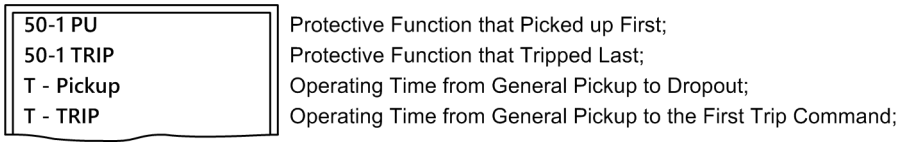
Figure D-1 Default display of 7RW80

Depending on the V- connection different default dispalys are visible

Setting Parameter 213 `VT Connect. 3ph`	Visible Default Displays
Van, Vbn, Vcn	1 and 2
Vab, Vbc, VGnd	1 and 2
Vab, Vbc, VSyn	1, 2 and 3
Vab, Vbc	1 and 2
Vph-g, VSyn	4 and 3
Vab, Vbc, Vx	1 and 2

Spontaneous Fault Display

After a fault has occurred, the most important fault data are automatically displayed after general device pickup in the order shown in the picture below.



[dw_display-spontanmeldungen, 1, en_US]

Figure D-2 Representation of spontaneous messages on the device display

D.6 Protocol-dependent Functions

Protocoll → / Function ↓	IEC 60870-5-103	IEC 61850 Ethernet (EN 100)	Profibus DP	DNP3.0 Modbus ASCII/RTU
Operational Measured Values	Yes	Yes	Yes	Yes
Metered Values	Yes	Yes	Yes	Yes
Fault Recording	Yes	Yes	No	No
Remote Protection Setting	No	Yes	No	No
User-defined Indications and Switching Objects	Yes	Yes	Yes	Yes
Time Synchronization	Yes	Yes	Yes	Yes
Messages with Time Stamp	Yes	Yes	Yes	Yes
Commissioning Aids				
Measured Value Indication Blocking	Yes	Yes	No	No
Creating Test Messages	Yes	Yes	No	No
Physical Mode	Asynchronous	Synchronous	Asynchronous	Asynchronous
Transmission Mode	cyclically/ event	cyclically/ event	cyclically	cyclically/ event(DNP) cyclically(Modbus)
Baud Rate	1 200 to 115 000	up to 100 MBaud	up to 1,5 MBaud	2400 to 19200
Typ	– RS232 – RS485 – optical fiber	Ethernet TP	– RS485 – optical fiber (double ring)	– RS485 – optical fiber

E Functions, Settings, Information

E.1 Functional Scope

Addr.	Information	Setting Options	Default Setting	Comments
103	Grp Chge OPTION	Disabled Enabled	Disabled	Setting Group Change Option
104	OSC. FAULT REC.	Disabled Enabled	Enabled	Oscillographic Fault Records
143	24 V/f	Disabled Enabled	Disabled	24 Overexcit. Protection (Volt/ Hertz)
146	VECTOR JUMP	Disabled Enabled	Disabled	Jump of Voltage Vector
150	27/59	Disabled Enabled	Enabled	27, 59 Under/Overvoltage Protection
152	VT BROKEN WIRE	Disabled Enabled	Enabled	VT broken wire supervision
154	81 O/U	Disabled Enabled	Enabled	81 Over/Underfrequency Protection
155	Load Restore	Disabled Enabled	Disabled	Load Restoration
161	25 Function 1	Disabled SYNCHROCHECK	Disabled	25 Function group 1
182	74 Trip Ct Supv	Disabled 2 Binary Inputs 1 Binary Input	Disabled	74TC Trip Circuit Supervision
617	ServiProt (CM)	Disabled T103 DIGSI	T103	Port B usage
-	FLEXIBLE FCT. 1...20	Flexible Function 01 Flexible Function 02 Flexible Function 03 Flexible Function 04 Flexible Function 05 Flexible Function 06 Flexible Function 07 Flexible Function 08 Flexible Function 09 Flexible Function 10 Flexible Function 11 Flexible Function 12 Flexible Function 13 Flexible Function 14 Flexible Function 15 Flexible Function 16 Flexible Function 17 Flexible Function 18 Flexible Function 19 Flexible Function 20	Please select	Flexible Functions 1...20

E.2 Settings

Addresses which have an appended “A” can only be changed with DIGSI, under “Additional Settings”.

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
0	FLEXIBLE FUNC.	Flx	OFF ON Alarm Only	OFF	Flexible Function
0	OPERRAT. MODE	Flx	3-phase 1-phase no reference	3-phase	Mode of Operation
0	MEAS. QUANTITY	Flx	Please select Voltage Frequency df/dt rising df/dt falling Binray Input dV/dt rising dV/dt falling	Please select	Selection of Measured Quantity
0	MEAS. METHOD	Flx	Fundamental True RMS Positive seq. Negative seq. Zero sequence Ratio I2/I1	Fundamental	Selection of Measurement Method
0	PICKUP WITH	Flx	Exceeding Dropping below	Exceeding	Pickup with
0	VOLTAGE	Flx	Please select Va-n Vb-n Vc-n Va-b Vb-c Vc-a Vn Vx	Please select	Voltage
0	VOLTAGE SYSTEM	Flx	Phase-Phase Phase-Ground	Phase-Phase	Voltage System
0	P.U. THRESHOLD	Flx	2.0 .. 260.0 V	110.0 V	Pickup Threshold
0	P.U. THRESHOLD	Flx	2.0 .. 200.0 V	110.0 V	Pickup Threshold
0	P.U. THRESHOLD	Flx	40.00 .. 60.00 Hz	51.00 Hz	Pickup Threshold
0	P.U. THRESHOLD	Flx	50.00 .. 70.00 Hz	61.00 Hz	Pickup Threshold
0	P.U. THRESHOLD	Flx	0.10 .. 20.00 Hz/s	5.00 Hz/s	Pickup Threshold
0	P.U. THRESHOLD	Flx	2.0 .. 260.0 V	110.0 V	Pickup Threshold
0	P.U. THRESHOLD	Flx	4 .. 100 V/s	60 V/s	Pickup Threshold
0	T TRIP DELAY	Flx	0.00 .. 3600.00 sec	1.00 sec	Trip Time Delay
0A	T PICKUP DELAY	Flx	0.00 .. 60.00 sec	0.00 sec	Pickup Time Delay
0A	T DROPOUT DELAY	Flx	0.00 .. 60.00 sec	0.00 sec	Dropout Time Delay
0A	BLK.by Vol.Loss	Flx	NO YES	YES	Block in case of Meas.-Voltage Loss

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
0A	DROPOUT RATIO	Flx	0.70 .. 0.99	0.95	Dropout Ratio
0A	DROPOUT RATIO	Flx	1.01 .. 3.00	1.05	Dropout Ratio
0	DO differential	Flx	0.02 .. 1.00 Hz	0.03 Hz	Dropout differential
202	Vnom PRIMARY	P.System Data 1	0.10 .. 800.00 kV	20.00 kV	Rated Primary Voltage
203	Vnom SECONDARY	P.System Data 1	34 .. 225 V	100 V	Rated Secondary Voltage (L-L)
206A	Vph / Vdelta	P.System Data 1	1.00 .. 3.00	1.73	Matching ratio Phase-VT To Open-Delta-VT
209	PHASE SEQ.	P.System Data 1	A B C A C B	A B C	Phase Sequence
210A	TMin TRIP CMD	P.System Data 1	0.01 .. 32.00 sec	0.15 sec	Minimum TRIP Command Duration
211A	TMax CLOSE CMD	P.System Data 1	0.01 .. 32.00 sec	1.00 sec	Maximum Close Command Duration
213	VT Connect. 3ph	P.System Data 1	Van, Vbn, Vcn Vab, Vbc, VGnd Vab, Vbc, VSyn Vab, Vbc Vph-g, VSyn Vab, Vbc, Vx	Van, Vbn, Vcn	VT Connection, three-phase
214	Rated Frequency	P.System Data 1	50 Hz 60 Hz	50 Hz	Rated Frequency
220	Threshold BI 1	P.System Data 1	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 1
221	Threshold BI 2	P.System Data 1	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 2
222	Threshold BI 3	P.System Data 1	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 3
223	Threshold BI 4	P.System Data 1	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 4
224	Threshold BI 5	P.System Data 1	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 5
225	Threshold BI 6	P.System Data 1	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 6
226	Threshold BI 7	P.System Data 1	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 7
232	VXnom PRIMARY	P.System Data 1	0.10 .. 800.00 kV	20.00 kV	Rated Primary Voltage X
233	VXnom SECONDARY	P.System Data 1	100 .. 225 V	100 V	Rated Secondary Voltage X

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
302	CHANGE	Change Group	Group A Group B Group C Group D Binary Input Protocol	Group A	Change to Another Setting Group
401	WAVEFORM-TRIGGER	Osc. Fault Rec.	Save w. Pickup Save w. TRIP Start w. TRIP	Save w. Pickup	Waveform Capture
402	WAVEFORM DATA	Osc. Fault Rec.	Fault event Pow.Sys.Flt.	Fault event	Scope of Waveform Data
403	MAX. LENGTH	Osc. Fault Rec.	0.30 .. 5.00 sec	2.00 sec	Max. length of a Waveform Capture Record
404	PRE. TRIG. TIME	Osc. Fault Rec.	0.05 .. 0.50 sec	0.10 sec	Captured Waveform Prior to Trigger
405	POST REC. TIME	Osc. Fault Rec.	0.05 .. 0.50 sec	0.10 sec	Captured Waveform after Event
406	BinIn CAPT.TIME	Osc. Fault Rec.	0.10 .. 5.00 sec	0.50 sec	Capture Time via Binary Input
610	FltDisp.LED/LCD	Device, General	Target on PU Target on TRIP	Target on PU	Fault Display on LED / LCD
611	Spont. FltDisp.	Device, General	YES NO	NO	Spontaneous display of flt.annunciations
614A	OP. QUANTITY 59	P.System Data 1	Vphph Vph-n V1 V2	Vphph	Opera. Quantity for 59 Overvolt. Prot.
615A	OP. QUANTITY 27	P.System Data 1	V1 Vphph Vph-n	V1	Opera. Quantity for 27 Undervolt. Prot.
640	Start image DD	Device, General	image 1 image 2 image 3	image 1	Start image Default Display
1101	FullScaleVolt.	P.System Data 2	0.10 .. 800.00 kV	20.00 kV	Measurem:FullScale-Voltage(Equipm.rating)
4301	FCT 24 V/f	24 V/f Overflux	OFF ON	OFF	24 Overexcit. Protection (Volt/Hertz)
4302	24-1 PICKUP	24 V/f Overflux	1.00 .. 1.20	1.10	24-1 V/f Pickup
4303	24-1 DELAY	24 V/f Overflux	0.00 .. 60.00 sec	10.00 sec	24-1 V/f Time Delay
4304	24-2 PICKUP	24 V/f Overflux	1.00 .. 1.40	1.40	24-2 V/f Pickup
4305	24-2 DELAY	24 V/f Overflux	0.00 .. 60.00 sec	1.00 sec	24-2 V/f Time Delay
4306	24-t(V/f=1.05)	24 V/f Overflux	0 .. 20000 sec	20000 sec	24 V/f = 1.05 Time Delay
4307	24-t(V/f=1.10)	24 V/f Overflux	0 .. 20000 sec	6000 sec	24 V/f = 1.10 Time Delay
4308	24-t(V/f=1.15)	24 V/f Overflux	0 .. 20000 sec	240 sec	24 V/f = 1.15 Time Delay
4309	24-t(V/f=1.20)	24 V/f Overflux	0 .. 20000 sec	60 sec	24 V/f = 1.20 Time Delay
4310	24-t(V/f=1.25)	24 V/f Overflux	0 .. 20000 sec	30 sec	24 V/f = 1.25 Time Delay
4311	24-t(V/f=1.30)	24 V/f Overflux	0 .. 20000 sec	19 sec	24 V/f = 1.30 Time Delay
4312	24-t(V/f=1.35)	24 V/f Overflux	0 .. 20000 sec	13 sec	24 V/f = 1.35 Time Delay

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
4313	24-t(V/f=1.40)	24 V/f Overflux	0 .. 20000 sec	10 sec	24 V/f = 1.40 Time Delay
4314	24 T COOL DOWN	24 V/f Overflux	0 .. 20000 sec	3600 sec	24 Time for Cooling Down
4601	VECTOR JUMP	Vector Jump	OFF ON	OFF	Jump of Voltage Vector
4602	DELTA PHI	Vector Jump	2 .. 30 °	10 °	Jump of Phasor DELTA PHI
4603	T DELTA PHI	Vector Jump	0.00 .. 60.00 sec	0.00 sec	T DELTA PHI Time Delay
4604	T RESET	Vector Jump	0.10 .. 60.00 sec	5.00 sec	Reset Time after Trip
4605A	V MIN	Vector Jump	10.0 .. 125.0 V	80.0 V	Minimal Operation Voltage V MIN
4606A	V MAX	Vector Jump	10.0 .. 170.0 V	130.0 V	Maximal Operation Voltage V MAX
4607A	T BLOCK	Vector Jump	0.00 .. 60.00 sec	0.15 sec	Time Delay of Blocking
5001	FCT 59	27/59 O/U Volt.	OFF ON Alarm Only	OFF	59 Overvoltage Protection
5002	59-1 PICKUP	27/59 O/U Volt.	20 .. 260 V	110 V	59-1 Pickup
5003	59-1 PICKUP	27/59 O/U Volt.	20 .. 150 V	110 V	59-1 Pickup
5004	59-1 DELAY	27/59 O/U Volt.	0.00 .. 100.00 sec	0.50 sec	59-1 Time Delay
5005	59-2 PICKUP	27/59 O/U Volt.	20 .. 260 V	120 V	59-2 Pickup
5006	59-2 PICKUP	27/59 O/U Volt.	20 .. 150 V	120 V	59-2 Pickup
5007	59-2 DELAY	27/59 O/U Volt.	0.00 .. 100.00 sec	0.50 sec	59-2 Time Delay
5009	59 Phases	27/59 O/U Volt.	All phases Largest phase	Largest phase	Phases for 59
5015	59-1 PICKUP V2	27/59 O/U Volt.	2 .. 150 V	30 V	59-1 Pickup V2
5016	59-2 PICKUP V2	27/59 O/U Volt.	2 .. 150 V	50 V	59-2 Pickup V2
5017A	59-1 DOUT RATIO	27/59 O/U Volt.	0.90 .. 0.99	0.95	59-1 Dropout Ratio
5018A	59-2 DOUT RATIO	27/59 O/U Volt.	0.90 .. 0.99	0.95	59-2 Dropout Ratio
5019	59-1 PICKUP V1	27/59 O/U Volt.	20 .. 150 V	110 V	59-1 Pickup V1
5020	59-2 PICKUP V1	27/59 O/U Volt.	20 .. 150 V	120 V	59-2 Pickup V1
5030	59 Vp>	27/59 O/U Volt.	20 .. 260 V	110 V	59 Pickup Vp>
5031	59 Vp>	27/59 O/U Volt.	20 .. 150 V	110 V	59 Pickup Vp>
5032	59 Vp> V1	27/59 O/U Volt.	20 .. 150 V	110 V	59 Pickup Vp> V1
5033	59 Vp> V2	27/59 O/U Volt.	2 .. 150 V	30 V	59 Pickup Vp> V2
5034	59 T Vp>	27/59 O/U Volt.	0.1 .. 5.0 sec	5.0 sec	59 T Vp> Time Delay
5035	Pickup - Time	27/59 O/U Volt.	1.00 .. 20.00 0.01 .. 999.00		Pickup - Time
5101	FCT 27	27/59 O/U Volt.	OFF ON Alarm Only	OFF	27 Undervoltage Protection
5102	27-1 PICKUP	27/59 O/U Volt.	10 .. 210 V	75 V	27-1 Pickup
5103	27-1 PICKUP	27/59 O/U Volt.	10 .. 120 V	45 V	27-1 Pickup
5106	27-1 DELAY	27/59 O/U Volt.	0.00 .. 100.00 sec	1.50 sec	27-1 Time Delay
5109	27 Phases	27/59 O/U Volt.	Smallest phase All phases	All phases	Phases for 27
5110	27-2 PICKUP	27/59 O/U Volt.	10 .. 210 V	70 V	27-2 Pickup
5111	27-2 PICKUP	27/59 O/U Volt.	10 .. 120 V	40 V	27-2 Pickup
5112	27-2 DELAY	27/59 O/U Volt.	0.00 .. 100.00 sec	0.50 sec	27-2 Time Delay

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
5113A	27-1 DOUT RATIO	27/59 O/U Volt.	1.01 .. 3.00	1.20	27-1 Dropout Ratio
5114A	27-2 DOUT RATIO	27/59 O/U Volt.	1.01 .. 3.00	1.20	27-2 Dropout Ratio
5130	27 Vp<	27/59 O/U Volt.	10 .. 210 V	75 V	27 Pickup Vp<
5131	27 Vp<	27/59 O/U Volt.	10 .. 120 V	45 V	27 Pickup Vp<
5132	27 T Vp<	27/59 O/U Volt.	0.1 .. 5.0 sec	1.0 sec	27 T Vp< Time Delay
5133	Pickup - Time	27/59 O/U Volt.	0.05 .. 1.00 0.01 .. 999.00		Pickup - Time
5201	VT BROKEN WIRE	Meas-urem.Superv	ON OFF	OFF	VT broken wire supervision
5202	Σ V>	Meas-urem.Superv	1.0 .. 100.0 V	8.0 V	Threshold voltage sum
5203	Vph-ph max<	Meas-urem.Superv	1.0 .. 100.0 V	16.0 V	Maximum phase to phase voltage
5204	Vph-ph min<	Meas-urem.Superv	1.0 .. 100.0 V	16.0 V	Minimum phase to phase voltage
5205	Vph-ph max-min>	Meas-urem.Superv	10.0 .. 200.0 V	16.0 V	Symmetry phase to phase voltages
5208	T DELAY ALARM	Meas-urem.Superv	0.00 .. 32.00 sec	1.25 sec	Alarm delay time
5401	FCT 81 O/U	81 O/U Freq.	OFF ON	OFF	81 Over/Under Frequency Protection
5402	Vmin	81 O/U Freq.	10 .. 150 V	65 V	Minimum required voltage for operation
5402	Vmin	81 O/U Freq.	20 .. 150 V	35 V	Minimum required voltage for operation
5403	81-1 PICKUP	81 O/U Freq.	40.00 .. 60.00 Hz	49.50 Hz	81-1 Pickup
5404	81-1 PICKUP	81 O/U Freq.	50.00 .. 70.00 Hz	59.50 Hz	81-1 Pickup
5405	81-1 DELAY	81 O/U Freq.	0.00 .. 100.00 sec	60.00 sec	81-1 Time Delay
5406	81-2 PICKUP	81 O/U Freq.	40.00 .. 60.00 Hz	49.00 Hz	81-2 Pickup
5407	81-2 PICKUP	81 O/U Freq.	50.00 .. 70.00 Hz	59.00 Hz	81-2 Pickup
5408	81-2 DELAY	81 O/U Freq.	0.00 .. 100.00 sec	30.00 sec	81-2 Time Delay
5409	81-3 PICKUP	81 O/U Freq.	40.00 .. 60.00 Hz	47.50 Hz	81-3 Pickup
5410	81-3 PICKUP	81 O/U Freq.	50.00 .. 70.00 Hz	57.50 Hz	81-3 Pickup
5411	81-3 DELAY	81 O/U Freq.	0.00 .. 100.00 sec	3.00 sec	81-3 Time delay
5412	81-4 PICKUP	81 O/U Freq.	40.00 .. 60.00 Hz	51.00 Hz	81-4 Pickup
5413	81-4 PICKUP	81 O/U Freq.	50.00 .. 70.00 Hz	61.00 Hz	81-4 Pickup
5414	81-4 DELAY	81 O/U Freq.	0.00 .. 100.00 sec	30.00 sec	81-4 Time delay
5415A	DO differential	81 O/U Freq.	0.02 .. 1.00 Hz	0.02 Hz	Dropout differential
5421	FCT 81-1 O/U	81 O/U Freq.	OFF ON f> ON f<	OFF	81-1 Over/Under Frequency Protection
5422	FCT 81-2 O/U	81 O/U Freq.	OFF ON f> ON f<	OFF	81-2 Over/Under Frequency Protection
5423	FCT 81-3 O/U	81 O/U Freq.	OFF ON f> ON f<	OFF	81-3 Over/Under Frequency Protection

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
5424	FCT 81-4 O/U	81 O/U Freq.	OFF ON f> ON f<	OFF	81-4 Over/Under Frequency Protection
5501	LR t Monitor	Load Restore	1 .. 3600 sec	3600 sec	Load restoration monitor time
5502	LR Max. Cycles	Load Restore	1 .. 10	2	Load restoration maximal no. of cycles
5520	LR1	Load Restore Load Restore	ON OFF	OFF	Load restoration element 1
5521	LR1 Start	Load Restore	40.00 .. 60.00 Hz	49.50 Hz	Load restoration elem. 1 start frequency
5522	LR1 Start	Load Restore	50.00 .. 70.00 Hz	59.50 Hz	Load restoration elem. 1 start frequency
5523	LR1 Pickup	Load Restore	0.02 .. 2.00 Hz	0.04 Hz	Load restoration element 1 Pickup
5524	LR1 t pickup	Load Restore	0 .. 10800 sec	600 sec	Load restoration element 1 Pickup time
5525	LR1 Dropout	Load Restore	0.00 .. 2.00 Hz	0.02 Hz	Load restoration element 1 Dropout
5526	LR1 t dropout	Load Restore	0 .. 10800 sec	60 sec	Load restoration element 1 Dropout time
5527	LR1 t CB Close	Load Restore	0.01 .. 32.00 sec	1.00 sec	Load restoration element 1 CB Close time
5528	LR1 after 81-1	Load Restore	YES NO	NO	Load restoration element 1 after 81-1
5529	LR1 after 81-2	Load Restore	YES NO	NO	Load restoration element 1 after 81-2
5530	LR1 after 81-3	Load Restore	YES NO	NO	Load restoration element 1 after 81-3
5531	LR1 after 81-4	Load Restore	YES NO	NO	Load restoration element 1 after 81-4
5540	LR2	Load Restore Load Restore	ON OFF	OFF	Load restoration element 2
5541	LR2 Start	Load Restore	40.00 .. 60.00 Hz	49.00 Hz	Load restoration elem. 2 start frequency
5542	LR2 Start	Load Restore	50.00 .. 70.00 Hz	59.00 Hz	Load restoration elem. 2 start frequency
5543	LR2 Pickup	Load Restore	0.02 .. 2.00 Hz	0.04 Hz	Load restoration element 2 Pickup
5544	LR2 t pickup	Load Restore	0 .. 10800 sec	600 sec	Load restoration element 2 Pickup time
5545	LR2 Dropout	Load Restore	0.00 .. 2.00 Hz	0.02 Hz	Load restoration element 2 Dropout
5546	LR2 t dropout	Load Restore	0 .. 10800 sec	60 sec	Load restoration element 2 Dropout time
5547	LR2 t CB Close	Load Restore	0.01 .. 32.00 sec	1.00 sec	Load restoration element 2 CB Close time
5548	LR2 after 81-1	Load Restore	YES NO	NO	Load restoration element 2 after 81-1

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
5549	LR2 after 81-2	Load Restore	YES NO	NO	Load restoration element 2 after 81-2
5550	LR2 after 81-3	Load Restore	YES NO	NO	Load restoration element 2 after 81-3
5551	LR2 after 81-4	Load Restore	YES NO	NO	Load restoration element 2 after 81-4
5560	LR3	Load Restore Load Restore	ON OFF	OFF	Load restoration element 3
5561	LR3 Start	Load Restore	40.00 .. 60.00 Hz	47.50 Hz	Load restoration elem. 3 start frequency
5562	LR3 Start	Load Restore	50.00 .. 70.00 Hz	57.50 Hz	Load restoration elem. 3 start frequency
5563	LR3 Pickup	Load Restore	0.02 .. 2.00 Hz	0.04 Hz	Load restoration element 3 Pickup
5564	LR3 t pickup	Load Restore	0 .. 10800 sec	600 sec	Load restoration element 3 Pickup time
5565	LR3 Dropout	Load Restore	0.00 .. 2.00 Hz	0.02 Hz	Load restoration element 3 Dropout
5566	LR3 t dropout	Load Restore	0 .. 10800 sec	60 sec	Load restoration element 3 Dropout time
5567	LR3 t CB Close	Load Restore	0.01 .. 32.00 sec	1.00 sec	Load restoration element 3 CB Close time
5568	LR3 after 81-1	Load Restore	YES NO	NO	Load restoration element 3 after 81-1
5569	LR3 after 81-2	Load Restore	YES NO	NO	Load restoration element 3 after 81-2
5570	LR3 after 81-3	Load Restore	YES NO	NO	Load restoration element 3 after 81-3
5571	LR3 after 81-4	Load Restore	YES NO	NO	Load restoration element 3 after 81-4
5580	LR4	Load Restore Load Restore	ON OFF	OFF	Load restoration element 4
5581	LR4 Start	Load Restore	40.00 .. 60.00 Hz	47.50 Hz	Load restoration elem. 4 start frequency
5582	LR4 Start	Load Restore	50.00 .. 70.00 Hz	57.50 Hz	Load restoration elem. 4 start frequency
5583	LR4 Pickup	Load Restore	0.02 .. 2.00 Hz	0.04 Hz	Load restoration element 4 Pickup
5584	LR4 t pickup	Load Restore	0 .. 10800 sec	600 sec	Load restoration element 4 Pickup time
5585	LR4 Dropout	Load Restore	0.00 .. 2.00 Hz	0.02 Hz	Load restoration element 4 Dropout
5586	LR4 t dropout	Load Restore	0 .. 10800 sec	60 sec	Load restoration element 4 Dropout time
5587	LR4 t CB Close	Load Restore	0.01 .. 32.00 sec	1.00 sec	Load restoration element 4 CB Close time
5588	LR4 after 81-1	Load Restore	YES NO	NO	Load restoration element 4 after 81-1
5589	LR4 after 81-2	Load Restore	YES NO	NO	Load restoration element 4 after 81-2

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
5590	LR4 after 81-3	Load Restore	YES NO	NO	Load restoration element 4 after 81-3
5591	LR4 after 81-4	Load Restore	YES NO	NO	Load restoration element 4 after 81-4
6101	Synchronizing	SYNC function 1	ON OFF	OFF	Synchronizing Function
6102	SyncCB	SYNC function 1	OBJVERWparaMEIN-STELL	none	Synchronizable circuit breaker
6103	Vmin	SYNC function 1	20 .. 125 V	90 V	Minimum voltage limit: Vmin
6104	Vmax	SYNC function 1	20 .. 140 V	110 V	Maximum voltage limit: Vmax
6105	V<	SYNC function 1	1 .. 60 V	5 V	Threshold V1, V2 without voltage
6106	V>	SYNC function 1	20 .. 140 V	80 V	Threshold V1, V2 with voltage
6107	SYNC V1<V2>	SYNC function 1	YES NO	NO	ON-Command at V1< and V2>
6108	SYNC V1>V2<	SYNC function 1	YES NO	NO	ON-Command at V1> and V2<
6109	SYNC V1<V2<	SYNC function 1	YES NO	NO	ON-Command at V1< and V2<
6110A	Direct CO	SYNC function 1	YES NO	NO	Direct ON-Command
6111A	TSUP VOLTAGE	SYNC function 1	0.00 .. 60.00 sec	0.10 sec	Supervision time of V1>;V2> or V1<;V2<
6112	SYN. DURATION	SYNC function 1	0.01 .. 1200.00 sec	30.00 sec	Maximum duration of synchronism-check
6113A	25 Synchron	SYNC function 1	YES NO	YES	Switching at synchronous condition
6121	Balancing V1/V2	SYNC function 1	0.50 .. 2.00	1.00	Balancing factor V1/V2
6122A	ANGLE ADJUSTM.	SYNC function 1	0 .. 360 °	0 °	Angle adjustment (transformer)
6123	CONNECTIONof V2	SYNC function 1	A-B B-C C-A	A-B	Connection of V2
6125	VT Vn2, primary	SYNC function 1	0.10 .. 800.00 kV	20.00 kV	VT nominal voltage V2, primary
6150	dV SYNCHK V2>V1	SYNC function 1	0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6151	dV SYNCHK V2<V1	SYNC function 1	0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6152	df SYNCHK f2>f1	SYNC function 1	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6153	df SYNCHK f2<f1	SYNC function 1	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6154	dα SYNCHK α2>α1	SYNC function 1	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6155	dα SYNCHK α2<α1	SYNC function 1	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
8101	MEASURE. SUPERV	Measurem.Superv	OFF ON	ON	Measurement Supervision
8102	BALANCE V-LIMIT	Measurem.Superv	10 .. 100 V	50 V	Voltage Threshold for Balance Monitoring
8103	BAL. FACTOR V	Measurem.Superv	0.58 .. 0.90	0.75	Balance Factor for Voltage Monitor
8201	FCT 74TC	74TC TripCirc.	ON OFF	ON	74TC TRIP Circuit Supervision
8202	Alarm Delay	74TC TripCirc.	1 .. 30 sec	2 sec	Delay Time for alarm
8311	MinMax cycRESET	Min/Max meter	NO YES	YES	Automatic Cyclic Reset Function
8312	MiMa RESET TIME	Min/Max meter	0 .. 1439 min	0 min	MinMax Reset Timer
8313	MiMa RESETCYCLE	Min/Max meter	1 .. 365 Days	7 Days	MinMax Reset Cycle Period
8314	MinMaxRES.START	Min/Max meter	1 .. 365 Days	1 Days	MinMax Start Reset Cycle in
8315	MeterResolution	Energy	Standard Factor 10 Factor 100	Standard	Meter resolution

E.3 Information List

Indications for IEC 60 870-5-103 are always reported ON / OFF if they are subject to general interrogation for IEC 60 870-5-103. If not, they are reported only as ON.

New user-defined indications or such newly allocated to IEC 60 870-5-103 are set to ON / OFF and subjected to general interrogation if the information type is not a spontaneous event (".._Ev""). Further information on indications can be found in detail in the SIPROTEC 4 System Description, Order No. E50417-H1176-C151.

In columns "Event Log", "Trip Log" and "Ground Fault Log" the following applies:

UPPER CASE NOTATION "ON/OFF":	definitely set, not allocatable
lower case notation "on/off":	preset, allocatable
*:	not preset, allocatable
<blank>:	neither preset nor allocatable

In the column "Marked in Oscill. Record" the following applies:

UPPER CASE NOTATION "M":	definitely set, not allocatable
lower case notation "m":	preset, allocatable
*:	not preset, allocatable
<blank>:	neither preset nor allocatable

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
-	>Back Light on (>Light on)	Device, General	SP	On Off	*		*	LED	BI		BO					
-	Reset LED (Reset LED)	Device, General	IntSP	On	*		*	LED			BO		160	19	1	No
-	Stop data transmission (DataStop)	Device, General	IntSP	On Off	*		*	LED			BO		160	20	1	Yes
-	Test mode (Test mode)	Device, General	IntSP	On Off	*		*	LED			BO		160	21	1	Yes
-	Feeder GROUNDED (Feeder gnd)	Device, General	IntSP	*	*		*	LED			BO					
-	Breaker OPENED (Brk OPENED)	Device, General	IntSP	*	*		*	LED			BO					
-	Hardware Test Mode (HWTestMod)	Device, General	IntSP	On Off	*		*	LED			BO					
-	Clock Synchronization (SynchClock)	Device, General	IntSP_Ev	*	*		*									
-	Disturbance CFC (Distur.CFC)	Device, General	OUT	On Off	*			LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
-	Fault Recording Start (FltRecSta)	Osc. Fault Rec.	IntSP	On Off	*		m	LED			BO					
-	Setting Group A is active (P-GrpA act)	Change Group	IntSP	On Off	*		*	LED			BO		160	23	1	Yes
-	Setting Group B is active (P-GrpB act)	Change Group	IntSP	On Off	*		*	LED			BO		160	24	1	Yes
-	Setting Group C is active (P-GrpC act)	Change Group	IntSP	On Off	*		*	LED			BO		160	25	1	Yes
-	Setting Group D is active (P-GrpD act)	Change Group	IntSP	On Off	*		*	LED			BO		160	26	1	Yes
-	Controlmode REMOTE (ModeREMOTE)	Cntrl Authority	IntSP	On Off	*			LED			BO					
-	Control Authority (Cntrl Auth)	Cntrl Authority	IntSP	On Off	*			LED			BO		101	85	1	Yes
-	Controlmode LOCAL (ModeLOCAL)	Cntrl Authority	IntSP	On Off	*			LED			BO		101	86	1	Yes
-	52 Breaker (52Breaker)	Control Device	CF_D12	On Off				LED			BO		240	160	20	
-	52 Breaker (52Breaker)	Control Device	DP	On Off					BI			CB	240	160	1	Yes
-	Disconnect Switch (Disc.Swit.)	Control Device	CF_D2	On Off				LED			BO		240	161	20	
-	Disconnect Switch (Disc.Swit.)	Control Device	DP	On Off					BI			CB	240	161	1	Yes
-	Ground Switch (GndSwit.)	Control Device	CF_D2	On Off				LED			BO		240	164	20	
-	Ground Switch (GndSwit.)	Control Device	DP	On Off					BI			CB	240	164	1	Yes
-	>CB ready Spring is charged (>CB ready)	Process Data	SP	*	*		*	LED	BI		BO	CB				

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
-	>Door closed (>Door-Close)	Process Data	SP	*	*		*	LED	BI		BO	CB				
-	>Cabinet door open (>Door open)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	101	1	1	Yes
-	>CB waiting for Spring charged (>CB wait)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	101	2	1	Yes
-	>No Voltage (Fuse blown) (>No Volt.)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	160	38	1	Yes
-	>Error Motor Voltage (>Err Mot V)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	181	1	Yes
-	>Error Control Voltage (>ErrCntrlV)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	182	1	Yes
-	>SF6-Loss (>SF6-Loss)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	183	1	Yes
-	>Error Meter (>Err Meter)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	184	1	Yes
-	>Transformer Temperature (>Tx Temp.)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	185	1	Yes
-	>Transformer Danger (>Tx Danger)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	186	1	Yes
-	Reset Minimum and Maximum counter (ResMinMax)	Min/Max meter	IntSP_Ev	ON												
-	Reset meter (Meter res)	Energy	IntSP_Ev	ON					BI							
-	Error Systeminterface (SysIntErr.)	Protocol	IntSP	On Off	*	*		LED			BO					
-	Threshold Value 1 (ThreshVal1)	Thresh.-Switch	IntSP	On Off				LED		FK TO NL IN E	BO	CB				

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
1	No Function configured (Not configured)	Device, General	SP	*	*											
2	Function Not Available (Non Existent)	Device, General	SP	*	*											
3	>Synchronize Internal Real Time Clock (>Time Synch)	Device, General	SP_Ev	*	*			LED	BI		BO		135	48	1	Yes
4	>Trigger Waveform Capture (>Trig.Wave.Cap.)	Osc. Fault Rec.	SP	*	*		m	LED	BI		BO		135	49	1	Yes
5	>Reset LED (>Reset LED)	Device, General	SP	*	*		*	LED	BI		BO		135	50	1	Yes
7	>Setting Group Select Bit 0 (>Set Group Bit0)	Change Group	SP	*	*		*	LED	BI		BO		135	51	1	Yes
8	>Setting Group Select Bit 1 (>Set Group Bit1)	Change Group	SP	*	*		*	LED	BI		BO		135	52	1	Yes
009.0100	Failure EN100 Modul (Failure Modul)	EN100-Modul 1	IntSP	On Off	*		*	LED			BO					
009.0101	Failure EN100 Link Channel 1 (Ch1) (Fail Ch1)	EN100-Modul 1	IntSP	On Off	*		*	LED			BO					
009.0102	Failure EN100 Link Channel 2 (Ch2) (Fail Ch2)	EN100-Modul 1	IntSP	On Off	*		*	LED			BO					
15	>Test mode (>Test mode)	Device, General	SP	*	*		*	LED	BI		BO		135	53	1	Yes
16	>Stop data transmission (>DataStop)	Device, General	SP	*	*		*	LED	BI		BO		135	54	1	Yes
51	Device is Operational and Protecting (Device OK)	Device, General	OUT	On Off	*		*	LED			BO		135	81	1	Yes
52	At Least 1 Protection Funct. is Active (ProtActive)	Device, General	IntSP	On Off	*		*	LED			BO		160	18	1	Yes
55	Reset Device (Reset Device)	Device, General	OUT	On	*		*						160	4	1	No
56	Initial Start of Device (Initial Start)	Device, General	OUT	On	*		*	LED			BO		160	5	1	No
67	Resume (Resume)	Device, General	OUT	On	*		*	LED			BO					
68	Clock Synchronization Error (Clock SyncError)	Device, General	OUT	On Off	*		*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
69	Daylight Saving Time (DayLightSavTime)	Device, General	OUT	On Off	*		*	LED			BO					
70	Setting calculation is running (Settings Calc.)	Device, General	OUT	On Off	*		*	LED			BO		160	22	1	Yes
71	Settings Check (Settings Check)	Device, General	OUT	*	*		*	LED			BO					
72	Level-2 change (Level-2 change)	Device, General	OUT	On Off	*		*	LED			BO					
73	Local setting change (Local change)	Device, General	OUT	*	*		*									
110	Event lost (Event Lost)	Device, General	OUT_Ev	On	*			LED			BO		135	130	1	No
113	Flag Lost (Flag Lost)	Device, General	OUT	On	*		m	LED			BO		135	136	1	Yes
125	Chatter ON (Chatter ON)	Device, General	OUT	On Off	*		*	LED			BO		135	145	1	Yes
126	Protection ON/OFF (via system port) (ProtON/OFF)	P.System Data 2	IntSP	On Off	*		*	LED			BO					
140	Error with a summary alarm (Error Sum Alarm)	Device, General	OUT	On Off	*		*	LED			BO		160	47	1	Yes
160	Alarm Summary Event (Alarm Sum Event)	Device, General	OUT	On Off	*		*	LED			BO		160	46	1	Yes
167	Failure: Voltage Balance (Fail V balance)	Meas-urem.Superv	OUT	On Off	*		*	LED			BO		135	186	1	Yes
170.0001	>25-group 1 activate (>25-1 act)	SYNC function 1	SP	On Off			*	LED	BI							
170.0043	>25 Synchronization request (>25 Sync requ.)	SYNC function 1	SP	On Off			*	LED	BI							
170.0049	25 Sync. Release of CLOSE Command (25 CloseRelease)	SYNC function 1	OUT	On Off			*	LED			BO		41	201	1	Yes
170.0050	25 Synchronization Error (25 Sync. Error)	SYNC function 1	OUT	On Off			*	LED			BO		41	202	1	Yes

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
170.0051	25-group 1 is BLOCKED (25-1 BLOCK)	SYNC function 1	OUT	On Off			*	LED			BO		41	204	1	Yes
170.2007	25 Sync. Measuring request of Control (25 Measu. req.)	SYNC function 1	SP	On Off			*	LED								
170.2008	>BLOCK 25-group 1 (>BLK 25-1)	SYNC function 1	SP	On Off			*	LED	BI							
170.2009	>25 Direct Command output (>25direct CO)	SYNC function 1	SP	On Off			*	LED	BI							
170.2011	>25 Start of synchronization (>25 Start)	SYNC function 1	SP	On Off			*	LED	BI							
170.2012	>25 Stop of synchronization (>25 Stop)	SYNC function 1	SP	On Off			*	LED	BI							
170.2013	>25 Switch to V1> and V2< (>25 V1>V2<)	SYNC function 1	SP	On Off			*	LED	BI							
170.2014	>25 Switch to V1< and V2> (>25 V1<V2>)	SYNC function 1	SP	On Off			*	LED	BI							
170.2015	>25 Switch to V1< and V2< (>25 V1<V2<)	SYNC function 1	SP	On Off			*	LED	BI							
170.2016	>25 Switch to Sync (>25 synchr.)	SYNC function 1	SP	On Off			*	LED	BI							
170.2022	25-group 1: measurement in progress (25-1 meas.)	SYNC function 1	OUT	On Off			*	LED			BO		41	203	1	Yes
170.2025	25 Monitoring time exceeded (25 MonTimeExc)	SYNC function 1	OUT	On Off			*	LED			BO		41	205	1	Yes
170.2026	25 Synchronization conditions okay (25 Synchron)	SYNC function 1	OUT	On Off			*	LED			BO		41	206	1	Yes
170.2027	25 Condition V1>V2< fulfilled (25 V1> V2<)	SYNC function 1	OUT	On Off			*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
170.2028	25 Condition V1<V2> fulfilled (25 V1< V2>)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2029	25 Condition V1<V2< fulfilled (25 V1< V2<)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2030	25 Voltage difference (Vdiff) okay (25 Vdiff ok)	SYNC function 1	OUT	On Off			*	LED			BO		41	207	1	Yes
170.2031	25 Frequency difference (fdiff) okay (25 fdiff ok)	SYNC function 1	OUT	On Off			*	LED			BO		41	208	1	Yes
170.2032	25 Angle difference (alphadiff) okay (25 αdiff ok)	SYNC function 1	OUT	On Off			*	LED			BO		41	209	1	Yes
170.2033	25 Frequency f1 > fmax permissible (25 f1>>)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2034	25 Frequency f1 < fmin permissible (25 f1<<)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2035	25 Frequency f2 > fmax permissible (25 f2>>)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2036	25 Frequency f2 < fmin permissible (25 f2<<)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2037	25 Voltage V1 > Vmax permissible (25 V1>>)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2038	25 Voltage V1 < Vmin permissible (25 V1<<)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2039	25 Voltage V2 > Vmax permissible (25 V2>>)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2040	25 Voltage V2 < Vmin permissible (25 V2<<)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2090	25 Vdiff too large (V2>V1) (25 V2>V1)	SYNC function 1	OUT	On Off			*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
170.2091	25 Vdiff too large (V2<V1) (25 V2<V1)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2092	25 fdiff too large (f2>f1) (25 f2>f1)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2093	25 fdiff too large (f2<f1) (25 f2<f1)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2094	25 alphadiff too large (a2>a1) (25 α2>α1)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2095	25 alphadiff too large (a2<a1) (25 α2<α1)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2096	25 Multiple selection of func-groups (25 FG-Error)	SYNC function 1	OUT	On Off				LED			BO					
170.2097	25 Setting error (25 Set-Error)	SYNC function 1	OUT	On Off				LED			BO					
170.2101	Sync-group 1 is switched OFF (25-1 OFF)	SYNC function 1	OUT	On Off			*	LED			BO		41	36	1	Yes
170.2102	>BLOCK 25 CLOSE command (>BLK 25 CLOSE)	SYNC function 1	SP	On Off			*	LED	BI							
170.2103	25 CLOSE command is BLOCKED (25 CLOSE BLK)	SYNC function 1	OUT	On Off			*	LED			BO		41	37	1	Yes
171	Failure: Phase Sequence (Fail Ph. Seq.)	Measurem.Superv	OUT	On Off	*		*	LED			BO		160	35	1	Yes
176	Failure: Phase Sequence Voltage (Fail Ph. Seq. V)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	192	1	Yes
177	Failure: Battery empty (Fail Battery)	Device, General	OUT	On Off	*		*	LED			BO					
178	I/O-Board Error (I/O-Board error)	Device, General	OUT	On Off	*		*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
181	Error: A/D converter (Error A/D-conv.)	Device, General	OUT	On Off	*		*	LED			BO					
191	Error: Offset (Error Offset)	Device, General	OUT	On Off	*		*	LED			BO					
193	Alarm: NO calibration data available (Alarm NO calibr)	Device, General	OUT	On Off	*		*	LED			BO					
197	Measurement Supervision is switched OFF (MeasSup OFF)	Meas-urem.Superv	OUT	On Off	*		*	LED			BO		135	197	1	Yes
203	Waveform data deleted (Wave. deleted)	Osc. Fault Rec.	OUT_Ev	On	*			LED			BO		135	203	1	No
234.2100	27, 59 blocked via operation (27, 59 blk)	27/59 O/U Volt.	IntSP	On Off	*		*	LED			BO					
235.2110	>BLOCK Function $00 (>BLOCK $00)	Flx	SP	On Off	On Off	*	*	LED	BI	FK TO NL IN E	BO					
235.2111	>Function $00 instantaneous TRIP (>$00 instant.)	Flx	SP	On Off	On Off	*	*	LED	BI	FK TO NL IN E	BO					
235.2112	>Function $00 Direct TRIP (>$00 Dir.TRIP)	Flx	SP	On Off	On Off	*	*	LED	BI	FK TO NL IN E	BO					
235.2113	>Function $00 BLOCK TRIP Time Delay (>$00 BLK.TDly)	Flx	SP	On Off	On Off	*	*	LED	BI	FK TO NL IN E	BO					
235.2114	>Function $00 BLOCK TRIP (>$00 BLK.TRIP)	Flx	SP	On Off	On Off	*	*	LED	BI	FK TO NL IN E	BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
235.2115	>Function $00 BLOCK TRIP Phase A (>$00 BL.TripA)	Flx	SP	On Off	On Off	*	*	LED	BI	FK TO NL IN E	BO					
235.2116	>Function $00 BLOCK TRIP Phase B (>$00 BL.TripB)	Flx	SP	On Off	On Off	*	*	LED	BI	FK TO NL IN E	BO					
235.2117	>Function $00 BLOCK TRIP Phase C (>$00 BL.TripC)	Flx	SP	On Off	On Off	*	*	LED	BI	FK TO NL IN E	BO					
235.2118	Function $00 is BLOCKED ($00 BLOCKED)	Flx	OUT	On Off	On Off	*	*	LED			BO					
235.2119	Function $00 is switched OFF ($00 OFF)	Flx	OUT	On Off	*	*	*	LED			BO					
235.2120	Function $00 is ACTIVE ($00 ACTIVE)	Flx	OUT	On Off	*	*	*	LED			BO					
235.2121	Function $00 picked up ($00 picked up)	Flx	OUT	On Off	On Off	*	*	LED			BO					
235.2122	Function $00 Pickup Phase A ($00 pickup A)	Flx	OUT	On Off	On Off	*	*	LED			BO					
235.2123	Function $00 Pickup Phase B ($00 pickup B)	Flx	OUT	On Off	On Off	*	*	LED			BO					
235.2124	Function $00 Pickup Phase C ($00 pickup C)	Flx	OUT	On Off	On Off	*	*	LED			BO					
235.2125	Function $00 TRIP Delay Time Out ($00 Time Out)	Flx	OUT	On Off	On Off	*	*	LED			BO					
235.2126	Function $00 TRIP ($00 TRIP)	Flx	OUT	On Off	On	*	*	LED			BO					
235.2128	Function $00 has invalid settings ($00 inval.set)	Flx	OUT	On Off	On Off	*	*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
236.2127	BLOCK Flexible Function (BLK. Flex.Fct.)	Device, General	IntSP	On Off	*	*	*	LED			BO					
253	Failure VT circuit: broken wire (VT brk. wire)	Meas-urem.Superv	OUT	On Off	*		*	LED			BO					
255	Failure VT circuit (Fail VT circuit)	Meas-urem.Superv	OUT	On Off	*		*	LED			BO					
256	Failure VT circuit: 1 pole broken wire (VT b.w. 1 pole)	Meas-urem.Superv	OUT	On Off	*		*	LED			BO					
257	Failure VT circuit: 2 pole broken wire (VT b.w. 2 pole)	Meas-urem.Superv	OUT	On Off	*		*	LED			BO					
272	Set Point Operating Hours (SP. Op Hours>)	SetPoint(Stat)	OUT	On Off	*		*	LED			BO		135	229	1	Yes
301	Power System fault (Pow.Sys.Flt.)	Device, General	OUT	On Off	On Off								135	231	2	Yes
302	Fault Event (Fault Event)	Device, General	OUT	*	On								135	232	2	Yes
303	sensitive Ground fault (sens Gnd flt)	Device, General	OUT			ON OFF										
320	Warn: Limit of Memory Data exceeded (Warn Mem. Data)	Device, General	OUT	On Off	*		*	LED			BO					
321	Warn: Limit of Memory Parameter exceeded (Warn Mem. Para.)	Device, General	OUT	On Off	*		*	LED			BO					
322	Warn: Limit of Memory Operation exceeded (Warn Mem. Oper.)	Device, General	OUT	On Off	*		*	LED			BO					
323	Warn: Limit of Memory New exceeded (Warn Mem. New)	Device, General	OUT	On Off	*		*	LED			BO					
356	>Manual close signal (>Manual Close)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	6	1	Yes
397	>V MIN/MAX Buffer Reset (>V MiMaReset)	Min/Max meter	SP	On	*		*	LED	BI		BO					
398	>Vphph MIN/MAX Buffer Reset (>VphphMiMaRes)	Min/Max meter	SP	On	*		*	LED	BI		BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
399	>V1 MIN/MAX Buffer Reset (>V1 MiMa Reset)	Min/Max meter	SP	On	*		*	LED	BI		BO					
407	>Frq. MIN/MAX Buffer Reset (>Frq MiMa Reset)	Min/Max meter	SP	On	*		*	LED	BI		BO					
409	>BLOCK Op Counter (>BLOCK Op Count)	Statistics	SP	On Off			*	LED	BI		BO					
501	Relay PICKUP (Relay PICKUP)	P.System Data 2	OUT		ON		m	LED			BO		150	151	2	Yes
502	Relay Drop Out (Relay Drop Out)	Device, General	SP	*	*											
510	General CLOSE of relay (Relay CLOSE)	Device, General	SP	*	*											
511	Relay GENERAL TRIP command (Relay TRIP)	P.System Data 2	OUT		ON		m	LED			BO		150	161	2	Yes
545	Time from Pickup to drop out (PU Time)	Device, General	VI													
546	Time from Pickup to TRIP (TRIP Time)	Device, General	VI													
561	Manual close signal detected (Man.Clos.Detect)	P.System Data 2	OUT	On Off	*		*	LED			BO					
1020	Counter of operating hours (Op.Hours=)	Statistics	VI													
4601	>52-a contact (OPEN, if bkr is open) (>52-a)	P.System Data 2	SP	On Off	*		*	LED	BI		BO					
4602	>52-b contact (OPEN, if bkr is closed) (>52-b)	P.System Data 2	SP	On Off	*		*	LED	BI		BO					
5145	>Reverse Phase Rotation (>Reverse Rot.)	P.System Data 1	SP	On Off	*		*	LED	BI		BO					
5147	Phase rotation ABC (Rotation ABC)	P.System Data 1	OUT	On Off	*		*	LED			BO		70	128	1	Yes
5148	Phase rotation ACB (Rotation ACB)	P.System Data 1	OUT	On Off	*		*	LED			BO		70	129	1	Yes
5203	>BLOCK 81O/U (>BLOCK 81O/U)	81 O/U Freq.	SP	On Off	*		*	LED	BI		BO		70	176	1	Yes

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
5206	>BLOCK 81-1 (>BLOCK 81-1)	81 O/U Freq.	SP	On Off	*		*	LED	BI		BO		70	177	1	Yes
5207	>BLOCK 81-2 (>BLOCK 81-2)	81 O/U Freq.	SP	On Off	*		*	LED	BI		BO		70	178	1	Yes
5208	>BLOCK 81-3 (>BLOCK 81-3)	81 O/U Freq.	SP	On Off	*		*	LED	BI		BO		70	179	1	Yes
5209	>BLOCK 81-4 (>BLOCK 81-4)	81 O/U Freq.	SP	On Off	*		*	LED	BI		BO		70	180	1	Yes
5211	81 OFF (81 OFF)	81 O/U Freq.	OUT	On Off	*		*	LED			BO		70	181	1	Yes
5212	81 BLOCKED (81 BLOCKED)	81 O/U Freq.	OUT	On Off	On Off		*	LED			BO		70	182	1	Yes
5213	81 ACTIVE (81 ACTIVE)	81 O/U Freq.	OUT	On Off	*		*	LED			BO		70	183	1	Yes
5214	81 Under Voltage Block (81 Under V Blk)	81 O/U Freq.	OUT	On Off	On Off		*	LED			BO		70	184	1	Yes
5232	81-1 picked up (81-1 picked up)	81 O/U Freq.	OUT	*	On Off		*	LED			BO		70	230	2	Yes
5233	81-2 picked up (81-2 picked up)	81 O/U Freq.	OUT	*	On Off		*	LED			BO		70	231	2	Yes
5234	81-3 picked up (81-3 picked up)	81 O/U Freq.	OUT	*	On Off		*	LED			BO		70	232	2	Yes
5235	81-4 picked up (81-4 picked up)	81 O/U Freq.	OUT	*	On Off		*	LED			BO		70	233	2	Yes
5236	81-1 TRIP (81-1 TRIP)	81 O/U Freq.	OUT	*	On		m	LED			BO		70	234	2	Yes
5237	81-2 TRIP (81-2 TRIP)	81 O/U Freq.	OUT	*	On		m	LED			BO		70	235	2	Yes
5238	81-3 TRIP (81-3 TRIP)	81 O/U Freq.	OUT	*	On		m	LED			BO		70	236	2	Yes
5239	81-4 TRIP (81-4 TRIP)	81 O/U Freq.	OUT	*	On		m	LED			BO		70	237	2	Yes
5353	>BLOCK 24 (>BLOCK 24)	24 V/f Over-flux	SP	*	*		*	LED	BI		BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
5357	>24 Reset memory of thermal replica V/f (>24 RM th.repl.)	24 V/f Over-flux	SP	On Off	*		*	LED	BI		BO					
5361	24 is swiched OFF (24 OFF)	24 V/f Over-flux	OUT	On Off	*		*	LED			BO		71	83	1	Yes
5362	24 is BLOCKED (24 BLOCKED)	24 V/f Over-flux	OUT	On Off	On Off		*	LED			BO		71	84	1	Yes
5363	24 is ACTIVE (24 ACTIVE)	24 V/f Over-flux	OUT	On Off	*		*	LED			BO		71	85	1	Yes
5367	24 V/f warning element (24 warn)	24 V/f Over-flux	OUT	On Off	*		*	LED			BO		71	86	1	Yes
5369	24 Reset memory of thermal replica V/f (24 RM th. repl.)	24 V/f Over-flux	OUT	On Off	*		*	LED			BO		71	88	1	Yes
5370	24-1 V/f> picked up (24-1 picked up)	24 V/f Over-flux	OUT	*	On Off		*	LED			BO		71	89	2	Yes
5371	24-2 TRIP of V/f>> element (24-2 TRIP)	24 V/f Over-flux	OUT	*	On		m	LED			BO		71	90	2	Yes
5372	24 TRIP of th. element (24 th.TRIP)	24 V/f Over-flux	OUT	*	On		*	LED			BO		71	91	2	Yes
5373	24-2 V/f>> picked up (24-2 picked up)	24 V/f Over-flux	OUT	*	On Off		*	LED			BO		71	92	2	Yes
5581	>BLOCK Vector Jump (>VEC JUMP block)	Vector Jump	SP	*	*		*	LED	BI		BO					
5582	Vector Jump is switched OFF (VEC JUMP OFF)	Vector Jump	OUT	On Off	*		*	LED			BO		72	72	1	Yes
5583	Vector Jump is BLOCKED (VEC JMP BLOCKED)	Vector Jump	OUT	On Off	On Off		*	LED			BO		72	73	1	Yes
5584	Vector Jump is ACTIVE (VEC JUMP ACTIVE)	Vector Jump	OUT	On Off	*		*	LED			BO		72	74	1	Yes
5585	Vector Jump not in measurement range (VEC JUMP Range)	Vector Jump	OUT	On Off	*		*	LED			BO		72	75	1	Yes
5586	Vector Jump picked up (VEC JUMP pickup)	Vector Jump	OUT	*	On Off		*	LED			BO		72	76	2	Yes
5587	Vector Jump TRIP (VEC JUMP TRIP)	Vector Jump	OUT	*	On		*	LED			BO		72	77	2	Yes

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
6503	>BLOCK 27 undervoltage protection (>BLOCK 27)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO		74	3	1	Yes
6506	>BLOCK 27-1 Undervoltage protection (>BLOCK 27-1)	27/59 O/U Volt.	SP	On Off	*		*	LED	BI		BO		74	6	1	Yes
6508	>BLOCK 27-2 Undervoltage protection (>BLOCK 27-2)	27/59 O/U Volt.	SP	On Off	*		*	LED	BI		BO		74	8	1	Yes
6509	>Failure: Feeder VT (>FAIL:FEEDER VT)	Meas-urem.Superv	SP	On Off	*		*	LED	BI		BO		74	9	1	Yes
6510	>Failure: Busbar VT (>FAIL: BUS VT)	Meas-urem.Superv	SP	On Off	*		*	LED	BI		BO		74	10	1	Yes
6513	>BLOCK 59 overvoltage protection (>BLOCK 59)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO		74	13	1	Yes
6530	27 Undervoltage protection switched OFF (27 OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		74	30	1	Yes
6531	27 Undervoltage protection is BLOCKED (27 BLOCKED)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		74	31	1	Yes
6532	27 Undervoltage protection is ACTIVE (27 ACTIVE)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		74	32	1	Yes
6533	27-1 Undervoltage picked up (27-1 picked up)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		74	33	2	Yes
6534	27-1 Undervoltage PICKUP w/curr. superv (27-1 PU CS)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		74	34	2	Yes
6537	27-2 Undervoltage picked up (27-2 picked up)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		74	37	2	Yes
6538	27-2 Undervoltage PICKUP w/curr. superv (27-2 PU CS)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		74	38	2	Yes
6539	27-1 Undervoltage TRIP (27-1 TRIP)	27/59 O/U Volt.	OUT	*	On		m	LED			BO		74	39	2	Yes
6540	27-2 Undervoltage TRIP (27-2 TRIP)	27/59 O/U Volt.	OUT	*	On		*	LED			BO		74	40	2	Yes
6565	59 Overvoltage protection switched OFF (59 OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		74	65	1	Yes

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
6566	59 Overvoltage protection is BLOCKED (59 BLOCKED)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		74	66	1	Yes
6567	59 Overvoltage protection is ACTIVE (59 ACTIVE)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		74	67	1	Yes
6568	59-1 Overvoltage V> picked up (59-1 picked up)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		74	68	2	Yes
6570	59-1 Overvoltage V> TRIP (59-1 TRIP)	27/59 O/U Volt.	OUT	*	On		m	LED			BO		74	70	2	Yes
6571	59-2 Overvoltage V>> picked up (59-2 picked up)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO					
6573	59-2 Overvoltage V>> TRIP (59-2 TRIP)	27/59 O/U Volt.	OUT	*	On		*	LED			BO					
6851	>BLOCK 74TC (>BLOCK 74TC)	74TC Trip-Circ.	SP	*	*		*	LED	BI		BO					
6852	>74TC Trip circuit superv.: trip relay (>74TC trip rel.)	74TC Trip-Circ.	SP	On Off	*		*	LED	BI		BO		170	51	1	Yes
6853	>74TC Trip circuit superv.: bkr relay (>74TC brk rel.)	74TC Trip-Circ.	SP	On Off	*		*	LED	BI		BO		170	52	1	Yes
6861	74TC Trip circuit supervision OFF (74TC OFF)	74TC Trip-Circ.	OUT	On Off	*		*	LED			BO		170	53	1	Yes
6862	74TC Trip circuit supervision is BLOCKED (74TC BLOCKED)	74TC Trip-Circ.	OUT	On Off	On Off		*	LED			BO		153	16	1	Yes
6863	74TC Trip circuit supervision is ACTIVE (74TC ACTIVE)	74TC Trip-Circ.	OUT	On Off	*		*	LED			BO		153	17	1	Yes
6864	74TC blocked. Bin. input is not set (74TC ProgFail)	74TC Trip-Circ.	OUT	On Off	*		*	LED			BO		170	54	1	Yes
6865	74TC Failure Trip Circuit (74TC Trip cir.)	74TC Trip-Circ.	OUT	On Off	*		*	LED			BO		170	55	1	Yes
10080	Error Extension I/O (Error Ext I/O)	Device, General	OUT	On Off	*		*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
10081	Error Ethernet (Error Ethernet)	Device, General	OUT	On Off	*		*	LED			BO					
10083	Error Basic I/O (Error Basic I/O)	Device, General	OUT	On Off	*		*	LED			BO					
17330	>Load restoration Block (>LR Block)	Load Restore	SP	On Off	*		*	LED	BI	FK TO NL IN E	BO					
17331	>Load restoration break (>LR Break)	Load Restore	SP	On Off	*		*	LED	BI	FK TO NL IN E	BO					
17332	>Load restoration Process (>LR Process)	Load Restore	SP	*	*		*	LED	BI	FK TO NL IN E	BO					
17333	>Load restoration Reset (>LR Reset)	Load Restore	SP	On Off	*		*	LED	BI	FK TO NL IN E	BO					
17334	Load restoration is OFF (LR OFF)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17335	Load restoration successful (LR Successful)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17336	Load restoration Block (LR Block)	Load Restore	OUT	On Off	On Off		*	LED	BI	FK TO NL IN E	BO					
17337	Load restoration break (LR Break)	Load Restore	OUT	On Off	On Off		*	LED	BI	FK TO NL IN E	BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
17338	Load restoration Process (LR Process)	Load Restore	OUT	On Off	*		*	LED	BI	FK TO NL IN E	BO					
17339	Load restoration element 1 Start (LR1 Start)	Load Restore	OUT	On Off	*		*	LED			BO					
17340	Load restoration element 1 Pickup (LR1 Pickup)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17341	Load restoration element 1 CB Close (LR1 CB Close)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17343	Load restoration element 1 Active (LR1 Active)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17344	Load restoration element 1 Setting Error (LR1 Set-Error)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17345	Load restoration element 1 monitor mode (LR1 Monitor)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17346	Load restoration element 2 Start (LR2 Start)	Load Restore	OUT	On Off	*		*	LED			BO					
17347	Load restoration element 2 Pickup (LR2 Pickup)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17348	Load restoration element 2 CB Close (LR2 CB Close)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17350	Load restoration element 2 Active (LR2 Active)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17351	Load restoration element 2 Setting Error (LR2 Set-Error)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17352	Load restoration element 2 monitor mode (LR2 Monitor)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17353	Load restoration element 3 Start (LR3 Start)	Load Restore	OUT	On Off	*		*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
17354	Load restoration element 3 Pickup (LR3 Pickup)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17355	Load restoration element 3 CB Close (LR3 CB Close)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17357	Load restoration element 3 Active (LR3 Active)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17358	Load restoration element 3 Setting Error (LR3 Set-Error)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17359	Load restoration element 3 monitor mode (LR3 Monitor)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17360	Load restoration element 4 Start (LR4 Start)	Load Restore	OUT	On Off	*		*	LED			BO					
17361	Load restoration element 4 Pickup (LR4 Pickup)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17362	Load restoration element 4 CB Close (LR4 CB Close)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17364	Load restoration element 4 Active (LR4 Active)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17365	Load restoration element 4 Setting Error (LR4 Set-Error)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17366	Load restoration element 4 monitor mode (LR4 Monitor)	Load Restore	OUT	On Off	On Off		*	LED			BO					
17370	>Block Undervoltage protection Vp< (>BLOCK Vp<)	27/59 O/U Volt.	SP	On Off	*		*	LED	BI		BO					
17371	>Block Overvoltage protection Vp> (>BLOCK Vp>)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO					
17372	Vp< Undervoltage picked up (Vp< picked up)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO					
17373	Vp> Overvoltage picked up (Vp> picked up)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	information number	Data Unit	General Interrogation
17374	Vp< Undervoltage TRIP (Vp< TRIP)	27/59 O/U Volt.	OUT	*	On		*	LED			BO					
17375	Vp> Overvoltage TRIP (Vp> TRIP)	27/59 O/U Volt.	OUT	*	On		*	LED			BO					
30053	Fault recording is running (Fault rec. run.)	Osc. Fault Rec.	OUT	*	*		*	LED			BO					
31000	Q0 operationcounter= (Q0 OpCnt=)	Control Device	VI	*												
31001	Q1 operationcounter= (Q1 OpCnt=)	Control Device	VI	*												
31008	Q8 operationcounter= (Q8 OpCnt=)	Control Device	VI	*												

E.4 Group Indications

Nr.	Bedeutung	Nr.	Bedeutung
140	Error Sum Alarm	177	Fail Battery
		178	I/O-Board error
		10080	Error Ext I/O
		10081	Error Ethernet
		10083	Error Basic I/O
		191	Error Offset
		193	Alarm NO calibr
160	Alarm Sum Event	167	Fail V balance
		176	Fail Ph. Seq. V
171	Fail Ph. Seq.	176	Fail Ph. Seq. V

E.5 Measured Values

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	information number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
-	Number of TRIPs= (#of TRIPs=)	Statistics	-	-	-	-	-	CFC		
-	Operating hours greater than (OpHour>)	SetPoint(Stat)	-	-	-	-	-	CFC		
170.2050	V1 = (V1 =)	SYNC function 1	130	1	No	9	1	CFC		
170.2051	f1 = (f1 =)	SYNC function 1	130	1	No	9	4	CFC		
170.2052	V2 = (V2 =)	SYNC function 1	130	1	No	9	3	CFC		
170.2053	f2 = (f2 =)	SYNC function 1	130	1	No	9	7	CFC		
170.2054	dV = (dV =)	SYNC function 1	130	1	No	9	2	CFC		
170.2055	df = (df =)	SYNC function 1	130	1	No	9	5	CFC		
170.2056	dalpha = (dα =)	SYNC function 1	130	1	No	9	6	CFC		
621	Va (Va =)	Measurement	134	157	No	9	2	CFC		
622	Vb (Vb =)	Measurement	134	157	No	9	3	CFC		
623	Vc (Vc =)	Measurement	134	157	No	9	4	CFC		
624	Va-b (Va-b=)	Measurement	160	145	Yes	3	1	CFC		
			134	157	No	9	5			
625	Vb-c (Vb-c=)	Measurement	134	157	No	9	6	CFC		
626	Vc-a (Vc-a=)	Measurement	134	157	No	9	7	CFC		
627	VN (VN =)	Measurement	134	118	No	9	1	CFC		
629	V1 (positive sequence) (V1 =)	Measurement	-	-	-	-	-	CFC		
630	V2 (negative sequence) (V2 =)	Measurement	-	-	-	-	-	CFC		
632	Vsync (synchronism) (Vsync =)	Measurement	-	-	-	-	-	CFC		
644	Frequency (Freq=)	Measurement	134	157	No	9	1	CFC		
765	(V/Vn) / (f/fn) (V/f =)	Measurement	134	157	No	9	8	CFC	CD	DD
766	Calculated temperature (V/f) (V/f th=)	Measurement	-	-	-	-	-	CFC	CD	DD
832	Vo (zero sequence) (Vo =)	Measurement	134	118	No	9	2	CFC		
859	Va-n Min (Va-nMin=)	Min/Max meter	-	-	-	-	-	CFC		
860	Va-n Max (Va-nMax=)	Min/Max meter	-	-	-	-	-	CFC		
861	Vb-n Min (Vb-nMin=)	Min/Max meter	-	-	-	-	-	CFC		
862	Vb-n Max (Vb-nMax=)	Min/Max meter	-	-	-	-	-	CFC		
863	Vc-n Min (Vc-nMin=)	Min/Max meter	-	-	-	-	-	CFC		
864	Vc-n Max (Vc-nMax=)	Min/Max meter	-	-	-	-	-	CFC		

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	information number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
865	Va-b Min (Va-bMin=)	Min/Max meter	-	-	-	-	-	CFC		
867	Va-b Max (Va-bMax=)	Min/Max meter	-	-	-	-	-	CFC		
868	Vb-c Min (Vb-cMin=)	Min/Max meter	-	-	-	-	-	CFC		
869	Vb-c Max (Vb-cMax=)	Min/Max meter	-	-	-	-	-	CFC		
870	Vc-a Min (Vc-aMin=)	Min/Max meter	-	-	-	-	-	CFC		
871	Vc-a Max (Vc-aMax=)	Min/Max meter	-	-	-	-	-	CFC		
872	V neutral Min (Vn Min =)	Min/Max meter	-	-	-	-	-	CFC		
873	V neutral Max (Vn Max =)	Min/Max meter	-	-	-	-	-	CFC		
874	V1 (positive sequence) Voltage Minimum (V1 Min =)	Min/Max meter	-	-	-	-	-	CFC		
875	V1 (positive sequence) Voltage Maximum (V1 Max =)	Min/Max meter	-	-	-	-	-	CFC		
882	Frequency Minimum (fmin=)	Min/Max meter	-	-	-	-	-	CFC		
883	Frequency Maximum (fmax=)	Min/Max meter	-	-	-	-	-	CFC		
888	Pulsed Energy Wp (active) (Wp(puls))	Energy	133	55	No	205	-	CFC		
889	Pulsed Energy Wq (reactive) (Wq(puls))	Energy	133	56	No	205	-	CFC		
30800	Voltage VX (VX =)	Measurement	-	-	-	-	-	CFC		
30801	Voltage phase-neutral (Vph-n =)	Measurement	-	-	-	-	-	CFC		

Literature

/1/ SIPROTEC 4 System Description
E50417-H1176-C151-B6

/2/ SIPROTEC DIGSI, Start UP
E50417-G1176-C152-A3

/3/ DIGSI CFC, Manual
E50417-H1176-C098-B2

/4/ SIPROTEC SIGRA 4, Manual
E50417-H1176-C070-A7

Glossary

Bay controllers

Bay controllers are devices with control and monitoring functions without protective functions.

Bit pattern indication

Bit pattern indication is a processing function by means of which items of digital process information applying across several inputs can be detected together in parallel and processed further. The bit pattern length can be specified as 1, 2, 3 or 4 bytes.

BP_xx

→ Bit pattern indication (Bitstring Of x Bit), x designates the length in bits (8, 16, 24 or 32 bits).

Buffer battery

The buffer battery ensures that specified data areas, flags, timers and counters are retained retentively.

C_xx

Command without feedback

CF_xx

Command with feedback

CFC

Continuous Function Chart. CFC is a graphical editor with which a program can be created and configured by using ready-made blocks.

CFC blocks

Blocks are parts of the user program delimited by their function, their structure or their purpose.

Chatter ON

A rapidly intermittent input (for example, due to a relay contact fault) is switched off after a configurable monitoring time and can thus not generate any further signal changes. The function prevents overloading of the system when a fault arises.

Combination devices

Combination devices are bay devices with protection functions and a control display.

Combination matrix

From DIGSI V4.6 onward, up to 32 compatible SIPROTEC 4 devices can communicate with one another in an Inter Relay Communication combination (IRC combination). Which device exchanges which information is defined with the help of the combination matrix.

Communication branch

A communications branch corresponds to the configuration of 1 to n users that communicate by means of a common bus.

Communication reference CR

The communication reference describes the type and version of a station in communication by PROFIBUS.

Component view

In addition to a topological view, SIMATIC Manager offers you a component view. The component view does not offer any overview of the hierarchy of a project. It does, however, provide an overview of all the SIPROTEC 4 devices within a project.

COMTRADE

Common Format for Transient Data Exchange, format for fault records.

Container

If an object can contain other objects, it is called a container. The object Folder is an example of such a container.

Control Display

The display which is displayed on devices with a large (graphic) display after you have pressed the control key is called the control display. It contains the switchgear that can be controlled in the feeder with status display. It is used to perform switching operations. Defining this display is part of the configuration.

Data pane

The right-hand area of the project window displays the contents of the area selected in the → navigation window, for example indications, measured values, etc. of the information lists or the function selection for the device configuration.

DCF77

The extremely precise official time is determined in Germany by the "Physikalisch-Technische-Bundesanstalt PTB" in Braunschweig. The atomic clock station of the PTB transmits this time via the long-wave time-signal transmitter in Mainflingen near Frankfurt/Main. The emitted time signal can be received within a radius of approx. 1,500 km from Frankfurt/Main.

Device container

In the Component View, all SIPROTEC 4 devices are assigned to an object of type Device container. This object is a special object of DIGSI Manager. However, since there is no component view in DIGSI Manager, this object only becomes visible in conjunction with STEP 7.

Double command

Double commands are process outputs which indicate 4 process states at 2 outputs: 2 defined (for example ON/OFF) and 2 undefined states (for example intermediate positions)

Double-point indication

Double-point indications are items of process information which indicate 4 process states at 2 inputs: 2 defined (for example ON/OFF) and 2 undefined states (for example intermediate positions).

DP

→ Double-point indication

DP_I

→ Double point indication, intermediate position 00

Drag and drop

Copying, moving and linking function, used at graphics user interfaces. Objects are selected with the mouse, held and moved from one data area to another.

Earth

The conductive earth whose electric potential can be set equal to zero at every point. In the area of earth electrodes the earth can have a potential deviating from zero. The term "Earth reference plane" is often used for this state.

Earth (verb)

This term means that a conductive part is connected via an earthing system to the → earth.

Earthing

Earthing is the total of all means and measures used for earthing.

Electromagnetic compatibility

Electromagnetic compatibility (EMC) is the ability of an electrical apparatus to function fault-free in a specified environment without influencing the environment unduly.

EMC

→ Electromagnetic compatibility

ESD protection

ESD protection is the total of all the means and measures used to protect electrostatic sensitive devices.

EVA

Limiting value, user-defined

ExBPxx

External bit pattern indication via an ETHERNET connection, device-specific → Bit pattern indication

ExC

External command without feedback via an ETHERNET connection, device-specific

ExCF

Command with feedback via an ETHERNET connection, device-specific

ExDP

External double point indication via an ETHERNET connection, device-specific → Double point indication

ExDP_I

External double point indication via an ETHERNET connection, intermediate position 00, device-specific → Double point indication

ExMV

External metered value via an ETHERNET connection, device-specific

ExSI

External single point indication via an ETHERNET connection, device-specific → Single point indication

ExSI_F

External single point indication via an ETHERNET connection, Spontaneous event, device-specific → Fleeting indication, → Single point indication

Field devices

Generic term for all devices assigned to the field level: Protection devices, combination devices, bay controllers.

Fleeting Indication

Fleeting indications are single-point indications present for a very short time, in which only the coming of the process signal is logged and further processed time-correctly.

FMS communication branch

Within an FMS communication branch, the users communicate on the basis of the PROFIBUS FMS protocol via a PROFIBUS FMS network.

Folder

This object type is used to create the hierarchical structure of a project.

General interrogation (GI)

During the system start-up the state of all the process inputs, of the status and of the fault image is sampled. This information is used to update the system-end process image. The current process state can also be sampled after a data loss by means of a GI.

GOOSE message

GOOSE messages (Generic Object Oriented Substation Event) according to IEC 61850 are data packets which are transferred event-controlled via the Ethernet communication system. They serve for direct information exchange among the relays. This mechanism implements cross-communication between bay units.

GPS

Global Positioning System. Satellites with atomic clocks on board orbit the earth twice a day on different paths in approx. 20,000 km. They transmit signals which also contain the GPS universal time. The GPS receiver determines its own position from the signals received. From its position it can derive the delay time of a satellite signal and thus correct the transmitted GPS universal time.

Hierarchy level

Within a structure with higher-level and lower-level objects a hierarchy level is a container of equivalent objects.

HV field description

The HV project description file contains details of fields which exist in a ModPara-project. The actual field information of each field is stored in a HV field description file. Within the HV project description file, each field is allocated such a HV field description file by a reference to the file name.

HV project description

All the data is exported once the configuration and parameterization of PCUs and sub-modules using ModPara has been completed. This data is split up into several files. One file contains details about the fundamental project structure. This also includes, for example, information detailing which fields exist in this project. This file is called a HV project description file.

ID

Internal double point indication → Double point indication

ID_S

Internal double point indication, intermediate position 00 → Double point indication

IEC

International Electrotechnical Commission, international standardization body

IEC61850

International communication standard for communication in substations. The objective of this standard is the interoperability of devices from different manufacturers on the station bus. An Ethernet network is used for data transfer.

IEC address

Within an IEC bus a unique IEC address has to be assigned to each SIPROTEC 4 device. A total of 254 IEC addresses are available for each IEC bus.

IEC communication branch

Within an IEC communication branch the users communicate on the basis of the IEC60-870-5-103 protocol via an IEC bus.

Initialization string

An initialization string comprises a range of modem-specific commands. These are transmitted to the modem within the framework of modem initialization. The commands can, for example, force specific settings for the modem.

Inter relay communication

→ IRC combination

IntSP

Internal single point indication → Single point indication

IntSP_Ev

Internal indication Spontaneous event → Fleeting indication, → Single point indication

IRC combination

Inter Relay Communication, IRC, is used for directly exchanging process information between SIPROTEC 4 devices. You require an object of type IRC combination to configure an inter relay communication. Each user of the combination and all the necessary communication parameters are defined in this object. The type and scope of the information exchanged between the users is also stored in this object.

IRIG B

Time signal code of the Inter-Range Instrumentation Group

ISO 9001

The ISO 9000 ff range of standards defines measures used to assure the quality of a product from the development stage to the manufacturing stage.

LFO-Filter

(Low-Frequency-Oscillation) Filter for low frequency oscillations

Link address

The link address gives the address of a V3/V2 device.

List view

The right window section of the project window displays the names and icons of objects which represent the contents of a container selected in the tree view. Because they are displayed in the form of a list, this area is called the list view.

LPS

Line Post Sensor

LV

Limiting value

Master

Masters may send data to other users and request data from other users. DIGSI operates as a master.

Metered value

Metered values are a processing function with which the total number of discrete similar events (counting pulses) is determined for a period, usually as an integrated value. In power supply companies the electrical work is usually recorded as a metered value (energy purchase/supply, energy transportation).

MLFB

MLFB is the abbreviation for "MaschinenLesbare FabrikateBezeichnung" (machine-readable product designation). This is the equivalent of an order number. The type and version of a SIPROTEC 4 device is coded in the order number.

Modem connection

This object type contains information on both partners of a modem connection, the local modem and the remote modem.

Modem profile

A modem profile consists of the name of the profile, a modem driver and may also comprise several initialization commands and a user address. You can create several modem profiles for one physical modem. To do so you need to link various initialization commands or user addresses to a modem driver and its properties and save them under different names.

Modems

Modem profiles for a modem connection are stored in this object type.

MV

Measured value

MVMV

Metered value which is formed from the measured value

MVT

Measured value with time

MVU

Measured value, user-defined

Navigation pane

The left pane of the project window displays the names and symbols of all containers of a project in the form of a folder tree.

Object

Each element of a project structure is called an object in DIGSI.

Object properties

Each object has properties. These might be general properties that are common to several objects. An object can also have specific properties.

Off-line

In offline mode a connection to a SIPROTEC 4 device is not required. You work with data which are stored in files.

On-line

When working in online mode, there is a physical connection to a SIPROTEC 4 device. This connection can be implemented as a direct connection, as a modem connection or as a PROFIBUS FMS connection.

OUT

Output Indication

OUT_Ev

Output indication Spontaneous event→ Fleeting indication

Parameterization

Comprehensive term for all setting work on the device. The parameterization is done with DIGSI or sometimes also directly on the device.

Parameter set

The parameter set is the set of all parameters that can be set for a SIPROTEC 4 device.

Phone book

User addresses for a modem connection are saved in this object type.

PMV

Pulse metered value

Process bus

Devices with a process bus interface allow direct communication with SICAM HV modules. The process bus interface is equipped with an Ethernet module.

PROFIBUS

PROcess FIeld BUS, the German process and field bus standard, as specified in the standard EN 50170, Volume 2, PROFIBUS. It defines the functional, electrical, and mechanical properties for a bit-serial field bus.

PROFIBUS address

Within a PROFIBUS network a unique PROFIBUS address has to be assigned to each SIPROTEC 4 device. A total of 254 PROFIBUS addresses are available for each PROFIBUS network.

Project

Content-wise, a project is the image of a real power supply system. Graphically, a project is represented as a number of objects which are integrated in a hierarchical structure. Physically, a project consists of a number of directories and files containing project data.

Protection devices

All devices with a protective function and no control display.

Reorganizing

Frequent addition and deletion of objects results in memory areas that can no longer be used. By reorganizing projects, you can release these memory areas again. However, a cleanup also reassigns the VD addresses. The consequence is that all SIPROTEC 4 devices have to be reinitialized.

RIO file

Relay data Interchange format by Omicron.

RSxxx-interface

Serial interfaces RS232, RS422/485

Service interface

Rear serial interface on the devices for connecting DIGSI (for example, via modem).

SICAM PAS (Power Automation System)

Substation control system: The range of possible configurations spans from integrated standalone systems (SICAM PAS and M&C with SICAM PAS CC on one computer) to separate hardware for SICAM PAS and SICAM PAS CC to distributed systems with multiple SICAM Station Units. The software is a modular system with basic and optional packages. SICAM PAS is a purely distributed system: the process interface is implemented by the use of bay units / remote terminal units.

SICAM Station Unit

The SICAM Station Unit with its special hardware (no fan, no rotating parts) and its Windows XP Embedded operating system is the basis for SICAM PAS.

SICAM WinCC

The SICAM WinCC operator control and monitoring system displays the state of your network graphically, visualizes alarms, interrupts and indications, archives the network data, offers the possibility of intervening manually in the process and manages the system rights of the individual employee.

Single command

Single commands are process outputs which indicate 2 process states (for example, ON/OFF) at one output.

Single point indication

Single indications are items of process information which indicate 2 process states (for example, ON/OFF) at one output.

SIPROTEC

The registered trademark SIPROTEC is used for devices implemented on system base V4.

SIPROTEC 4 device

This object type represents a real SIPROTEC 4 device with all the setting values and process data it contains.

SIPROTEC 4 Variant

This object type represents a variant of an object of type SIPROTEC 4 device. The device data of this variant may well differ from the device data of the original object. However, all variants derived from the original object have the same VD address as the original object. For this reason they always correspond to the same real SIPROTEC 4 device as the original object. Objects of type SIPROTEC 4 variant have a variety of uses, such as documenting different operating states when entering parameter settings of a SIPROTEC 4 device.

Slave

A slave may only exchange data with a master after being prompted to do so by the master. SIPROTEC 4 devices operate as slaves.

SP

→ Single point indication

SP_W

→ Single point indication Spontaneous event → Fleeting indication, → Single point indication

System interface

Rear serial interface on the devices for connecting to a substation controller via IEC or PROFIBUS.

TI

Transformer Tap Indication

Time stamp

Time stamp is the assignment of the real time to a process event.

Topological view

DIGSI Manager always displays a project in the topological view. This shows the hierarchical structure of a project with all available objects.

Transformer Tap Indication

Transformer tap indication is a processing function on the DI by means of which the tap of the transformer tap changer can be detected together in parallel and processed further.

Tree view

The left pane of the project window displays the names and symbols of all containers of a project in the form of a folder tree. This area is called the tree view.

Ungrounded

Without any electrical connection to → ground.

User address

A user address comprises the name of the user, the national code, the area code and the user-specific phone number.

Users

From DIGSI V4.6 onward , up to 32 compatible SIPROTEC 4 devices can communicate with one another in an Inter Relay Communication combination. The individual participating devices are called users.

VD

A VD (Virtual Device) includes all communication objects and their properties and states that are used by a communication user through services. A VD can be a physical device, a module of a device or a software module.

VD address

The VD address is assigned automatically by DIGSI Manager. It exists only once in the entire project and thus serves to identify unambiguously a real SIPROTEC 4 device. The VD address assigned by DIGSI Manager must be transferred to the SIPROTEC 4 device in order to allow communication with DIGSI Device Editor.

VFD

A VFD (Virtual Field Device) includes all communication objects and their properties and states that are used by a communication user through services.

VI

VI stands for Value Indication.

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