SIEMENS

SIPROTEC

Line Differential Protection 7SD80

V4.6

Manual

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E50417-G1140-C474-A1

Note

For safety purposes, please note instructions and warnings in the Preface.

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Order no.: E50417-G1140-C474-A1

Preface

Purpose of this Manual

This manual describes the functions, operation, installation, and placing into service of device 7SD80. In particular:

- 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 A.

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

Target Audience

Protection engineers, commissioning engineers, personnel concerned with adjustment, checking, and service of selective protective equipment, automatic and control facilities, and personnel of electrical facilities and power plants.

Applicability of this Manual

This manual applies to: SIPROTEC 4 Line Differential Protection 7SD80; 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 C37.90 (see Chapter 4 "Technical Data")

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

UL certification according to standard UL 508 for the devices 7SD803x and 7SD807x has been applied for.

IND. CONT. EQ.
69CA

Additional Support

Should further information on the System SIPROTEC 4 be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the local Siemens representative.

Our Customer Support Center provides a 24-hour service.

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e-mail: power-academy.energy@siemens.com

Safety Information

This manual does not constitute a complete index of all required safety measures for operation of the equipment (module, device), as special operational conditions may require additional measures. However, it comprises important information that should be noted for purposes of personal safety as well as avoiding material damage. Information that is highlighted by means of a warning triangle and according to the degree of danger, is illustrated as follows.

DANGER!

Danger indicates that death, severe personal injury or substantial material damage will result if proper precautions are not taken.

WARNING!

indicates that death, severe personal injury or substantial property damage may result if proper precautions are not taken.

Caution!

indicates that minor personal injury or property damage may result if proper precautions are not taken. This particularly applies to damage to or within the device itself and consequential damage thereof.

Note

indicates information on the device, handling of the device, or the respective part of the instruction manual which is important to be noted.

WARNING!

Qualified Personnel

Commissioning and operation of the equipment (module, device) as set out in this manual may only be carried out by qualified personnel. Qualified personnel in terms of the technical safety information as set out in this manual are persons who are authorized to commission, activate, to ground and to designate devices, systems and electrical circuits in accordance with the safety standards.

Use as prescribed

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

The successful and safe operation of the device is dependent on proper handling, storage, installation, operation, and maintenance.

When operating an electrical equipment, certain parts of the device are inevitably subject to dangerous voltage. Severe personal injury or property damage may result if the device is not handled properly.

Before any connections are made, the device must be grounded to the ground terminal.

All circuit components connected to the voltage supply may be subject to dangerous voltage.

Dangerous voltage may be present in the device even after the power supply voltage has been removed (capacitors can still be charged).

Operational equipment with exposed current transformer circuits may not be operated.

The limit values as specified in this manual or in the operating instructions may not be exceeded. This aspect must also be observed 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 goes for the 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`

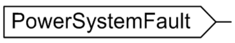
Possible settings of text parameters, which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI), are additionally written in italics. This also applies to header bars for selection menus.

`„Messages“`

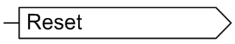
Designators for information, which may be output by the relay or required from other devices or from the switch gear, are marked in a monospace type style in quotation marks.

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

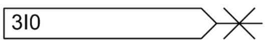
The following symbols are used in drawings:



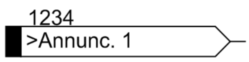
Device-internal logical input signal



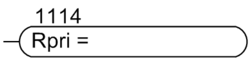
Device-internal logical output signal



Internal input signal of an analog quantity

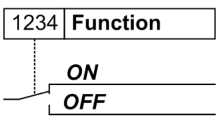


External binary input signal with number (binary input, input indication)



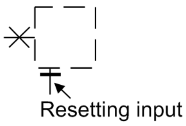
External binary input signal with number (example of a value indication)

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

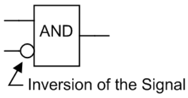


Example of a parameter switch designated **FUNCTION** with address 1234 and the possible settings ON and OFF

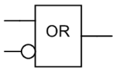
Besides these, graphical symbols are used according to IEC 60617-12 and IEC 60617-13 or symbols derived from these standards. Some of the most frequently used are listed below:



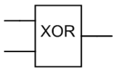
Analog input variable



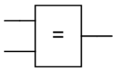
AND operation of input variables



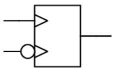
OR operation of input variables



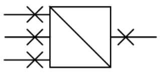
Exclusive OR (antivalence): output is active if only **one** of the inputs is active



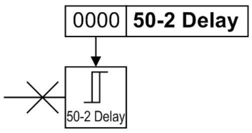
Coincidence: output is active if **both** inputs are active or inactive at the same time



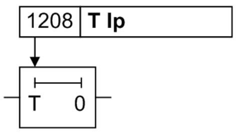
Dynamic input signals (edge-triggered) above with positive, below with negative edge



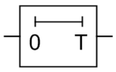
Formation of one analog output signal from a number of analog input signals



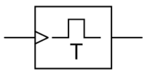
Threshold element with setting address and parameter names



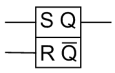
Timer (pickup delay T adjustable) with setting address and parameter names



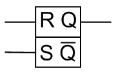
Timer (dropout delay T not adjustable)



Edge-triggered time element with action time T



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 resetting input (R) setting input (S), output (Q) and inverted output ($\overline{Q}$), resetting input dominant

■

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Introduction 1

This chapter introduces the SIPROTEC 4 7SD80 and gives an overview of the device's application, properties and functions.

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1.1 Overall Operation

The digital SIPROTEC 7SD80 overcurrent protection is equipped with a powerful microprocessor. It allows all tasks to be processed digitally, from the acquisition of measured quantities to sending commands to circuit breakers. Figure 1-1 shows the basic structure of the 7SD80 device.

Analog Inputs

The measuring inputs (MI) convert the currents and voltages coming from the instrument transformers and adapt them to the level appropriate for the internal processing of the device. The device provides 4 current transformers and - depending on the model - additionally 3 voltage transformers. Three current inputs serve for the input of the phase currents, another current input (I_N) may be used for measuring the ground fault current I_N (current transformer starpoint) or for a separate ground current transformer (for sensitive ground fault detection I_{Ns} and directional determination of ground faults) - depending on the model.

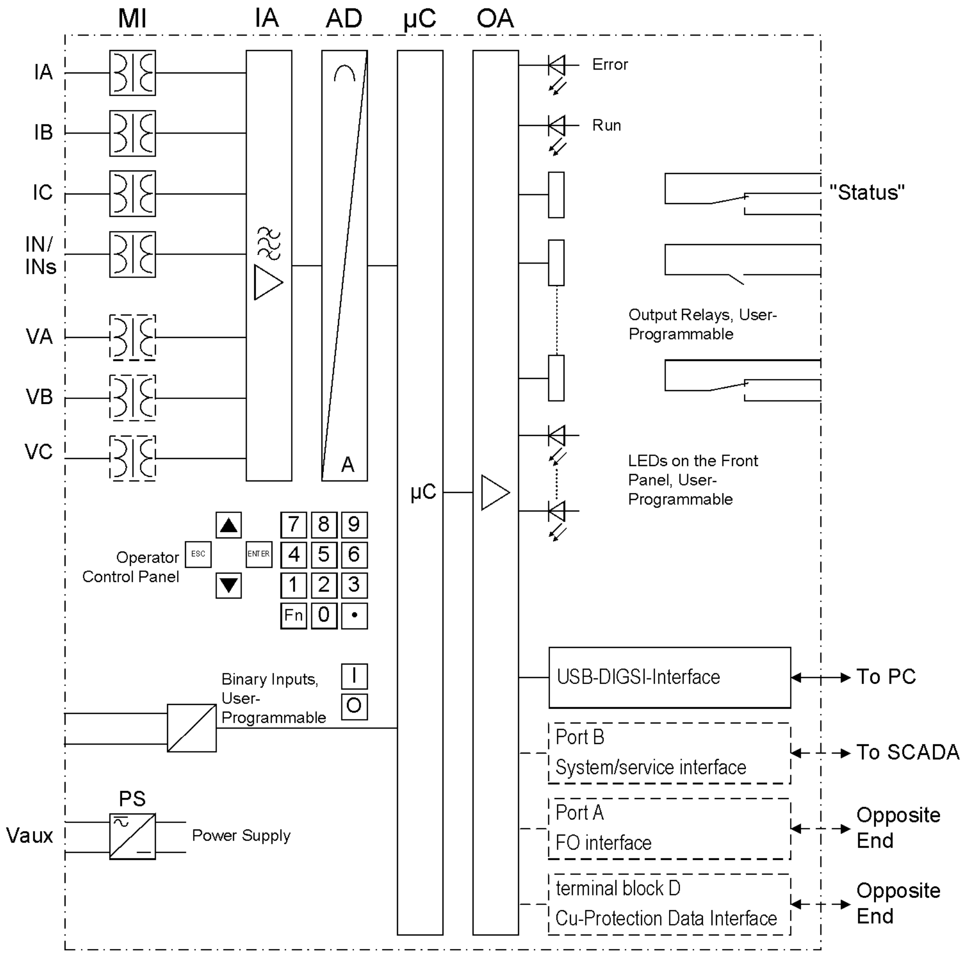

Figure 1-1 Hardware structure of the 7SD80 differential protection

There is one voltage input available for each phase-to-ground voltage. The differential protection does not need measuring voltages due to its functional principle. Directional overcurrent protection, however, requires the phase-to-ground voltage V_A, V_B and V_C to be connected. Additionally, voltages can be connected that allow displaying voltages and power values and also measuring the line voltage for automatic reclosing. The analog quantities are forwarded to the input amplifier group (IA).

The input amplifier group IA provides high-resistance termination for the analog 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) element consists of an analog-to-digital (A/D) converter and memory components for data transmission to the microcomputer system.

Microcomputer System

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

- Filtering and preparation of the measured quantities
- Continuous monitoring of the measured quantities
- Monitoring of the pickup conditions for the individual protection functions
- Interrogation of limit values and time sequences
- Control of signals for the logic functions
- Decision on trip and close commands
- Recording of messages, fault data and fault values for analysis
- Administration of the operating system and its functions, e.g. data storage, realtime clock, communication, interfaces, etc.
- Formation of the local differential protection values (phasor analysis and charge current computation) and creation of the transmission protocol
- Decoding the received transmission protocol, synchronization of differential protection values and totaling the differential currents and charge currents
- Monitoring the communication with the device of the remote end

The information is provided via output amplifier OA.

Binary Inputs and Outputs

Binary inputs and outputs to and from the computer system are relayed via the input/output modules. The computer system obtains information from the system (e.g. remote resetting) or from other devices (e.g. blocking commands). Outputs are, in particular, commands to the switchgear units and annunciations for remote signaling of important events and statuses.

Front Elements

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 communication with the remote device. These elements enable the user to retrieve all device information such as configuration and setting parameters, operational indications and fault indications or measured values and to edit setting parameters.

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 the user to conveniently handle all device functions.

Port A can be used as protection interface to communicate with another 7SD80 device via an optical fiber cable.

If you are using a copper link to create a connection to the other 7SD80 device, use the voltage terminals D1 and D2 as protection interface.

The protection data interfaces are used to transfer the data of the measured quantities from each end of the protected zone to the opposite end. Further information such as closing of the local circuit breaker or other externally injected trip commands can be transmitted to the opposite end via the protection interface.

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

The functional units described are supplied by a power supply (PS) with the adequate power in the different voltage levels. Transient voltage dips may occur if the auxiliary voltage supply system becomes short-circuited. Usually, they are bridged by a capacitor storage (see also the Section 4, Technical Data).

A buffer battery is located behind the lower front cover.

1.2 Application Scope

The digital Line Differential Protection SIPROTEC 4 7SD80 is a selective short-circuit protection for overhead lines and cables with single- and multi-ended infeeds in radial, ring or any type of meshed systems of any transmission level. The measured data are compared separately for each phase.

A major advantage of the differential protection principle is the instantaneous tripping in the event of a short circuit at any point within the entire protected zone. The current transformers limit the protected zone at the ends towards the remaining system. This rigid delimitation is the reason why the differential protection scheme shows such an ideal selectivity.

The differential protection system requires a 7SD80 device as well as a set of current transformers at either end of the protected zone. Voltage transformers are not required for the differential protection functions in the 7SD80; they are, however, available to record and display measured values (voltages, power, power factor) or when using a directional overcurrent protection element.

The devices located at the ends of the protected zone exchange measuring information via protection interfaces using communication links (usually optical fiber or copper cables).

Since fault-free data transmission is the prerequisite for the proper operation of the protection, it is continuously monitored internally.

Protection Functions

The device's basic function is to detect short-circuits or ground faults in the protected zone – even weak-current or high-resistance short-circuits. Even complex multiphase faults are detected correctly, as the measured values are evaluated separately for each phase. The protection is restraint against inrush currents of power transformers. When switching a line onto a fault, it is possible to send an instantaneous trip signal. The 7SD80 line differential protection includes the differential protection functions of phase comparison protection and ground fault differential protection. Both differential protection functions operate independently of each other.

In the event of a communication failure, the devices can automatically switch to emergency operation using an integrated overcurrent protection until communication is restored. The overcurrent protection comprises two definite time-overcurrent protection elements and one inverse time-overcurrent protection element. Both elements operate directional or non-directional. Additionally, the device features a third definite time-overcurrent protection element that always operates non-directionally.

For inverse time overcurrent protection, several characteristic curves of different standards are available.

Alternatively, the time overcurrent protection can be used as a backup time overcurrent protection, i.e. it operates independent of and parallel to the differential protection at either end.

The communication link can be used for transmitting further information. Besides measured values, it is possible to transmit binary information.

All protection functions in the 7SD80 always trip 3-pole. They can work together with an integrated automatic reclose function (optional). The automatic reclose functions enables 3-pole automatic reclosing with two reclose attempts.

The thermal overload protection protects cables and power transformers from inadmissible heating due to overload.

Additionally, a two-element overvoltage and undervoltage protection and a four-element frequency protection can be used. A circuit-breaker failure protection monitors the response of the circuit breaker following a trip command.

Control Functions

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

The switch positions are fed back to the device via auxiliary contacts of the circuit breakers and binary inputs. The current switch positions can be read out at the device and used for plausibility monitoring and interlockings. The number of the devices 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 feedbacks. Depending on the equipment, one binary input (single point indication) or two binary inputs (double point indication) can be used. The release to switch can be restricted by appropriate settings for the switching authority (remote or local), and by the operating mode (interlocked/non-interlocked, with or without password validation). Interlocking conditions for switching (e.g. switchgear interlocking) can be defined with the help 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. With the SIPROTEC 4 operating software DIGSI, all operation and evaluation tasks can be executed using this **operator** interface, for instance specifying and editing configuration parameters and settings, configuring user-specific logic functions, retrieving operational messages and measured values, inquiring device conditions and measured values, issuing control commands.

Port A is located on the bottom side of the device. This protection data interface connects the device to its partner device at the remote end of the protected object.

Alternatively, you can implement the communication link using the voltage terminals D-1 and D-2.

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

Alternatively, there are additional connection options available in connection with PROFIBUS DP and the DNP3.0 and MODBUS protocols. If an EN100 module is available, it is also possible to use the IEC61850 protocol.

You can also use **port B** to connect a time synchronization device such as DCF77 or IRIG-B.

1.3 Characteristics

General Properties

- Powerful 32-bit microprocessor system
- Complete digital processing of measured values and control, from the sampling of the analog input values, the processing and organization of the communication between devices up to the closing and tripping commands to the circuit breakers.
- Total galvanic and fail-safe separation of the internal processing circuits from the measuring, control and supply circuits of the system via measuring transformers, binary input and output modules and DC or AC converters
- Suited for lines with two ends, even with transformers in the protected zone
- Easy device operation using the integrated operator panel or from a connected personal computer running DIGSI
- Storage of fault indications as well as instantaneous values for fault recording
- Digital protection data transmission; communication of the device through optical fiber cables
- Communication is possible via a single copper wire pair (typically 8 km (4.97 miles), max. 20 km (12.43 miles), depending on the used cable type, see Section 4, Technical Data).
- Permanent supervision of the protection data transmission for disturbance, failure or transfer time variations

Phase Comparison Protection

- Differential protection for two ends with digital protection data transmission
- Protection for all types of short-circuits in systems with any starpoint conditioning
- Reliable distinction between load and short-circuit conditions using adaptive measurement methods, also for high-resistance faults with small fault currents
- High sensitivity in light load operation, highest stability against load steps and power fluctuations
- Due to phase segregated measurement, the pickup sensitivity is independent of the fault type
- Suited for feeder transformers in the protected zone
- Detection of high-resistance, weak-current faults due to high sensitivity of the protection functions
- Fast tripping also on weak or zero infeed ends (breaker intertrip)
- No frequency dependency

Ground Fault Differential Protection for Grounded Systems

- Short command time
- High sensitivity for short circuits to ground
- High stability against external ground faults by stabilizing the through-flowing ground current

Ground Fault Differential Protection for Isolated / Grounded Systems

- Short command time
- High sensitivity for short circuits to ground
- High stability against external short-circuits to ground using the magnitude and phase relationship of the ground current flowing through for stabilization

External Direct and Remote Tripping

- Tripping of the local end by an external device via binary input
- Tripping of the opposite end by local protection functions or by an external device via binary input

Time Overcurrent Protection

- Optionally selectable as emergency function during protection data communication failure or as backup function or both
- A maximum of 3 definite time elements and one inverse time element, each for phase currents and ground current
- A maximum of 2 directional definite time elements and one directional inverse time element, each for phase currents and ground current
- For inverse time overcurrent protection, selection from various characteristics of different standards possible
- Blocking options e.g. for reverse interlocking with any element
- Instantaneous tripping when closing onto a short circuit possible with any element

Inrush Current Restraint

- Insensitive to inrush currents, even in the case of feeder transformers in the protected zone, and against higher-frequency transients
- High stability also for different current transformer saturation

Circuit-Breaker Failure Protection

- With independent current elements for the monitoring of the current flow through each pole of the circuit breaker
- Separate pickup thresholds for phase and ground currents
- Monitoring time element for tripping
- Initiation by the trip command of each integrated protection function
- Initiation by external trip functions possible
- Single-element or two-element
- No dropout and seal-in times

Thermal Overload Protection

- Thermal replica of the current heat losses of the protected object
- RMS measurement for all three phase currents
- Adjustable thermal and current-dependent warning elements

Voltage Protection

- Overvoltage and undervoltage detection with different elements
- Two overvoltage elements for the phase-to-ground voltages
- Two overvoltage elements for the phase-to-phase voltages
- Two overvoltage elements for the positive sequence voltage
- Two overvoltage elements for the negative sequence system of the voltages
- Two overvoltage elements for the zero system of the voltages or for any other single-phase voltage
- Adjustable dropout conditions
- Two undervoltage elements for the phase-to-ground voltages
- Two undervoltage elements for the phase-to-phase voltages
- Two undervoltage elements for the positive sequence system of the voltages
- Adjustable current criterion for undervoltage protection functions

Frequency Protection 81 (Optional)

- Monitoring of falling below (f<) and/or exceeding (f>) with 4 frequency limits and time delays that are independently adjustable
- Particularly insensitive to harmonics and abrupt phase angle changes
- Wide frequency range (approx. 25 Hz to 70 Hz)

Automatic Reclose Function (Optional)

- For reclosing after 3-pole open condition
- Two reclosing attempts
- With separate action times for each reclosing attempt, optionally without action times
- With separate dead times
- Optionally controlled by protection element pickup with separate dead times after 1-pole, 2-pole or 3-pole pickup

Monitoring Functions

- Reliability of the device is greatly increased because of self-monitoring of the internal measurement circuits, the auxiliary power supply as well as the hardware and software
- Monitoring of the current transformer and voltage transformer secondary circuits using summation and symmetry check techniques
- Monitoring of communication with statistics showing the availability of transmission telegrams
- Check of the consistency of protection settings at both line ends: no processor system start-up with inconsistent settings which could lead to a malfunction of the differential protection system
- Trip circuit monitoring possible
- Check of local and remote measured values and comparison of both
- Broken wire supervision for the secondary CT circuits with fast phase segregated blocking of the differential protection system in order to avoid malfunction
- Supervision of measuring voltage failure using "Fuse Failure Monitor"

Flexible Protection Functions

- Up to 20 customizable protection functions with 3-phase or 1-phase operation
- Any calculated or directly measured variable can theoretically be evaluated
- Standard protection logic with a constant (i.e. definite time) characteristic curve
- Internal and configurable pickup and dropout delay
- Editable indication texts

User-defined Logic Functions (CFC)

- Internal and external signals can be logically combined to realize user-defined logic functions
- All common logic functions
- Time delays and limit value interrogations

Command Processing

- Switching devices can be opened and closed manually using control keys, programmable function keys, via port B (e.g. of SICAM or SCADA), or via the user interface (using a personal computer and the DIGSI operating software)
- Feedback of the circuit-breaker states via the breaker auxiliary contacts (for commands with feedback)
- Plausibility monitoring of the circuit-breaker positions and interlocking conditions.

Commissioning; Operation; Maintenance

- Indication of the local and remote measured values according to magnitude and phase angle
- Indication of the calculated differential and restraint currents
- Indication of the measured values of the communication connection, as runtime and availability

Additional Functions

- Battery-buffered clock which can be synchronized via a synchronization signal (DCF77, IRIGB via satellite receiver), binary input or system interface
- Continuous calculation and indication of operational measured values on the front display, indication of measured values of the far end or all ends (for devices with active interfaces)
- Fault event memory (trip log) for the last eight network faults (faults in the power system), with real time stamps
- Fault recording and data transfer for fault recording for a maximum time range of 15 seconds.
- Switching statistics: Counting of the trip and close commands initiated by the device as well as recording of the short-circuit data and accumulation of the disconnected fault currents
- Communication with central control and memory components via serial interfaces possible (depending on the ordered variant), optionally via RS232, RS485 connection, modem or fiber optic cable
- Commissioning aids such as connection check, direction check and circuit-breaker check

■

Functions 2

This chapter describes the numerous functions available on the SIPROTEC 4 device 7SD80. 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.

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2.3	Breaker Intertrip and Remote Tripping	75
2.4	Backup Overcurrent	78
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2.6	Circuit-Breaker Failure Protection 50BF	101
2.7	Thermal Overload Protection 49	112
2.8	Undervoltage and Overvoltage Protection 27/59 (Optional)	116
2.9	Frequency Protection 81 (Optional)	133
2.10	Direct Local Trip	139
2.11	Automatic Reclosure Function 79 (Optional)	141
2.12	Circuit-Breaker Test	155
2.13	Direct Remote Trip and Transmission of Binary Information	161
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2.1 General

You can edit the function parameters via the user interface or service interface from a PC running the DIGSI software; some parameters can also be changed using the controls at the front panel of the device. The procedure is set out in detail in the SIPROTEC 4 System Description /1/.

2.1.1 Functional Scope

The 7SD80 relay comprises protection functions and additional functions. The hardware and firmware are designed for this scope of functions. Additionally, the control functions can be matched to the system requirements. Individual functions can be activated or deactivated during the configuration procedure or the interaction of functions be modified.

2.1.1.1 Description

Setting the Scope of Functions

Example for the configuration of the scope of functions:

A system consists of overhead lines and underground cables. Since automatic reclosing is only needed for the overhead lines, the automatic reclosing function is disabled for the relays protecting the underground cables.

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

Functions configured as ***Disabled*** are not processed in the 7SD80. There are no messages issued and the corresponding settings (functions, limit values) are not queried during configuration.

Note

Available functions and default settings depend on the ordered variant of the relay (see A.1 for details).

2.1.1.2 Setting Notes

Setting the Scope of Functions

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 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 prevailing system conditions.

Password no. 7 is required (for parameter set) to change configuration parameters in the device. Without the password you can only read the settings but not edit and transmit them to the device.

Special Settings

Most settings are self-explaining. 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 differential protection function **87 DIFF.PROTEC.** (address 112) as a main function of the device should always be ***Enabled***. This also applies to the supplementary functions of the differential protection such as breaker intertrip.

The external trip initiation (address 122 **DTT Direct Trip**) is a command that is initiated from an external device for tripping the local circuit breaker.

At address 126 **Back-Up O/C**, you can set the characteristic group which the time overcurrent protection uses for operation. In addition to the definite-time overcurrent protection an inverse-time overcurrent protection can be configured that either operates according to an IEC characteristic (***50(N) 51(N) IEC***) or to an ANSI characteristic (***50(N) 51(N)ANSI***). This selection is independent of whether the time overcurrent protection is intended to operate as emergency protection (only in case of protection communication failure) or as independent backup protection. Device versions equipped with directional overcurrent protection (MLFB position 14 = R or S) additionally provide a directional definite time overcurrent protection element and a directional inverse time overcurrent protection element. The characteristic curves of the two inverse time overcurrent protection elements are identical. The different characteristic curves are shown in the Technical Data (Section 4.6). You can also disable the time overcurrent protection (***Disabled***).

Set to ***Disabled***, the entire time overcurrent protection can be disabled.

For overload protection you can define in address 142 **49** whether the function is to be ***Enabled*** or ***Disabled***.

In address 139 you can set the breaker failure protection to ***Enabled*** or ***Disabled***. The setting option ***enabled w/ 3I0>*** subjects the ground current and the negative sequence current to a plausibility check.

If the device features an automatic reclosing function, address 133 and 134 are of importance. Automatic reclosure is only permitted for overhead lines. It must not be used in any other case. If the protected object consists of a combination of overhead lines and other equipment (e.g. overhead line in unit with a transformer or overhead line/cable), reclosing is only permissible if it is ensured that reclosing will only be performed in the event of a fault on the overhead line. If no automatic reclosing function is desired for the feeder at which 7SD80 operates, or if an external device is used for reclosure, set address 133 **79 Auto Recl.** to ***Disabled***. Or you can enter the number of desired reclosing attempts there. You can select ***1 AR-cycle*** or ***2 AR-cycles***.

The **AR control mode** at address 134 allows a maximum of four options. On the one hand, it can be determined whether the automatic reclosure cycles are carried out according to the fault type detected by the **pickup** of the starting protective function(s) or according to the type of **trip command**. On the other hand, the automatic reclosing function can be operated **with** or **without** action time.

The setting ***Trip ...*** (with trip command ..., default setting) allows you to specify different dead times for each automatic reclose cycle.

The setting ***Pickup ...*** (with pickup ...) allows you to enter different dead times for the automatic reclose cycles for 1-phase, 2-phase and 3-phase short circuits. The **pickup** status of the protection functions at the instant the trip command disappears is decisive here. This operating mode enables making the dead times dependent on the type of fault also for three-pole reclosure cycles. Tripping is always three-pole.

The setting ***... w/ Tact*** (with ... action time) provides an action time for each automatic reclose cycle. The action time is started by a general pickup of all protection functions. If there is no trip command yet when the action time has expired, the corresponding automatic reclosure cycle cannot be executed. Section 2.11 provides detailed information on this topic. For time graded protection this setting is recommended. If the protection function which is to operate with automatic reclosure does not have a general pickup signal for starting the action times, select ***... w/o Tact*** (without action time).

Address 137 **27/59** allows activating the voltage protection function with a variety of undervoltage and overvoltage protection elements.

For the trip circuit supervision enter the number of trip circuits to be monitored at address 140 **74 Trip Ct Supv**: ***1 trip circuit***, ***2 trip circuits*** or ***3 trip circuits***, unless you omit it (***Disabled***).

If the device is connected to voltage transformers, specify this condition in address 144 **V-TRANSFORMER**. The voltage-based functions, for instance the directional overcurrent protection elements, the ground fault differential protection in resonant-grounded/isolated systems or determination of the voltage-based measured values, can only be activated if voltage transformers are connected.

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. The flexible function can be configured in DIGSI at „ Settings“, „Additional Functions“ and „Settings“. The routing is done, as usual, under „Settings“ and „Masking I/O“. If you want to use the flexible protection function, the device must be connected to voltage transformers.

2.1.1.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
103	Grp Chge OPTION	Disabled Enabled	Disabled	Setting Group Change Option
112	87 DIFF.PROTEC.	Enabled Disabled	Enabled	87 Differential protection
122	DTT Direct Trip	Disabled Enabled	Disabled	DTT Direct Transfer Trip
124	50HS SOTF	Disabled Enabled	Disabled	50HS Instantaneous SOTF
126	Back-Up O/C	Disabled 50(N) 51(N) IEC 50(N) 51(N) ANSI 50(N) 67(N) IEC 50(N) 67(N) ANSI	50(N) 51(N) IEC	Backup overcurrent
133	79 Auto Recl.	Disabled 1 AR-cycle 2 AR-cycles	Disabled	79 Auto-Reclose Function
134	AR control mode	PU w/ActionTime PU w/o ActionT. Trip w/ActionT. Trip w/oActionT	Trip w/ActionT.	Auto-Reclose control mode
136	81 O/U	Disabled Enabled	Disabled	81 Over/Underfrequency Protec-tion
137	27/59	Disabled Enabled	Disabled	27, 59 Under/Overvoltage Protec-tion
139	50BF	Disabled Enabled enabled w/ 3I0>	Disabled	50BF Breaker Failure Protection
140	74 Trip Ct Supv	Disabled 1 trip circuit 2 trip circuits 3 trip circuits	Disabled	74TC Trip Circuit Supervision
142	49	Disabled Enabled	Disabled	49 Thermal Overload Protection
144	V-TRANSFORMER	Not connected connected ONLY VN	connected	Voltage transformers

Addr.	Parameter	Setting Options	Default Setting	Comments
617	ServiProt (CM)	Disabled T103 DIGSI TIME SYNCH	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

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 Description

Command-dependent Messages "No Trip – No Flag"

The indication of messages masked to local LEDs and the generation of additional messages can be made dependent on whether the device has issued a trip signal. This information is then not output if during a system disturbance one or more protection functions have picked up but no tripping by the 7SD80 resulted because the fault was cleared by a different device (e.g. on another line). These messages are then limited to faults in the line to be protected.

The following figure illustrates the creation of the reset command for stored messages. By the moment of the device dropout, the presetting of the parameter610 **FltDisp.LED/LCD** decides, whether the new fault will be stored or reset.

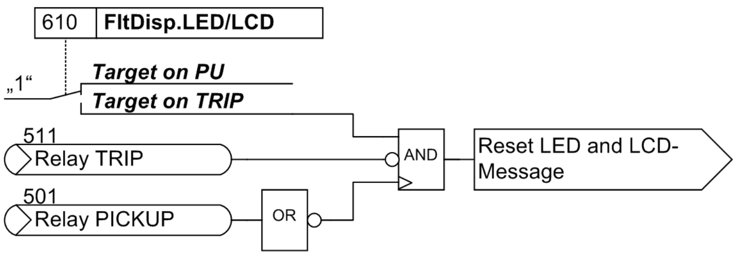


Figure 2-1 Creation of the reset command for the latched LED and LCD messages

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 Display

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

Use parameter 615 **Spont. FltDisp.** to specify whether or not a spontaneous fault message should appear automatically on the display (***YES***) or not (***NO***).

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 parameter 640 **Start image DD**. The pages available for each device version are listed in the Appendix A.5.

Protection Interface Test Mode

To check the communication quality of the two 7SD80 devices during commissioning, set parameter 650 **PDI Test Mode** to ***ON***. The availability of the communication link via the protection interface is displayed as a statistical value (see Section 2.17.2).

2.1.2.3 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under "Display Additional 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
615	Spont. FltDisp.	NO YES	NO	Spontaneous display of flt.annunciations
625A	T MIN LED HOLD	0 .. 60 min; ∞	0 min	Minimum hold time of latched LEDs
640	Start image DD	image 1 image 2 image 3 image 4 image 5 image 6 image 7 image 8	image 1	Start image Default Display
650	PDI Test Mode	OFF ON	OFF	PDI Test Mode

2.1.2.4 Information List

No.	Information	Type of Information	Comments
-	Test mode	IntSP	Test mode
-	DataStop	IntSP	Stop data transmission
-	UnlockDT	IntSP	Unlock data transmission via BI
-	Reset LED	IntSP	Reset LED
-	SynchClock	IntSP_Ev	Clock Synchronization
-	>Light on	SP	>Back Light on
-	HWTestMod	IntSP	Hardware Test Mode
-	Error FMS1	OUT	Error FMS FO 1
-	Error FMS2	OUT	Error FMS FO 2
-	Distur.CFC	OUT	Disturbance CFC
-	Brk OPENED	IntSP	Breaker OPENED
-	Feeder gnd	IntSP	Feeder GROUNDED
1	Not configured	SP	No Function configured
2	Non Existent	OUT	Function Not Available
3	>Time Synch	SP	>Synchronize Internal Real Time Clock
5	>Reset LED	SP	>Reset LED
11	>Annunc. 1	SP	>User defined annunciation 1
12	>Annunc. 2	SP	>User defined annunciation 2
13	>Annunc. 3	SP	>User defined annunciation 3
14	>Annunc. 4	SP	>User defined annunciation 4
15	>Test mode	SP	>Test mode
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
60	Reset LED	OUT_Ev	Reset LED
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
126	ProtON/OFF	IntSP	Protection ON/OFF (via system port)
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
181	Error A/D-conv.	OUT	Error: A/D converter
182	Alarm Clock	OUT	Alarm: Real Time Clock
183	Error Board 1	OUT	Error Board 1

No.	Information	Type of Information	Comments
184	Error Board 2	OUT	Error Board 2
185	Error Board 3	OUT	Error Board 3
186	Error Board 4	OUT	Error Board 4
187	Error Board 5	OUT	Error Board 5
190	Error Board 0	OUT	Error Board 0
191	Error Offset	OUT	Error: Offset
193	Alarm adjustm.	OUT	Alarm: Analog input adjustment invalid
194	Error neutralCT	OUT	Error: Neutral CT different from MLFB
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
2054	Emer. mode	OUT	Emergency mode
32200	PDITestFOon/OFF	IntSP	PDI Test Mode FO ON/OFF
32201	PDITestCuon/OFF	IntSP	PDI Test Mode Cu ON/OFF
32202	PDI Test Mode	OUT	PDI Test Mode
32203	PDI Test remote	OUT	PDI Test Mode remote
32224	PDI FO: AGING	OUT	PDI FO: aging (distance damping high)
32225	PDI Cu: AGING	OUT	PDI Cu: aging (distance damping high)

2.1.3 General Power System Data (Power System Data 1)

The device requires certain data regarding the network and substation so that it can adapt its functions to this data depending on the application. The data required include for instance rated data of the substation and the measuring transformers, polarity and connection of the measured quantities, if necessary features of the circuit breakers, and others. Furthermore, there are several function parameters associated with several functions rather than one specific protection, control or monitoring function. The Power System Data 1 can generally only be changed from a PC running DIGSI and are discussed in this section.

2.1.3.1 Setting Notes

Polarity of Current Transformers

In address 201 **CT Starpoint** the polarity of the current transformers must be entered, in other words, the location of the CT starpoint (Figure 2-2). The setting defines the measuring direction of the device (current in line direction is defined as positive at both line ends). The reversal of this parameter also reverses the polarity of the ground current input I_N.

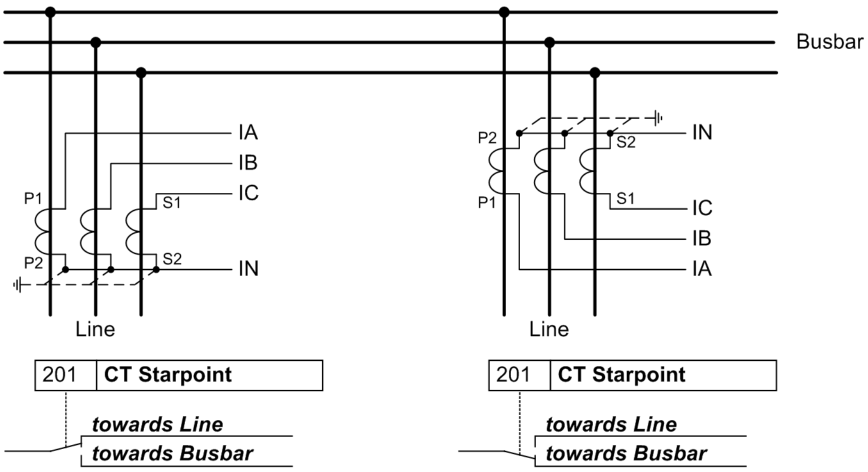


Figure 2-2 Polarity of current transformers

Nominal Values of Transformers

In addresses 203 **Vnom PRIMARY** and 204 **Vnom SECONDARY** the device obtains information on the primary and secondary rated voltage (phase-to-phase voltage) of the voltage transformers.

The voltage connection is required for all functions that work on the basis of power or voltage values, e.g. ground fault differential protection in resonant-grounded/isolated systems, directional overcurrent protection, voltage protection, frequency protection, and to display and record the voltages.

Please make sure that the rated secondary transformer current matches the rated current of the device.

Correct entry of the primary data is a prerequisite for the correct computation of operational measured values with primary magnitude. If the settings of the device are performed with primary values using DIGSI, these primary data are an indispensable requirement for the correct function of the device.

Current Connection

The device features four current measurement inputs, three of which are connected to the set of current transformers. Various possibilities exist for the fourth current input I_4:

- Connection of the I_4 input to the ground current in the neutral point of the set of current transformers on the protected feeder (normal connection, see Appendix, A.3a):

  Address 220 is then set to: **I4 transformer** = ***In prot. line*** and address 221 **I4/Iph CT** = **1**.

- Connection of the I_4 input to a separate ground current transformer on the protected line (e.g. a summation CT or core balance CT, see Appendix, A.3):

  Address 220 is then set to: **I4 transformer** = ***In prot. line*** and address 221 **I4/Iph CT** is set:

$$I_4 / I_{ph\ CT} = \frac{\text{Ratio of ground current transformer}}{\text{Ratio of phase current transformers}}$$

Example:

Phase current transformers 500 A/5 A

Core balance CT 300 A / 5AI4/IphCT = 300/500 = 0.6

$$I_4 / I_{ph\ CT} = \frac{60/1}{500/5} = 0.600$$

- Connecting the I_4 input to the starpoint current of a transformer; this is used for the ground fault differential protection:

  Address 220 is then set to: **I4 transformer** = and address 221**I4/Iph CT** depends on the transformation ratio of the starpoint transformer to the transformer set of the protected line.

- If the input I_4 is not required, set:

  Address 220 **I4 transformer** = ***Not connected***,

  Address 221 **I4/Iph CT** is then irrelevant.

  In this case, the neutral current is calculated by summing the phase currents.

Rated Frequency

The rated frequency of the system is set at address 230 **Rated Frequency**. The factory setting of the model variant must only be changed if the device is to be used for a purpose other than intended when ordering. You can set ***50 Hz*** or ***60 Hz***.

System Starpoint

The manner in which the system neutral point is grounded must be considered for the correct processing of ground faults and double ground faults. Accordingly, set address 207 **SystemStarpoint** = ***Grounded***, ***Peterson-C.Gnd.*** or ***Isolated***. For low-resistance or high-resistance („impedance grounded“) systems, set ***Grounded***.

Depending on the setting of this parameter, the ground fault differential protection uses either the measured ground current (***Grounded***) or the values calculated from the power values (***Peterson-C.Gnd.*** or ***Isolated***).

Command Duration

In address 240 the minimum trip command duration **TMin TRIP CMD** is set. It applies to all protection and control functions that can initiate a trip command. It also determines the duration of the trip pulse when a circuit-breaker trip test is initiated via the device. This parameter can only be set in DIGSI at **Display Additional Settings**.

In address 241 the maximum close command duration **TMax CLOSE CMD** is set. This applies to all close commands issued by the device. It also determines the length of the close command pulse when a circuit-breaker test cycle is issued via the device. It must be 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 that another trip is initiated by a protection function. This parameter can only be set in DIGSI at **Display Additional Settings**.

Circuit-Breaker Test

7SD80 allows a circuit-breaker test during operation using a trip-and-close command entered on the front panel or from DIGSI. The duration of the trip command is set as explained above. Address 242 **T-CBtest-dead** determines the duration from the end of the trip command until the start of the close command for this test. It should not be less than 0.1 s.

Pickup Thresholds of the Binary Inputs (BI Thresholds)

At address 260 **Threshold BI 1** to 266 **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 here.

2.1.3.2 Settings

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

Addr.	Parameter	Setting Options	Default Setting	Comments
201	CT Starpoint	towards Line towards Busbar	towards Line	CT Starpoint
203	Vnom PRIMARY	0.4 .. 500.0 kV	10.0 kV	Rated Primary Voltage
204	Vnom SECONDARY	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
205	CT PRIMARY	10 .. 20000 A	400 A	CT Rated Primary Current
206	CT SECONDARY	1A 5A	1A	CT Rated Secondary Current
207	SystemStarpoint	Grounded Peterson-C.Gnd. Isolated	Grounded	System Starpoint is
220	I4 transformer	Not connected In prot. line	In prot. line	I4 current transformer is
221	I4/Iph CT	0.010 .. 5.000	1.000	Matching ratio I4/Iph for CT's
230	Rated Frequency	50 Hz 60 Hz	50 Hz	Rated Frequency
240A	TMin TRIP CMD	0.02 .. 30.00 sec	0.10 sec	Minimum TRIP Command Duration
241A	TMax CLOSE CMD	0.01 .. 30.00 sec	1.00 sec	Maximum Close Command Duration
242	T-CBtest-dead	0.00 .. 30.00 sec	0.10 sec	Dead Time for CB test-autoreclosure
260	Threshold BI 1	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 1
261	Threshold BI 2	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 2
262	Threshold BI 3	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 3
263	Threshold BI 4	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 4
264	Threshold BI 5	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 5
265	Threshold BI 6	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 6
266	Threshold BI 7	Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 7

2.1.4 Oscillographic Fault Records

The 7SD80 multifunctional protection with control is equipped with a fault record memory. The instantaneous values of the measured values

i_A, i_B, i_C, i_N, i_{Ns} and v_A, v_B, v_C, $3I0_{diff}$, $3I0_{rest}$

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

2.1.4.1 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 tipping.

Note

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

2.1.4.2 Setting Notes

Specifications

The actual storage time encompasses the pre-fault time **PRE. TRIG. TIME** (address 411) ahead of the reference instant, the normal recording time and the post-fault time **POST REC. TIME** (address 412) after the storage criterion has reset. The maximum storage time for each fault recording (**MAX. LENGTH**) is entered in address 410. Recording per fault must not exceed 5 seconds. A total of 8 records can be saved. However, the total length of time of all fault records in the buffer must not exceed 25 seconds.

2.1.4.3 Settings

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

Addr.	Parameter	Setting Options	Default Setting	Comments
402A	WAVEFORMTRIGGE R	Save w. Pickup Save w. TRIP Start w. TRIP	Save w. Pickup	Waveform Capture
403A	WAVEFORM DATA	Fault event Pow.Sys.Flt.	Fault event	Scope of Waveform Data
410	MAX. LENGTH	0.30 .. 5.00 sec	2.00 sec	Max. length of a Waveform Capture Record
411	PRE. TRIG. TIME	0.05 .. 0.50 sec	0.25 sec	Captured Waveform Prior to Trigger
412	POST REC. TIME	0.05 .. 0.50 sec	0.10 sec	Captured Waveform after Event
415	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 In-formation	Comments
-	FltRecSta	IntSP	Fault Recording Start
4	>Trig.Wave.Cap.	SP	>Trigger Waveform Capture
30053	Fault rec. run.	OUT	Fault recording is running

2.1.5 Change Group

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

2.1.5.1 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). In 7SD80 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.

Subsection 3.1 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
301	ACTIVE GROUP	Group A Group B Group C Group D	Group A	Active Setting Group is
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 General Protection Data (Power System Data 2)

The general protection data (**P.System Data 2**) include settings associated with all functions rather than a specific protection, monitoring or control function. In contrast to the **P.System Data 1** as discussed before, they can be changed over with the setting groups and set on the operator panel of the device.

2.1.6.1 Setting Notes

Rated Values of Protected Lines

With address 1103 **FullScaleVolt.** you inform the device of the primary nominal voltage (phase-to-phase) of the equipment to be protected (if voltages are applied). This setting influences the displays of the operational measured values in %.

The primary nominal current (address 1104 **FullScaleCurr.**) is that of the protected object. For cables the thermal continuous current-loading capacity can be selected. For overhead lines the rated current is usually not defined. set the rated current of the current transformers (as set in address 205 **CT PRIMARY**, Section 2.1.3.1). If the current transformers have different nominal currents at the ends of the protected object, set the highest nominal current value for all ends.

This setting will not only have an impact on the indication of the operational measured values in per cent, but **must also be exactly the same for each end of the protected object**, since it is the basis for the current comparison at the ends.

General Line Data

The directional values (power, power factor, work and based on work: minimum, maximum, average and threshold values), calculated in the operational measured values, are usually defined positive in direction to the protected object. This requires that the connection polarity for the entire device is configured accordingly in the **P.System Data 1** (compare also „Polarity of the Current Transformers“, address 201). But it is also possible to define the „forward“ direction for the protection functions and the positive direction for the power etc. differently, e.g. so that the active power flow (from the line to the busbar) is indicated in the positive sense. To do so, set address 1107 **P,Q sign** to ***reversed***. If the setting is ***not reversed*** (default), the positive direction for the power etc. corresponds to the „forward“ direction for the protection functions.

Circuit-Breaker Status

Information regarding the circuit-breaker position is required by various protection and supplementary functions to ensure their optimal functionality. The device has a circuit-breaker status recognition which processes the status of the circuit-breaker auxiliary contacts and contains also a detection based on the measured currents and voltages (see also Section 2.16).

In address 1130 the residual current **PoleOpenCurrent** is set, which will definitely not be exceeded when the circuit-breaker pole is open. If parasitic currents (e.g. through induction) can be excluded when the circuit breaker is open, this setting may be very sensitive. Otherwise this setting must be increased. Usually the presetting is sufficient. This parameter can only be set in DIGSI at **Display Additional Settings**.

The seal-in time **SI Time all Cl.** (address 1132) determines the period of time during which the active protection functions are enabled following each energization of the line. This time is started when the internal switching detection function recognizes closing of the circuit breaker or if the circuit-breaker auxiliary contacts or a binary device input signal that the circuit breaker was closed. The time must therefore be longer than the command time of these protection functions plus a safety margin. This parameter can only be set in DIGSI at **Display Additional Settings**.

In address 1134 **Line Closure** the criteria for the internal recognition of line energization are determined. ***Only with ManCI*** means that only the manual close signal via binary input or the integrated control is evaluated as closure. ***I OR V or ManCl*** means that additionally the measured currents or voltages are used to determine closure of the circuit breaker, whereas ***52a OR I or M/C*** implies that either the currents or the states of the circuit-breaker auxiliary contacts are used to determine closure of the circuit breaker. If the voltage transformers are not arranged on the line side, the setting ***52a OR I or M/C*** must be used. In the case of ***I or Man.Close*** only the currents or the manual close signals are used to recognize closing of the circuit breaker.

Before each closing detection, the circuit breaker must be recognized as being open for the settable time 1133 **T DELAY SOTF**.

Address 1135 **Reset Trip CMD** determines under which conditions a trip command is reset. If ***CurrentOpenPole*** is set, the trip command is reset as soon as the current disappears. It is important that the value set in address 1130 **PoleOpenCurrent**(see above) is undershot. If ***Current AND 52a*** is set, the circuit-breaker auxiliary contact must send a message that the circuit breaker is open. It is a prerequisite for this setting that the position of the auxiliary contacts is allocated via a binary input.

For special applications, in which the device trip command does not always lead to a complete cutoff of the current, the setting ***Pickup Reset*** can be chosen. In this case, the trip command is reset as soon as the pickup of the tripping protection function drops off and - just as with the other setting options- the minimum trip command duration (address 240) has elapsed. The setting ***Pickup Reset*** makes sense, for instance, during the test of the protection equipment, when the system-side load current cannot be cut off and the test current is injected in parallel to the load current.

While the time **SI Time all Cl.** (address 1132, see above) is activated following each recognition of line energization, **SI Time Man.Cl** (address 1150) defines the time following manual closure during which special influence on the protection functions is activated. This parameter can only be set in DIGSI at **Display Additional Settings**.

Note

For CB Test and automatic reclosure the CB auxiliary contact status derived with the binary inputs >CB1 ... No. 371, 410 and 411) are relevant for the circuit-breaker test and for automatic reclosure to be able to indicate the circuit-breaker position. The other binary inputs >CB ... (no. 379 and 380) are used to detect the status of the line (address 1134) and to reset the trip command (address 1135). Address 1135 is also used by other protection functions, e.g. switching on overcurrent. For applications with 2 circuit breakers per feeder (1.5 circuit-breaker systems or ring bus), the binary inputs >CB1... must be connected to the correct circuit breaker. The binary inputs >CB... then need the correct signals for detecting the circuit-breaker status. In certain cases, an additional CFC logic may be necessary.

For commands via the integrated control (local control, DIGSI, serial interface) address 1152 **Man.Clos. Imp.** determines whether a close command via the integrated control function should be treated by the protection regarding the MANUAL CLOSE (like instantaneous re-opening when switching onto a fault). This address also informs the device to which switchgear this applies. You can select from the switching devices which are available to the integrated control. Select the circuit breaker which operates for manual closure and, if required, for automatic reclosure (usually Q0). If ***none*** is set here, a CLOSE command via the control will not generate a MANUAL CLOSE impulse for the protection function.

2.1.6.2 Settings

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

The table indicates region-specific default settings. Column C (configuration) indicates the corresponding secondary nominal current of the current transformer.

Addr.	Parameter	C	Setting Options	Default Setting	Comments
1103	FullScaleVolt.		0.4 .. 500.0 kV	10.0 kV	Measurem:FullScaleVoltage(Equipm.rating)
1104	FullScaleCurr.		10 .. 20000 A	400 A	Measurem:FullScaleCurrent(Equipm.rating)
1107	P,Q sign		not reversed reversed	not reversed	P,Q operational measured values sign
1130A	PoleOpenCurrent	1A	0.05 .. 1.00 A	0.10 A	Pole Open Current Threshold
		5A	0.25 .. 5.00 A	0.50 A	
1131A	PoleOpenVoltage		2 .. 70 V	30 V	Pole Open Voltage Threshold
1132A	SI Time all Cl.		0.01 .. 30.00 sec	0.10 sec	Seal-in Time after ALL closures
1133A	T DELAY SOTF		0.05 .. 30.00 sec	0.25 sec	minimal time for line open before SOTF
1134	Line Closure		only with ManCl I OR V or ManCl 52a OR I or M/C I or Man.Close	only with ManCl	Recognition of Line Closures with
1135	Reset Trip CMD		CurrentOpenPole Current AND 52a Pickup Reset	CurrentOpenPole	RESET of Trip Command
1150A	SI Time Man.Cl		0.01 .. 30.00 sec	0.30 sec	Seal-in Time after MANUAL closures
1152	Man.Clos. Imp.		(Setting options depend on configuration)	None	MANUAL Closure Impulse after CONTROL

2.1.6.3 Information List

No.	Information	Type of Information	Comments
301	Pow.Sys.Flt.	OUT	Power System fault
302	Fault Event	OUT	Fault Event
356	>Manual Close	SP	>Manual close signal
357	>Blk Man. Close	SP	>Block manual close cmd. from external
361	>FAIL:Feeder VT	SP	>Failure: Feeder VT (MCB tripped)
371	>Bkr1 Ready	SP	>Breaker 1 READY (for AR,CB-Test)
378	>52 faulty	SP	>52 Breaker faulty (for 50BF)
379	>52a 3p Closed	SP	>52a Bkr. aux. contact (3pole closed)
380	>52b 3p Open	SP	>52b Bkr. aux. contact (3pole open)
383	>Enable ARzones	SP	>Enable all AR Zones / Elements
385	>Lockout SET	SP	>Lockout SET
386	>Lockout RESET	SP	>Lockout RESET
410	>52a Bkr1 3p Cl	SP	>52a Bkr1 aux. 3pClosed (for AR,CB-Test)
411	>52b Bkr1 3p Op	SP	>52b Bkr1 aux. 3p Open (for AR,CB-Test)
501	Relay PICKUP	OUT	Relay PICKUP
502	Relay Drop Out	OUT	Relay Drop Out
503	Relay PICKUP ØA	OUT	Relay PICKUP Phase A
504	Relay PICKUP ØB	OUT	Relay PICKUP Phase B
505	Relay PICKUP ØC	OUT	Relay PICKUP Phase C
506	Relay PICKUP G	OUT	Relay PICKUP GROUND
510	Relay CLOSE	OUT	Relay GENERAL CLOSE command
511	Relay TRIP	OUT	Relay GENERAL TRIP command
530	LOCKOUT	IntSP	LOCKOUT is active
533	Ia =	VI	Primary fault current Ia
534	Ib =	VI	Primary fault current Ib
535	Ic =	VI	Primary fault current Ic
536	Definitive TRIP	OUT	Relay Definitive TRIP
545	PU Time	VI	Time from Pickup to drop out
546	TRIP Time	VI	Time from Pickup to TRIP
561	Man.Clos.Detect	OUT	Manual close signal detected
562	Man.Close Cmd	OUT	CB CLOSE command for manual closing
563	CB Alarm Supp	OUT	CB alarm suppressed
590	Line closure	OUT	Line closure detected

2.1.7 EN100-Module 1

2.1.7.1 Description

The EN100-Module 1 enables integration of the 7SD80 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 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)

2.1.8 Protection Interface

2.1.8.1 Description

General

For a layout of lines with two ends, you need one protection interface for each device. Depending on the ordering code, the device features a protection interface via optical fiber (Prot FO) and/or a protection interface via copper connection (Prot Cu). To connect Prot Cu, use the voltage terminals D1 and D2.

The input of the protection interface Prot Cu has an insulated design. The integrated overvoltage protection reduces the insulation strength. Use an external isolating transformer to increase the insulation strength. The ordering data can be found in Section A.1 under Accessories.

If the device has 2 protection interfaces, the data are preferably exchanged with the device at the other end of the protected object via the FO protection interface. If the optical fiber link fails, the device automatically switches to the Cu protection interface. When the optical fiber link is restored, the FO protection interface automatically resumes communication.

If you want to have the communication link monitored, you have to define the minimum reception level, the maximum permissible fault rate and monitoring times for each device during parameterization. The device's role within the communication line, i.e. whether it operates as master or slave, is defined in the differential protection topology. For further information, please refer to 2.2.1.

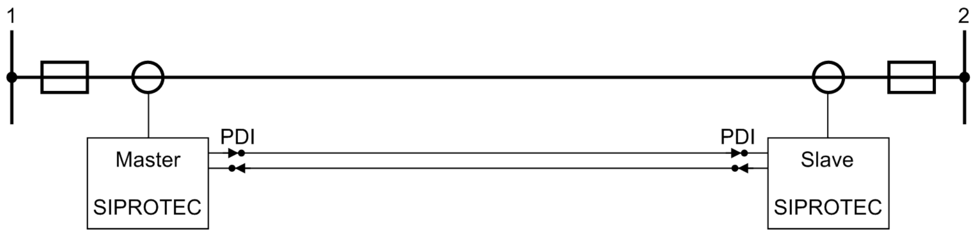


Figure 2-3 Connecting 2 7SD80 devices via protection data interfaces

Communication Failure

The communication is continuously monitored by the devices. Single faulty data telegrams are not a direct risk if they occur only occasionally. They are recognized and counted in the device which detects the disturbance and can be read out as statistical information.

If several faulty or no telegrams are received, this is considered a communication **disturbance**. A corresponding indication is issued.

2.1.8.2 Setting Notes

General

The protection interfaces connect the devices via optical fiber or copper cables. The communication is permanently monitored by the devices. Address 4510 **TD-DATA DISTURB** defines after which time delay the user is informed about a faulty or missing telegram.

Once a fault has been detected in the protection interface communication, the time at address 4512 **Td ResetRemote** is started for resetting the remote signals. Please note that only the time of the device whose remote end has failed is effective.

Protection Interface Optical Fiber

If you use an optical fiber connection, switch it ***ON*** or ***OFF*** at address 4501 **PDI FO**.

Address 4502 **PDI FO TER** allows you to enter the permissible maximum fault rate in percent.

At address 4503 **PDI FO level** you can define the minimum receiving level.

Notes on the settings are given in the Technical Data.

Protection Interface Copper Cable Cu

If you use a copper cable connected to the voltage terminals of the device, switch it ***ON*** or ***OFF*** at address 4601 **PDI Cu**.

Address 4602 **PDI Cu TER** allows you to enter the permissible maximum fault rate in percent.

At address 4604 **PDI Cu MAX ATT** you can set the maximum attenuation.

At address 4605 **PDI Cu S/N** you can define the minimum signal/noise ratio.

At address 4603 **PDI Cu mode** you can specify the transmission parameters.

Notes on the settings are given in the Technical Data.

2.1.8.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
4501	PDI FO	ON OFF	ON	Protection Data Interface fiber optic
4502	PDI FO TER	0.5 .. 20.0 %	1.0 %	PDI FO max. telegram error rate
4503	PDI FO level	-30 .. -10 dBm	-28 dBm	PDI FO min. receive level
4510	TD-DATA DISTURB	0.05 .. 2.00 sec	0.10 sec	Time delay for data disturbance alarm
4512	Td ResetRemote	0.00 .. 300.00 sec; ∞	0.00 sec	Remote signal RESET DELAY for comm.fail
4601	PDI Cu	ON OFF	ON	Protection Data Interface copper
4602	PDI Cu TER	0.5 .. 20.0 %	1.0 %	PDI Cu max. telegram error rate
4603	PDI Cu mode	01 02 03 04 05 06	01	PDI Cu operation mode
4604	PDI Cu MAX ATT	0 .. 46 dB	46 dB	PDI Cu maximum attenuation
4605	PDI Cu S/N	6 .. 30 dB	6 dB	PDI Cu min signal to noise ratio

2.1.8.4 Information List

No.	Information	Type of Information	Comments
3217	PDI FO mirror	OUT	PDI FO data mirror
3218	PDI Cu mirror	OUT	PDI Cu data mirror
3227	>PDI FO stop	SP	>PDI FO is stopped
3228	>PDI Cu stop	SP	>PDI Cu is stopped
3230	PDI FO faulty	OUT	PDI FO failure
3232	PDI Cu faulty	OUT	PDI Cu failure
3243	PDI FO con. to.	VI	PDI FO connected to relay ID
3244	PDI Cu con. to.	VI	PDI Cu connected to relay ID
3258	PDI FO TER	OUT	PDI FO telegram error rate exceeded
3259	PDI Cu TER	OUT	PDI Cu telegram error rate exceeded
32227	PDI-FO RQ LOW	OUT	PDI-FO receive level to low
32228	PDI-Cu ATT HIGH	OUT	PDI-FO attenuation to high
32229	PDI-Cu S/N LOW	OUT	PDI-FO signal to noise ratio to low

2.2 Phase Comparison Protection and Ground Differential Protection

The differential protection can be used in solid or resistive grounded, isolated and resonant-grounded systems.

It comprises a phase comparison protection and a ground differential protection. The sensitive ground element operates directionally or non-directionally.

The following chapter describes the functions

- Differential protection topology
- Phase comparison protection
- Ground current differential protection in grounded systems
- Ground fault differential protection in resonant-grounded/isolated systems
- Differential protection test and commissioning

2.2.1 Differential Topology

The devices at both ends of the protected object communicate over their protection interfaces with one device acting as master, the other as slave.

The device configured as master can perform the time synchronization for both devices.

2.2.1.1 Setting Notes

Protection Data Topology

At address 4701 **ID OF MASTER** and 4702 **ID OF SLAVE** you can enter the device identification number of the two protection devices at the line ends.

Use address 4710 **LOCAL RELAY** to define which of the two devices acts as master and which as slave.

If you want the master to perform the time synchronization for both devices, please observe for which of the two device a stable time signal is available.

2.2.1.2 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
4701	ID OF MASTER	1 .. 65534	1	Identification number of Master
4702	ID OF SLAVE	1 .. 65534	2	Identification number of Slave
4710	LOCAL RELAY	Master Slave	Master	Local relay is

2.2.1.3 Information List

No.	Information	Type of Information	Comments
3491	Master Login	OUT	Master in Login state
3492	Slave Login	OUT	Slave in Login state

2.2.2 Phase Comparison Protection

2.2.2.1 Description

General

The phase comparison protection evaluates the phase currents at both ends of the protected object. The two 7SD80 devices at the ends of the protected object communicate over their protection interfaces. The phase-specific comparison and the resulting decision to trip the circuit breaker is made separately for each end.

The digitalized currents are first filtered to suppress DC components and higher harmonics.

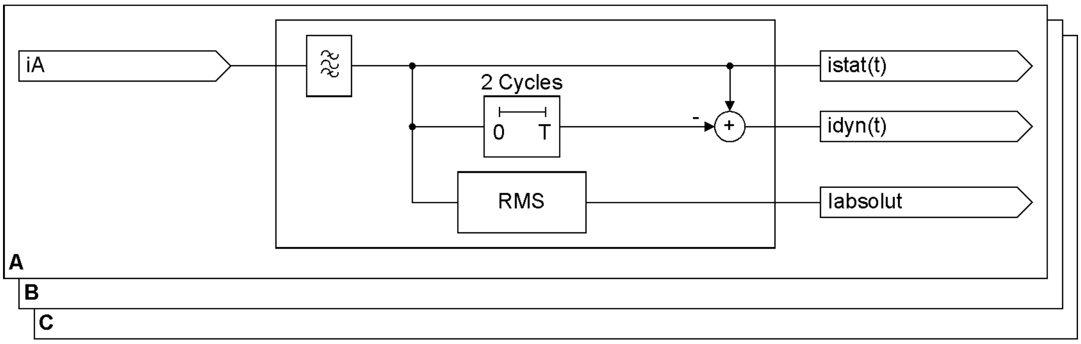


Figure 2-4 Phase comparison protection, determination of the input variables

These filtered values are available to a sensitive dynamic element and a static element. By comparing the polarity of the currents at the two ends of the protected object, they recognize whether the fault is external or internal. An internal fault applies if the polarity of the fault currents is identical on both sides; an internal fault or a load step occurs with different polarities.

If the comparison shows without any doubt that a fault is present, the trip command is sent. It is maintained over a set minimum command duration.

The phase comparison protection may trip only at one end in case of single-end infeed. The non-feeding end can also be switched off by means of a transfer trip signal.

Element Idyn

The dynamic filter algorithm generates the value idyn(t). It represents the current change of the filtered value (fundamental component) over two cycles. If the current change exceeds the set threshold **87L Idyn>**, the phase comparison protection is started.

The polarity of the current change is transmitted to the device at the remote end of the protected object.

The dynamic element operates very sensitively in case of internal faults. In case of external faults, the method is very stable even during different primary rated currents or different saturation of the current transformers at the two ends.

Element Istat

The static element **Istat** operates directly with the filtered fundamental value. If the amplitude of the fundamental component exceeds the set threshold **87L Isteady>**, the phase comparison protection is started.

The polarity of the current is transmitted to the device at the remote end of the protected object.

The static element is insensitive towards low fault currents.

Pickup Logic

The dynamic and the static element pick up independently of each other selectively for each phase.

To prevent tripping during an energization, a separate dynamic switch-on threshold **`87L Idyn close>`** is used.

The pickup is maintained over 2 measuring cycles. After the 2 measuring cycles have expired, the dynamic sign comparison is blocked.

If the pickup is successful, an internal pickup signal is transmitted to the other device.

The element Idyn is blocked if the frequency deviates by more than 10 % from the rated frequency.

The function is blocked if the communication between the two devices at the ends of the protected object fails for more than two measuring cycles.

This function can also be blocked via binary input „`>87L block`“.

The following figure shows the formation of the phase-specific pickup of the elements **`87L Isteady>`** and **`87L Idyn>`**.

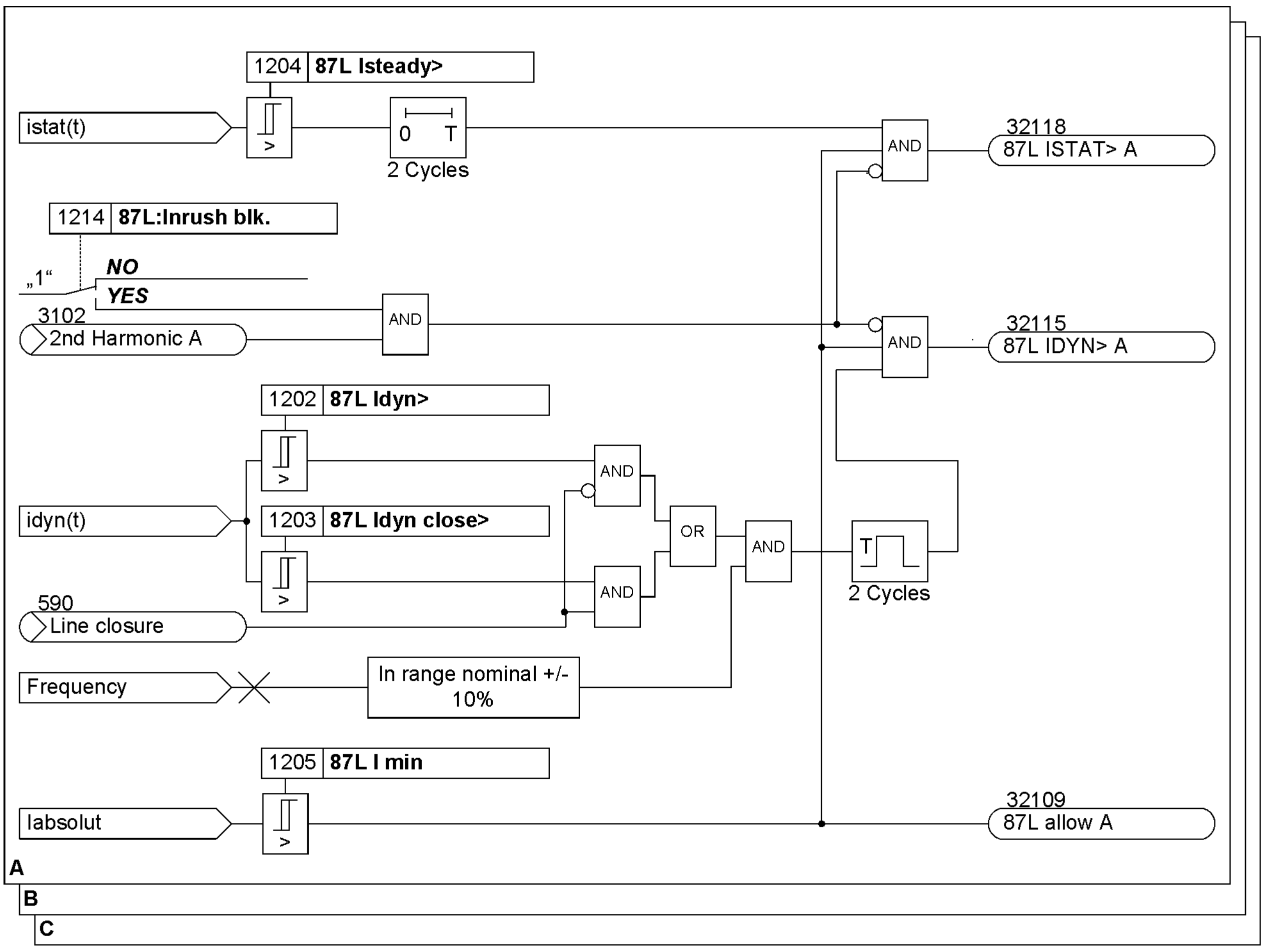


Figure 2-5 Logic diagram of the phase comparison protection, phase-selective generation of the Istat and Idyn signal

The pickup signals created locally, signs of idyn and istat and the blocking information are sent to the device at the opposite end.

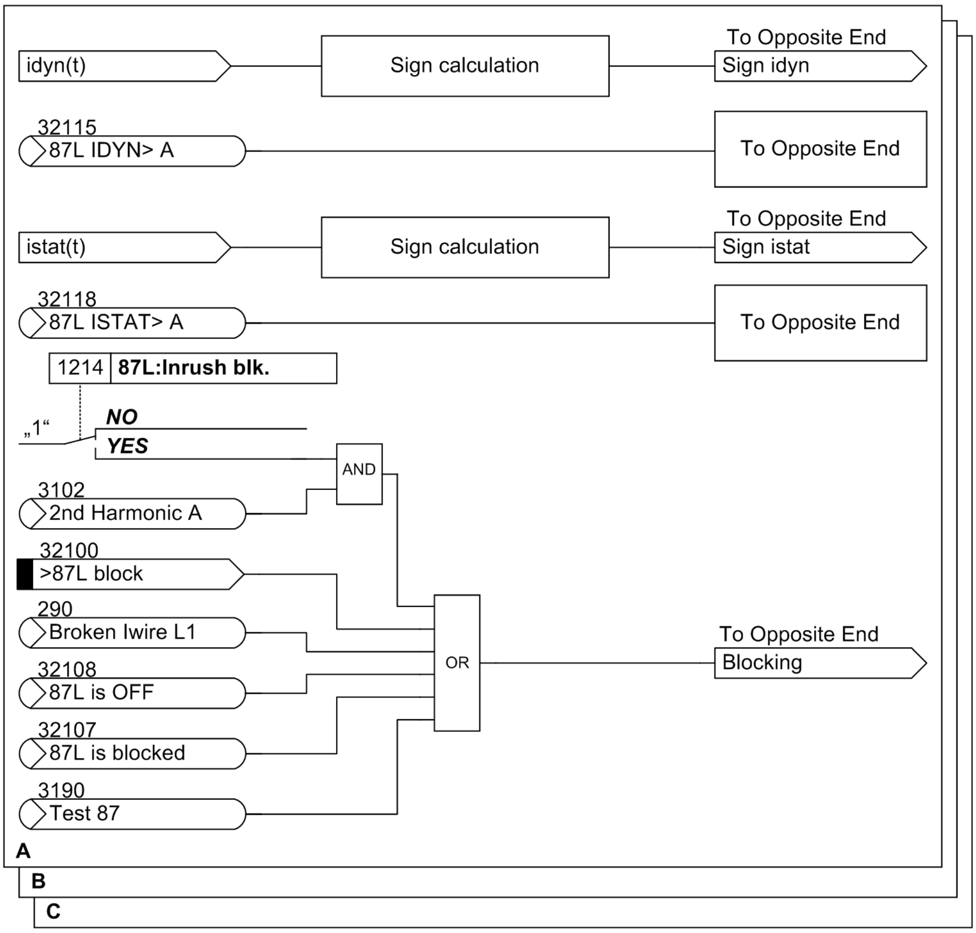


Figure 2-6 Phase comparison protection, sending the differential protection information to the opposite end

The received pickup and blocking information is compared with the own differential protection information and element-specific pickup indications are created.

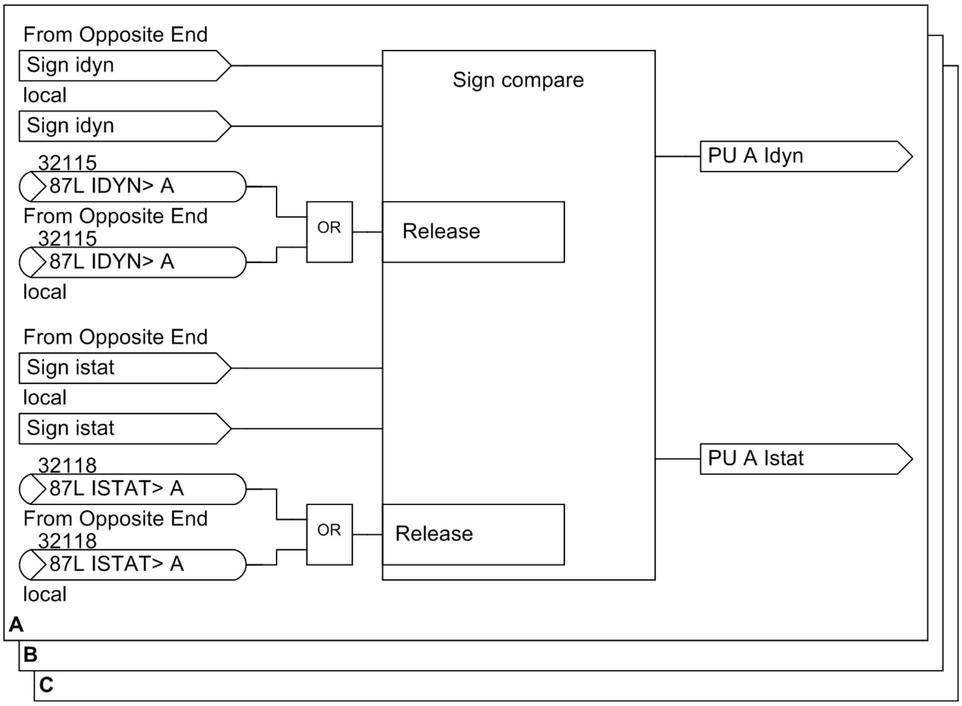


Figure 2-7 Phase comparison protection, receiving the differential protection information from the opposite end

The following figure shows the formation of the phase-specific pickup of the phase comparison protection.

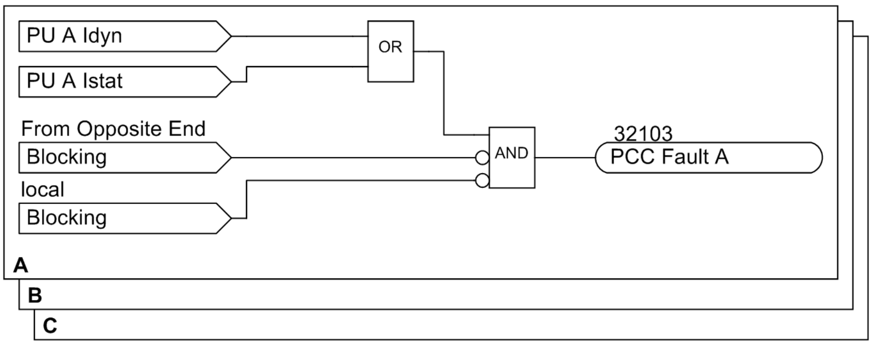


Figure 2-8 Logic diagram of phase comparison protection for pickup in a grounded system

The following figure shows the pickup behavior of the phase comparison protection in resonant-grounded or isolated systems.

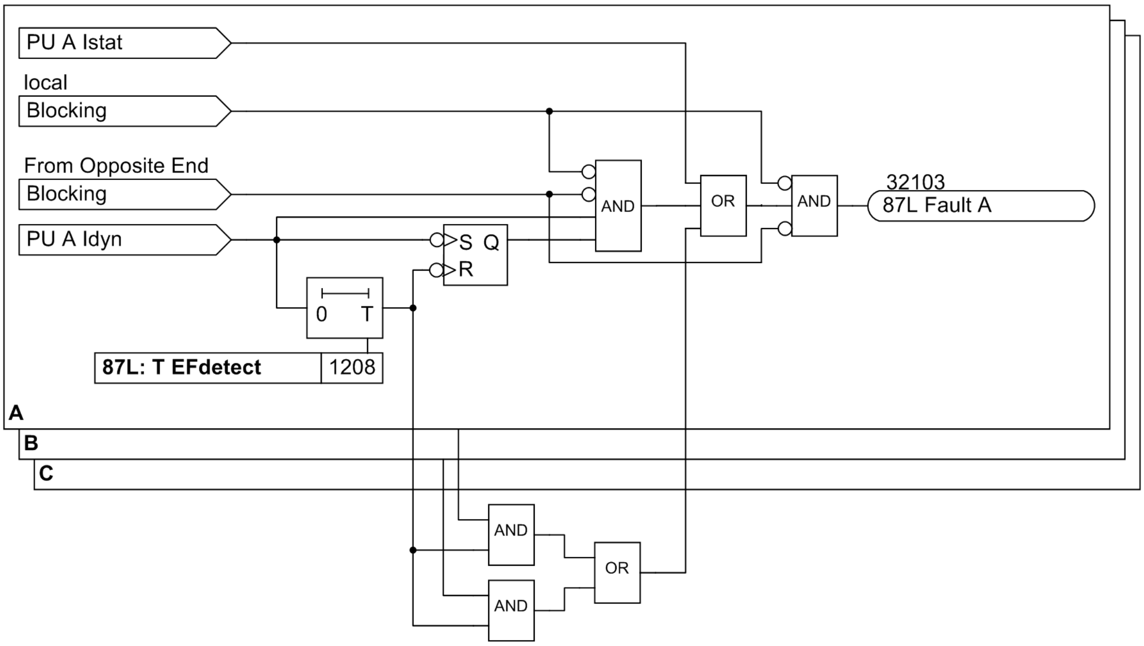


Figure 2-9 Phase comparison protection in resonant-grounded/isolated systems

You will find the logic diagram for the general pickup of the differential protection and the differential protection tripping in Section 2.2.5.

2.2.2.2 Setting Notes

General

The phase comparison protection can be switched ***ON*** or ***OFF*** at address 1201 **87L PCC-Prot.**. This requires the differential protection to be set to ***Enabled*** at address 112 **87 DIFF.PROTEC.**.

For cables and long lines, the capacitive charging current is decisive for determining the pickup values. The charging current is calculated as follows:

$I_C = 2\pi \cdot f_{Nom} \cdot C_B' \cdot s \cdot V_{Nom}/\sqrt{3}$

where

I_C	charging current in A
f_{Nom}	rated power system frequency in Hz
C_B'	referred rated capacitance of the line in F/km
V_{Nom}	rated system voltage in V
s	line length in km

Pickup Values for Resistive or Solid Grounded, Resonant-grounded and Isolated Systems

At address 1202 **87L Idyn>** you can set the dynamic tripping threshold. The value for **87L Idyn>** should be set to at least 0.2 of the largest primary transformer rated current and larger than 2.5 to 3 times the capacitive charging current of the line. If inductances can be connected in the protected zone (common-mode reactor or transformers) for energized lines, **87L Idyn>** should be greater than the maximum expected inrush current.

The dynamic tripping threshold for closing is set in address 1203 **87L Idyn close>**. The value for **87L Idyn close>** should be ≥ **87L Idyn>**, but it should equal at least 3 times the value of the capacitive charging current of the protected line. If inductances are present in the protected zone (common-mode reactor or transformers), **87L Idyn close>** should be set greater than the maximum expected inrush current.

The static tripping threshold is set in address 1204 **87L Isteady>**. The static tripping threshold should be set to a value that is larger than the transformer rated current plus at least 3 times the capacitive charging current of the line. If inductances are present in the protected zone (common-mode reactor or transformers), **87L Isteady>** must be set greater than the maximum expected inrush current.

At address 1205 **87L I min** you can enter the threshold for releasing the pickup signal. The value should at least correspond to the setting of **87L Idyn>**, but not exceed the largest transformer rated current of the constellation.

Note

When using different transformers in the constellation, set identical primary setting values. The secondary setting values can be different.

Time Delays

The trip time delay for **87L Isteady>** is set in address 1206 **87L Trip Delay**.

With the inrush current detection activated, the time delay **87L Trip Delay** must be at least 20 ms for the blocking by the inrush current detection to be effective. In resonant-grounded or isolated systems, transients must have subsided before tripping takes place. The delay should be at least 3 cycles (60 ms at 50 Hz and 54 Ms at 60 Hz). For large systems, the time delay must be increased accordingly (see Figure 2-16).

At address 1208 **87L: T EFdetect** you set the time after which an evolving fault is detected. The parameter is disabled in resonant-grounded or isolated power systems. In the specified time, the 1-phase trip command of the dynamic element **87L: T EFdetect** is not forwarded to the tripping logic.

Address 1207 **87L Man. Close** allows you to set the behavior of the phase comparison protection for manual closing for **87L Isteady>**. In this case, tripping can be ***DELAYED*** or ***UNDELAYED*** (see Figure 2-16).

At parameter 1214 **87L:Inrush blk.** you can enable or disable the blocking function for the phase comparison in case of inrush. If the parameter is enabled, tripping of the element **87L Idyn>** is generally delayed by one cycle. Inrush blocking can thus become effective.

2.2.3 Ground Current Differential Protection in Grounded Systems

The ground current differential protection of the 7SD80 operates as a stabilized (restrained) differential protection in grounded systems. The two 7SD80 devices exchange the phasors of the ground currents and the associated restraining quantities over their protection interfaces. The restraining currents and the current phasors are summed up in each device and compared to a pickup characteristic. In the event of an internal short-circuit, the associated circuit breaker is tripped.

2.2.3.1 Description

Basic Principle / Influencing Variables

In healthy operation, both ends of a line carry the same current. This current flows into one side of the considered zone and leaves it again on the other side. A difference in current is a clear indication of a fault within this line section.

If the actual current transformation ratios are the same, the secondary windings of the current transformers **CT1** and **CT2** at the line ends can be connected to form a closed electric circuit with a secondary current **I**; a measuring element **M** which is connected to the electrical balance point remains at zero current in healthy operation.

When a fault occurs in the zone limited by the transformers, a current $i_1 + i_2$ which is proportional to the fault currents $\underline{I}_1 + \underline{I}_2$ flowing in from both sides is fed to the measuring element. As a result, the simple circuit ensures reliable tripping of the protection if the fault current flowing into the protected zone during a fault is high enough for the measuring element **M** to respond.

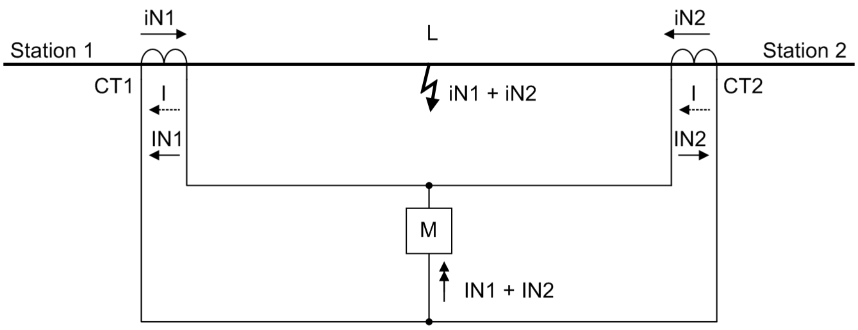


Figure 2-10 Basic principle of the differential protection for a line with two ends

This principle only applies to the primary system as long as quadrature-axis components of current are negligible. Quadrature-axis components of current can be caused by line capacitances or excitation currents of transformers and parallel reactors.

The secondary currents which are applied to the devices via the current transformers, are subject to measuring errors caused by the response characteristic of the current transformers and the input circuits of the devices. Transmission errors such as signal jitters can also cause deviations of the measured quantities. As a result of all these influences, the total sum of all currents processed in the devices in healthy operation is not exactly zero. The ground current differential protection is stabilized against these influences.

Additional measuring errors which may arise in the device itself by hardware tolerances, calculation tolerances, deviations in time or due to the „quality“ of the measured quantities such as harmonics and deviations in frequency, are also estimated by the device and increase the local self-restraining quantity automatically. Here, the permissible variations in the protection data transmission and processing periods are also considered.

For transient inrush currents the devices have a separate inrush current restraint feature.

Evaluation of Measured Values

The ground current differential protection in grounded systems evaluates the sum of the ground current phasors.

Each device calculates a ground current at each end of the protected object (fundamental component of the ground current) and transmits it to the partner device. The received and the locally measured ground current phasor is added to the ground differential current. The ground differential current value equals the fault current that the differential protection system „sees“. In the ideal case, it equals the short-circuit current. In healthy operation, the differential current value is low and for lines about similar to the capacitive charging current.

The restraining quantity counteracts the ground differential current. It is the total of the maximum measured errors at the ends of the protected object and is calculated from the current measured quantities and power system parameters that were set. Therefore, the highest possible error value of the current transformers within the nominal range and/or the short-circuit current range is multiplied with the current flowing through each end of the protected object. The total value, including the measured internal errors, is then transmitted to the other end. This is the reason why the restraint current is a replica of the greatest possible measurement error of the entire differential protection system.

The pickup characteristic of the differential protection is derived from the restraining characteristic $I_{diff} = I_{rest}$ (45° curve) which is cut off below the setting value **87N L: I-DIFF>**. It complies with the equation

I_{rest} = **87N L: I-DIFF>** + Σ (current transformer errors and other measuring errors).

If the calculated differential current exceeds the pickup threshold and the greatest possible measurement error, the fault must be internal (grayed area in the illustration).

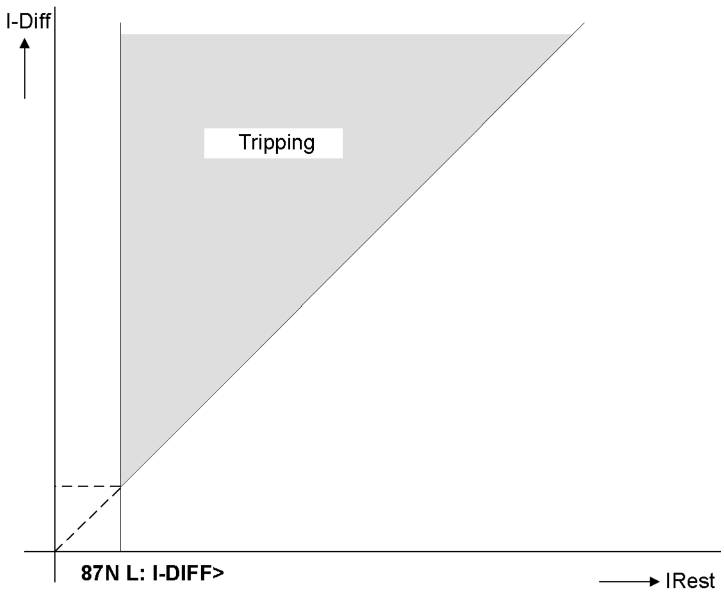


Figure 2-11 Pickup characteristic of the ground differential protection

If it is desired that an internal fault should initiate a TRIP command and additionally a local current of a specific quantity should exist, the value of this current can be set at address 1225 **87N L: I>RELEAS**. The default setting for this parameter is zero so that this additional criterion does not become effective.

The differential current and the restraint current 3I0diff and 3I0restr are included in the fault record.

Blocking / Interblocking

The ground current differential protection can be blocked via a binary input. The blocking at one end of a protected object affects all ends via the communications link (interblocking). If the overcurrent protection is configured as an emergency function, all devices will automatically switch to this emergency operation mode.

Pickup Logic

The following figure illustrates the pickup logic of the ground current differential protection for grounded systems.

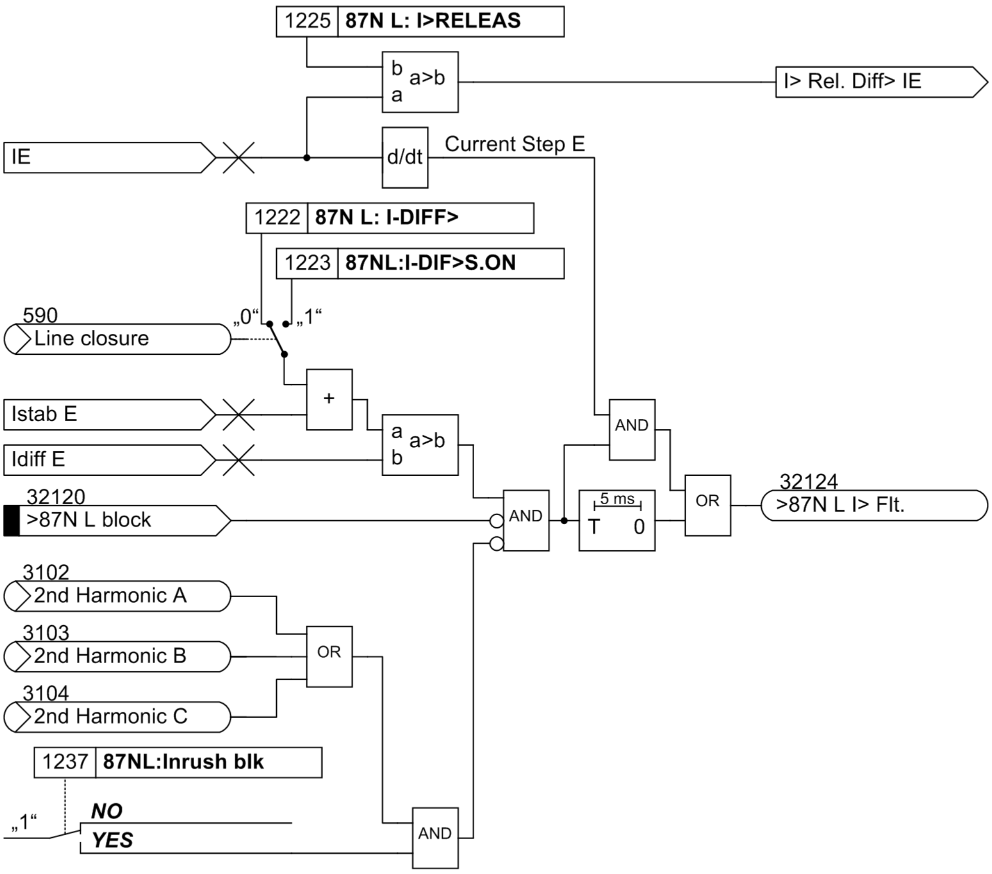


Figure 2-12 Ground current differential protection pickup, grounded system

You will find the logic diagram for the general pickup of the differential protection and the differential protection tripping in Section 2.2.5.

2.2.3.2 Setting Notes

General

The operating mode of the ground differential protection depends on the neutral point treatment in the protected zone. In grounded systems, address 207 **SystemStarpoint** must be set to ***Grounded***.

The ground differential protection can be switched ***ON*** or ***OFF*** at address 1221 **87N L: Protect.**. This requires the ground differential protection to be set to ***Enabled*** at address 112 **87 DIFF.PROTEC.**. The setting ***Alarm only*** is only relevant for ground fault detection in resonant-grounded or isolated systems.

If a device is switched off or if the ground differential protection is disabled or blocked in a device, calculation of measured values becomes impossible. The entire ground differential protection system of both ends is blocked in this case.

Pickup Value Ground Current Differential Protection

The current sensitivity is set at address 1222 **87N L: I-DIFF>**. It is determined by the entire current flowing into a protected zone in case of a fault. This is the total fault current regardless of how it is distributed between the ends of the protected object.

This pickup value must be set to a value that is higher than the total steady-state quadrature-axis component of current of the protected object. For cables and long overhead lines, the charging current has to be considered in particular. It is calculated from the operational capacitance (see Section 2.2.2.2).

Considering the variations of voltage and frequency, the value set should be at least 2,5 to 3 times higher than the calculated charging current. Moreover, the pickup value should not be smaller than 15 % of the primary rated current of the largest transformer in the protection configuration.

If setting is performed from a personal computer using DIGSI, the parameters can be set either as primary or as secondary quantities. If secondary quantities are set, all currents must be converted to the secondary side of the current transformers.

Time Delays

In special application cases, it may be advantageous to delay the tripping of the differential protection using an additional timer, e.g. in case of reverse interlocking. The time delay **87N L: T-DELAY** (address 1224) is only started upon detection of an internal fault. This parameter can only be set in DIGSI at **Display Additional Settings**.

With the inrush current restraint activated, the time delay **87N L: T-DELAY** must be at least 20 ms for the blocking by the inrush current restraint to be effective.

If it is desired that a TRIP command is generated in the event of an internal fault only if simultaneously the current of the local line end has exceeded a specific quantity, then this current threshold can be set for enabling the differential protection TRIP at address 1225 **87N L: I>RELEAS**. This parameter can only be set in DIGSI at **Display Additional Settings**.

2.2.4 Ground Fault Differential Protection in Resonant-grounded/Isolated Systems

The ground fault differential protection can be applied in power systems whose starpoint is not grounded or grounded through an arc suppression coil (Petersen coil). It is based on the power values. This requires the phase voltages or the 3V0 voltage (Appendix A.3, Figure A-11) to be connected to the devices at both ends of the protected object.

2.2.4.1 Description

General

Single-phase ground faults are not detected by the short-circuit protection since no short circuit current flows. The power system operation is not immediately affected by a ground fault (the voltage triangle is maintained, Figure 2-13). Therefore, fast tripping is usually not required or desired. The ground fault is to be detected, indicated and the affected piece of equipment is to be localized, if possible, eliminating the ground fault by initiating appropriate switching operations.

The 7SD80 enables the precise localization of the piece of equipment (line) affected by the ground fault.

In resonant-grounded systems, a core balance current transformer **must** be used to detect the ground current.

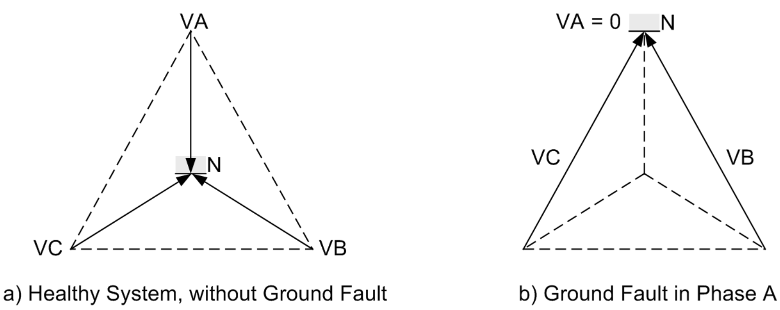


Figure 2-13 Ground fault in non-grounded neutral system

Pickup

Pickup occurs when the settable threshold for the displacement voltage $3 \cdot V_0$ is exceeded. To obtain steady-state measured quantities, the ground fault detection can be delayed by a configurable time after the displacement voltage has occurred.

Determination of the Phase Affected by the Ground Fault

Following pickup caused by the displacement voltage, the phase affected by the ground fault is determined first. To do this, the individual phase-to-ground voltages are measured. If the voltage magnitude for any given phase is below the setting value V_{min}, that phase is detected as the ground faulted phase as long as the remaining phase-to-ground voltages are simultaneously above the setting value V_{max}.

Sensitive Ground Fault Direction Determination

The direction of the ground fault can be determined from the direction of the ground fault current in relation to the displacement voltage. The only restriction is that the active or reactive current components must be available with sufficient magnitude at the point of measurement.

In networks with isolated starpoint, the ground fault current flows as capacitive current from the healthy lines via the measuring point to the point of ground fault. For the determination of the direction the capacitive reactive power is most relevant.

In networks with arc suppression coils, the Petersen coil superimposes a corresponding inductive current on the capacitive ground fault current when a ground fault occurs, so that the capacitive current at the point of fault is compensated. Depending on the measuring point in the system the resultant measured current may be inductive or capacitive. Therefore, the reactive current is not suited for direction determination of the ground current. In this case, only the ohmic (active) residual current which results from the losses of the Petersen coil can be used for direction determination. This residual ground fault residual current is only about some per cent of the capacitive ground fault current.

The active and reactive component of the power is decisive for the ground fault protection pickup.

A fault in forward direction must be detected at both ends of the protected object for the ground fault differential protection to pick up.

In case of a single feeder, the residual current per watt at the opposite end of the infeed can be so weak that it is impossible to determine the direction at that end. In this case, the amplitudes of the active currents of the two ends are additionally compared to initiate pickup and localize the ground fault.

The amplitude of the active current (resonant-grounded system) and the reactive current (for isolated starpoint) are included in the fault record. The local wattmetric ground current or reactive current is recorded as Iee1, the wattmetric ground current or the reactive current of the opposite end as Iee2.

Pickup Logic

The following figure shows the pickup logic of the ground fault differential protection resonant-grounded or isolated systems.

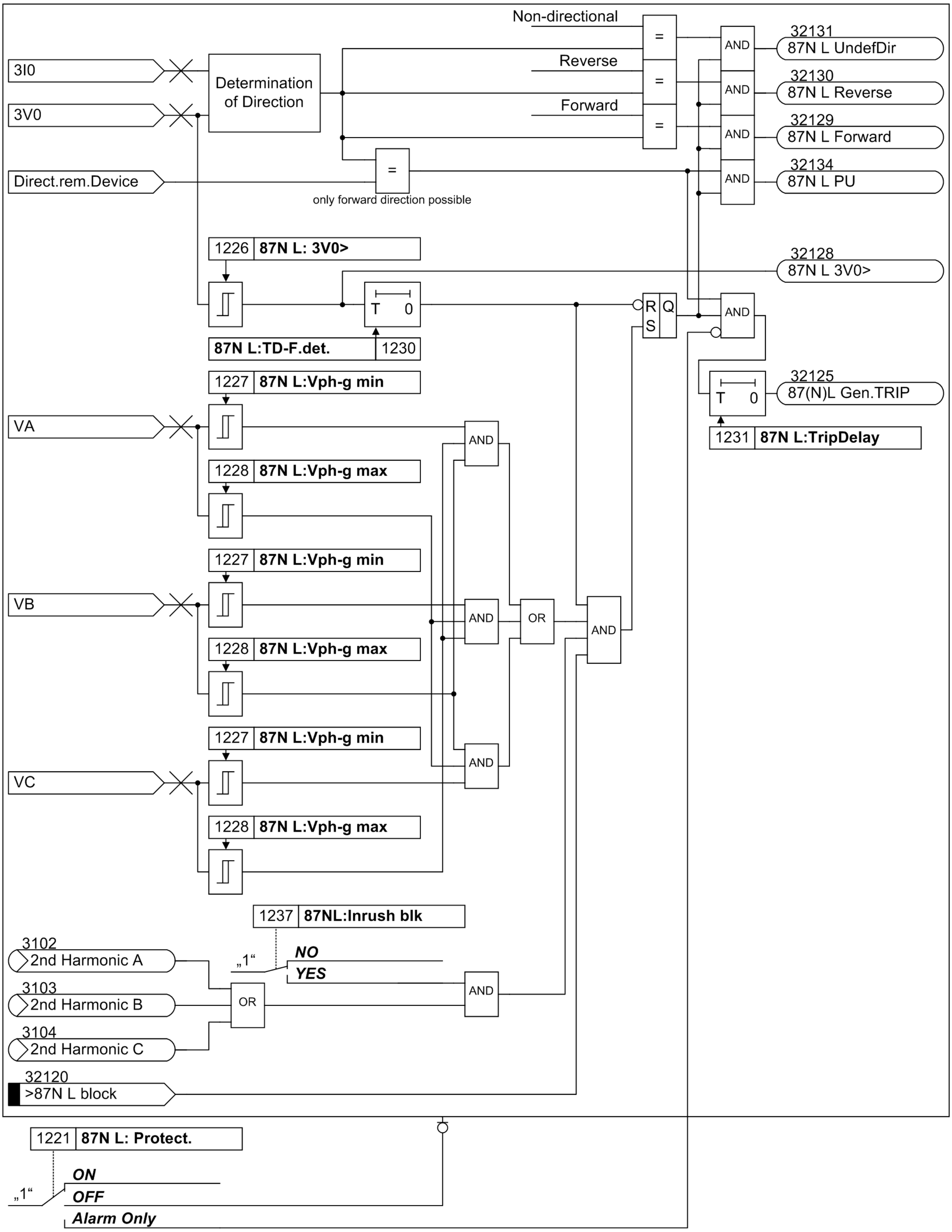


Figure 2-14 Ground fault differential protection pickup, isolated/resonant-grounded system

If only the V0 voltage is connected, only parameter 1226 **87N L: 3V0>** is effective. The threshold checks **87N L:Vph-g min** and **87N L:Vph-g max** (parameter 1227 and 1228) are not relevant.

You will find the logic diagram for the differential protection trip in Section 2.2.5.

2.2.4.2 Setting Notes

General

The operating mode of the ground differential protection depends on the neutral point treatment in the protected zone. In resonant-grounded or isolated system, you have to set ***Peterson-C.Gnd.*** or ***Isolated*** at address 207 **SystemStarpoint**.

The ground differential protection can be switched ***ON*** or ***OFF*** at address 1221 **87N L: Protect.**. If set to ***Alarm only***, an indication will be output when a fault is detected. Tripping is not initiated. This requires the ground differential protection to be set to ***Enabled*** at address 112 **87 DIFF.PROTEC.**.

If a device is switched off at any end of the protected object or if the protection interface communication is interrupted, a calculation of measured values becomes impossible. The function then operates locally and only issues directional indications and pickup indications but no pickup and tripping indications of the ground fault differential protection.

Pickup Values

The pickup threshold of the displacement voltage is set in address 1226 **87N L: 3V0>**.

At address 1229 **87N L: IN(s)>** you can enter the minimum current for direction determination. The pickup current is to be set as high as possible to avoid false pickup of the device provoked by unbalanced currents in the system and by current transformers. Dependent on the grounding of the network starpoint, the magnitude of the capacitive ground fault current (for isolated networks) or the wattmetric residual current (for compensated networks) is decisive.

In **isolated** systems, a ground fault in a cable will allow the total capacitive ground fault currents of the entire electrically connected system, with the exception of the faulted cable itself, to flow through the measuring point as the latter flows directly to the fault location (i.e. not back via the measuring point). Enter about half of this ground fault current as pickup value.

In **resonant-grounded** systems directional determination is made more difficult since a much larger reactive current (capacitive or inductive) is superimposed on the critical wattmetric (active) current. Therefore, depending on the system configuration and the position of the arc-compensating coil, the total ground current supplied to the device may vary considerably in its values with regard to magnitude and phase angle. The device, however, must evaluate only the active component of the ground fault current, the ground fault residual current, that is $I_E \cdot \cos\varphi$. This requires extremely high accuracy, particularly with regard to phase angle measurement of all the instrument transformers. Furthermore, the device must not be set to operate too sensitive. When applying this function in resonant-grounded systems, a reliable direction determination can only be achieved when toroidal current transformers are connected. Here the following rule of thumb applies: set the value to half the expected measured current, whereby only the residual wattmetric current is used. Residual wattmetric current predominantly derives from losses of the Petersen coil.

For phase determination **87N L:Vph-g min** (address 1227) is the criterion that applies to the ground-faulted phase if simultaneously the other two phase voltages **87N L:Vph-g max** (address 1228) have been exceeded. Accordingly, the setting **87N L:Vph-g min** must be set smaller than the minimum phase-to-ground voltage that occurs during operation. This setting, too, is uncritical. 40 V (default setting) should always be correct. **87N L:Vph-g max** must be greater than the maximum phase-to-ground voltage occurring during operation, but less than the minimum phase-to-phase voltage occurring during operation. For V_N = 100 V, the value must therefore be 75 V (default setting). The definite detection of the phase affected by the ground fault is a further prerequisite for alarming a ground fault. When connecting the voltage V0 (Appendix A.3, Figure A-11), the check of the phase voltages does not take place.

Time Delays

The ground fault is detected and reported only when the displacement voltage has applied for at least the time **`87N L:TD-F.det.`** (address 1230). This stabilizing time also takes effect when ground fault conditions change (e.g. change of direction).

The tripping can be delayed via the time delay **`87N L:TripDelay`** (address1231).

With the inrush current restraint activated, the time delay **`87N L:TripDelay`** must be at least 20 ms for the blocking by the inrush current restraint to be effective.

2.2.5 Differential Protection Pickup Logic and Tripping Logic

2.2.5.1 Description

Pickup Logic

Once the differential protection function has reliably registered a fault within its tripping zone, the signal “`87(N)L Gen.Flt.`“ (general pickup of the differential protection) is generated. For the differential protection function itself, this pickup signal is of no concern since the tripping conditions are available at the same time. This signal, however, is required to initiate the internal or external supplementary functions, e.g. fault recording, automatic reclosing.

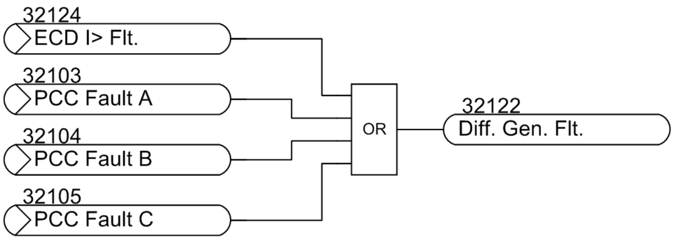


Figure 2-15 General pickup

Tripping Logic

The following figure shows the tripping logic of the differential protection.

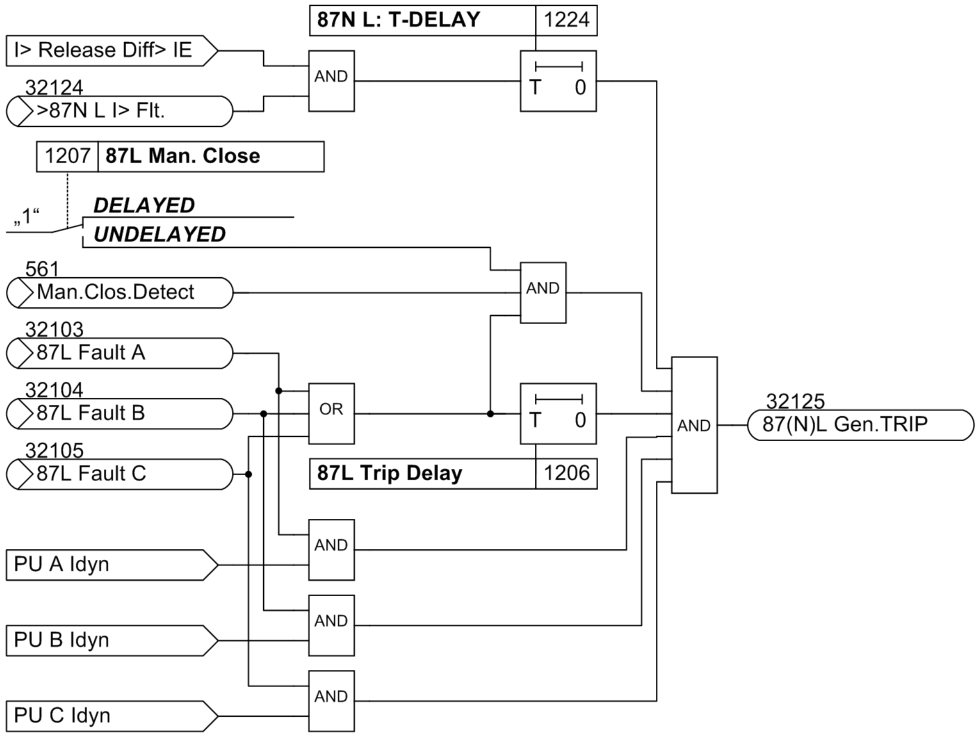


Figure 2-16 Differential protection trip

If the pickup signals apply for longer than the configurable trip time delay, the differential protection trips.

2.2.6 87 Differential Protection

The following tables provide an overview of the parameters and information of the functions:

- phase comparison protection

- Ground current differential protection in grounded systems

- ground fault differential protection in resonant-grounded/isolated systems

2.2.6.1 Settings

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

The table indicates region-specific default settings. Column C (configuration) indicates the corresponding secondary nominal current of the current transformer.

Addr.	Parameter	C	Setting Options	Default Setting	Comments
1201	87L PCC-Prot.		OFF ON	ON	Phase current comparison protection
1202	87L Idyn>	1A	0.20 .. 20.00 A; ∞	0.33 A	Dynamic trip threshold
		5A	1.00 .. 100.00 A; ∞	1.65 A	
1203	87L Idyn close>	1A	0.20 .. 20.00 A; ∞	0.33 A	Dynamic trip threshold line closure
		5A	1.00 .. 100.00 A; ∞	1.65 A	
1204	87L Isteady>	1A	0.50 .. 20.00 A; ∞	1.33 A	Steady pick up threshold
		5A	2.50 .. 100.00 A; ∞	6.65 A	
1205	87L I min	1A	0.10 .. 20.00 A; ∞	1.00 A	Minimal phase current
		5A	0.50 .. 100.00 A; ∞	5.00 A	
1206	87L Trip Delay		0.00 .. 0.10 sec	0.00 sec	Trip Delay
1207	87L Man. Close		DELAYED UNDELAYED	DELAYED	Trip response after manual close
1208	87L: T EFdetect		0.00 .. 32.00 sec	0.00 sec	Evolving fault detect.time 1ph faults
1214	87L:Inrush blk.		NO YES	NO	Inrush blocking
1221	87N L: Protect.		OFF ON Alarm Only	ON	87N L protection
1222	87N L: I-DIFF>	1A	0.10 .. 20.00 A	0.30 A	3I0-DIFF> Pickup value
		5A	0.50 .. 100.00 A	1.50 A	
1224A	87N L: T-DELAY		0.00 .. 300.00 sec; ∞	0.00 sec	3I0-DIFF Trip time delay
1225A	87N L: I>RELEAS	1A	0.00 .. 20.00 A	0.00 A	Min.current to release 3I0-DIFF-Trip
		5A	0.00 .. 100.00 A	0.00 A	
1226	87N L: 3V0>		5 .. 150 V	50 V	3V0> pickup
1227	87N L:Vph-g min		10 .. 100 V	40 V	Vph-g min of faulted phase
1228	87N L:Vph-g max		10 .. 100 V	75 V	Vph-g max of healthy phases
1229	87N L: IN(s)>		0.003 .. 1.000 A	0.050 A	IN(s)> to release directional element
1230	87N L:TD-F.det.		0.00 .. 320.00 sec	1.00 sec	Time delay for fault detection
1231	87N L:TripDelay		0.00 .. 320.00 sec	0.00 sec	Trip Delay
1233	CT Err. I1		0.003 .. 1.600 A	0.050 A	Current I1 for CT Angle Error
1234	CT Err. F1		0.0 .. 5.0 °	0.0 °	CT Angle Error at I1

Addr.	Parameter	C	Setting Options	Default Setting	Comments
1235	CT Err. I2		0.003 .. 1.600 A	1.000 A	Current I2 for CT Angle Error
1236	CT Err. F2		0.0 .. 5.0 °	0.0 °	CT Angle Error at I2
1237	87NL:Inrush blk		NO YES	NO	Inrush blocking

2.2.6.2 Information List

No.	Information	Type of Information	Comments
3190	Test 87	IntSP	87 Set test state of 87
3191	Commiss.87	IntSP	87 Set Commissioning state of 87
3192	Test 87 remote	OUT	87 Remote relay in test state
3193	Comm. 87 active	OUT	87 Commissioning state is active
3197	>Test 87 ON	SP	87 >Set test state of 87
3198	>Test 87 OFF	SP	87 >Reset test state of 87
3199	Test 87 ON/off	IntSP	87 Test state of 87 ON/OFF
3200	Test 87 ONoffBI	IntSP	87 Test state ON/OFF via BI
3260	>Comm. 87 ON	SP	87 >Commissioning state ON
3261	>Comm. 87 OFF	SP	87 >Commissioning state OFF
3262	Comm 87 ON/OFF	IntSP	87 Commissioning state ON/OFF
3263	Comm 87 ONoffBI	IntSP	87 Commissioning state ON/OFF via BI
32100	>87L block	SP	>87L Protection blocking signal
32102	87L active	OUT	87L Protection is active
32103	87L Fault A	OUT	87L Fault detection A
32104	87L Fault B	OUT	87L Fault detection B
32105	87L Fault C	OUT	87L Fault detection C
32107	87L is blocked	OUT	87L Protection is blocked
32108	87L is OFF	OUT	87L Protection is switched off
32109	87L allow A	OUT	87L A released
32110	87L allow B	OUT	87L B released
32111	87L allow C	OUT	87L C released
32112	87 CTRatioAlarm	OUT	87 CT primary ratio is too high
32113	87L receive blk	OUT	87L receive blocking
32114	87L send blk	OUT	87L send blocking
32115	87L IDYN> A	OUT	87L IDYN> A
32116	87L IDYN> B	OUT	87L IDYN> B
32117	87L IDYN> C	OUT	87L IDYN> C
32118	87L ISTAT> A	OUT	87L ISTAT> A
32119	87L ISTAT> B	OUT	87L ISTAT> B
32120	>87N L block	SP	>87N L Protection blocking signal
32121	>87N L active	OUT	>87N L: Protection is active
32122	87(N)L Gen.Flt.	OUT	87(N)L Fault detection
32124	>87N L I> Flt.	OUT	>87N L: Fault detection of I-Diff>
32125	87(N)L Gen.TRIP	OUT	87(N)L General TRIP

No.	Information	Type of Information	Comments
32126	87N L block	OUT	87N L: Protection is blocked
32127	87N L OFF	OUT	87N L: Protection is switched off
32128	87N L 3V0>	OUT	87N L: detection 3V0> pickup
32129	87N L Forward	OUT	87N L: detection Forward
32130	87N L Reverse	OUT	87N L: detection Reverse
32131	87N L UndefDir	OUT	87N L: detection Undef. Direction
32132	87N L rec. blk	OUT	87N L: receive blocking
32133	87N L send blk	OUT	87N L: send blocking
32134	87N L PU	OUT	87N L: pickup
32150	87L ISTAT> C	OUT	87L ISTAT> C

2.2.7 Differential Protection Test and Commissioning

2.2.7.1 Differential Protection Test

General

If differential protection test mode (test mode in the following) is activated, the differential protection is blocked in the entire system. Depending on the configuration, the overcurrent protection acts as emergency function.

In the local device all currents from the other devices are set to zero. The local device only evaluates the locally measured currents, interprets them as differential current but does not send them to the other devices. This enables measuring the thresholds of the differential protection. Moreover, the test mode prevents in the local device that tripping of the differential protection generates a transfer trip signal.

The test mode can be activated/deactivated as follows:

- Operation panel: Menu Control/Taggings/Set: „Test mode“
- Via binary inputs (no. 3197 „`>Test 87 ON`“, no. 3198 „`>Test 87 OFF`“) if this was routed
- In DIGSI with Control / Taggings: „Diff: Test mode“

The test mode status of the other device of the line protection system is indicated on the local device by the indication „`Test 87 remote`“ (No. 3192).

Mode of Operation

Below, the logic is shown in a simplified way:

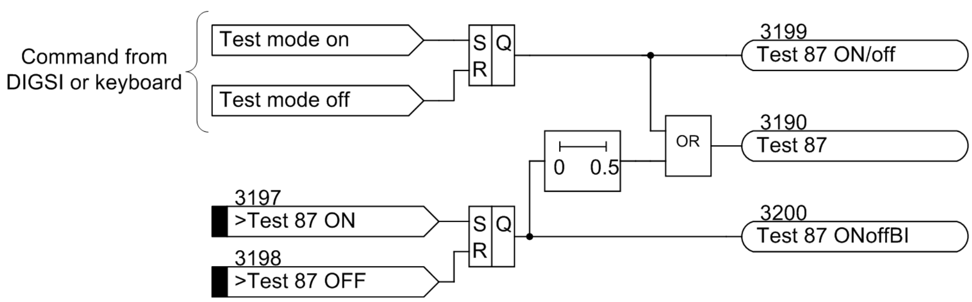


Figure 2-17 Logic diagram of the test mode

Depending on the way used for controlling the test mode, either the indication „Test 87 ON/off“ (no. 3199) or „Test 87 ONoffBI“ (no. 3200) is generated. The way used for deactivating the test mode always has to be identical to the way used for activating. The indication „Test 87“ (no. 3190) is generated independently of the chosen way. When deactivating the test mode via the binary inputs, a time delay of 500 ms becomes effective.

The following figures show possible variants for controlling the binary inputs. If a switch is used for the control (Figure 2-19), it has to be observed that binary input „>Test 87 ON“ (no. 3197) is parameterized as NO contact and that binary input „>Test 87 OFF“ (no. 3198) is parameterized as NC contact.

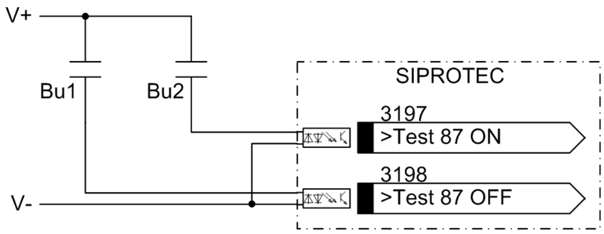


Figure 2-18 External push-button wiring for controlling the differential protection test mode

Bu1 Push-button „Switching off the differential protection test mode“

Bu2 Push-button „Switching on the differential protection test mode“

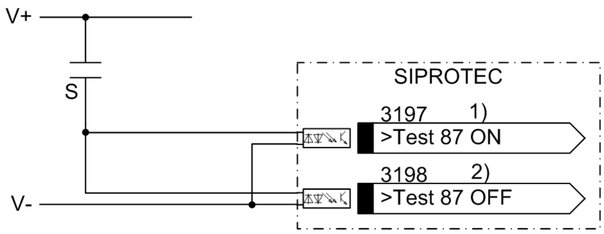


Figure 2-19 External switch wiring for controlling the differential protection test mode

S Switch „Switching the differential protection test mode on/off“

1) Binary input as make contact

2) Binary input as break contact

If a test switch is to be used for changing to test mode, we recommend the following procedure:

- Block the differential protection via a binary input.
- Use the test switch to activate/deactivate the test mode.
- Reset the blocking of the differential protection via the binary input.

2.2.7.2 Differential Protection Commissioning

General

In differential protection commissioning mode (commissioning mode in the following) the differential protection does not generate TRIP commands. The commissioning mode is intended to support the commissioning of the differential protection.

You can check:

- transformer polarity, using the constellation measured values
- differential currents
- restraint currents

By editing parameters, the operating point of the differential protection can be changed without any risk up to the generation of a pickup.

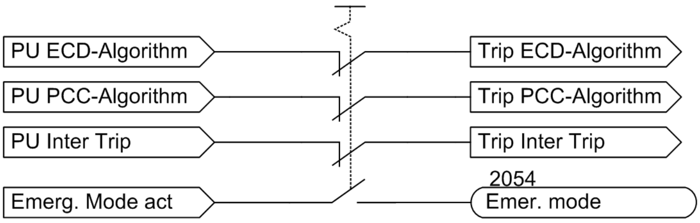


Figure 2-20 Commissioning mode - overview

The commissioning mode is activated on a device of the protective device constellation and also affects the device at the other end of the protected object (indication no. 3193„`Comm. 87 active`“). The commissioning mode has to be deactivated on the device on which it was activated.

The commissioning mode can be activated/deactivated as follows:

- Operation panel: Menu Control/Taggings/Set: „Commissioning mode“
- Via binary inputs (no. 3260 „`>Comm. 87 ON`“, no. 3261 „`>Comm. 87 OFF`“) if this was routed
- In DIGSI with Control / Taggings: „Diff: Commissioning mode“

Mode of Operation

Below, the logic is shown in a simplified way:

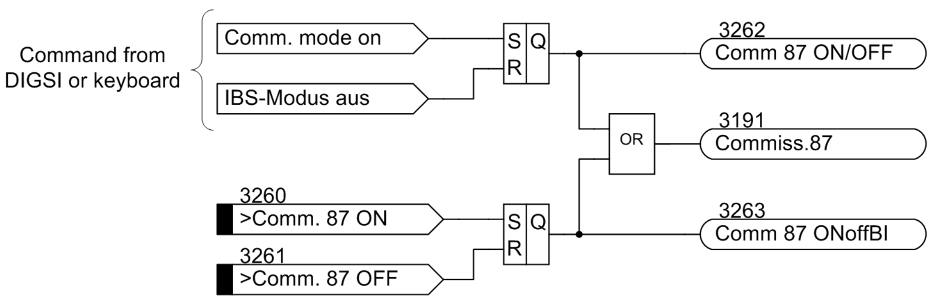


Figure 2-21 Logic diagram of the commissioning mode

There are two ways to set the commissioning mode. The first way is to use a command (commissioning mode on / commissioning mode off) which is generated either when operating the integrated keypad or when operating with DIGSI. The second way is to use the binary inputs (no. 3260 „>Comm. 87 ON“, no. 3261 „>Comm. 87 OFF“).

Depending on the way used for controlling the commissioning mode, either the indication „Comm 87 ON/OFF“ (no. 3262) or „Comm 87 ONoffBI“ (no. 3263) is generated. The way used for deactivating the commissioning mode always has to be identical to the way used for activating. The indication „Commiss.87“ (no. 3191) is generated independently of the chosen way.

The following figures show possible variants for controlling the binary inputs. If a switch is used for control (Figure 2-23), it has to be observed that binary input „>Comm. 87 ON“ (no. 3260) is parameterized as NO contact and that binary input „>Comm. 87 OFF“ (no. 3261) is parameterized as NC contact.

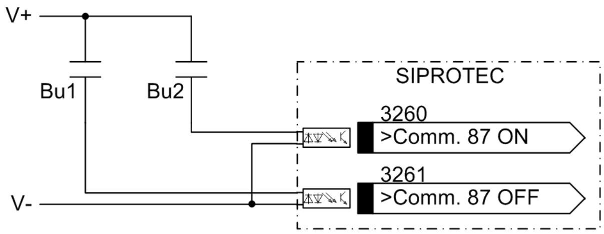


Figure 2-22 External push-button wiring for controlling the differential protection commissioning mode

Bu1 Push-button „Switching off the differential protection commissioning mode“

Bu2 Push-button „Switching on the differential protection commissioning mode“

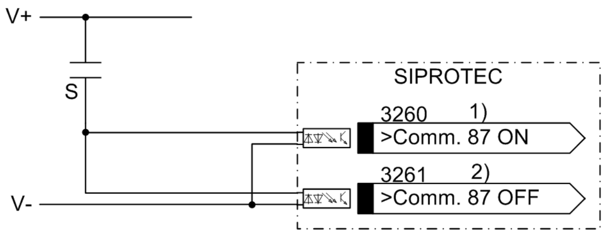


Figure 2-23 External switch wiring for controlling the differential protection commissioning mode

S Switch „Switching the differential protection commissioning mode on/off“

1) Binary input as make contact

2) Binary input as break contact

2.3 Breaker Intertrip and Remote Tripping

The 7SD80 device allows transmitting a trip command created by the local differential protection to the other end of the protected object (intertripping). Likewise, any desired command of another internal protection function or of an external protection, monitoring or control equipment can be transmitted for remote tripping.

2.3.1 Description

Transmit Circuit

The transmission signal can originate from two different sources (Figure 2-24). If the parameter **85 DT: SEND** is set to ***YES***, each tripping command of the differential protection is routed immediately to the transmission function „ITrp.sen. A“ to "...C“ (intertrip) and transmitted via the protection data interfaces and communication links.

The send function can be triggered via binary input „>85 DT 3pol“ (remote tripping). The transmission signal can be delayed with **85 DT: TD-BI** and prolonged with **85 DT:T-PROL BI**.

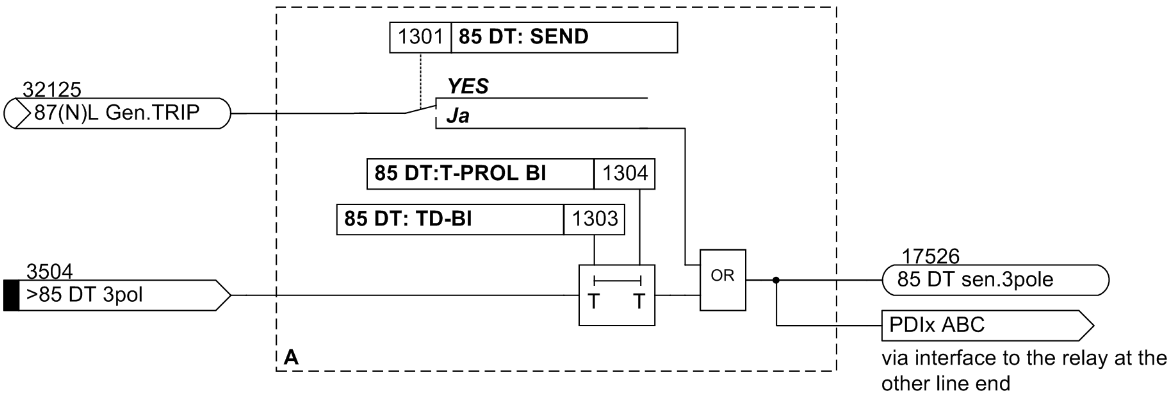


Figure 2-24 Logic diagram of the intertrip — transmission circuit

Receive Circuit

On the receiving end the signal can lead to a trip. Alternatively, it can also cause an alarm only. In this way it is possible to determine for each end of the protected object whether the received signal is to trip at this particular end or not.

If the received signal is to cause the trip, it will be forwarded to the tripping logic of the device.

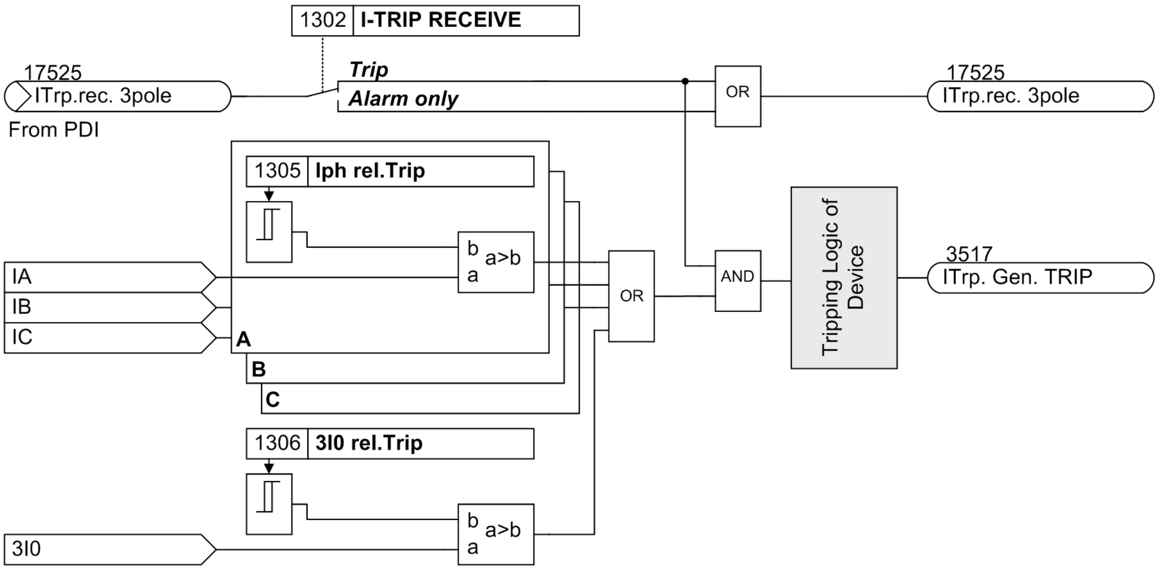


Figure 2-25 Logic diagram of the intertrip — receiving circuit

Additional Options

Since the signals for remote tripping can be set to just generate an indication, any other desired signals can be transmitted as well. After the binary input(s) have been activated, the signals which are set to cause an alarm at the receiving end are transmitted. These alarms can in turn execute any desired actions at the receiving end.

2.3.2 Setting Notes

General

The intertrip function for tripping caused by the differential protection can be activated (***YES***) or deactivated (***NO***) at address 1301 **85 DT: SEND**.

To ensure that the faulted line is cleared, the intertrip function must be activated. In some applications, e.g. a single feed, it may be desirable to switch off the feeding end only. In such exceptional cases, the intertrip function is not needed.

Intertrip / Remote Tripping

The activated intertrip function starts automatically when the differential protection trips at only one end.

If the relevant binary inputs are allocated and activated by an external source, the intertrip signal is transmitted as well. In this case, the signal to be transmitted can be delayed with address 1303 **85 DT: TD-BI**. This delay stabilizes the originating signal against dynamic interferences which may possibly occur on the control cabling. Address 1304 **85 DT:T-PROL BI** is used to extend a signal after it has been effectively injected from an external source.

The reaction of a device when receiving an intertrip/remote tripping signal is set in address 1302 **85 DT: RECEIVE**. If it is desired to cause tripping, set the value ***Trip***. If the received signal, however, is supposed to cause an alarm only, ***Alarm only*** must be set if this indication is to be further processed externally.

The setting times depend on the individual case of application. A delay is necessary if the external control signal originates from a disturbed source and a restraint seems appropriate. Of course, the control signal has to be longer than the delay for the signal to be effective. If the signal is processed externally at the receiving end, a prolongation time might become necessary for the transmitting end so that the reaction desired at the receiving end can be executed reliably.

Release Thresholds

Before the release for tripping is given, the phase and ground currents must exceed settable thresholds. You can set these thresholds at the following addresses:

- 1305 **`85 DT Iph rel.`** for the minimum phase current
- 1306 **`85 DT 3I0 rel.`** for the minimum ground current 3I0

2.3.3 Settings

The table indicates region-specific default settings. Column C (configuration) indicates the corresponding secondary nominal current of the current transformer.

Addr.	Parameter	C	Setting Options	Default Setting	Comments
1301	85 DT: SEND		YES NO	YES	85 DT: State of transm.the intertrip cmd
1302	85 DT: RECEIVE		Alarm only Trip	Trip	85 DT: React.if intertrip cmd is receiv.
1303	85 DT: TD-BI		0.00 .. 30.00 sec	0.00 sec	85 DT: Delay for intertrip via bin.input
1304	85 DT:T-PROL BI		0.00 .. 30.00 sec	0.00 sec	85 DT: Prol. for intertrip via bin.input
1305	85 DT Iph rel.	1A	0.0 .. 25.0 A; ∞	0.0 A	85 DT minimal Phase Current to rel. trip
		5A	0.0 .. 125.0 A; ∞	0.0 A	
1306	85 DT 3I0 rel.	1A	0.0 .. 25.0 A; ∞	0.0 A	85 DT minimal 3I0 Current to rel. trip
		5A	0.0 .. 125.0 A; ∞	0.0 A	

2.3.4 Information List

No.	Information	Type of Information	Comments
3504	>85 DT 3pol	SP	>86 DT: >Intertrip 3 pole signal input
3517	85 DT Gen. TRIP	OUT	85 DT: General TRIP
17525	85 DT rec.3pole	OUT	85 DT: Received 3pole
17526	85 DT sen.3pole	OUT	85 DT: Sending 3pole

2.4 Backup Overcurrent

The 7SD80 features an overcurrent protection function which can be used as either backup or emergency overcurrent protection. All elements are independent of each other and can be combined as desired.

The overcurrent protection has two overcurrent elements with definite trip time and one overcurrent protection element with inverse time delay for the phase currents and for the ground current. These elements operate directionally or non-directionally.

One additional definite-time overcurrent protection element always operates non-directionally. It features an additional release input and can act as emergency element if the other elements are used for backup purposes.

The elements are independent of each other and can be combined in any way. Blocking by external criteria via binary inputs is possible.

2.4.1 Operating Modes

Emergency Overcurrent Protection

The differential protection as a whole can only operate correctly if both devices receive the data of the respective other device properly. The emergency overcurrent protection in contrast requires only the local currents. Acting as emergency overcurrent protection, it automatically replaces the differential protection as short-circuit protection if data communication of the differential protection is faulty (emergency operation). The differential protection is blocked in this case.

Backup Time Overcurrent Protection

If the overcurrent protection is set as backup time overcurrent protection, it will work independently of the other protection and monitoring functions, i.e. also independently of the differential protection. The backup overcurrent protection can also act as the only short-circuit protection if no suitable channels for the communication between the protection devices are available yet during the initial commissioning. It can be used as busbar protection via reverse interlocking in combination with other protection devices or as backup protection function for protection device failure at continuing lines.

2.4.2 Non-directional Overcurrent Protection

Measured Quantities

The phase currents are fed to the device via the input transformers of the measuring input. The ground current $3I_0$ is calculated from the phase currents.

Definite Time High-set Element 50-1

Each phase current is compared with the setting value **50-B2 PICKUP** after numerical filtering; the ground current is compared with **50N-B2 PICKUP**. A trip command is issued after pickup of an element and expiration of the associated time delays **50-B2 DELAY** or **50N-B2 DELAY**. The dropout value is about 7 % below the pickup value, but at least 5 % of the rated current.

Figure 2-26 shows the logic diagram of the 50-1 elements. They can be blocked via binary input „>BLOCK 50-B2“. Additionally, the ground current element can be blocked separately via the binary input „>BLOCK 50N-B2“.

The binary input „>5X-B InstTRIP“ and the evaluation of the indication „switch“ (onto fault) are common to all elements. They may, however, separately affect the phase and/or ground current elements.

Parameter **50-B1 DELAY** (address 2618) determines whether a non-delayed trip of this element via binary input „>5X-B InstTRIP“ is possible (***YES***) or impossible (***NO***). This parameter is also used for fast tripping before reclosing

If parameter **50-B2 Inrush** (address2625) is set to ***YES***, the element is blocked.

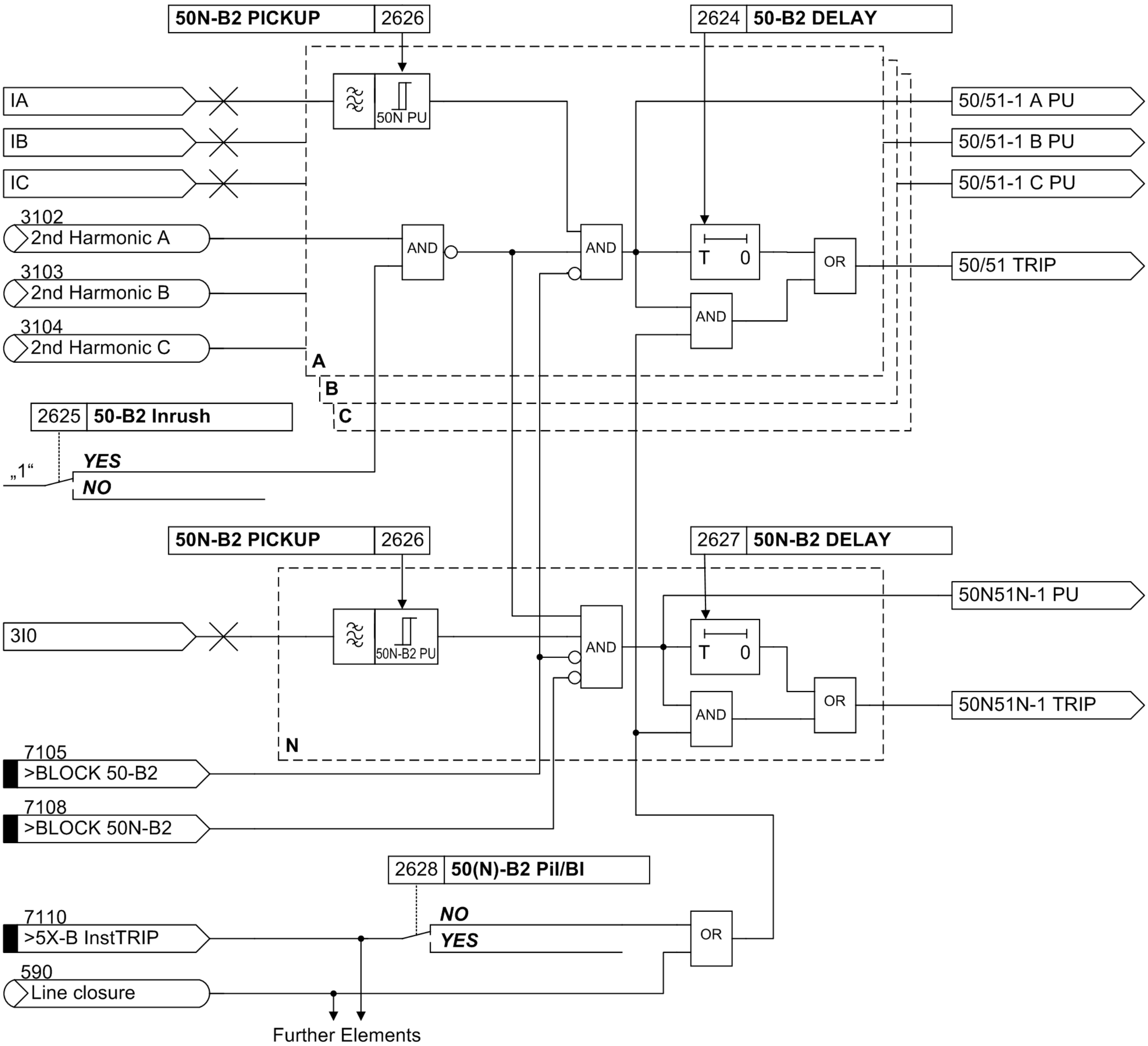


Figure 2-26 Logic diagram of the 50-1 element

Definite Time Overcurrent Element 50-2

The logic of the overcurrent elements 50-2 is the same as the logic of the 50-1 elements described above. In all names, -1 has to be replaced by -2. The parameter names of the 50-2 elements are listed in section 2.4.4.

Definite Time Overcurrent Element 50-3

The 50-3 element operates independently of the other elements. Its logic corresponds to the 50-1 and 50-2 elements described above, but operates non-directional only.

If parameter **`50-STUB Inrush`** (address 2653) is set to ***YES***, the element is blocked.

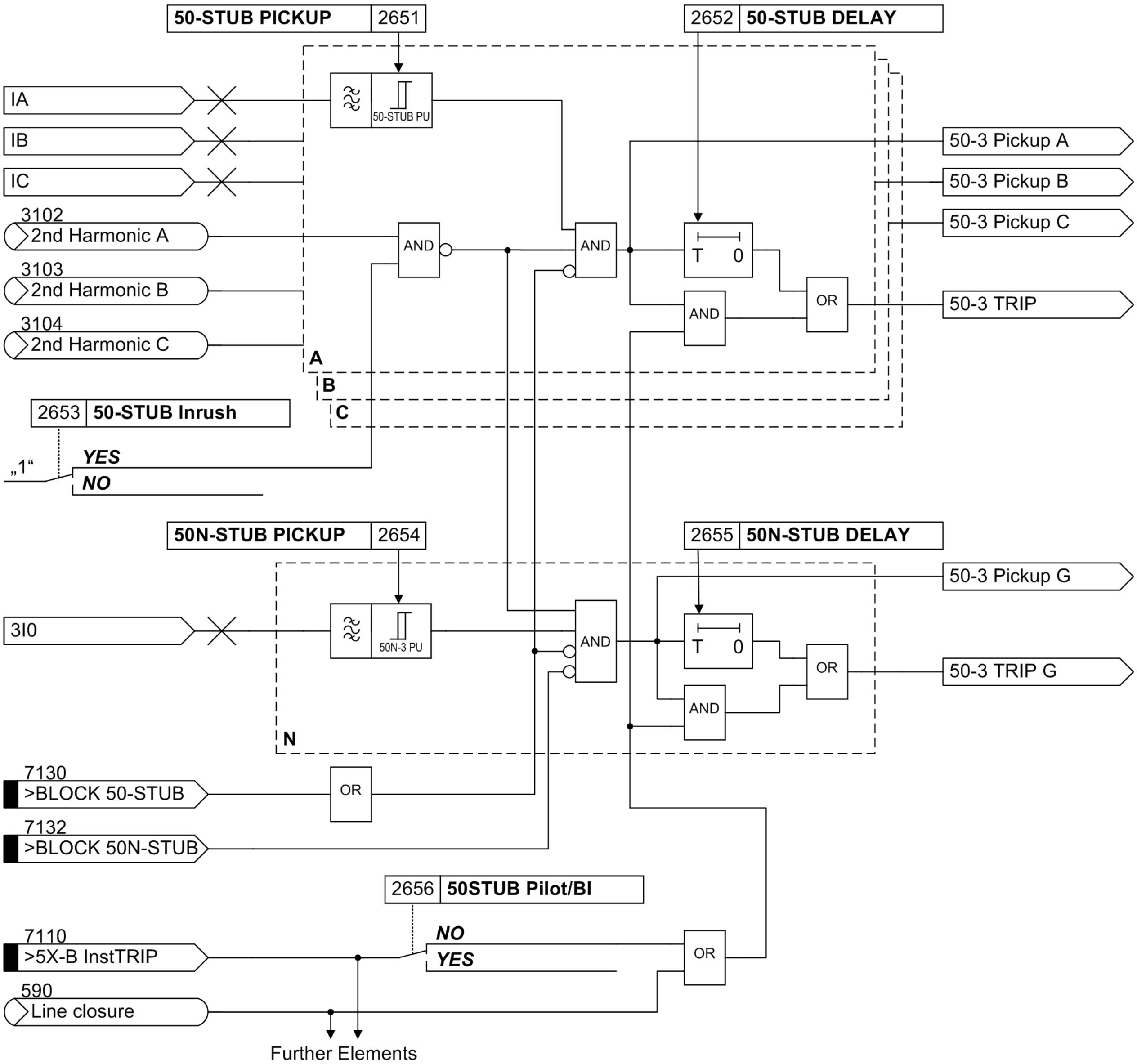


Figure 2-27 Logic diagram of the 50-3 element

Inverse Time Overcurrent Element 51

The logic of the inverse overcurrent element basically operates in the same way as the other elements. The time delay, however, is calculated based on the type of the set characteristic, the intensity of the current and a time multiplier (following figure). A pre-selection of the available characteristics was already carried out during the configuration of the protection functions. Furthermore, an additional constant time delay **`51-B AddT-DELAY`** or **`51N-B AddTdelay`** may be selected which is added to the inverse time. The possible characteristics are shown in the Technical Data.

The non-directional and the directional inverse time overcurrent element 51 always uses the same characteristic curve that is parameterized via 2642 (IEC) or 2643 (ANSI). Different inverse times and additional times can be parameterized here.

The following figure shows the logic diagram. The setting addresses of the IEC characteristic curves are shown by way of example. In the setting notes (Section 2.4.4), the different setting addresses are described in detail.

If parameter **51-B Inrush** (address 2637) is set to ***YES***, the element is blocked.

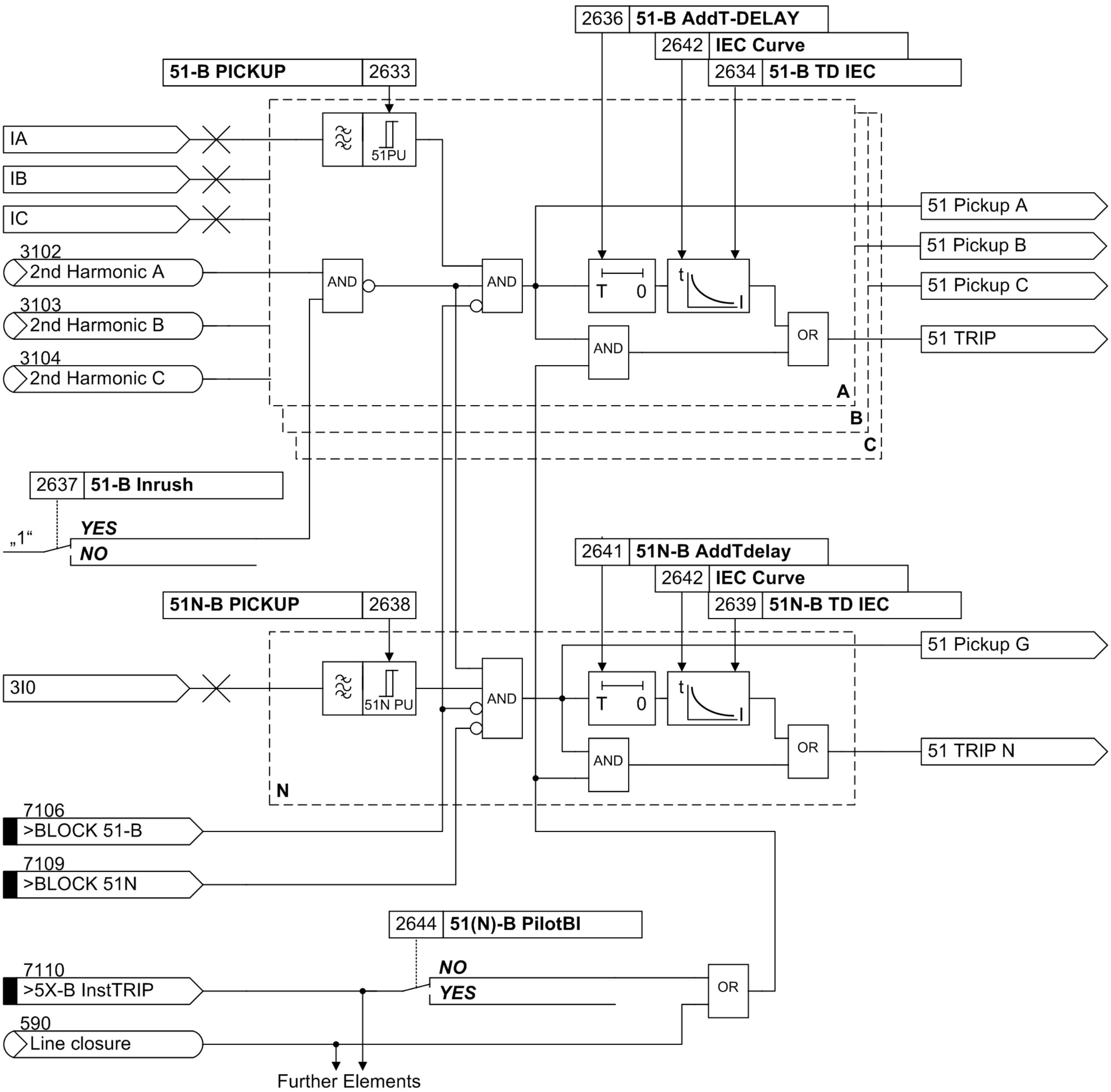


Figure 2-28 Logic diagram of the 51 element (inverse time overcurrent protection) - example for IEC characteristic

Pickup Logic and Tripping Logic

The pickup signals of the individual phases (or ground) and of the individual elements are interlinked in such a way that both the phase information and the element which has picked up are indicated (Table 2-1).

Table 2-1 Pickup signals of the single phases

Internal indication	Display	Output indication	No.
50-2 PU A 50-1 PU A 50-3 PU A 51 PU A	2-26 2-27 2-28	„5X-B Pickup ØA“	7162
50-2 PU B 50-1 PU B 50-3 PU B 51 PU B	2-26 2-27 2-28	„5X-B Pickup ØB“	7163
50-2 PU C 50-1 PU C 50-3 PU C 51 PU C	2-26 2-27 2-28	„5X-B Pickup ØC“	7164
50-2 PU N 50-1 PU N 50-3 PU N 51 PU N	2-26 2-27 2-28	„5X-B Pickup Gnd“	7165
50-1 PU A 50-1 PU B 50-1 PU C 50-1 PU N	2-26 2-26 2-26 2-26	„50(N)-B2 PICKUP“	7192
50-2 PU A 50-2 PU B 50-2 PU C 50-2 PU N	2-26 2-26 2-26 2-26	„50(N)-B1 PICKUP“	7191
50-3 PU A 50-3 PU B 50-3 PU C 50-3 PU N	2-27 2-27 2-27 2-27	„50-STUB PICKUP“	7201
51 PU A 51 PU B 51 PU C 51 PU N	2-28 2-28 2-28 2-28	„51(N)-B PICKUP“	7193
(All pickups)		„5X-B PICKUP“	7161

The trip is signaled specifically for each element, e.g. „`50(N)-B2 TRIP`“.

2.4.3 Directional Overcurrent Protection

Measured Quantities

The phase currents are fed to the device via the input transformers of the measuring input. The ground current $3I_0$ is calculated from the phase currents.

For the directional Iph> elements, the used measuring voltage is determined by the fault type.

The current phase-to-ground voltage is used

- for 1-phase or 3-phase faults,
- if the phase-to-ground voltage is > 4 V,
- not within the first 50 ms after short-circuit inception as the present voltage is disturbed by transients during this time.

The saved phase-to-ground voltage is used

- for 1-phase or 3-phase faults,
- up to max. 2 sec. after saving the phasors
- if there was not pickup before short-circuit occurrence.

The unfaulted phase-to-phase voltage is used

- for 1-phase faults
- for unfaulted phase-to-ground voltages
- if the voltage value is > 70% of the rated voltage.

The negative-sequence system quantities $\underline{V}_2$ and $\underline{I}_2$ are used

- for 1-phase or 2-phase faults
- if $\underline{I}_2$ > 50 mA and $\underline{V}_2$ > 5 V.

When using the negative-sequence system quantities, it is the short circuit with the higher current which determines the direction in case of two 1-phase short circuits.

If none of the above measured quantities is available, an already existing result of the direction determination is used or the directional element is blocked for the corresponding phase.

The behavior in the even to a measuring voltage failure can be set. The elements operate directionally or non-directionally.

The time overcurrent protection only operates directionally if all 3 phase-to-ground voltages are connected. Address 144 must be set to ***connected*** here.

Directional Characteristic

The directional characteristic of the directional overcurrent elements is fixed. The angle difference $\varphi(\underline{V}) - \varphi(\underline{I})$ is calculated from the voltage phasors and current phasors using the impedance $\underline{Z} = \underline{V}/\underline{I}$ and the direction is determined using the depicted directional characteristic.

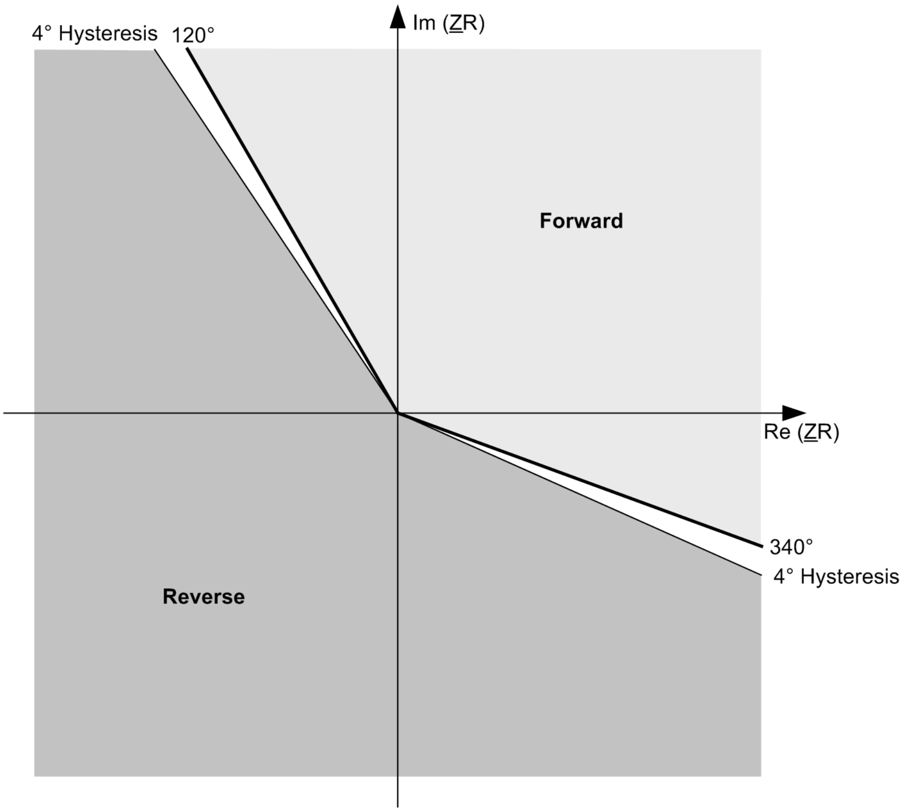


Figure 2-29 Directional characteristic of the time overcurrent protection

Definite Time Overcurrent Element 67-1

The directional overcurrent elements basically work in the same way as the non-directional elements. Pickup, however, depends on the result of the direction determination. The direction determination is accomplished using the measured quantities and the corresponding directional characteristics.

67-B2 PICKUP is used as setting values for the phase current; **67N-B2 PICKUP** is used for the ground current. A trip command is issued after pickup of an element and expiration of the associated time delays **67-B2 DELAY** or **67N-B2 DELAY**. The dropout value is approximately 7% below the pickup value, but at least 1.8% of the nominal current, below the pickup value.

Figure 2-30 shows the logic diagram of the 67-1 elements. They can be blocked via the binary input . Additionally, the ground current element can be blocked separately via the binary input „>BLOCK 67N-TOC“.

The binary input „>5X-B InstTRIP“ and the evaluation of the indication „switch“ (onto fault) can act separately on the directional phase and/or ground element.

Parameter **67(N)-B2 Pil/BI** (address 2628) determines whether a non-delayed trip of this element via binary input „>5X-B InstTRIP“ is possible (***YES***) or impossible (***NO***). This parameter is also used for instantaneous tripping before automatic reclosing.

The indications or are created from the individual directional indications (to) determined specifically for the phase or current if a valid direction was determined for a phase or ground current (forward or reverse). These indications can then be transmitted to another device where they can cause instantaneous tripping there if an overcurrent element of the receiving device has picked up, too. The indications must be linked via CFC to this end.

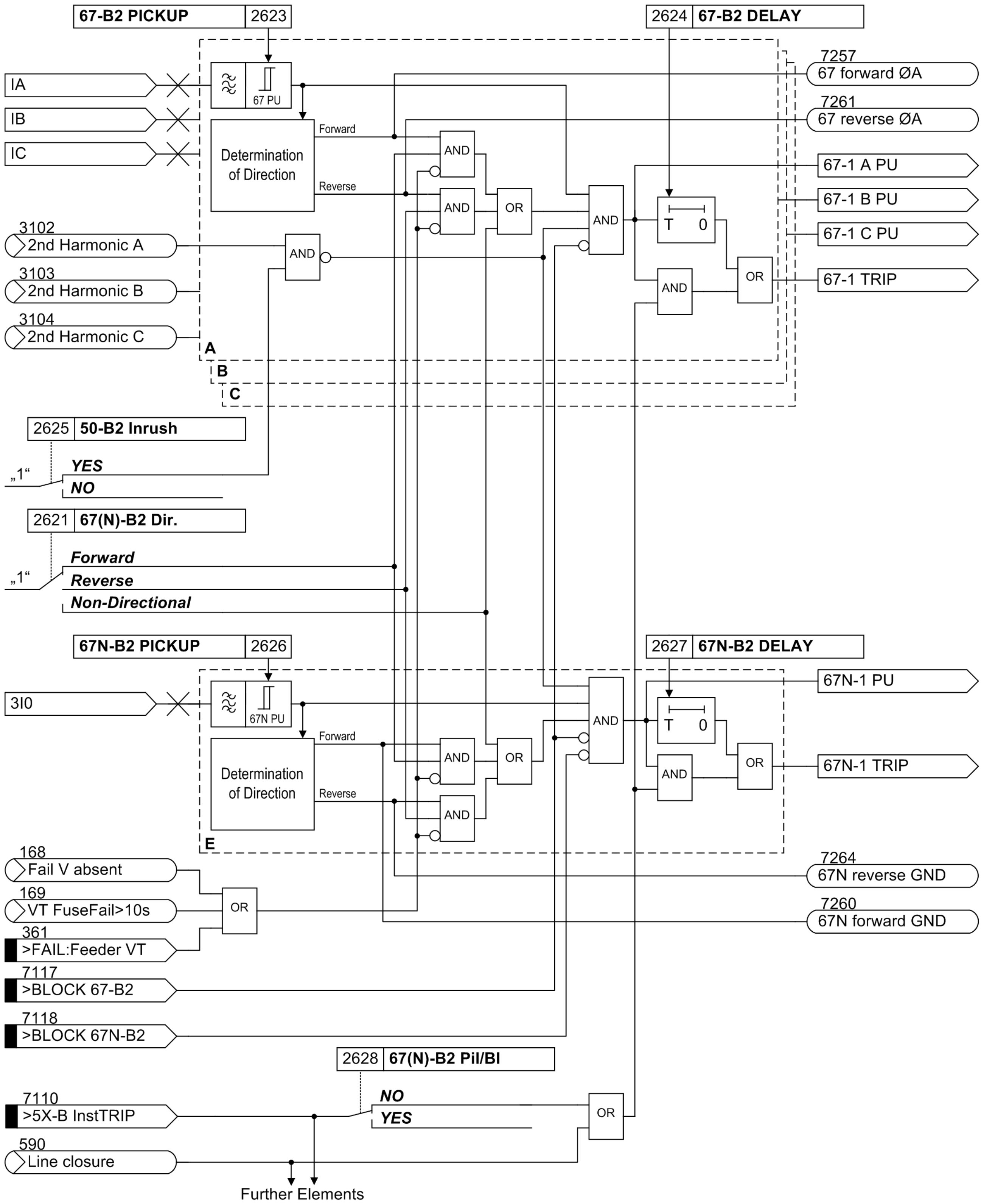


Figure 2-30 Logic diagram of the 67-1 element

Definite Time High-set Element 67-2

The directional overcurrent element basically works in the same way as the non-directional element. Pickup, however, depends on the result of the direction determination. The direction determination is accomplished using the measured quantities and the corresponding directional characteristics.

67-B1 PICKUP is used as setting values for the phase current; **67N-B1 PICKUP** is used for the ground current. A trip command is issued after pickup of an element and expiration of the associated time delays **67-B1 DELAY** or **50N-B1 DELAY**. The dropout value is approximately 7% below the pickup value, but at least 1.8% of the nominal current, below the pickup value.

Figure 2-30 shows the logic diagram of the 67-1 elements. The same applies analogously to the high-set current element 67-2.

Inverse Time Overcurrent Element 67-TOC

The logic of the inverse overcurrent element basically operates in the same way as that of the non-directional element. Pickup, however, depends on the result of the direction determination. The direction determination is accomplished using the measured quantities and the corresponding directional characteristics.

The time delay, however, is calculated based on the type of the set characteristic, the intensity of the current and the time factor **67-TOC TD ANSI** or **67N-TOC TD ANSI**. Furthermore, an additional constant time delay **67-TOC AddTDel.** or **67N-TOC AddTDel** may be selected which is added to the inverse time. The possible characteristics are shown in the Technical Data.

The indications or are created from the individual directional indications (to) determined for the phase and ground current provided that a valid directional result (forward or reverse) was determined for the phase or ground current. These indications can then be transmitted to another device where they can cause instantaneous tripping if an overcurrent element of the received device has picked up, too. The indications must be linked via CFC to this end.

The following figure shows the logic diagram of the directional 67-TOC element. The setting addresses for the IEC characteristics are shown by way of example. In the setting notes (Section 2.4.4), the different setting addresses are described in detail.

The non-directional and the directional inverse time overcurrent element 51 always uses the same characteristic curve that is parameterized via 2642 (IEC) or 2643 (ANSI). Different inverse times and additional times can be parameterized here.

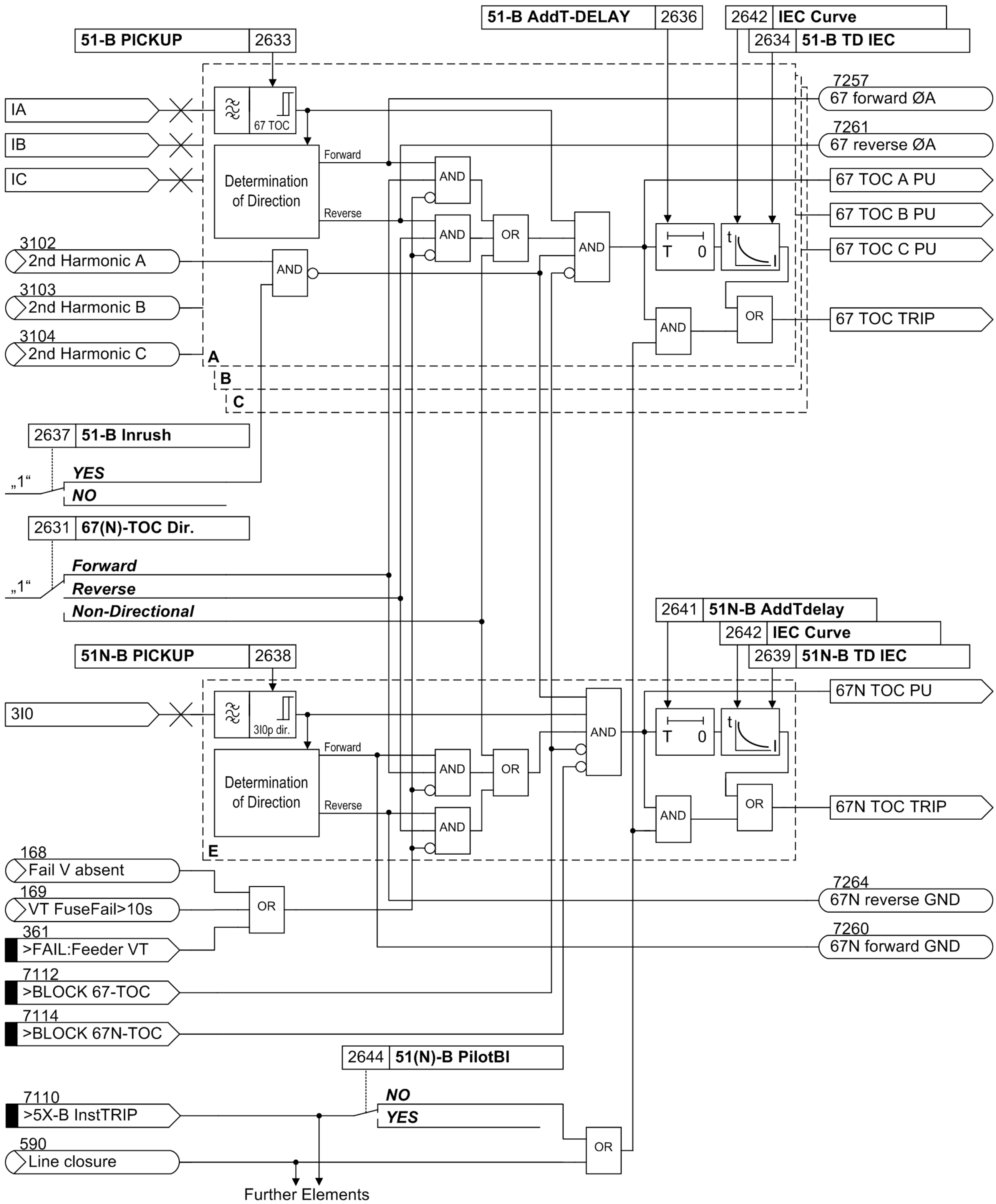


Figure 2-31 Logic diagram of the 67 TOC element (directional, inverse time overcurrent protection) - example for IEC characteristic

Pickup Logic and Tripping Logic

The pickup signals of the individual phases (or ground) and of the individual elements are interlinked in such a way that both the phase information and the element which has picked up are indicated (Table 2-1).

Table 2-2 Pickup signals of the single phases

Internal indication	Display	Output indication	No.
67-1 PU A 67-2 PU A 67-TOC PU A	2-30 2-31		
67-1 PU B 67-2 PU B 67-TOC PU B	2-30 2-31		
67-1 PU C 67-2 PU C 67-TOC PU C	2-30 2-31		
67-1 PU N 67-2 PU N 67-TOC PU N	2-30 2-31		
67-1 PU A 67-1 PU B 67-1 PU C 67-1 PU N	2-30 2-30 2-30 2-30	„67(N)-B2 PICKUP“	7251
67-2 PU A 67-2 PU B 67-2 PU C 67-2 PU N		„67(N)-B1 PICKUP“	7250
67-TOC PU A 67-TOC PU B 67-TOC PU C 67-TOC PU N	2-31 2-31 2-31 2-31	„67(N)-TOC PICK.“	7252
(All pickups)			

The trip is signaled specifically for each element, e.g. „`67(N)-B2 TRIP`“.

Behavior during Measuring Voltage Failure

An element-specific parameter, e.g. **`67(N)-B1 on FFM`** allows you to define how the directional overcurrent protection acts when the measuring voltage fails. The overcurrent protection then works either ***`Non-Directional`*** or it is .

2.4.4 Setting Notes

General

The setting notes described in the following apply to non-directional and directional overcurrent protection.

Operating Modes

You set the operating mode of the overcurrent protection elements specifically for each element. The setting applies collectively to the corresponding phase and ground element.

50-1, 3I0>	address 2620
50-2, 3I0>>	address 2610
50N, 3I0p	address 2630
50-3, 3I0>>>	address 2650

The following settings are possible:

- If set to ***ON***, the time overcurrent protection operates independently of the other protection functions as backup overcurrent protection.
- If set to ***Only Emer. prot***, the overcurrent protection operates as emergency function.
- Set to ***OFF***, the element is disabled.

Direction

The elements 50-1, 50-2 and 50N operate directionally and non-directionally.

The direction is set specifically for each element. The setting applies collectively to the corresponding phase and ground element.

50-1, 3I0>	address 2621
50-2, 3I0>>	address 2611
50N, 3I0p	address 2631

The following settings are possible:

- ***Non-Directional***
- ***Forward***
- ***Reverse***

The operating mode of the directional element in the event of measuring voltage failure is set specifically for each element. The setting applies collectively to the corresponding phase and ground element.

50-1, 3I0>	address 2622
50-2, 3I0>>	address 2612
50N, 3I0p	address 2632

The following settings are possible:

- ***Non-Directional***
- ***BLOCKED***

The 50-3 element always operates non-directionally.

Inrush Blocking

You can specify for each element of the overcurrent protection whether the element will be blocked when inrush is detected. The setting applies collectively to the corresponding phase and ground element.

50-1, 3I0>	address 2625
50-2, 3I0>>	address 2615
50N, 3I0p	address 2637
50-3, 3I0>>>	address 2653

Pickup Values

The elements can be combined. The pickup values are determined by the type of protected object.

The pickup values are set specifically for each element:

50-B2 PICKUP, **67-B2 PICKUP** address 2623

50N-B2 PICKUP, **67N-B2 PICKUP** address 2626

50-B1 PICKUP, **67-B1 PICKUP** address 2613

50N-B1 PICKUP, **67N-B1 PICKUP** address 2616

51-B PICKUP, **67-TOC PICKUP** address 2633

51N-B PICKUP, **67N-TOC PICKUP** address 2638

The setting of the current pickup value is basically determined by the maximum operational current. Pickup due to overload must be excluded as the device operates as short-circuit protection in this mode with correspondingly short command times and not as overload protection. A pickup value setting of about 10% is recommended for line protection, and a setting of about 20% of the expected peak load is recommended for transformers and motors.

The ground current elements detect the smallest anticipated ground fault current.

For very long lines with small source impedance or on applications with large reactances (e.g. transformers, series reactors), the 50-2 elements can also be used for current grading. In this case, they must be set such that they do not pickup reliably on a short circuit at the line end.

For the inverse time elements a safety margin between pickup value and setting value has already been implemented. Pick up only occurs at a current which is approximately 10% above the set value. Please bear this in mind when specifying the setting values of the inverse time elements.

If an element is not required, set the pickup value to ∞.

Time Delays

The time delays are set specifically for each element:

50-B2 DELAY, **67-B2 DELAY** addess 2624

50N-B2 DELAY, **67N-B2 DELAY** addess 2627

50-B1 DELAY, **67-B1 DELAY** addess 2614

50N-B1 DELAY, **67N-B1 DELAY** addess 2617

51-B TD IEC, **67-TOC TD IEC** addess 2634 (IEC characteristic)

51N-B TD IEC, **67N-TOC TD IEC** addess 2639 (IEC characteristic)

51-B TD ANSI, **67-TOC TD ANSI** addess 2635 (ANSI characteristic)

51N-B TD ANSI, **67N-TOC TD ANSI** addess 2640 (ANSI characteristic)

They are determined by the time grading chart created for the power system. If used as emergency overcurrent protection, shorter tripping times are advisable as this function is only activated in the case of the loss of the local measuring voltage.

The times for the ground current elements can be set shorter, according to a separate time grading chart for ground currents.

You can set additional time delays for definite-time elements with IEC characteristic.

51-B AddT-DELAY, **67-TOC AddTDel.** addess 2636

51N-B AddTdelay, **67N-TOC AddTDel** addess 2641

Instantaneous Tripping via Binary Input

Binary input „>5X-B InstTRIP“ allows you to bypass the time delays. The binary input applies to all elements collectively.

You can specify for each element whether instantaneous tripping takes effect. The setting applies collectively to the corresponding phase and ground element.

50-1, 3I0>	address 2628
50-2, 3I0>>	address 2618
50N, 3I0p	address 2644

The following settings are possible:

- If set to ***YES***, the element trips instantaneously when the binary input is activated.
- When set to ***NO***, the set time delays take effect.

Characteristic Curves for the 50N Element

During configuration of the scope of functions at address 126, the available characteristics were determined. Depending on the selection made there, only the parameters associated with this characteristic curve are accessible.

The inverse time elements enable the user to select different characteristic curves. Address 126 allows you to specify whether you work with IEC characteristics (***50(N) 51(N) IEC***) or ANSI characteristics(***50(N) 51(N)ANSI***).

If you work with IEC characteristics, you can select the following setting options at address 2642:

- ***Normal Inverse***
- ***Very Inverse***
- ***Extremely Inv.***
- ***LongTimeInverse***

If you work with ANSI characteristics, you can select the following setting options at address 2643:

- ***Inverse***
- ***Short Inverse***
- ***Long Inverse***
- ***Moderately Inv.***
- ***Very Inverse***
- ***Extremely Inv.***
- ***Definite Inv.***

The characteristics and equations they are based on are listed in the „Technical Data“. They apply for directional and non-directional elements alike.

2.4.5 Settings

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

The table indicates region-specific default settings. Column C (configuration) indicates the corresponding secondary nominal current of the current transformer.

Addr.	Parameter	C	Setting Options	Default Setting	Comments
2603A	67N dir. meas.		V0/I0 or V2/I2 with V0/I0 with V2/I2	V0/I0 or V2/I2	67N, Measurement of direction
2610	Op.Mode50(N)-B1		ON Only Emer. prot OFF	OFF	Operating Mode 50(N)-B1
2610	Op.Mode67(N)-B1		ON Only Emer. prot OFF	OFF	Operating Mode 67(N)-B1
2611	67(N)-B1 Dir.		Non-Directional Forward Reverse	Non-Directional	67(N)-B1 Direction
2612	67(N)-B1 on FFM		Non-Directional BLOCKED	BLOCKED	67(N)-B1 Direct. stage on Fuse Failure
2613	50-B1 PICKUP	1A	0.10 .. 25.00 A; ∞	2.00 A	50-B1 Pickup
		5A	0.50 .. 125.00 A; ∞	10.00 A	
2613	67-B1 PICKUP		0.10 .. 25.00 A; ∞	2.00 A	67-B1 Pickup threshold
2614	50-B1 DELAY		0.00 .. 30.00 sec; ∞	0.30 sec	50-B1 Delay
2614	67-B1 DELAY		0.00 .. 30.00 sec; ∞	0.30 sec	67-B1 set time delay
2615	50-B1 Inrush		NO YES	NO	50-B1 Inrush blocking
2615	67-B1 Inrush		NO YES	NO	67-B1 Inrush blocking
2616	50N-B1 PICKUP	1A	0.05 .. 25.00 A; ∞	0.50 A	50N-B1 Pickup
		5A	0.25 .. 125.00 A; ∞	2.50 A	
2616	67N-B1 PICKUP		0.05 .. 25.00 A; ∞	0.50 A	67N-B1 Pickup threshold
2617	50N-B1 DELAY		0.00 .. 30.00 sec; ∞	2.00 sec	50N-B1 Delay
2617	67N-B1 DELAY		0.00 .. 30.00 sec; ∞	2.00 sec	67N-B1 set time delay
2618	50(N)-B1 Pil/BI		NO YES	YES	Instantaneous trip via Pilot Prot./BI
2618	67(N)-B1 Pil/BI		NO YES	NO	Instantaneous trip via Pilot Prot./BI
2620	Op.Mode50(N)-B2		ON Only Emer. prot OFF	Only Emer. prot	Operating Mode 50(N)-B2
2620	Op.Mode67(N)-B2		ON Only Emer. prot OFF	Only Emer. prot	Operating Mode 67(N)-B2

Addr.	Parameter	C	Setting Options	Default Setting	Comments
2621	67(N)-B2 Dir.		Non-Directional Forward Reverse	Non-Directional	67(N)-B2 Direction
2622	67(N)-B2 on FFM		Non-Directional BLOCKED	BLOCKED	67(N)-B2 Direct. stage on Fuse Failure
2623	50-B2 PICKUP	1A	0.10 .. 25.00 A; ∞	1.50 A	50-B2 Pickup
		5A	0.50 .. 125.00 A; ∞	7.50 A	
2623	67-B2 PICKUP		0.05 .. 50.00 A; ∞	1.50 A	67-B2 Pickup threshold
2624	50-B2 DELAY		0.00 .. 30.00 sec; ∞	0.50 sec	50-B2 Delay
2624	67-B2 DELAY		0.00 .. 30.00 sec; ∞	0.50 sec	67-B2 set time delay
2625	50-B2 Inrush		NO YES	NO	50-B2 Inrush blocking
2625	67-B2 Inrush		NO YES	NO	67-B2 Inrush blocking
2626	50N-B2 PICKUP	1A	0.05 .. 25.00 A; ∞	0.20 A	50N-B2 Pickup
		5A	0.25 .. 125.00 A; ∞	1.00 A	
2626	67N-B2 PICKUP		0.05 .. 25.00 A; ∞	0.20 A	67N-B2 Pickup threshold
2627	50N-B2 DELAY		0.00 .. 30.00 sec; ∞	2.00 sec	50N-B2 Delay
2627	67N-B2 DELAY		0.00 .. 30.00 sec; ∞	2.00 sec	67N-B2 set time delay
2628	50(N)-B2 Pil/BI		NO YES	NO	Instantaneous trip via Pilot Prot./BI
2628	67(N)-B2 Pil/BI		NO YES	NO	Instantaneous trip via Pilot Prot./BI
2630	Op.Mode 51(N)-B		ON Only Emer. prot OFF	OFF	Operating Mode 51(N)-B
2630	Op.Mode67(N)TOC		ON Only Emer. prot OFF	OFF	Operating Mode 67(N)-TOC
2631	67(N)-TOC Dir.		Non-Directional Forward Reverse	Non-Directional	67(N)-TOC Direction
2632	67(N)-TOCon FFM		Non-Directional BLOCKED	BLOCKED	67(N)-TOC Direct. stage on Fuse Failure
2633	51-B PICKUP	1A	0.10 .. 4.00 A; ∞	∞ A	51-B Pickup
		5A	0.50 .. 20.00 A; ∞	∞ A	
2633	67-TOC PICKUP		0.10 .. 4.00 A; ∞	∞ A	67-TOC Pickup threshold
2634	51-B TD IEC		0.05 .. 3.00 sec; ∞	0.50 sec	51-B Time Dial for IEC characteristic
2634	67-TOC TD IEC		0.05 .. 3.00 sec; ∞	0.50 sec	67-TOC Time Dial for IEC characteristic
2635	51-B TD ANSI		0.50 .. 15.00 ; ∞	5.00	51-B Time Dial for ANSI characteristic

Addr.	Parameter	C	Setting Options	Default Setting	Comments
2635	67-TOC TD ANSI		0.50 .. 15.00 ; ∞	5.00	67-TOC Time Dial for ANSI characteristic
2636	51-B AddT-DELAY		0.00 .. 30.00 sec	5.00 sec	51-B Additional Time Delay
2636	67-TOC AddTDel.		0.00 .. 30.00 sec	5.00 sec	67-TOC Additional Time Delay
2637	51-B Inrush		NO YES	NO	51-B Inrush blocking
2637	67-TOC Inrush		NO YES	NO	67-TOC Inrush blocking
2638	51N-B PICKUP	1A	0.05 .. 4.00 A; ∞	∞ A	51N-B Pickup
		5A	0.25 .. 20.00 A; ∞	∞ A	
2638	67N-TOC PICKUP		0.05 .. 4.00 A; ∞	∞ A	67N-TOC Pickup thresh-old
2639	51N-B TD IEC		0.05 .. 3.00 sec; ∞	0.50 sec	51N-B Time Dial for IEC characteristic
2639	67N-TOC TD IEC		0.05 .. 3.00 sec; ∞	0.50 sec	67N-TOC Time Dial for IEC characteristic
2640	51N-B TD ANSI		0.50 .. 15.00 ; ∞	5.00	51N-B Time Dial for ANSI characteristic
2640	67N-TOC TD ANSI		0.50 .. 15.00 ; ∞	5.00	67N-TOC Time Dial for ANSI char.
2641	51N-B AddTdelay		0.00 .. 30.00 sec	0.00 sec	51N-B Additional Time Delay
2641	67N-TOC AddTDel		0.00 .. 30.00 sec	0.00 sec	67N-TOC Additional Time Delay
2642	IEC Curve		Normal Inverse Very Inverse Extremely Inv. LongTimeInverse	Normal Inverse	IEC Curve
2642	IEC Curve		Normal Inverse Very Inverse Extremely Inv. LongTimeInverse	Normal Inverse	IEC Curve
2643	ANSI Curve		Inverse Short Inverse Long Inverse Moderately Inv. Very Inverse Extremely Inv. Definite Inv.	Inverse	ANSI Curve
2643	ANSI Curve		Inverse Short Inverse Long Inverse Moderately Inv. Very Inverse Extremely Inv. Definite Inv.	Inverse	ANSI Curve

Addr.	Parameter	C	Setting Options	Default Setting	Comments
2644	51(N)-B PilotBI		NO YES	NO	Instantaneous trip via Pilot Prot./BI
2644	67(N)TOC Pil/BI		NO YES	NO	Instantaneous trip via Pilot Prot./BI
2650	50(N)-STUB OpMo		ON Only Emer. prot OFF	OFF	50(N)-STUB Operating Mode
2651	50-STUB PICKUP	1A	0.10 .. 25.00 A; ∞	1.50 A	50-STUB Pickup
		5A	0.50 .. 125.00 A; ∞	7.50 A	
2652	50-STUB DELAY		0.00 .. 30.00 sec; ∞	0.30 sec	50-STUB Delay
2653	50-STUB Inrush		NO YES	NO	50-STUB Inrush blocking
2654	50N-STUB PICKUP	1A	0.05 .. 25.00 A; ∞	0.20 A	50N-STUB Pickup
		5A	0.25 .. 125.00 A; ∞	1.00 A	
2655	50N-STUB DELAY		0.00 .. 30.00 sec; ∞	2.00 sec	50N-STUB Delay
2656	50STUB Pilot/BI		NO YES	NO	Instantaneous trip via Pilot Prot./BI

2.4.6 Information List

No.	Information	Type of Information	Comments
7104	>BLOCK 50-B1	SP	>BLOCK 50-B1 Backup OverCurrent
7105	>BLOCK 50-B2	SP	>BLOCK 50-B2 Backup OverCurrent
7106	>BLOCK 51-B	SP	>BLOCK 51-B Backup OverCurrent
7107	>BLOCK 50N-B1	SP	>BLOCK 50N-B1 Backup OverCurrent
7108	>BLOCK 50N-B2	SP	>BLOCK 50N-B2 Backup OverCurrent
7109	>BLOCK 51N	SP	>BLOCK 51N Backup OverCurrent
7110	>5X-B InstTRIP	SP	>50(N)/51(N) BackupO/C InstantaneousTrip
7112	>BLOCK 67-TOC	SP	>BLOCK Backup OverCurrent 67-TOC
7114	>BLOCK 67N-TOC	SP	>BLOCK Backup OverCurrent 67N-TOC
7115	>BLOCK 67-B1	SP	>BLOCK Backup OverCurrent 67-B1
7116	>BLOCK 67N-B1	SP	>BLOCK Backup OverCurrent 67N-B1
7117	>BLOCK 67-B2	SP	>BLOCK Backup OverCurrent 67-B2
7118	>BLOCK 67N-B2	SP	>BLOCK Backup OverCurrent 67N-B2
7130	>BLOCK 50-STUB	SP	>BLOCK 50-STUB
7132	>BLOCK 50N-STUB	SP	>BLOCK 50N-STUB
7152	5X-B BLOCK	OUT	50(N)/51(N) Backup O/C is BLOCKED
7153	5X-B ACTIVE	OUT	50(N)/51(N) Backup O/C is ACTIVE
7154	50(N)-B2 OFF	OUT	Backup O/C stage 50(N)-B2 is sw. OFF
7155	50(N)-B1 OFF	OUT	Backup O/C stage 50(N)-B1 is sw. OFF
7156	50(N)-STUB OFF	OUT	Backup O/C stage 50(N)-STUB is sw. OFF
7157	51(N)-B OFF	OUT	Backup O/C stage 51(N)-B is sw. OFF
7161	5X-B PICKUP	OUT	50(N)/51(N) Backup O/C PICKED UP

No.	Information	Type of Information	Comments
7162	5X-B Pickup ØA	OUT	50(N)/51(N) Backup O/C PICKUP Phase A
7163	5X-B Pickup ØB	OUT	50(N)/51(N) Backup O/C PICKUP Phase B
7164	5X-B Pickup ØC	OUT	50(N)/51(N) Backup O/C PICKUP Phase C
7165	5X-B Pickup Gnd	OUT	50(N)/51(N) Backup O/C PICKUP GROUND
7191	50(N)-B1 PICKUP	OUT	50(N)-B1 Pickup
7192	50(N)-B2 PICKUP	OUT	50(N)-B2 Pickup
7193	51(N)-B PICKUP	OUT	51(N)-B Pickup
7201	50-STUB PICKUP	OUT	50-STUB Pickup
7211	5X-B TRIP	OUT	50(N)/51(N)-B General TRIP command
7221	50(N)-B1 TRIP	OUT	50(N)-B1 TRIP
7222	50(N)-B2 TRIP	OUT	50(N)-B2 TRIP
7223	51(N)-B TRIP	OUT	51(N)-B TRIP
7235	50-STUB TRIP	OUT	50-STUB TRIP
7250	67(N)-B1 PICKUP	OUT	67(N)-B1 Pickup
7251	67(N)-B2 PICKUP	OUT	67(N)-B2 Pickup
7252	67(N)-TOC PICK.	OUT	67(N)-TOC Pickup
7253	67(N) TRIP	OUT	67(N) General TRIP command
7254	67(N)-B1 TRIP	OUT	67(N)-B1 TRIP
7255	67(N)-B2 TRIP	OUT	67(N)-B2 TRIP
7256	67(N)-TOC TRIP	OUT	67(N)-TOC TRIP
7257	67 forward ØA	OUT	67 Phase A forward
7258	67 forward ØB	OUT	67 Phase B forward
7259	67 forward ØC	OUT	67 Phase C forward
7260	67N forward GND	OUT	67N Gnd forward
7261	67 reverse ØA	OUT	67 Phase A reverse
7262	67 reverse ØB	OUT	67 Phase B reverse
7263	67 reverse ØC	OUT	67 Phase C reverse
7264	67N reverse GND	OUT	67N Gnd forward
7265	67(N) forward	OUT	67(N) forward
7266	67(N) reverse	OUT	67(N) reverse
7267	>67(N) InstTRIP	SP	>67(N) BackupO/C InstantaneousTrip
17530	67(N) BLOCK	OUT	67(N) Backup O/C is BLOCKED
17531	67(N) ACTIVE	OUT	67(N) Backup O/C is ACTIVE
17532	67(N)-B2 OFF	OUT	Backup O/C stage 67(N)-B2 is sw. OFF
17533	67(N)-B1 OFF	OUT	Backup O/C stage 67(N)-B1 is sw. OFF
17534	67(N)-TOC OFF	OUT	Backup O/C stage 67(N)-TOC is sw. OFF
17535	67(N) PICKUP	OUT	67(N) Backup O/C PICKED UP
17536	67 Pickup ØA	OUT	67 Backup O/C PICKUP Phase A
17537	67 Pickup ØB	OUT	67 Backup O/C PICKUP Phase B
17538	67 Pickup ØC	OUT	67 Backup O/C PICKUP Phase C
17539	67N Pickup Gnd	OUT	67N Backup O/C PICKUP GROUND

2.5 Inrush Restraint

2.5.1 Description

If the protected zone of the device reaches beyond a transformer, a high inrush current must be anticipated when switching on the transformer. This current flows into the protected zone, but does not leave it again.

The inrush current can amount to a multiple of the rated current and is characterized by a considerable 2nd harmonic content (double rated frequency) which is practically absent during a short circuit. If the second harmonic content in the differential current exceeds a selectable threshold, tripping is blocked.

The inrush restraint has an upper limit: It no longer takes effect when a (configurable) current value is surpassed since, in this case, it can only be an internal high-current fault.

Figure 2-32 shows a simplified logic diagram. The condition for the inrush current detection is examined in each device in which this function has been activated. The blocking condition is transmitted to the other device so that it is effective at both ends of the protected object.

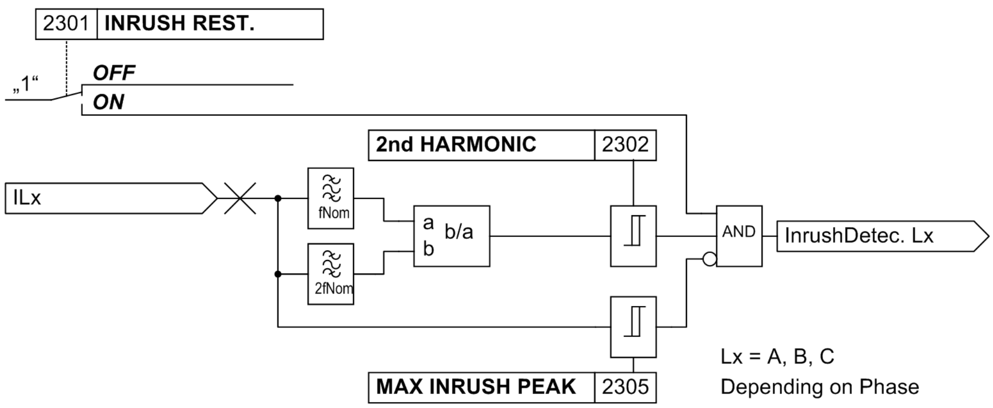


Figure 2-32 Logic diagram of the inrush restraint for one phase

Since the inrush restraint operates individually for each phase, the protection is fully operative when the transformer is switched onto a single-phase fault, in which case it is possible for an inrush current to flow through one of the undisturbed phases. It is, however, also possible to set the protection in such a way that when the permissible harmonic content in the current of only one single phase is exceeded, not only the phase with the inrush current but also the remaining phases of the differential stage are blocked. This cross-block function can be limited to a selectable duration. Figure 2-33 shows the logic diagram.

The cross-block function also affects both devices since it not only extends the inrush current detection to all three phases but also sends it to the other device via the communication link.

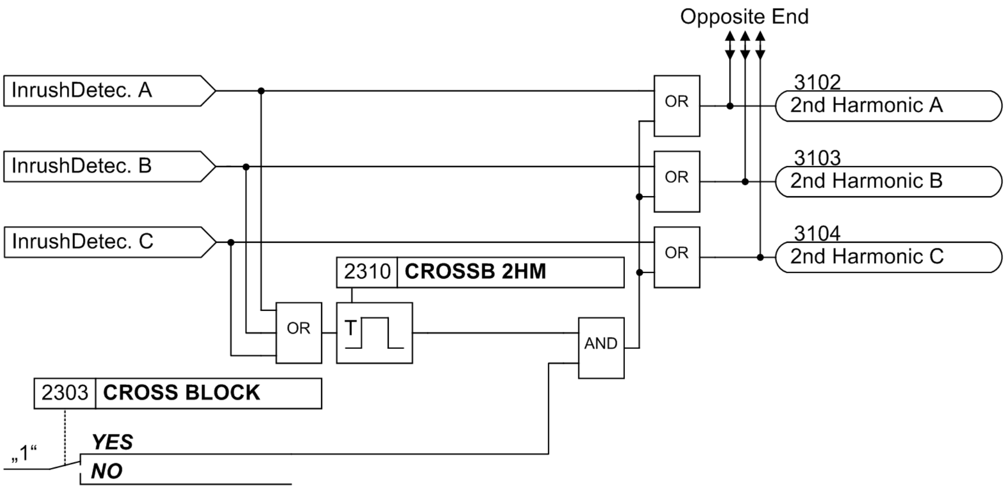


Figure 2-33 Logic diagram of the cross-block function for one end

2.5.2 Setting Notes

The inrush current detection is required for the following applications:

- For the differential protection if an inductance is located in the protected zone.
- For the time overcurrent protection if a transformer is located in the protected zone or if the protected line ends on a transformer.

Inrush current detection can be turned ***ON*** or ***OFF*** at address 2301 **INRUSH REST.**.

It is based on the evaluation of the second harmonic which exists in the inrush current. Ex-works a ratio of **15 %** of the **2nd HARMONIC** I_{2fN}/I_{fN} is set under address 2302, which can normally be taken over. However, the component required for restraint can be parameterized. In order to be able to achieve a higher degree of restraint in case of exceptionally unfavorable inrush conditions, you may also set a smaller value.

However, if the local measured current exceeds a value set in address 2305 **MAX INRUSH PEAK**, there will be no inrush restraint. The peak value is decisive. The set value should be higher than the maximum inrush current peak value that can be expected. For transformers set the value above $\sqrt{2} \cdot I_{NTransf.}/u_{kTransf.}$. If a line ends on a transformer, a smaller value may be selected, considering the damping of the current by the line impedance.

The crossblock function can be activated (***YES*** or deactivated (***NO***) in address 2303 **CROSS BLOCK**. The time after exceeding of the current threshold for which this crossblock is to be activated is set under address 2310 **CROSSB 2HM**. With the setting ∞ the crossblock function is always active until the second harmonic content in all phases has dropped below the set value.

2.5.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
2301	INRUSH REST.	OFF ON	OFF	Inrush Restraint
2302	2nd HARMONIC	10 .. 45 %	15 %	2nd. harmonic in % of fundamental
2303	CROSS BLOCK	NO YES	NO	Cross Block
2305	MAX INRUSH PEAK	1.1 .. 25.0 A	15.0 A	Maximum inrush-peak value
2310	CROSSB 2HM	0.00 .. 60.00 sec; ∞	0.00 sec	Time for Crossblock with 2nd harmonic

2.5.4 Information List

No.	Information	Type of Information	Comments
3102	2nd Harmonic A	OUT	Tolerance invalid in phase A
3103	2nd Harmonic B	OUT	Tolerance invalid in phase B
3104	2nd Harmonic C	OUT	Tolerance invalid in phase C

2.6 Circuit-Breaker Failure Protection 50BF

The circuit-breaker failure protection provides rapid backup fault clearance in the event that the circuit breaker fails to respond to a trip command from a protection function of the local circuit breaker.

2.6.1 Description

General

Each time a fault protection relay of a feeder issues a trip command to the circuit breaker, it is repeated to the breaker failure protection (Figure 2-34). A timer T–BF in the breaker failure protection is started. The timer runs as long as a trip command is present and current continues to flow through the breaker poles.

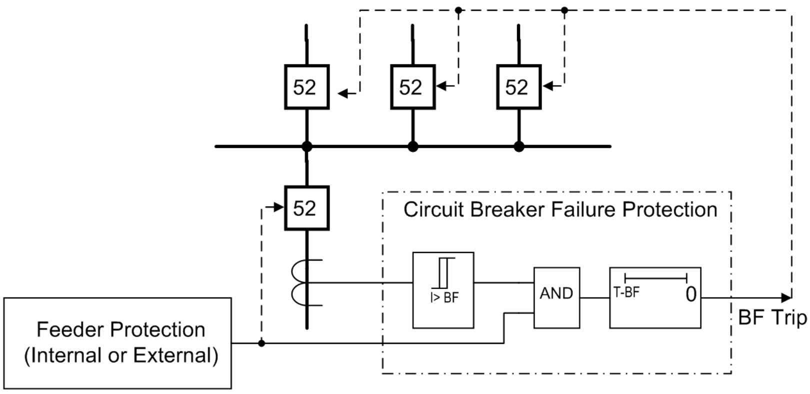


Figure 2-34 Simplified function diagram of circuit-breaker failure protection with current flow monitoring

Normally, the breaker will open and interrupt the fault current. The current monitoring element quickly resets (typical 10 ms) and stops the timer T–BF.

If the trip command is not carried out (breaker failure case), current continues to flow and the timer runs to its set limit. The breaker failure protection then issues a command to trip the backup breakers and interrupt the fault current.

The reset time of the feeder protection is not relevant because the breaker failure protection itself recognizes the interruption of the current.

For protection functions where the tripping criterion is not dependent on current (e.g. Buchholz protection), current flow is not a reliable criterion for proper operation of the breaker. In such cases, the circuit-breaker position can be derived from the auxiliary contacts of the breaker. Therefore, instead of monitoring the current, the condition of the auxiliary contacts is monitored (see Figure 2-35). For this purpose, the outputs from the auxiliary contacts must be fed to binary inputs on the relay (refer also to Subsection 2.16).

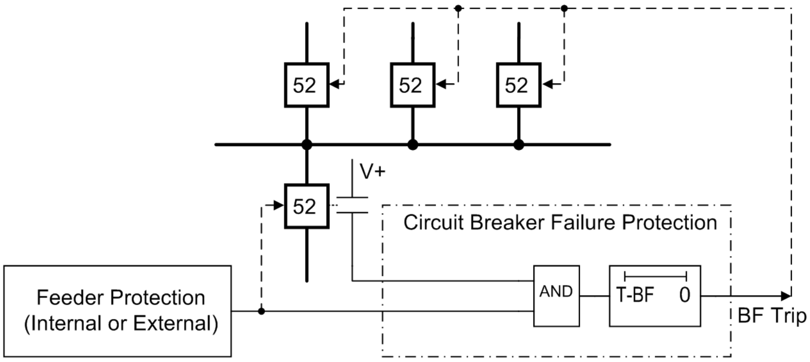


Figure 2-35 Simplified function diagram of circuit-breaker failure protection controlled by circuit-breaker auxiliary contact

Monitoring the Current Flow

Each of the phase currents and an additional plausibility current (see below) are filtered by numerical filter algorithms so that only the fundamental component is used for further evaluation.

Special measures are taken in order to detect a current interruption. In case of sinusoidal currents the current interruption is detected after approximately 10 ms. With aperiodic DC current components in the fault current and/or in the current transformer secondary circuit after interruption (e.g. current transformers with linearized core), or saturation of the current transformers caused by the DC component in the fault current, it can take one AC cycle before the interruption of the primary current is reliably detected.

The currents are monitored and compared with the set limit value. Besides the three phase currents, two additional current thresholds are provided in order to allow a plausibility check. For this plausibility check, a separate threshold value can be used if the configuration is made accordingly (see Figure 2-36).

As plausibility current, the ground current (residual current I_E ($3 \cdot I_0$) is preferably used. If the residual current from the neutral of the current transformer set is connected to the device it is used. If the residual current is not available, the device calculates it with the formula:

$$3 \cdot \underline{I}_0 = \underline{I}_A + \underline{I}_B + \underline{I}_C$$

Additionally, the value calculated by 7SD80 of three times the negative sequence current $3 \cdot I_2$ is used for plausibility check. This is calculated according to the equation:

$$3 \cdot \underline{I}_2 = \underline{I}_A + \underline{a}^2 \cdot \underline{I}_B + \underline{a} \cdot \underline{I}_C$$

where

$$\underline{a} = e^{j120°}.$$

These plausibility currents do not have any direct influence on the basic function of the breaker failure protection but they allow a plausibility check that at least two current thresholds must be exceeded before any of the time delays are started.

In case of high-resistance ground faults, it can happen that the ground current exceeds the sensitive threshold value **50NBF PICKUP** (address 3912) whereas the phase current involved in the short circuit does not exceed the threshold value **50BF PICKUP** (address 3902). The plausibility check would prevent the start of the breaker failure protection. In this case, the pickup threshold of the phase current monitoring **50BF PICKUP** can be switched to the threshold value **50NBF PICKUP**. Use the binary input 1404 „>50BF 3I0>“ for this purpose. This binary input is linked to an external signal that is suggestive of a high-resistance fault, e.g. ground fault or displacement voltage detected. The ground current threshold that is set more sensitive is thus also used for monitoring the phase currents (Figure 2-36).

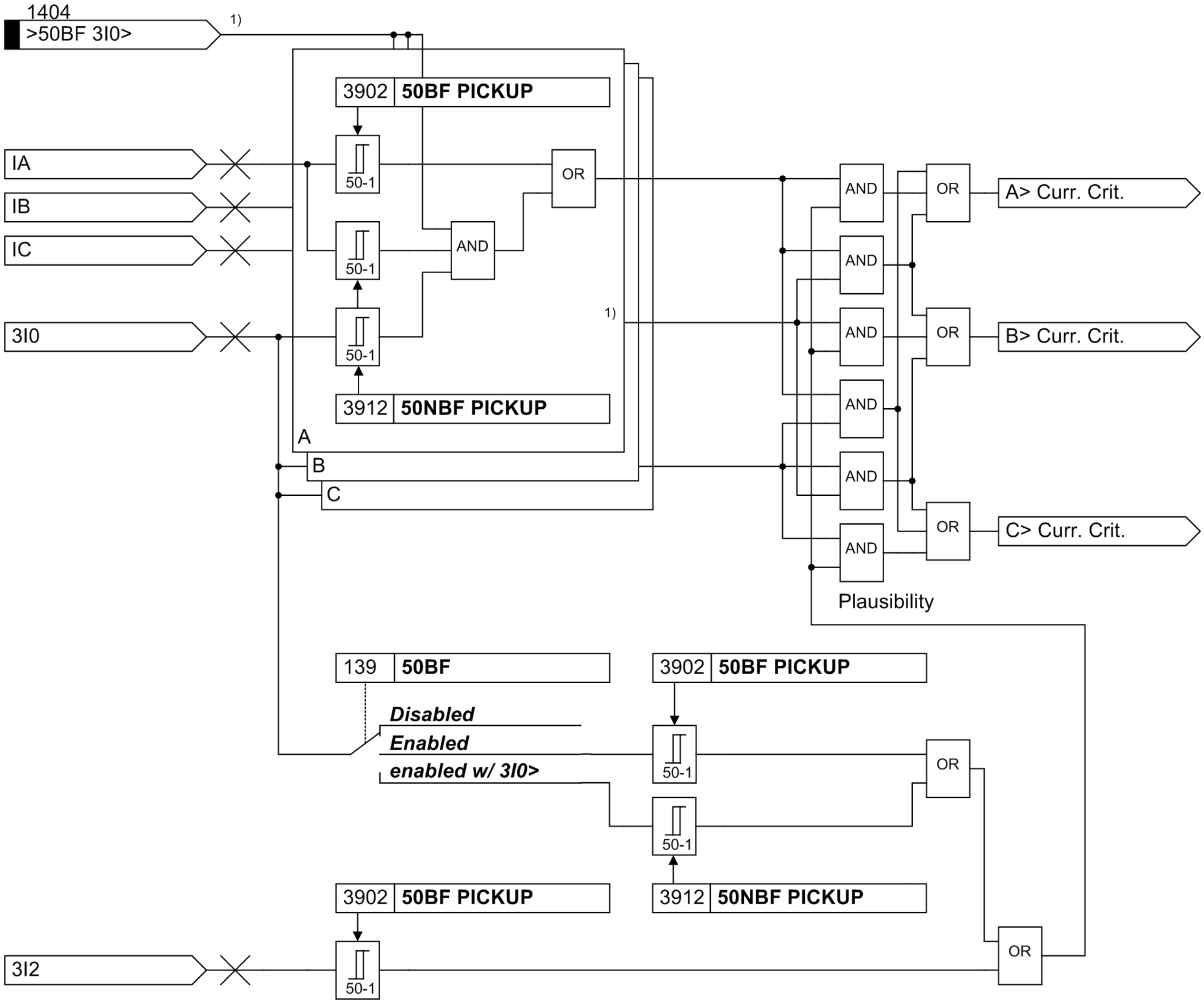


Figure 2-36 Current flow monitoring with plausibility currents $3 \cdot I_0$ and $3 \cdot I_2$

1) only usable/visible if address 139 is set to ***enabled w/ 3I0>***

In-Phase Start

Common phase initiation is used for transformer feeders or if the busbar protection trips.

If the breaker failure protection is intended to be initiated by further external protection devices, it is recommended, for security reasons, to connect two starting criteria to the device. Besides the trip command of the external relay to the binary input „>50BF Start 3p“ (FNo. 1415) it is recommended to connect also the general device pickup to binary input „>50BF release“ (FNo. 1432). For Buchholz protection it is recommended that the trip command is connected to the device by two separate wire pairs.

Nevertheless, it is possible to initiate the breaker failure protection in single-channel mode should a separate release criterion not be available. The binary input „>50BF release“ (FNo. 1432) must then not be assigned to any physical input of the device during configuration.

Figure 2-38 shows the operating principle. When the trip signal appears from any internal or external feeder protection and at least one current flow criterion (according to Figure 2-36) is present, the breaker failure protection is initiated and the corresponding time delay(s) is (are) started.

If the current criterion is not satisfied for any of the phases, the circuit-breaker auxiliary contact can be interrogated according to figure 2-37. After a 3-pole trip command, the circuit breaker has only operated correctly when no current flows over any of the poles.

Figure 2-37 shows the generation of the internal signal „52 closed“ (see figure 2-38 left) if at least one breaker pole is closed.

Using binary input 1424 „>50BFSTRTonlyT2“, the trip time delay 3906 **50BF-2 Delay** can be started. After it has elapsed, the breaker failure protection TRIP command 1494 „50BF BusTrip“ is generated.

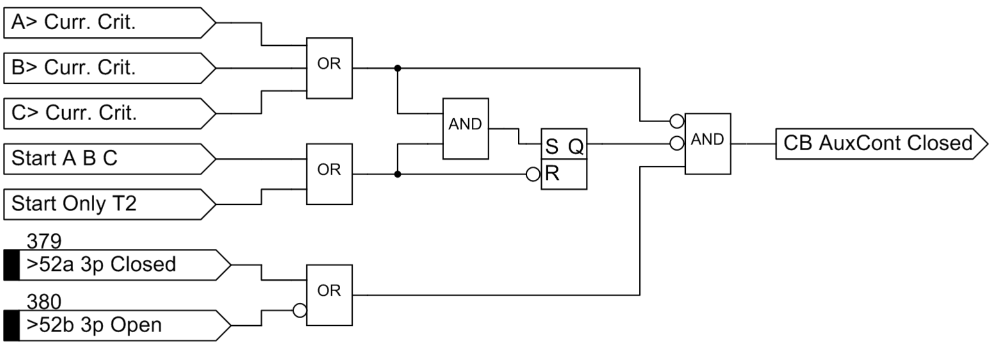


Figure 2-37 Generation of the signal "CB aux closed"

If an internal protection function or an external protection device trips without current flow, the breaker failure protection is initiated by the internal input „Start internal w/o I“, if the trip signal comes from the internal voltage protection or frequency protection, or by the external input „>50BF STARTw/oI“. In this case the start signal is maintained until the circuit breaker is signaled to be open by the auxiliary contact criterion.

Initiation can be blocked via the binary input „>BLOCK 50BF“ (e.g. during test of the feeder protection relay).

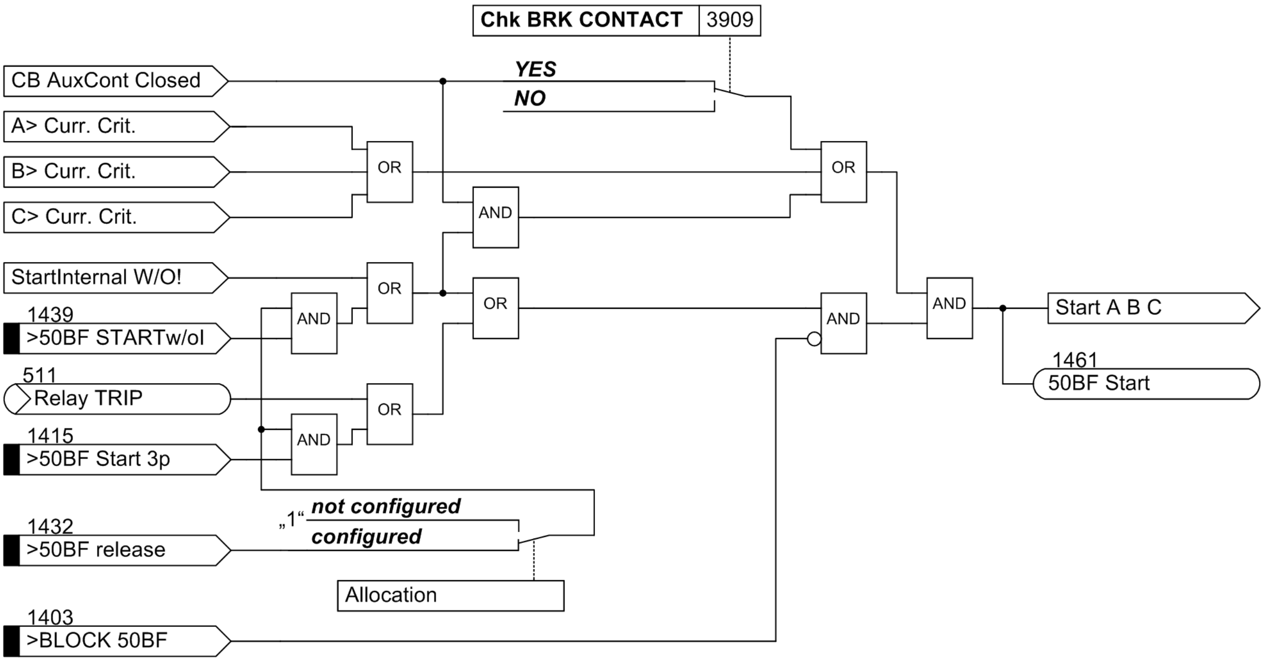


Figure 2-38 Circuit-breaker failure protection with common phase initiation

Time Delays

When the initiate conditions are fulfilled, the associated timers are started. The circuit-breaker pole(s) must open before the associated time has elapsed.

Time delays can be set for 3-pole initiation and for two-element protection.

With single-element breaker failure protection, the trip command is relayed to the adjacent circuit breakers which interrupt the fault current if the local feeder breaker fails (see Figure 2-34 and Figure 2-35). The adjacent circuit breakers are those located at the busbar or busbar section to which the feeder under consideration is connected. The possible initiation conditions for the breaker failure protection are those discussed above. Depending on the application of the feeder protection, common phase or phase-segregated initiation conditions may occur. Tripping by the breaker failure protection is always 3-pole.

T2 is used as time delay.

With two-element breaker failure protection, the trip command of the feeder protection is usually repeated, after a first time element, to the feeder circuit breaker, often via a second trip coil or set of trip coils, if the breaker has not responded to the original trip command. A second time element monitors the response to this repeated trip command and trips the breakers of the relevant bus-bar section, if the fault has not yet been cleared after this second time.

The time delay T2 is started after the T1 timer has expired if address 3913 **T2StartCriteria** = ***With exp. of T1***.

If address 3913 **T2StartCriteria** = ***Parallel withT1***, T1 and T2 are started simultaneously. The T2 timer can be started by a separate binary input 1424„>50BFSTRTonlyT2“.

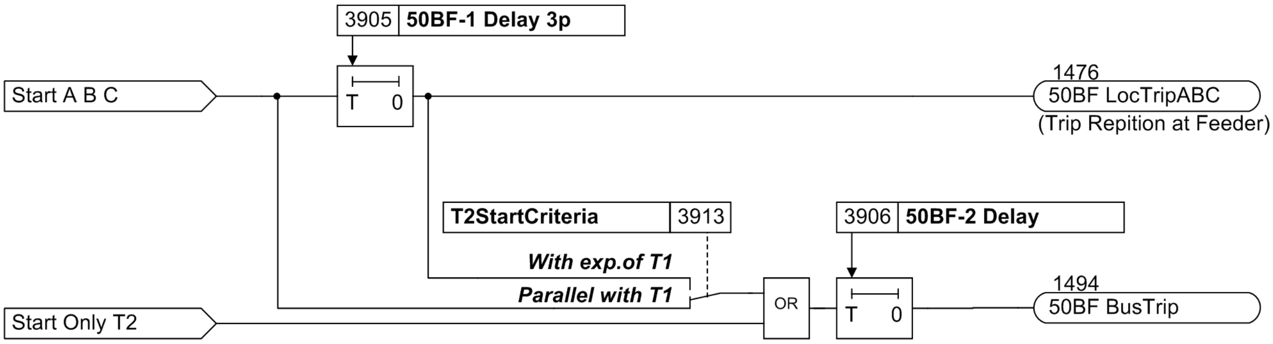


Figure 2-39 Logic diagram of the two-element circuit-breaker failure protection

Circuit-Breaker Malfunction

There may be cases when it is already obvious that the circuit breaker associated with a feeder protection relay cannot clear a fault, e.g. when the tripping voltage or the tripping energy is not available.

In such a case it is not necessary to wait for the response of the feeder circuit breaker. If provision has been made for the detection of such a condition (e.g. control voltage monitor or air pressure monitor), the monitor alarm signal can be fed to the binary input „`>52 faulty`“ of the 7SD80. On occurrence of this alarm and a trip command by the feeder protection, a separate timer **`T3-BkrDefective`**, which is normally set to 0, is started (Figure 2-40). Thus, the adjacent circuit breakers (bus-bar) are tripped immediately in case the feeder circuit breaker is not operational.

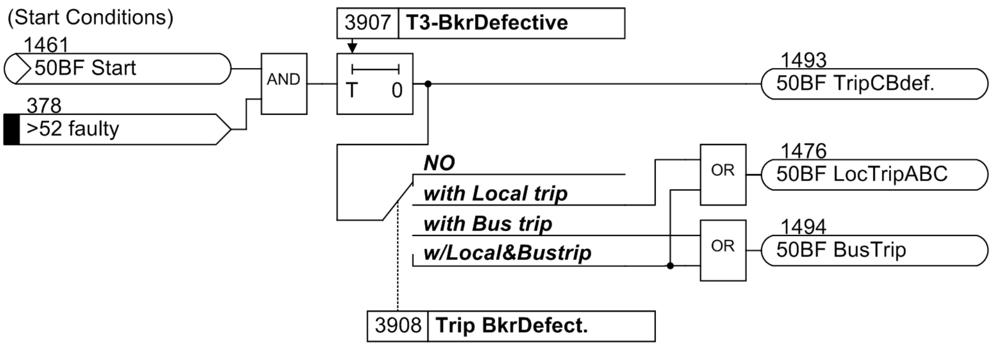


Figure 2-40 Circuit-breaker faulty

Transfer Trip to the Remote End Circuit Breaker

The device has the facility to provide an additional intertrip signal to the circuit breaker at the remote line end in the event that the local feeder circuit breaker fails. For this, a suitable protection signal transmission link is required (e.g. via communication cable, power line carrier transmission, radio transmission, or optical fiber transmission). With devices using digital transmission via protection interface, the remote commands can be applied (see also Section 2.13).

To realize this intertrip, the desired command – usually the trip command which is intended to trip the adjacent breakers — is assigned to a binary output of the device. The contact of this output triggers the transmission device. When using digital signal transmission the command is connected to a remote command via the user-defined logic (CFC).

End Fault Protection

An end fault is defined here as a fault which has occurred at the end of a line or protected object, between the circuit breaker and the current transformer set.

This situation is shown in Figure 2-41. The fault is located — as seen from the current transformer (= measurement location) — on the busbar side, it will thus not be regarded as a feeder fault by the feeder protection device. It can only be detected by either a reverse element of the feeder protection or by the busbar protection. However, a trip command given to the feeder circuit breaker does not clear the fault since the opposite end continues to feed the fault. Thus, the fault current does not stop flowing even though the feeder circuit breaker has properly responded to the trip command.

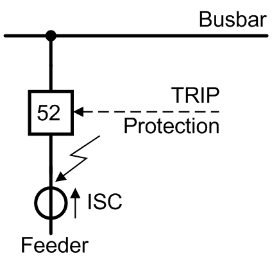


Figure 2-41 End fault between circuit breaker and current transformers

The end fault protection has the task to recognize this situation and to transmit a trip signal to the remote end(s) of the protected object to clear the fault. For this purpose, the output command „`50BF EndFltTrip`“ is available to trigger a signal transmission device (e.g. power line carrier, radio wave, or optical fiber) – if applicable, together with other commands that need to be transferred or (when using digital signal transmission) as command via the protection data interface.

The end fault protection detects an end fault because it registers that current is flowing even though the circuit-breaker auxiliary contacts signal that the circuit breaker is open. An additional criterion is the presence of any breaker failure protection initiate signal. Figure 2-42 shows the functional principle. If the breaker failure protection is initiated and current flow is detected (current criteria „L*> current criterion“ according to Figure 2-36), but no circuit-breaker pole is closed (auxiliary contact criterion „52 closed“), the timer **`EndFault Delay`** is started. At the end of this time, a trip command is sent to the opposite end.

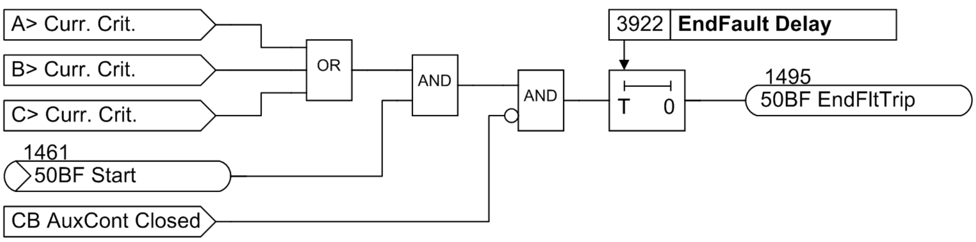


Figure 2-42 Functional diagram of the end fault protection

2.6.2 Setting Notes

General

The circuit-breaker failure protection and its ancillary functions (end fault protection, pole discrepancy supervision) can only operate if they were set during configuration of the scope of functions (address 139 **50BF**, setting ***Enabled*** or ***enabled w/ 3I0>***).

Breaker Failure Protection (50BF)

The breaker failure protection is switched ***ON*** or ***OFF*** at address 3901 **FCT 50BF Break.**.

The current threshold **50BF PICKUP** (address 3902) should be selected such that the protection will operate with the smallest expected fault current. A setting of 10 % below the minimum fault current for which breaker failure protection must operate is recommended. On the other hand, the value should not be set lower than necessary.

If the breaker failure protection is configured with zero sequence current threshold (address 139 = ***enabled w/ 3I0>***), the pickup threshold for the zero sequence current **50NBF PICKUP** (address 3912) can be set independently of **50BF PICKUP**.

Normally, the breaker failure protection evaluates the current flow criterion as well as the position of the breaker auxiliary contact(s). If the auxiliary contact(s) status is not available in the device, this criterion cannot be processed. In this case, set address 3909 **Chk BRK CONTACT** to ***NO***.

Two-Element Breaker Failure Protection

With two-element operation, the trip command is repeated after a time delay T1 to the local feeder breaker, normally to a different set of trip coils of this breaker.

If the circuit breaker does not respond to this trip repetition, the adjacent circuit breakers are tripped after T2, i.e. the circuit breakers of the busbar or of the concerned busbar section and, if necessary, also the circuit breaker at the remote end unless the fault has been cleared.

The time delays can be set separately

- for trip repetition to the local feeder circuit breaker after a trip of the feeder protection **50BF-1 Delay 3p** (address 3905),
- for trip of the adjacent circuit breakers (busbar zone and remote end if applicable) **50BF-2 Delay** at address 3906.

The time delays to be set should be based on the maximum circuit-breaker operating time plus the dropout time of the current flow monitoring element plus a safety margin which takes into consideration the tolerance of the time delay. Figure 2-43 illustrates the time sequences in an example. The dropout time for sinusoidal currents is ≤ 15 ms. If current transformer saturation is anticipated, the time should be set to 25 ms.

Note

To prevent automatic reclosing after „50BF BusTrip“, you can set the time 3408 **T-Start MONITOR** so that it elapses together with **50BF-2 Delay**.

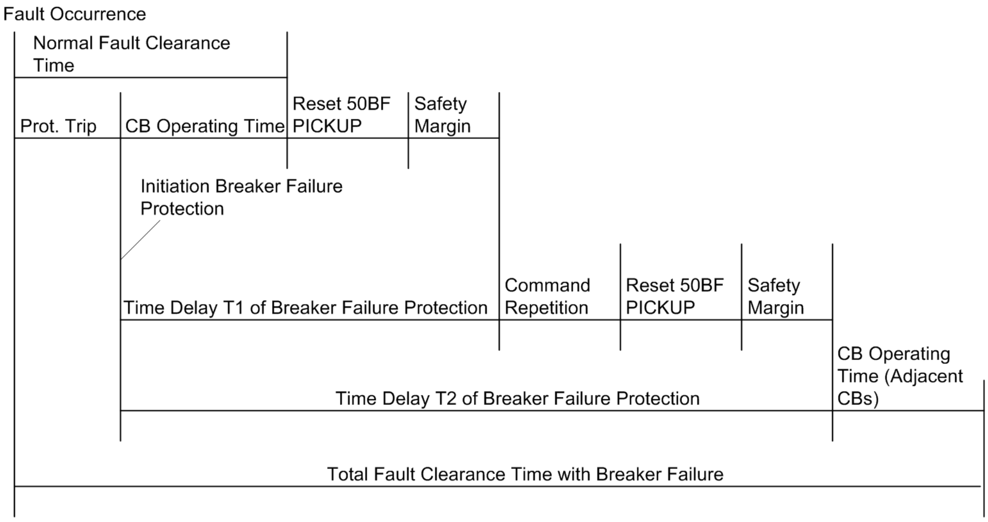


Figure 2-43 Time sequence example for normal clearance of a fault, and with circuit-breaker failure, using two-element breaker failure protection

Single-element Breaker Failure Protection

In single-element breaker failure protection, the adjacent circuit breakers, i.e. the breakers of the busbar or the busbar section affected, and where applicable also the breaker at the remote end, are tripped after the time delay **50BF-2 Delay** (address 3906) has elapsed.

The time **50BF-1 Delay 3p** (address 3905) is set to ∞ because it is not needed.

The time delay to be set should be based on the maximum circuit-breaker operating time plus the dropout time of the current flow monitoring element plus a safety margin which takes into consideration the tolerance of the time delay. Figure 2-44 illustrates the time sequences in an example. The dropout time for sinusoidal currents is ≤ 15 ms. If current transformer saturation is anticipated, the time should be set to 25 ms.

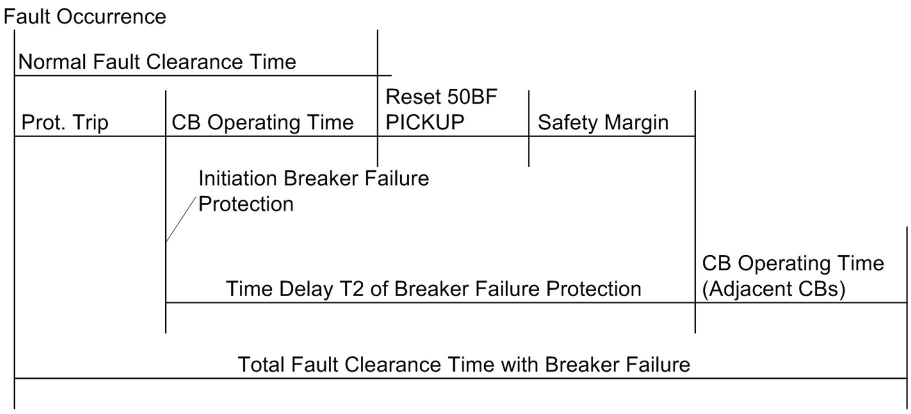


Figure 2-44 Time sequence example for normal clearance of a fault, and with circuit-breaker failure, using single-element breaker failure protection

Malfunction of the Local Circuit Breaker

If the circuit breaker associated with the feeder is not operational (e.g. control voltage failure or air pressure failure), it is apparent that the local breaker cannot clear the fault. If the relay is informed about this disturbance (via the binary input „>52 faulty“), the adjacent circuit breakers (busbar and remote end if applicable) are tripped after the time **T3-BkrDefective** (address 3907) which is usually set to **0**.

Address 3908 **Trip BkrDefect.** determines to which output the trip command is routed in the event that the breaker is not operational when a feeder protection trip occurs. Select that output which is used to trip the adjacent breakers (busbar trip).

End Fault Protection

The end fault protection can be switched separately ***ON*** or ***OFF*** in address 3921 **End Flt. elem.**. An end fault is a fault between the circuit breaker and the current transformer set of the feeder. The end fault protection presumes that the device is informed about the circuit-breaker position via breaker auxiliary contacts connected to binary inputs.

If, during an end fault, the circuit breaker is tripped by a reverse element of the feeder protection or by the busbar protection (the fault is a busbar fault as determined from the location of the current transformers), the fault current will continue to flow, because the fault is fed from the remote end of the feeder circuit.

The time **EndFault Delay** (address 3922) is started when, during the time of pickup condition of the feeder protection, the circuit-breaker auxiliary contacts indicate open poles and, at the same time, current flow is still detected (address 3902). The trip command of the end fault protection is intended for the transmission of an intertrip signal to the remote end circuit breaker.

Thus, the time delay must be set such that it can bridge out short transient apparent end fault conditions which may occur during switching of the breaker.

2.6.3 Settings

The table indicates region-specific default settings. Column C (configuration) indicates the corresponding secondary nominal current of the current transformer.

Addr.	Parameter	C	Setting Options	Default Setting	Comments
3901	FCT 50BF Break.		ON OFF	ON	50BF Breaker Failure Protection
3902	50BF PICKUP	1A	0.05 .. 20.00 A	0.10 A	50BF Pickup current threshold
		5A	0.25 .. 100.00 A	0.50 A	
3905	50BF-1 Delay 3p		0.00 .. 30.00 sec; ∞	0.00 sec	Delay after 3pole start for local trip
3906	50BF-2 Delay		0.00 .. 30.00 sec; ∞	0.15 sec	Delay of 2nd element for busbar trip
3907	T3-BkrDefective		0.00 .. 30.00 sec; ∞	0.00 sec	Delay for start with defective bkr.
3908	Trip BkrDefect.		NO with Local trip with Bus trip w/Local&Bustrip	NO	Trip output selection with defective bkr
3909	Chk BRK CONTACT		NO YES	YES	Check Breaker contacts

Addr.	Parameter	C	Setting Options	Default Setting	Comments
3912	50NBF PICKUP	1A	0.05 .. 20.00 A	0.10 A	50NBF Pickup neutral current threshold
		5A	0.25 .. 100.00 A	0.50 A	
3913	T2StartCriteria		With exp. of T1 Parallel withT1	Parallel withT1	T2 Start Criteria
3921	End Flt. elem.		ON OFF	OFF	End fault element
3922	EndFault Delay		0.00 .. 30.00 sec; ∞	2.00 sec	Trip delay of end fault element

2.6.4 Information List

No.	Information	Type of Information	Comments
1401	>50BF on	SP	>50BF: Switch on breaker fail prot.
1402	>50BF off	SP	>50BF: Switch off breaker fail prot.
1403	>BLOCK 50BF	SP	>BLOCK 50BF
1404	>50BF 3I0>	SP	>50BF use 3I0 threshold
1415	>50BF Start 3p	SP	>50BF: External start 3pole
1424	>50BFSTRTonlyT2	SP	>50BF: Start only delay time T2
1432	>50BF release	SP	>50BF: External release
1439	>50BF STARTw/oI	SP	>50BF: External start 3p (w/o current)
1440	BkrFailON/offBI	IntSP	Breaker failure prot. ON/OFF via BI
1451	50BF OFF	OUT	50BF is switched OFF
1452	50BF BLOCK	OUT	50BF is BLOCKED
1453	50BF ACTIVE	OUT	50BF is ACTIVE
1461	50BF Start	OUT	50BF Breaker failure protection started
1476	50BF LocTripABC	OUT	50BF Local trip - ABC
1493	50BF TripCBdef.	OUT	50BF Trip in case of defective CB
1494	50BF BusTrip	OUT	50BF Busbar trip
1495	50BF EndFltTrip	OUT	50BF Trip End fault element

2.7 Thermal Overload Protection 49

The thermal overload protection prevents damage to the protected object caused by thermal overloading, particularly in case of transformers, rotating machines, power reactors and cables. It is in general not necessary for overhead lines, since no meaningful overtemperature can be calculated because of the great variations in the environmental conditions (temperature, wind). In this case, however, a current-dependent alarm element is able to warn of an imminent overload.

2.7.1 Method of Operation

The unit computes the overtemperature according to a thermal single-body model as per the following thermal differential equation

$$\frac{d\Theta}{dt} + \frac{1}{\tau_{th}} \cdot \Theta = \frac{1}{\tau_{th}} \cdot \left(\frac{I}{k \cdot I_N}\right)^2$$

with

Θ	–	Current overtemperature, referred to the final overtemperature at maximum permissible phase current $k \cdot I_N$
τ_{th}	–	thermal time constant for the heating
I	–	present rms current
k	–	k–factor indicating the maximum permissible constant current referred to the nominal current of the current transformers
I_{Nom}	–	Rated current of the device

The solution of this equation is an e-function in steady-state operation whose asymptote represents the final overtemperature Θ_{End}. When the overtemperature reaches the first settable temperature threshold Θ_{alarm}, which is below the final overtemperature, an alarm is generated in order to allow a preventive load reduction. When the second overtemperature threshold, i.e. the final overtemperature (= tripping temperature), is reached, the protected object is disconnected from the network. The overload protection can, however, also be set to ***Alarm Only***. In this case, only an alarm is output when the final temperature is reached.

The overtemperatures are calculated separately for each phase in a thermal replica from the square of the associated phase current. This guarantees a true RMS value measurement and also considers the effect of harmonic content. A choice can be made whether the maximum calculated overtemperature of the three phases, the average overtemperature, or the overtemperature calculated from the phase with maximum current should be decisive for evaluation of the thresholds.

The maximum permissible continuous thermal overload current I_{max} is described as a multiple of the rated current I_{Nom}:

$I_{max} = k \cdot I_N$

In addition to the k-factor, the time constant τ_{th} as well as the alarm temperature Θ_{alarm} must be entered as settings of the protection.

Overload protection also features a current warning element I_{alarm} in addition to the temperature warning element which can output an early warning that an overload current is imminent, even when the temperature rise has not yet reached the alarm or trip temperature rise values.

The overload protection can be blocked via a binary input. In doing so, the thermal images are also reset to zero.

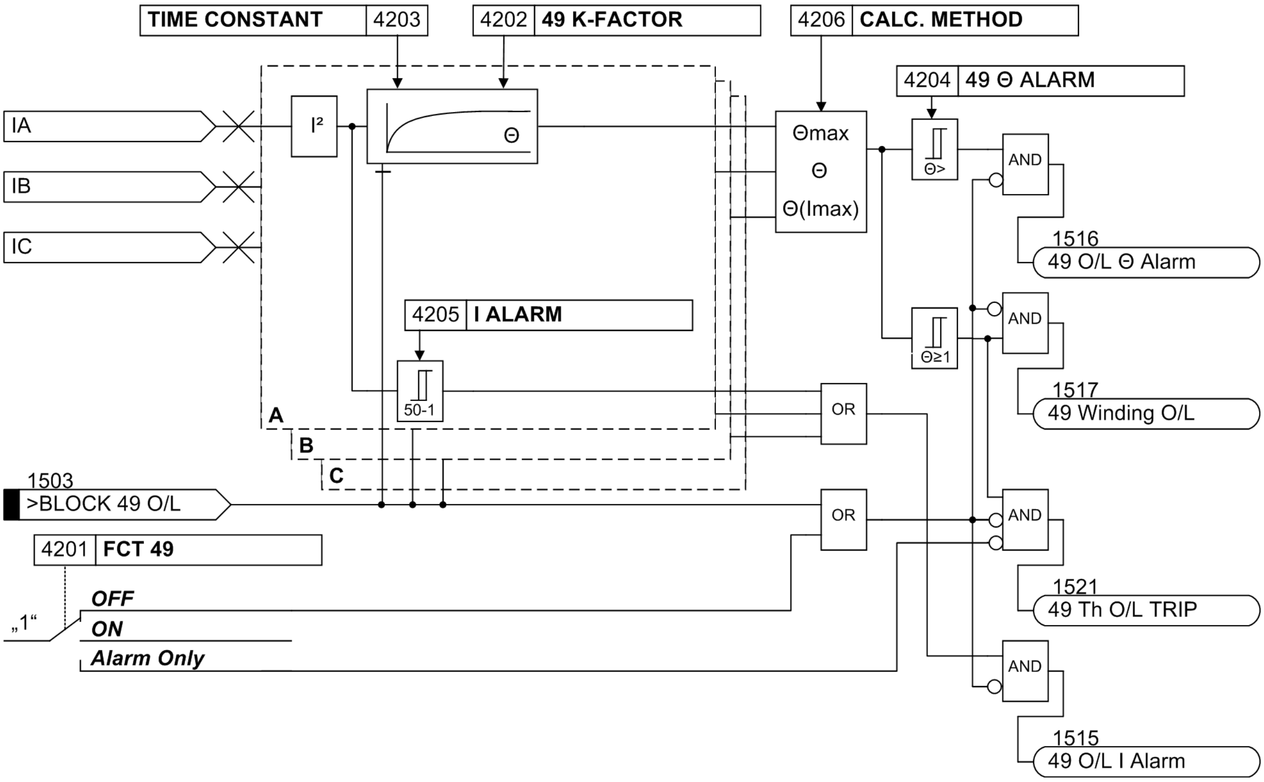


Figure 2-45 Logic diagram of the thermal overload protection

2.7.2 Setting Notes

General

A prerequisite for the application of the thermal overload function is that during the configuration of the functional scope in address 142 **49** = ***Enabled*** was set. At address 4201 **FCT 49** the function can be turned ***ON*** or ***OFF***. Furthermore ***Alarm Only*** can be set. With the latter setting the protection function is active but only outputs the indication „49 Winding O/L“ (address 1517) when the tripping temperature is reached. The indication „49 Th O/L TRIP“ (address 1521) is not generated.

K-Factor

The nominal device current is used as a basis for overload detection. The setting factor k is set under address 4202 **49 K-FACTOR**. It is determined by the relation between the permissible thermal continuous current and this rated current:

$$k = \frac{I_{max}}{I_N}$$

The permissible continuous current is at the same time the current at which the e-function of the overtemperature has its asymptote. It is not necessary to determine the tripping temperature since it results automatically from the final rise temperature at $k \cdot I_N$. Manufacturers of electrical machines usually state the permissible continuous current. If no data are available, k is set to 1.1 times the nominal current of the protected object. For cables, the permissible continuous current depends on the cross-section, the insulation material, the design and the method of installation, and can be derived from the relevant tables.

Please note that the overload capability of electrical equipment relates to its primary current. This has to be considered if the primary current differs from the rated current of the current transformers.

Example:

Belted cable 10 kV 150 mm^2

Permissible continuous current I_{max} = 322 A

Current transformers 400 A / 5 A

$$k = \frac{322\ \text{A}}{400\ \text{A}} = 0.805$$

Setting value **49 K-FACTOR** = **0.80**

Time Constant

The thermal time constant τ_{th} is set at address 4203 **TIME CONSTANT**. This is also provided by the manufacturer. Please note that the time constant is set in minutes. Quite often other values for determining the time constant are stated which can be converted into the time constant as follows:

1-s current

$$\frac{\tau_{th}}{\text{min}} = \frac{1}{60} \cdot \left(\frac{\text{perm. 1-s current}}{\text{perm. contin.current}}\right)^2$$

permissible current for application time other than 1°s, e.g. for 0.5°s

$$\frac{\tau_{th}}{\text{min}} = \frac{0.5}{60} \left(\frac{\text{perm. 0.5-s current}}{\text{perm. contin.current}}\right)^2$$

t_6–time; this is the time in seconds for which a current of 6 times the rated current of the protected object may flow

$$\frac{\tau_{th}}{\text{min}} = 0.6 \cdot t_6$$

Example:

Cable as above with

Permissible 1-s current 13.5 kA

$$\frac{\tau_{th}}{\text{min}} = \frac{1}{60} \cdot \left(\frac{13500\ \text{A}}{322\ \text{A}}\right)^2 = \frac{1}{60} \cdot 42^2 = 29.4$$

Setting value **TIME CONSTANT** = **29.4 min**

Warning Temperature Level

By setting a thermal alarm stage **49 Θ ALARM** (address 4204) an alarm can be provided before the tripping temperature is reached, so that a trip can be avoided by preventive load reduction or by switching over. The percentage is referred to the tripping temperature rise.

The current overload alarm setpoint **I ALARM** (address 4205) is stated as a factor of the nominal device current and should be set equal to or slightly below the permissible continuous current $k \cdot I_N$. It can also be used instead of the thermal alarm stage. In this case the thermal alarm stage is set to 100 % and thus practically ineffective.

Calculating the Overtemperature

The thermal replica is calculated individually for each phase. Address 4206 **CALC. METHOD** decides whether the highest of the three calculated temperatures (Θ ***max***) or their arithmetic average (***Average*** Θ) or the temperature calculated from the phase with maximum current (Θ ***from Imax***) should be decisive for the thermal alarm and tripping element.

Since an overload usually occurs in a balanced way, this setting is of minor importance. If unbalanced overloads are to be expected, however, these options lead to different results.

Averaging should only be used if a rapid thermal equilibrium is possible in the protected object, e.g. with belted cables. If the three phases are, however, more or less thermally isolated (e.g. single conductor cables or overhead lines), one of the maximum settings should be chosen at any rate.

2.7.3 Settings

The table indicates region-specific default settings. Column C (configuration) indicates the corresponding secondary nominal current of the current transformer.

Addr.	Parameter	C	Setting Options	Default Setting	Comments
4201	FCT 49		OFF ON Alarm Only	OFF	49 Thermal overload protection
4202	49 K-FACTOR		0.10 .. 4.00	1.10	49 K-Factor
4203	TIME CONSTANT		1.0 .. 999.9 min	100.0 min	Time Constant
4204	49 Θ ALARM		50 .. 100 %	90 %	49 Thermal Alarm Stage
4205	I ALARM	1A	0.10 .. 4.00 A	1.00 A	Current Overload Alarm Setpoint
		5A	0.50 .. 20.00 A	5.00 A	
4206	CALC. METHOD		Θ max Average Θ Θ from Imax	Θ max	Method of Acquiring Temperature

2.7.4 Information List

No.	Information	Type of Information	Comments
1503	>BLOCK 49 O/L	SP	>BLOCK 49 Overload Protection
1511	49 O / L OFF	OUT	49 Overload Protection is OFF
1512	49 O/L BLOCK	OUT	49 Overload Protection is BLOCKED
1513	49 O/L ACTIVE	OUT	49 Overload Protection is ACTIVE
1515	49 O/L I Alarm	OUT	49 Overload Current Alarm (I alarm)
1516	49 O/L Θ Alarm	OUT	49 Overload Alarm! Near Thermal Trip
1517	49 Winding O/L	OUT	49 Winding Overload
1521	49 Th O/L TRIP	OUT	49 Thermal Overload TRIP

2.8 Undervoltage and Overvoltage Protection 27/59 (Optional)

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

The overvoltage protection in 7SD80 measures the phase voltages V_{A-N}, V_{B-N} and V_{C-N} and the phase-to-phase voltages V_{A-B}, V_{B-C}. Furthermore, the device calculates the positive-sequence system and the negative-sequence system of the voltages so that the symmetrical components can be monitored, too.

The undervoltage protection can also use the phase voltages V_{A-N}, V_{B-N} and V_{C-N}, the phase-to-phase voltages V_{A-B}, V_{B-C} and V_{C-A}, as well as the positive sequence system.

These voltage protection functions can be combined according to the user's requirements. They can be switched on or off separately, or used for indication purposes only. In the latter case, the respective trip commands do not appear. Each voltage protection function comprises two elements, i.e. it is provided with two threshold settings each with the appropriate time delays.

Abnormally high voltages often occur e.g. on long transmission lines under low load conditions, in islanded systems when generator voltage regulation fails, or after full load shutdown of a generator from the system. Even if compensation reactors are used to avoid line overvoltages by compensation of the line capacitance and thus reduction of the overvoltage, the overvoltage will endanger the insulation if the reactors fail (e.g. due to fault clearance). The line must be de-energized within a very short time.

The undervoltage protection can be applied, for example, for disconnection or load shedding tasks in a system. Furthermore, this protection scheme can detect pending stability problems. With induction machines undervoltages have an effect on the stability and permissible torque thresholds.

2.8.1 Overvoltage Protection (ANSI 59)

Overvoltage Phase–Ground

Figure 2-46 depicts the logic diagram of the phase voltage elements. The fundamental frequency is numerically filtered from each of the three measuring voltages so that harmonics or transient voltage peaks are largely eliminated. Two threshold elements **59-1-Vph PICKUP** (address 3702) and **59-2-Vph PICKUP** (address 3704) are compared with the voltages. If a phase voltage exceeds these thresholds it is indicated separately for each phase. Furthermore, a general pickup indication „59-1-Vpg Pickup“ „59-2-Vpg Pickup“ exists for each element. The dropout ratio can be set (**59-Vph RESET** (address 3709)).

Each element starts a time delay which is common to all phases. Expiry of the respective time delay **59-1-Vph DELAY** (address 3703) or **59-2-Vph DELAY** (address 3705) is signaled and usually results in the trip command „59-Vpg TRIP“.

The overvoltage protection phase–ground can be blocked via a binary input „>59-Vphg BLOCK“.

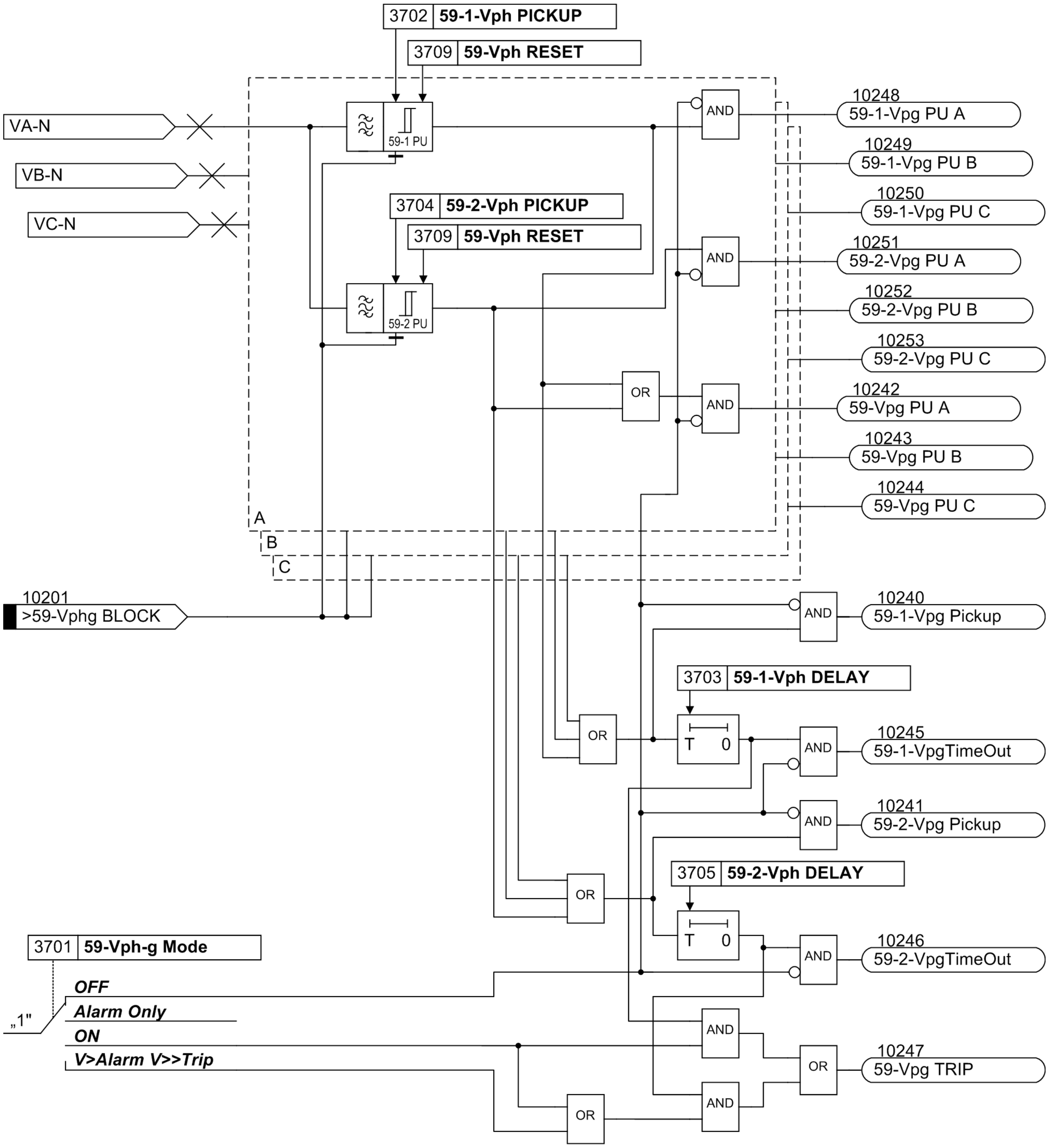


Figure 2-46 Logic diagram of the overvoltage protection for phase voltage

Overvoltage Phase-to-Phase

The phase-to-phase overvoltage protection operates just like the phase-to-ground protection except that it detects phase-to-phase voltages. Accordingly, phase-to-phase voltages which have exceeded one of the element thresholds **59-1-Vpp PICKUP** (address 3712) or **59-2-Vpp PICKUP** (address 3714) are also indicated. Apart from that, Figure 2-46 also applies generally.

The phase–phase overvoltage protection can also be blocked via a binary input „>59-Vphph BLOCK“.

Overvoltage Positive Sequence System V_1

The device calculates the positive sequence system according to its defining equation

$$\underline{V}_1 = {}^1/_3 \cdot (\underline{V}_A + \underline{a} \cdot \underline{V}_B + \underline{a}^2 \cdot \underline{V}_C)$$

where $\underline{a} = e^{j120°}$.

The resulting positive sequence voltage is fed to the two threshold elements **59-1-V1 PICKUP** (address 3732) and **59-2-V1 PICKUP** (address 3734) (see Figure 2-47). Combined with the associated time delays **59-1-V1 DELAY** (address 3733) and **59-2-V1 DELAY** (address 3735) these elements form a two-element overvoltage protection for the positive sequence system. Here too, the dropout ratio can be set.

The overvoltage protection for the positive sequence system can also be blocked via a binary input „>59-V1 BLOCK“.

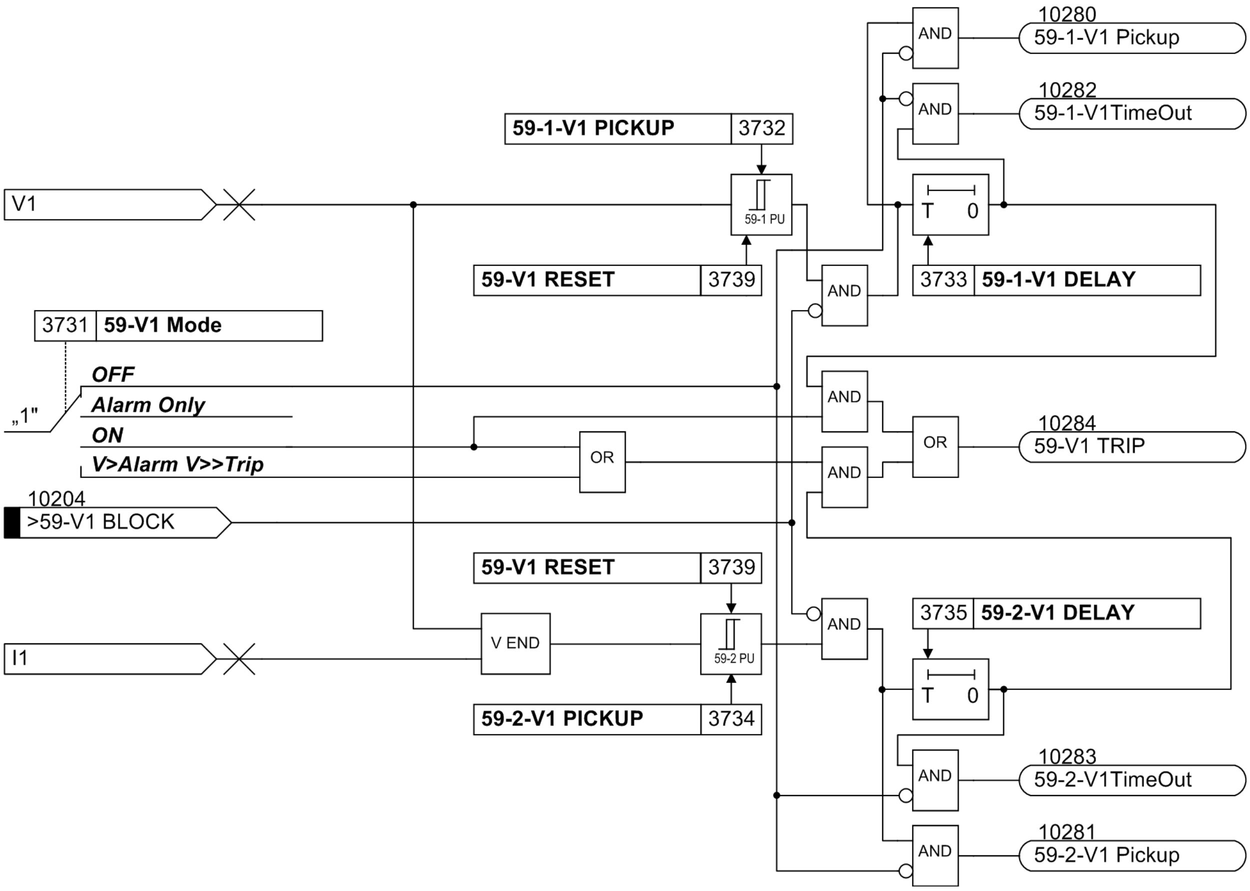


Figure 2-47 Logic diagram of the overvoltage protection for the positive sequence voltage system

Overvoltage Negative Sequence System V_2

The device calculates the negative sequence system voltages according to its defining equation:

$$\underline{V}_2 = {}^1/_3 \cdot (\underline{V}_A + \underline{a}^2 \cdot \underline{V}_B + \underline{a} \cdot \underline{V}_C)$$

where $\underline{a} = e^{j120°}$.

The resulting negative sequence voltage is fed to the two threshold elements **59-1-V2 PICKUP** (address 3742) and **59-2-V2 PICKUP** (address 3744). Figure 2-48 shows the logic diagram. Combined with the associated time delays **59-1-V2 DELAY** (address 3743) and **59-2-V2 DELAY** (address 3745) these elements form a two-element overvoltage protection for the negative sequence system. Here too, the dropout ratio can be set.

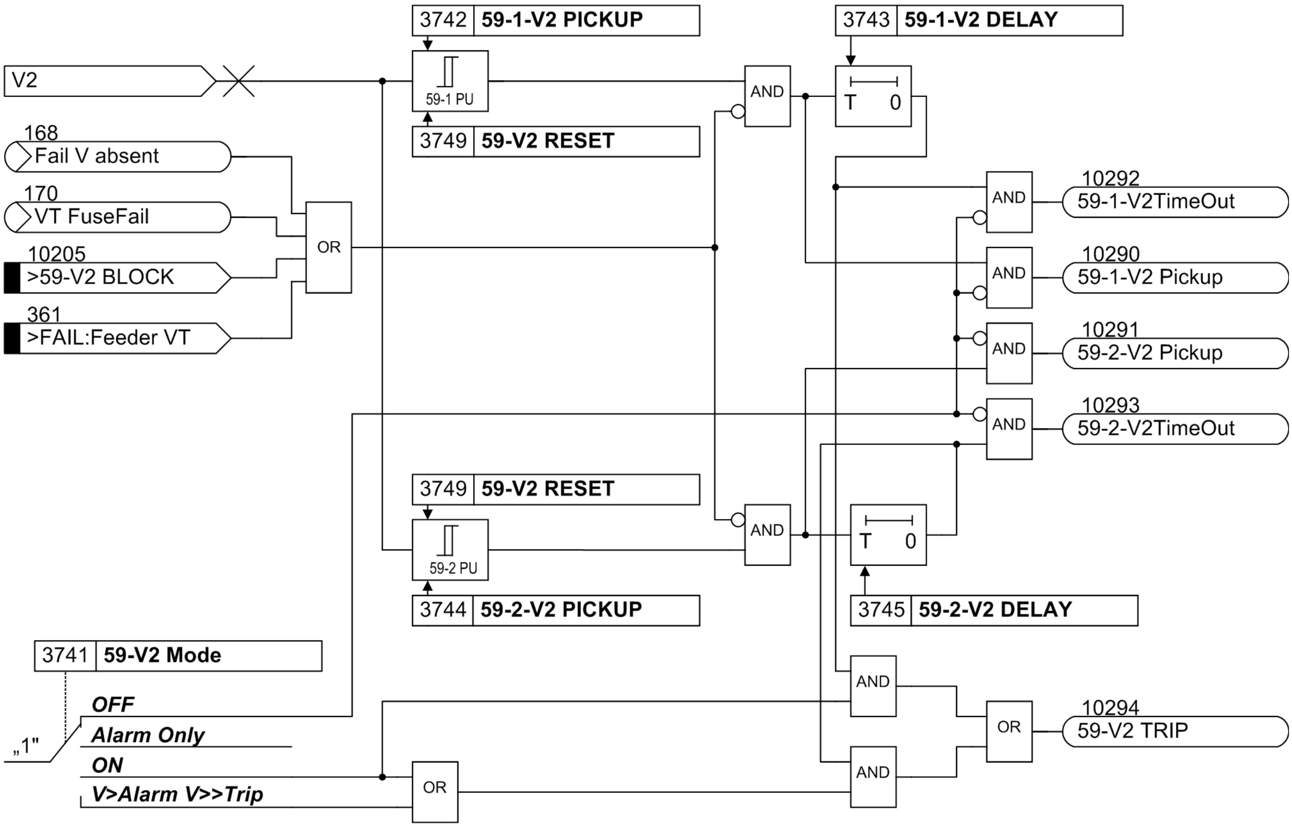


Figure 2-48 Logic diagram of the overvoltage protection for the negative sequence voltage system V_2

The overvoltage protection for the negative sequence system can also be blocked via a binary input „>59-V2 BLOCK“. The elements of the negative sequence voltage protection are automatically blocked as soon as an asymmetrical voltage failure is detected („fuse failure monitor“, also see Section 2.14.1, margin heading Rapid Measuring Voltage Failure „Fuse-Failure-Monitor“) or when tripping of the MCB for voltage transformers has been signaled via the binary input „>FAIL:Feeder VT“ (internal indication „internal blocking“).

Overvoltage Zero Sequence System $3V_0$

Figure 2-49 depicts the logic diagram of the zero sequence voltage element. The fundamental frequency is numerically filtered from the measuring voltage so that the harmonics or transient voltage peaks remain largely harmless.

The triple zero sequence voltage $3{\cdot}V_0$ is fed to the two threshold elements **59G-1-3V0PICKUP** (address 3722) and **59G-2-3V0PICKUP** (address 3724). Combined with the associated time delays **59G-1-3V0 DELAY** (address 3723) and **59G-2-3V0 DELAY** (address 3725) these elements form a two-element overvoltage protection for the zero sequence system. Here too, the dropout ratio can be set (**59G RESET**), address 3729). Furthermore, a restraint delay can be configured which is implemented by repeated measuring (approx. 3 periods).

The overvoltage protection for the zero sequence system can also be blocked via a binary input „>59-3V0 BLOCK“. The elements of the zero sequence voltage protection are automatically blocked as soon as an asymmetrical voltage failure was detected („Fuse–Failure–Monitor“, also see Section 2.14.1, margin heading „Fuse Failure Monitor (Non-symmetrical Voltages)“ or when the trip of the mcb for voltage transformers has been signaled via the binary input „>FAIL:Feeder VT“ (internal indication „internal blocking“).

According to Figure 2-49 the device calculates the voltage to be monitored:

$$3{\cdot}\underline{V}_0 = \underline{V}_A + \underline{V}_B + \underline{V}_C.$$

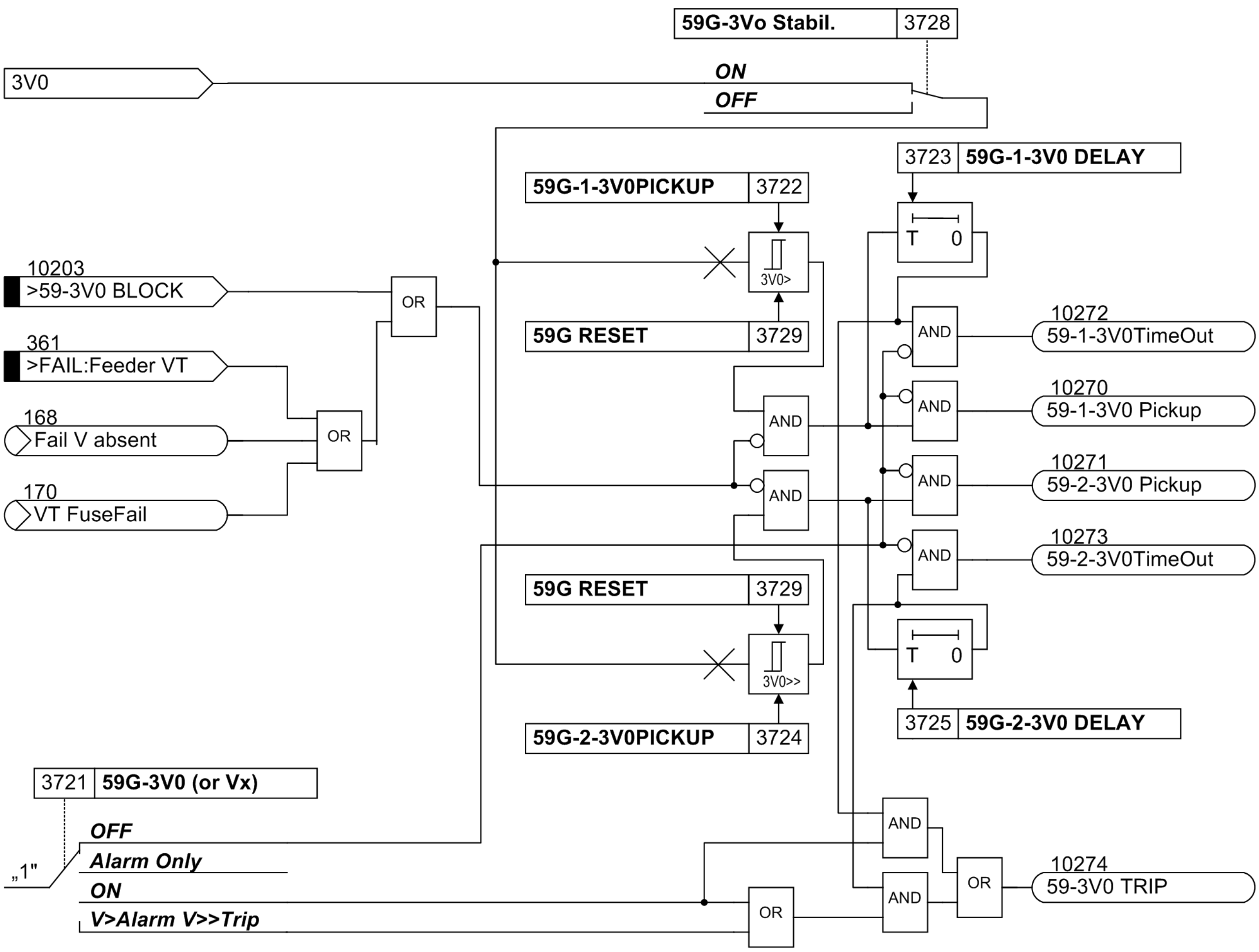


Figure 2-49 Logic diagram of the overvoltage protection for zero sequence voltage

2.8.2 Undervoltage Protection (ANSI 27)

Undervoltage Phase–Ground

Figure 2-50 depicts the logic diagram of the phase voltage elements. The fundamental frequency is numerically filtered from each of the three measuring voltages so that harmonics or transient voltage peaks are largely harmless. Two threshold elements **27-1-Vph PICKUP** (address 3752) and **27-2-Vph PICKUP** (address 3754) are compared with the voltages. If phase voltage falls below a threshold it is indicated phase-segregated. Furthermore, a general pickup indication „27-1-Vpg Pickup“ „27-2-Vpg Pickup“ exists for each element. The dropout ratio can be set (**27-Vph RESET**, address 3759).

Depending on the configuration of the substations, the voltage transformers are located on the busbar side or on the outgoing feeder side. This results in a different behavior of the undervoltage protection when the line is de-energized. While the voltage usually remains present or reappears on the busbar side after a trip command and opening of the circuit breaker, it becomes zero on the outgoing side. For the undervoltage protection this results in a pickup state being present if the voltage transformers are on the outgoing side. If this pickup must be reset, the current can be used as an additional criterion (current criterion **CURR.SUP 27-Vph**, address 3758) to achieve this result. Undervoltage will then only be detected if, together with the undervoltage condition, the minimum current **PoleOpenCurrent** of the corresponding phase is also exceeded. This condition is communicated by the central function control of the device.

The undervoltage protection phase-to-ground can be blocked via a binary input „27-Vphg BLK“. The elements of the undervoltage protection are then automatically blocked if a voltage failure is detected („fuse failure monitor“, also see Section 2.14.1) or if the trip of the mcb of the voltage transformers is indicated (internal blocking) via the binary input „>FAIL:Feeder VT“.

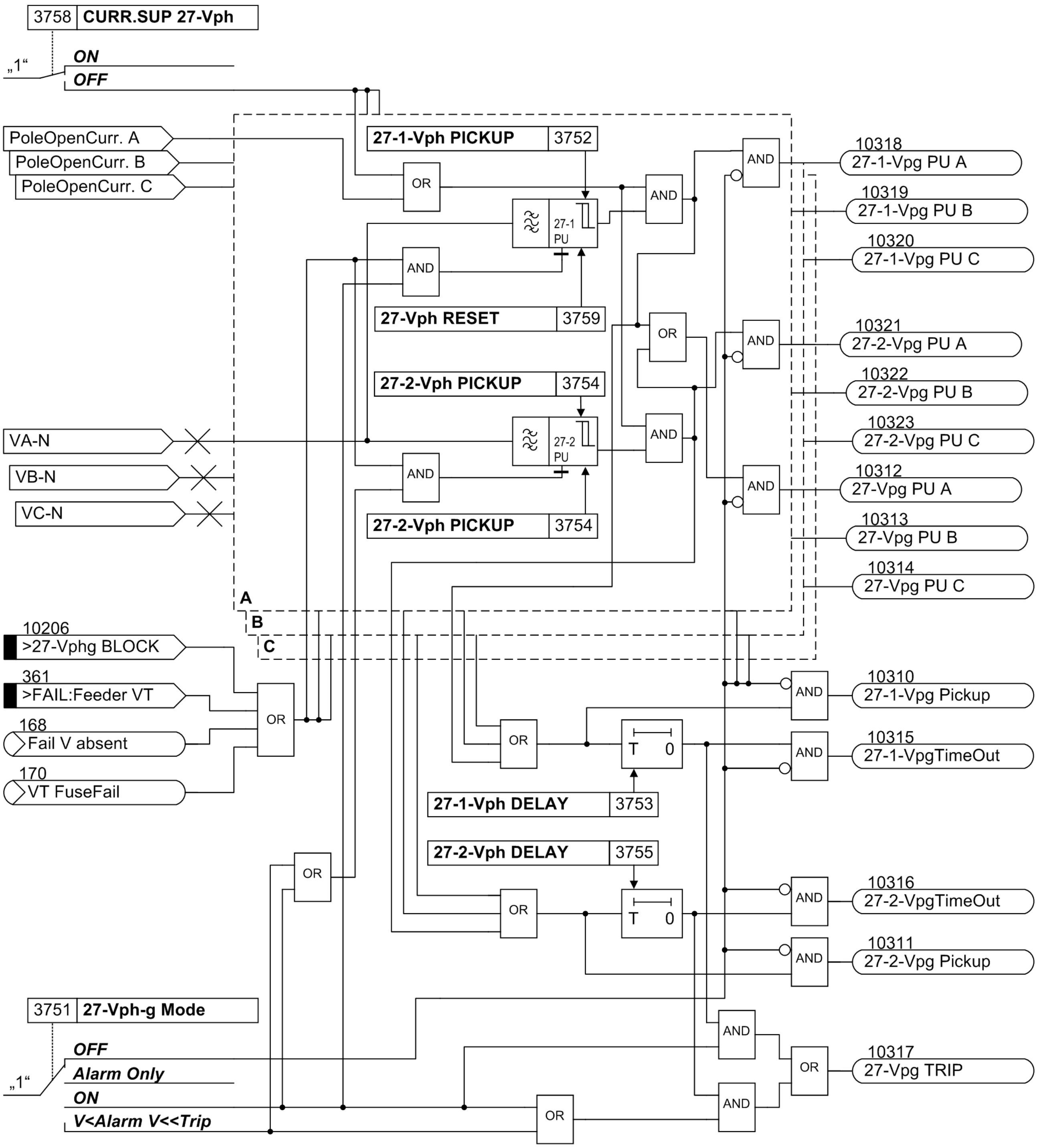


Figure 2-50 Logic diagram of the undervoltage protection for phase voltages

Undervoltage Phase-to-Phase

Basically, the phase-to-phase undervoltage protection operates like the phase-to-ground protection except that it detects phase-to-phase voltages. Accordingly, both phases are indicated during pickup of an undervoltage element if one of the stage thresholds **27-1-Vpp PICKUP** (address 3762) or **27-2-Vpp PICKUP** (address 3764) was undershot. Apart from that, Figure 2-50 also applies generally.

It is sufficient for the current criterion that current flow is detected in one of the involved phases.

The phase–phase undervoltage protection can also be blocked via a binary input „>27-Vphph BLOCK“. There is an automatic blocking if the measuring voltage failure was detected or voltage mcb tripping was indicated (internal blocking of the phases affected by the voltage failure).

Undervoltage Positive Sequence System V_1

The device calculates the positive sequence system according to its defining equation

$$\underline{V}_1 = {}^1/_3 \cdot (\underline{V}_A + \underline{a} \cdot \underline{V}_B + \underline{a}^2 \cdot \underline{V}_C)$$

where $\underline{a} = e^{j120°}$.

The resulting positive sequence voltage is fed to the two threshold elements **27-1-V1 PICKUP** (address 3772) and **27-2-V1 PICKUP** (address 3774) (see Figure 2-51). Combined with the associated time delays **27-1-V1 DELAY** (address 3773) and **27-2-V1 DELAY** (address 3775) these elements form a two-element overvoltage protection for the positive sequence system.

Current can be used as an additional criterion for the undervoltage protection of the positive sequence system (current criterion **CURR.SUP. 27-V1**, address 3778). An undervoltage is only detected if the current flow is detected in at least one phase together with the undervoltage criterion.

The undervoltage protection for the positive sequence system can be blocked via the binary input „>27-V1 BLOCK“. The stages of the undervoltage protection are automatically blocked if voltage failure is detected („fuse failure monitor“, also see Section 2.14.1) or, if the trip of the mcb for the voltage transformer is indicated via the binary input „>FAIL:Feeder VT“ (internal blocking).

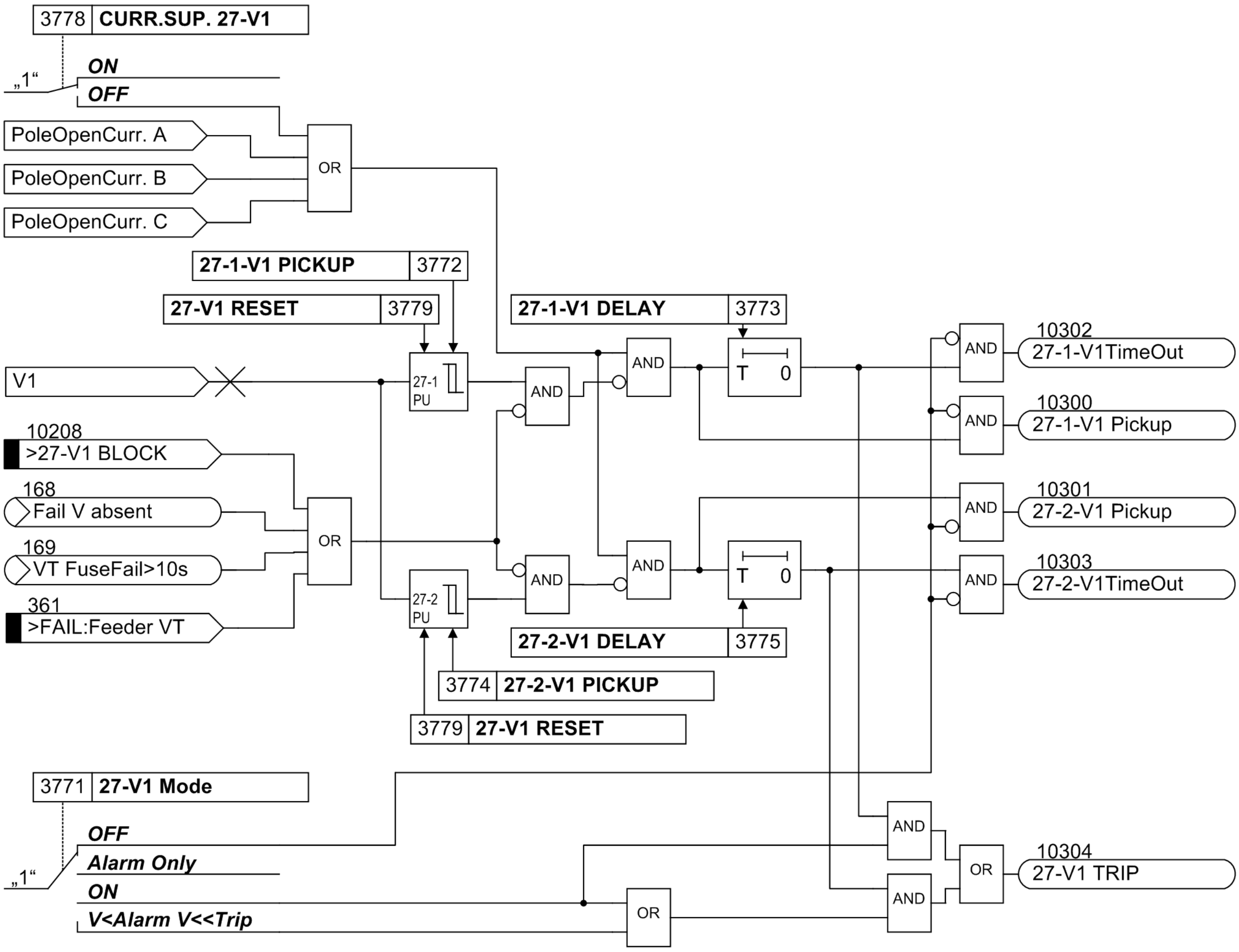


Figure 2-51 Logic diagram of the undervoltage protection for positive sequence voltage system

2.8.3 Setting Notes

General

The voltage protection can only operate if it has been set to ***Enabled*** during the configuration of the device scope (address 137).

The overvoltage and undervoltage elements can detect phase-to-ground voltages, phase-to-phase voltages or the symmetrical positive sequence system of the voltages; the symmetrical negative sequence system or the zero sequence voltage can also be used for overvoltage. Any combination is possible. Detection procedures that are not required are switched ***OFF***.

Note

For overvoltage protection it is particularly important to observe the setting notes: Never set an overvoltage element (V_{Ph-N}, V_{Ph-Ph}, V_1) lower than an undervoltage element. This would put the device immediately into a state of permanent pickup which cannot be reset by any measured value operation. As a result, operation of the device would be impossible!

Overvoltage Phase-to-Ground

The phase voltage elements can be switched ***ON*** or ***OFF*** in address 3701 **59-Vph-g Mode**. In addition to this, you can set ***Alarm Only***, i.e. these elements operate and send alarms but do not generate any trip command. The setting ***V>Alarm V>>Trip*** creates in addition also a trip command only for the 59-2 element (V>>).

The settings of the voltage threshold and the timer values depend on the type of application. To detect steady-state overvoltages on long lines carrying no load, set the **59-1-Vph PICKUP** element (address 3702) to at least 5 % above the maximum stationary phase-to-ground voltage expected during operation. Additionally, a high dropout to pickup ratio is required (address 3709 **59-Vph RESET** = presetting). This parameter can only be set in DIGSI at **Display Additional Settings**. The time delay **59-1-Vph DELAY** (address 3703) should be a few seconds so that overvoltages with short duration do not cause tripping.

The 59-2 phase (V_{ph}>>) element (address 3704) is provided for high overvoltages with short duration. Here an adequately high pickup value is set, e.g. the $1^1/_2$-fold of the nominal phase-to-ground voltage. 0.1 s to 0.2 s are then sufficient for the time delay **59-2-Vph DELAY** (address 3705).

Overvoltage Phase-to-Phase

Basically, the same considerations apply as for the phase undervoltage elements. These elements may be used instead of the phase voltage elements or be used additionally.. Accordingly set address 3711 **59-Vph-ph Mode** to ***ON***, ***OFF***, ***Alarm Only*** or ***V>Alarm V>>Trip***.

As phase–to–phase voltages are monitored, the phase–to–phase values are used for the settings **59-1-Vpp PICKUP** (address 3712) and **59-2-Vpp PICKUP** (address 3714).

For the time delays **59-1-Vpp DELAY** (address 3713) and **59-2-Vpp DELAY** (address 3715) the same considerations apply as above. The same is true for the dropout ratios (address 3719 **59-Vpp RESET**). The latter setting can only be altered in DIGSI at **Display Additional Settings**.

Overvoltage Positive Sequence System V_1

The positive sequence voltage elements can be used instead of or in addition to previously mentioned overvoltage elements. Accordingly set address 3731 **59-V1 Mode** to ***ON***, ***OFF***, ***Alarm Only*** or ***V>Alarm V>>Trip***.

For symmetrical voltages an increase of the positive sequence system corresponds to a logical AND combination of the phase voltages. These elements are particularly suited to the detection of steady-state overvoltages on long, weak-loaded transmission lines (Ferranti effect). Here too, the **59-1-V1 PICKUP** element (address 3732) with a longer time delay **59-1-V1 DELAY** (address 3733) is used for the detection of steady-state overvoltages (some seconds), the **59-2-V1 PICKUP** element (address 3734) with the short time delay **59-2-V1 DELAY** (address 3735) is used for the detection of high overvoltages that may jeopardize insulation.

Please note that the positive sequence system is established according to its defining equation
$V_1 = {}^1/_3 \cdot |\underline{V}_A + \underline{a} \cdot \underline{V}_B + \underline{a}^2 \cdot \underline{V}_C|$. For symmetrical voltages the amplitude equivalent to a phase-to-ground voltage.

The dropout to pickup ratio (address 3739 **59-V1 RESET**) is set as high as possible with regard to the detection of even small steady-state overvoltages. This parameter can only be set in DIGSI at **Display Additional Settings**.

Overvoltage Negative Sequence System V_2

The negative sequence voltage elements detect asymmetrical voltages. If it is desired that such voltages cause tripping, set address 3741 **59-V2 Mode** to ***ON***. To only signal such states, set address 3741 **59-V2 Mode** to ***Alarm Only***. If only one element is desired to generate a trip command, choose the setting ***V>Alarm V>>Trip***. With this setting a trip command is output by the 2nd element only. If negative sequence voltage protection is not required, set this parameter to ***OFF***.

This protective function also has two elements, one being **59-1-V2 PICKUP** (address 3742) with a greater time delay **59-1-V2 DELAY** (address 3743) for steady-state asymmetrical voltages and the other being **59-2-V2 PICKUP** (address 3744) with a short time delay **59-2-V2 DELAY** (address 3745) for high asymmetrical voltages.

Please note that the negative sequence system is established according to its defining equation $V_2 = {}^1/_3 \cdot |\underline{V}_A + \underline{a}^2 \cdot \underline{V}_B + \underline{a} \cdot \underline{V}_C|$. For symmetrical voltages and two swapped phases the amplitude is equivalent to the phase–to–ground voltage value.

The dropout to pickup ratio **59-V2 RESET** can be set in address 3749. This parameter can only be set in DIGSI at **Display Additional Settings**.

Zero Sequence System Overvoltage

The zero sequence voltage elements can be switched ***ON*** or ***OFF*** in address 3721 **59G-3V0 (or Vx)**. They can also be set to ***Alarm Only***, i.e. these elements operate and send alarms but do not generate any trip commands. If a trip command of the second element is still desired, the setting must be ***V>Alarm V>>Trip***.

This protective function also has two elements. The settings of the voltage threshold and the timer values depend on the type of application. Here no general guidelines can be established. The element **59G-1-3V0PICKUP** (address 3722) is usually set with a high sensitivity and a longer time delay **59G-1-3V0 DELAY** (address 3723). The **59G-2-3V0PICKUP** element (address 3724) and its time delay **59G-2-3V0 DELAY** (address 3725) allow to implement a second element with less sensitivity and a shorter time delay.

The zero-voltage stages feature a special time stabilization due to repeated measurements allowing them to be set rather sensitive. This stabilization can be disabled in address 3728 **59G-3Vo Stabil.** if a shorter pickup time is required. This parameter can only be set in DIGSI at **Display Additional Settings**. Please consider that sensitive settings combined with short pickup times are not recommended.

The dropout to pickup ratio **59G RESET** can be set in address 3729. This parameter can only be set in DIGSI at **Display Additional Settings**.

Undervoltage Phase-to-Ground

The phase voltage elements can be switched ***ON*** or ***OFF*** in address 3751 **27-Vph-g Mode**. In addition to this, you can set ***Alarm Only***, i.e. these elements operate and send alarms but do not generate any trip command. You can generate a trip command for the 2nd element only in addition to the alarm by setting ***V<Alarm V<<Trip***.

This undervoltage protection function has two elements. The **27-1-Vph PICKUP** element (address 3752) with a longer setting of the time **27-1-Vph DELAY** (address 3753) operates in the case of minor undervoltages. However, the value set here must not be higher than the undervoltage permissible in operation. In the presence of higher voltage dips, the **27-2-Vph PICKUP** element (address 3754) with the delay **27-2-Vph DELAY** (address 3755) becomes active

The dropout to pickup ratio **27-Vph RESET** can be set in address 3759. This parameter can only be set in DIGSI at **Display Additional Settings**.

The settings of the voltages and times depend on the intended use; therefore no general recommendations for the settings can be given. For load shedding, for example, the values are often determined by a priority grading coordination chart. In case of stability problems, the permissible levels and durations of overvoltages must be observed. With induction machines undervoltages have an effect on the permissible torque thresholds.

If the voltage transformers are located on the line side, the measuring voltages will be absent when the line is disconnected. To avoid the undervoltage levels picking up, the current criterion **CURR.SUP 27-Vph** (address 3758) is switched ***ON***. With bus—sided voltage transformers it can be switched ***OFF***. However, if the busbar is dead, the undervoltage protection will pick up and expire and then remain picked up. It must therefore be ensured that the protection is blocked by a binary input.

Undervoltage Phase-to-Phase

Basically, the same considerations apply as for the phase undervoltage elements. These elements may replace the phase voltage elements or be used additionally. Accordingly set address 3761 **27-Vph-ph Mode** to ***ON***, ***OFF***, ***Alarm Only*** or ***V<Alarm V<<Trip***.

As phase–to–phase voltages are monitored, the phase–to–phase values are used for the settings **27-1-Vpp PICKUP** (address 3762) and **27-2-Vpp PICKUP** (address 3764).

The corresponding times delay are **27-1-Vpp DELAY** (address 3763) and **27-2-Vpp DELAY** (address 3765).

The dropout to pickup ratio **27-Vph-ph RESET** can be set in address 3769. This parameter can only be set in DIGSI at **Display Additional Settings**.

If the voltage transformers are located on the line side, the measuring voltages will be absent when the line is disconnected. To avoid that the undervoltage levels in these cases are or remain picked up, the current criterion **CURR.SUP 27-Vpp** (address 3768) is switched ***ON***. With bus-sided voltage transformers it can be switched ***OFF***. However, if the busbar is dead, the undervoltage protection will pick up and expire and then remain picked up. It must therefore be ensured that the protection is blocked by a binary input.

Undervoltage Positive Sequence System V_1

The positive sequence undervoltage elements can be used instead of or in addition to previously mentioned undervoltage elements. Accordingly set address 3771 **27-V1 Mode** to ***ON***, ***OFF***, ***Alarm Only*** or ***V<Alarm V<<Trip***.

Basically, the same considerations apply as for the other undervoltage elements. Especially in case of stability problems, the positive sequence system is advantageous, since the positive sequence system is relevant for the limit of the stable energy transmission.

To achieve the two-element condition, the **27-1-V1 PICKUP** element (address 3772) is combined with a greater time delay **27-1-V1 DELAY** (address 3773), and the **27-2-V1 PICKUP** element (address 3774) with a shorter time delay **27-2-V1 DELAY** (address 3775).

Note that the positive sequence system is established according to its defining equation $V_1 = {}^1/_3 \cdot |\underline{V}_A + \underline{a} \cdot \underline{V}_B + \underline{a}^2 \cdot \underline{V}_C|$. For symmetrical voltages this is equivalent to a phase-ground voltage.

The dropout to pickup ratio **27-V1 RESET** can be set in address 3779. This parameter can only be set in DIGSI at **Display Additional Settings**.

If the voltage transformers are located on the line side, the measuring voltages will be missing when the line is disconnected. To avoid that the undervoltage levels in these cases are or remain picked up, the current criterion **CURR.SUP. 27-V1** (address 3778) is switched ***ON***. With bus-sided voltage transformers it can be switched ***OFF***. However, if the busbar is dead, the undervoltage protection will pick up and expire and then remain in a picked-up state. It must therefore be ensured in such cases that the protection is blocked by a binary input.

2.8.4 Settings

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

Addr.	Parameter	Setting Options	Default Setting	Comments
3701	59-Vph-g Mode	OFF Alarm Only ON V>Alarm V>>Trip	OFF	Operating mode Vph-g overvoltage prot.
3702	59-1-Vph PICKUP	1.0 .. 170.0 V; ∞	85.0 V	59-1 Pickup Overvoltage (phase-ground)
3703	59-1-Vph DELAY	0.00 .. 100.00 sec; ∞	2.00 sec	59-1 Time Delay
3704	59-2-Vph PICKUP	1.0 .. 170.0 V; ∞	100.0 V	59-2 Pickup Overvoltage (phase-ground)
3705	59-2-Vph DELAY	0.00 .. 100.00 sec; ∞	1.00 sec	59-2 Time Delay
3709A	59-Vph RESET	0.30 .. 0.99	0.98	Reset ratio
3711	59-Vph-ph Mode	OFF Alarm Only ON V>Alarm V>>Trip	OFF	Operating mode Vph-ph overvoltage prot.
3712	59-1-Vpp PICKUP	2.0 .. 220.0 V; ∞	150.0 V	59-1 Pickup Overvoltage (phase-phase)
3713	59-1-Vpp DELAY	0.00 .. 100.00 sec; ∞	2.00 sec	59-1 Time Delay
3714	59-2-Vpp PICKUP	2.0 .. 220.0 V; ∞	175.0 V	59-2 Pickup Overvoltage (phase-phase)
3715	59-2-Vpp DELAY	0.00 .. 100.00 sec; ∞	1.00 sec	59-2 Time Delay
3719A	59-Vpp RESET	0.30 .. 0.99	0.98	Reset ratio
3721	59G-3V0 (or Vx)	OFF Alarm Only ON V>Alarm V>>Trip	OFF	Operating mode 3V0 overvoltage
3722	59G-1-3V0PICKUP	1.0 .. 220.0 V; ∞	30.0 V	59G-1 Pickup 3V0 (zero seq.)
3723	59G-1-3V0 DELAY	0.00 .. 100.00 sec; ∞	2.00 sec	59G-1 Time Delay
3724	59G-2-3V0PICKUP	1.0 .. 220.0 V; ∞	50.0 V	59G-2 Pickup 3V0 (zero seq.)
3725	59G-2-3V0 DELAY	0.00 .. 100.00 sec; ∞	1.00 sec	59G-2 Time Delay
3728A	59G-3Vo Stabil.	ON OFF	ON	59G: Stabilization 3Vo-Measurement
3729A	59G RESET	0.30 .. 0.99	0.95	Reset ratio
3731	59-V1 Mode	OFF Alarm Only ON V>Alarm V>>Trip	OFF	Operating mode V1 overvoltage prot.
3732	59-1-V1 PICKUP	2.0 .. 220.0 V; ∞	150.0 V	59-1 Pickup Overvoltage (pos. seq.)
3733	59-1-V1 DELAY	0.00 .. 100.00 sec; ∞	2.00 sec	59-1 Time Delay
3734	59-2-V1 PICKUP	2.0 .. 220.0 V; ∞	175.0 V	59-2 Pickup Overvoltage (pos. seq.)

Addr.	Parameter	Setting Options	Default Setting	Comments
3735	59-2-V1 DELAY	0.00 .. 100.00 sec; ∞	1.00 sec	59-2 Time Delay
3739A	59-V1 RESET	0.30 .. 0.99	0.98	Reset ratio
3741	59-V2 Mode	OFF Alarm Only ON V>Alarm V>>Trip	OFF	Operating mode V2 overvoltage prot.
3742	59-1-V2 PICKUP	2.0 .. 220.0 V; ∞	30.0 V	59-1 Pickup Overvoltage (neg. seq.)
3743	59-1-V2 DELAY	0.00 .. 100.00 sec; ∞	2.00 sec	59-1 Time Delay
3744	59-2-V2 PICKUP	2.0 .. 220.0 V; ∞	50.0 V	59-2 Pickup Overvoltage (neg. seq.)
3745	59-2-V2 DELAY	0.00 .. 100.00 sec; ∞	1.00 sec	59-2 Time Delay
3749A	59-V2 RESET	0.30 .. 0.99	0.98	Reset ratio
3751	27-Vph-g Mode	OFF Alarm Only ON V<Alarm V<<Trip	OFF	Operating mode Vph-g undervolt-age prot.
3752	27-1-Vph PICKUP	1.0 .. 100.0 V; 0	30.0 V	27-1 Pickup Undervoltage (phase-neutral)
3753	27-1-Vph DELAY	0.00 .. 100.00 sec; ∞	2.00 sec	27-1 Time Delay
3754	27-2-Vph PICKUP	1.0 .. 100.0 V; 0	10.0 V	27-2 Pickup Undervoltage (phase-neutral)
3755	27-2-Vph DELAY	0.00 .. 100.00 sec; ∞	1.00 sec	27-2 Time Delay
3758	CURR.SUP 27-Vph	ON OFF	ON	Current supervision (Vph-g)
3759A	27-Vph RESET	1.01 .. 1.20	1.05	Reset ratio
3761	27-Vph-ph Mode	OFF Alarm Only ON V<Alarm V<<Trip	OFF	Operating mode Vph-ph under-voltage prot.
3762	27-1-Vpp PICKUP	1.0 .. 175.0 V; 0	50.0 V	27-1 Pickup Undervoltage (phase-phase)
3763	27-1-Vpp DELAY	0.00 .. 100.00 sec; ∞	2.00 sec	27-1 Time Delay
3764	27-2-Vpp PICKUP	1.0 .. 175.0 V; 0	17.0 V	27-2 Pickup Undervoltage (phase-phase)
3765	27-2-Vpp DELAY	0.00 .. 100.00 sec; ∞	1.00 sec	27-2 Time Delay
3768	CURR.SUP 27-Vpp	ON OFF	ON	Current supervision (Vph-ph)
3769A	27-Vph-ph RESET	1.01 .. 1.20	1.05	Reset ratio
3771	27-V1 Mode	OFF Alarm Only ON V<Alarm V<<Trip	OFF	Operating mode V1 Undervoltage prot.
3772	27-1-V1 PICKUP	1.0 .. 100.0 V; 0	30.0 V	27-1 Pickup Undervoltage (pos. seq.)

Addr.	Parameter	Setting Options	Default Setting	Comments
3773	27-1-V1 DELAY	0.00 .. 100.00 sec; ∞	2.00 sec	27-1 Time Delay
3774	27-2-V1 PICKUP	1.0 .. 100.0 V; 0	10.0 V	27-2 Pickup Undervoltage (pos. seq.)
3775	27-2-V1 DELAY	0.00 .. 100.00 sec; ∞	1.00 sec	27-2 Time Delay
3778	CURR.SUP. 27-V1	ON OFF	ON	Current supervision (V1)
3779A	27-V1 RESET	1.01 .. 1.20	1.05	Reset ratio

2.8.5 Information List

No.	Information	Type of Information	Comments
234.2100	27, 59 blk	IntSP	27, 59 blocked via operation
10201	>59-Vphg BLOCK	SP	>BLOCK 59-Vphg Overvolt. (phase-ground)
10202	>59-Vphph BLOCK	SP	>BLOCK 59-Vphph Overvolt (phase-phase)
10203	>59-3V0 BLOCK	SP	>BLOCK 59-3V0 Overvolt. (zero sequence)
10204	>59-V1 BLOCK	SP	>BLOCK 59-V1 Overvolt. (positive seq.)
10205	>59-V2 BLOCK	SP	>BLOCK 59-V2 Overvolt. (negative seq.)
10206	>27-Vphg BLOCK	SP	>BLOCK 27-Vphg Undervolt. (phase-ground)
10207	>27-Vphph BLOCK	SP	>BLOCK 27-Vphph Undervolt (phase-phase)
10208	>27-V1 BLOCK	SP	>BLOCK 27-V1 Undervolt (positive seq.)
10215	59-Vphg OFF	OUT	59-Vphg Overvolt. is switched OFF
10216	59-Vphg BLK	OUT	59-Vphg Overvolt. is BLOCKED
10217	59-Vphph OFF	OUT	59-Vphph Overvolt. is switched OFF
10218	59-Vphph BLK	OUT	59-Vphph Overvolt. is BLOCKED
10219	59-3V0 OFF	OUT	59-3V0 Overvolt. is switched OFF
10220	59-3V0 BLK	OUT	59-3V0 Overvolt. is BLOCKED
10221	59-V1 OFF	OUT	59-V1 Overvolt. is switched OFF
10222	59-V1 BLK	OUT	59-V1 Overvolt. is BLOCKED
10223	59-V2 OFF	OUT	59-V2 Overvolt. is switched OFF
10224	59-V2 BLK	OUT	59-V2 Overvolt. is BLOCKED
10225	27-Vphg OFF	OUT	27-Vphg Undervolt. is switched OFF
10226	27-Vphg BLK	OUT	27-Vphg Undervolt. is BLOCKED
10227	27-Vphph OFF	OUT	27-Vphph Undervolt. is switched OFF
10228	27-Vphph BLK	OUT	27-Vphph Undervolt. is BLOCKED
10229	27-V1 OFF	OUT	27-V1 Undervolt. is switched OFF
10230	27-V1 BLK	OUT	27-V1 Undervolt. is BLOCKED
10231	27/59 ACTIVE	OUT	27/59 Voltage protection is ACTIVE
10240	59-1-Vpg Pickup	OUT	59-1-Vphg Pickup
10241	59-2-Vpg Pickup	OUT	59-2-Vphg Pickup
10242	59-Vpg PU A	OUT	59-Vphg Pickup A
10243	59-Vpg PU B	OUT	59-Vphg Pickup B
10244	59-Vpg PU C	OUT	59-Vphg Pickup C
10245	59-1-VpgTimeOut	OUT	59-1-Vphg TimeOut
10246	59-2-VpgTimeOut	OUT	59-2-Vphg TimeOut

No.	Information	Type of Information	Comments
10247	59-Vpg TRIP	OUT	59-Vphg TRIP command
10248	59-1-Vpg PU A	OUT	59-1-Vphg Pickup A
10249	59-1-Vpg PU B	OUT	59-1-Vphg Pickup B
10250	59-1-Vpg PU C	OUT	59-1-Vphg Pickup C
10251	59-2-Vpg PU A	OUT	59-2-Vphg Pickup A
10252	59-2-Vpg PU B	OUT	59-2-Vphg Pickup B
10253	59-2-Vpg PU C	OUT	59-2-Vphg Pickup C
10255	59-1-Vpp Pickup	OUT	59-1-Vphph Pickup
10256	59-2-Vpp Pickup	OUT	59-2-Vphph Pickup
10257	59-Vpp PickupAB	OUT	59-Vphph Pickup A-B
10258	59-Vpp PickupBC	OUT	59-Vphph Pickup B-C
10259	59-Vpp PickupCA	OUT	59-Vphph Pickup C-A
10260	59-1-VppTimeOut	OUT	59-1-Vphph TimeOut
10261	59-2-VppTimeOut	OUT	59-2-Vphph TimeOut
10262	59-Vpp TRIP	OUT	59-Vphph TRIP command
10263	59-1-Vpp PU AB	OUT	59-1-Vphph Pickup A-B
10264	59-1-Vpp PU BC	OUT	59-1-Vphph Pickup B-C
10265	59-1-Vpp PU CA	OUT	59-1-Vphph Pickup C-A
10266	59-2-Vpp PU AB	OUT	59-2-Vphph Pickup A-B
10267	59-2-Vpp PU BC	OUT	59-2-Vphph Pickup B-C
10268	59-2-Vpp PU CA	OUT	59-2-Vphph Pickup C-A
10270	59-1-3V0 Pickup	OUT	59-1-3V0 Pickup
10271	59-2-3V0 Pickup	OUT	59-2-3V0 Pickup
10272	59-1-3V0TimeOut	OUT	59-1-3V0 TimeOut
10273	59-2-3V0TimeOut	OUT	59-2-3V0 TimeOut
10274	59-3V0 TRIP	OUT	59-3V0 TRIP command
10280	59-1-V1 Pickup	OUT	59-1-V1 Pickup
10281	59-2-V1 Pickup	OUT	59-2-V1 Pickup
10282	59-1-V1TimeOut	OUT	59-1-V1 TimeOut
10283	59-2-V1TimeOut	OUT	59-2-V1 TimeOut
10284	59-V1 TRIP	OUT	59-V1 TRIP command
10290	59-1-V2 Pickup	OUT	59-1-V2 Pickup
10291	59-2-V2 Pickup	OUT	59-2-V2 Pickup
10292	59-1-V2TimeOut	OUT	59-1-V2 TimeOut
10293	59-2-V2TimeOut	OUT	59-2-V2 TimeOut
10294	59-V2 TRIP	OUT	59-V2 TRIP command
10300	27-1-V1 Pickup	OUT	27-1-V1 Pickup
10301	27-2-V1 Pickup	OUT	27-2-V1 Pickup
10302	27-1-V1TimeOut	OUT	27-1-V1TimeOut
10303	27-2-V1TimeOut	OUT	27-2-V1TimeOut
10304	27-V1 TRIP	OUT	27-V1 TRIP command
10310	27-1-Vpg Pickup	OUT	27-1-Vphg Pickup
10311	27-2-Vpg Pickup	OUT	27-2-Vphg Pickup
10312	27-Vpg PU A	OUT	27-Vphg Pickup A
10313	27-Vpg PU B	OUT	27-Vphg Pickup B
10314	27-Vpg PU C	OUT	27-Vphg Pickup C

No.	Information	Type of Information	Comments
10315	27-1-VpgTimeOut	OUT	27-1-Vphg TimeOut
10316	27-2-VpgTimeOut	OUT	27-2-Vphg TimeOut
10317	27-Vpg TRIP	OUT	27-Vphg TRIP command
10318	27-1-Vpg PU A	OUT	27-1-Vphg Pickup A
10319	27-1-Vpg PU B	OUT	27-1-Vphg Pickup B
10320	27-1-Vpg PU C	OUT	27-1-Vphg Pickup C
10321	27-2-Vpg PU A	OUT	27-2-Vphg Pickup A
10322	27-2-Vpg PU B	OUT	27-2-Vphg Pickup B
10323	27-2-Vpg PU C	OUT	27-2-Vphg Pickup C
10325	27-1-Vpp Pickup	OUT	27-1-Vphph Pickup
10326	27-2-Vpp Pickup	OUT	27-2-Vphph Pickup
10327	27-Vpp PU AB	OUT	27-Vphph Pickup A-B
10328	27-Vpp PU BC	OUT	27-Vphph Pickup B-C
10329	27-Vpp PU CA	OUT	27-Vphph Pickup C-A
10330	27-1-VppTimeOut	OUT	27-1-Vphph TimeOut
10331	27-2-VppTimeOut	OUT	27-2-Vphph TimeOut
10332	27-Vpp TRIP	OUT	27-Vphph TRIP command
10333	27-1-Vpp PU AB	OUT	27-1-Vphph Pickup A-B
10334	27-1-Vpp PU BC	OUT	27-1-Vphph Pickup B-C
10335	27-1-Vpp PU CA	OUT	27-1-Vphph Pickup C-A
10336	27-2-Vpp PU AB	OUT	27-2-Vphph Pickup A-B
10337	27-2-Vpp PU BC	OUT	27-2-Vphph Pickup B-C
10338	27-2-Vpp PU CA	OUT	27-2-Vphph Pickup C-A

2.9 Frequency Protection 81 (Optional)

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.

Underfrequency is caused by increased real power demand of the loads or by a reduction of the generated power, e.g. in the event of disconnection from the power system, generator failure or faulty operation of the power/frequency regulation. Underfrequency protection is also applied for generators which operate (temporarily) 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 underfrequency protection. Underfrequency results also in increased reactive power demand of inductive loads.

Overfrequency is caused e.g. by load shedding, system disconnection or malfunction of the power/frequency control. There is also a risk of self-excitation for generators feeding long lines under no-load conditions.

In order that the frequency protection can work, you must connect the voltages to the device.

2.9.1 Description

Frequency Elements

Frequency protection consists of the four frequency elements f1 to f4. Each element can be set as overfrequency element (f>) or as underfrequency element (f<) with individual thresholds and time delays. This ensures variable matching to the application purpose.

- If an element is set to a value above the rated frequency, it is automatically interpreted to be an overfrequency element f>.
- If an element is set to a value below the rated frequency, it is automatically interpreted to be an underfrequency element f<.
- If an element is set exactly to the rated frequency, it is inactive.

Each element can be blocked via binary input and also the entire frequency protection function can be blocked.

Frequency Measurement

The largest of the 3 phase-to-phase voltages is used for frequency measurement. It must have an amount of at least 65 % of the rated voltage, which is set in parameter 204, **Vnom SECONDARY**. Below that value frequency measurement will not take place.

Numerical filters are employed to calculate from the measured voltage a quantity that is proportional to the frequency which is virtually linear in the specified range ($f_N \pm 10$ %). Filters and repeated measurements ensure that the frequency evaluation is virtually free from harmonic influences and phase jumps.

An accurate and quick measurement result is obtained by considering also the frequency change. When changing the frequency of the power system, the sign of the quotient $^{\Delta f}/_{dt}$ remains unchanged during several repeated measurements. If, however, a phase jump in the measured voltage temporarily simulates a frequency deviation, the sign of $^{\Delta f}/_{dt}$ will subsequently reverse. Thus the measurement results corrupted by a phase jump are quickly discarded.

The dropout value of each frequency element is approximately 20 MHz below (for f>) or above (for f<) of the pickup value.

Operating Ranges

Frequency evaluation requires a measured quantity that can be processed. This implies that at least a sufficiently high voltage is available and that the frequency of this voltage is within the working range of the frequency protection.

The frequency protection automatically selects the largest of the phase-to-phase voltages. If all three voltages are below the operating range of 65 % · V_N (secondary), the frequency cannot be determined. In that case the indication 5215 „81 UnderV Blk“ is displayed. If the voltage falls below this minimum value after a frequency element has picked up, the picked up element will drop out. This implies also that all frequency elements will drop out after a line has been switched off (with voltage transformers on line side).

When connecting a measuring voltage with a frequency outside the configured threshold of a frequency element, the frequency protection is immediately ready to operate. Since the filters of the frequency measurement must first go through a transient state, the command output time may increase slightly (approx. 1 period). This is because a frequency stage picks up only if the frequency has been detected outside the configured threshold in five consecutive measurements.

The frequency range is from 25 Hz to 70 Hz. If the frequency leaves this operating range, the frequency elements will drop out. If the frequency returns into the operating range, the measurement can be resumed provided that the measuring voltage is also inside the operating range. But if the measuring voltage is switched off, the picked up element will drop out immediately.

Power Swings

In interconnected systems, frequency deviations may also be caused by power swings. Depending on the power swing frequency, the mounting location of the device and the setting of the frequency elements, power swings may cause the frequency protection to pick up and even to trip. In these cases it is reasonable to block the frequency protection once power swings are detected. This can be accomplished via binary inputs and binary outputs (e.g. power swing detection of an external distance protection) or by corresponding logic operations using the user-defined logic (CFC). If, however, the power swing frequencies are known, tripping of the frequency protection function can also be avoided by adapting the time delays of the frequency protection correspondingly.

Pickup / Tripping

Figure 2-52 shows the logic diagram for the frequency protection function.

Once the frequency was reliably detected to be outside the configured thresholds of an element (above the setting value for f> elements or below for f< elements), a pickup signal of the corresponding element is generated. The decision is considered reliable if 5 measurements taken in intervals of $^1/_2$ period yield one frequency outside the set threshold.

After pickup, a time delay per element can be started. When the associated time has elapsed, one trip command per element is issued. A picked up element drops out if the cause of the pickup is no longer valid after five measurements or if the measuring voltage was switched off or the frequency is outside the operating range. When a frequency element drops out, the tripping signal of the corresponding frequency element is immediately terminated, but the trip command is maintained for at least the minimum command duration which was set for all tripping functions of the device.

Each of the four frequency elements can be blocked individually by binary inputs. The blocking takes immediate effect. It is also possible to block the entire frequency protection function via binary input.

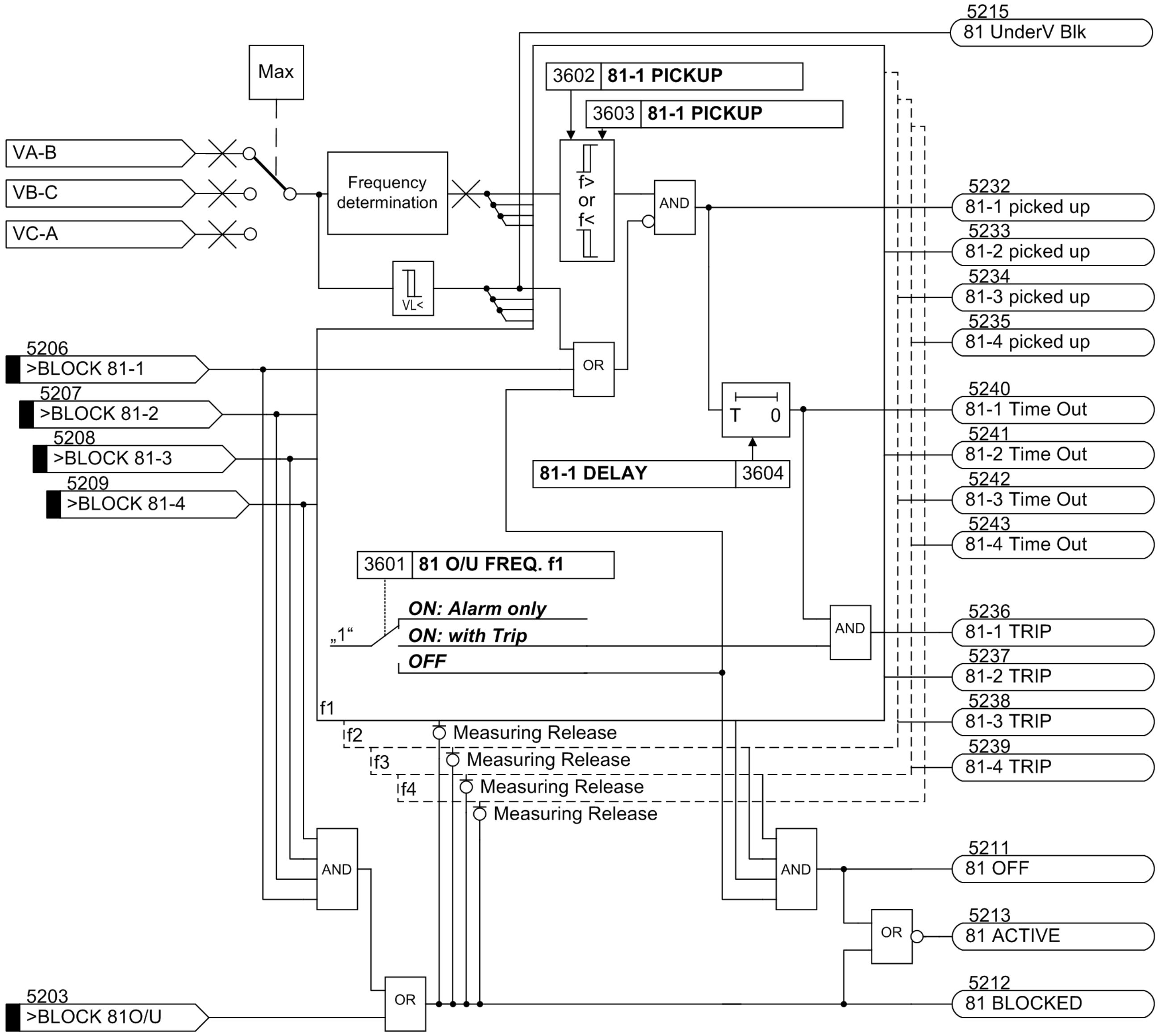


Figure 2-52 Logic diagram of frequency protection for 50 Hz rated frequency

2.9.2 Setting Notes

General

Frequency protection is only in effect and accessible if address 136 **81 O/U** is set to ***Enabled*** during configuration of protective functions. If the function is not required, set ***Disabled***.

The frequency protection function features 4 frequency elements f1 to f4 each of which can function as overfrequency element or underfrequency element. Each zone can be set active or inactive. This is set in addresses:

- 3601 **81 O/U FREQ. f1** for frequency element f1,
- 3611 **81 O/U FREQ. f2** for frequency element f2,
- 3621 **81 O/U FREQ. f3** for frequency element f3,
- 3631 **81 O/U FREQ. f4** for frequency element f4,

The following 3 options are available:

- Element ***OFF***: The element is ineffective;
- Element ***ON: with Trip***: The element is effective and issues an alarm and a trip command (after time has expired) following irregular frequency deviations;
- Element ***ON: Alarm only***: The element is effective and issues an alarm but no trip command following irregular frequency deviations;

Pickup Values, Time Delay

The configured pickup value determines whether a frequency element is to respond to overfrequency or underfrequency.

- If an element is set to a value above the rated frequency, it is automatically interpreted to be an overfrequency element f>.
- If an element is set to a value below the rated frequency, it is automatically interpreted to be an underfrequency element f<.
- If an element is set exactly to the rated frequency, it is inactive.

A pickup value can be set for each element according to above rules. The addresses and possible setting ranges are determined by the rated frequency as configured in the power system data 1 (Subsection 2.1.3.1) at **Rated Frequency** (address 230).

Please note that none of the frequency elements is set to less than 30 MHz above (for f>) or below (for f<) of the nominal frequency. Since the frequency elements have a hysteresis of approx. 20 MHz, it may otherwise happen that the element does not drop out when returning to the nominal frequency.

Only those addresses are accessible that match the configured nominal frequency. For each element, a trip time delay can be set:

- Address 3602 **81-1 PICKUP** pickup value for frequency element f1 at f_N = 50 Hz,
  Address 3603 **81-1 PICKUP** pickup value for frequency element f1 at f_N = 60 Hz,
  Address 3604 **81-1 DELAY** trip delay for frequency element f1;
- Address 3612 **81-2 PICKUP** pickup value for frequency element f2 at f_N = 50 Hz,
  Address 3613 **81-2 PICKUP** pickup value for frequency element f2 at f_N = 60 Hz,
  Address 3614 **81-2 DELAY** trip delay for frequency element f2;

- Address 3622 **81-3 PICKUP** pickup value for frequency element f3 at f_N = 50 Hz,
  Address 3623 **81-3 PICKUP** pickup value for frequency element f3 at f_N = 60 Hz,
  Address 3624 **81-3 DELAY** trip delay for frequency element f3;
- Address 3632 **81-4 PICKUP** pickup value for frequency element f4 at f_N = 50 Hz,
  Address 3633 **81-4 PICKUP** pickup value for frequency element f4 at f_N = 60 Hz,
  Address 3634 **81-4 DELAY** trip delay for frequency element f4;

The set times are additional time delays not including the operating times (measuring time, dropout time) of the protective function.

If underfrequency protection is used for load shedding purposes, then the frequency settings relative to other feeder relays are generally based on the priority of the customers served by the protective relay. Normally, load shedding requires a frequency / time grading that takes into account the importance of the consumers or consumer groups.

In interconnected networks, frequency deviations may also be caused by power swings. Depending on the power swing frequency, the mounting location of the device and the setting of the frequency elements, it is recommended to block the entire frequency protection function or single elements once a power swing has been detected. The time delays must then be coordinated thus that a power swing is detected before the frequency protection trips.

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

Since the dropout threshold is 20 MHz below or above the trip frequency, the resulting „minimum“ trip frequency is 30 MHz above or below the nominal frequency.

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

2.9.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
3601	81 O/U FREQ. f1	ON: Alarm only ON: with Trip OFF	ON: Alarm only	81 Over/Under Frequency Prot. element f1
3602	81-1 PICKUP	45.50 .. 54.50 Hz	49.50 Hz	81-1 Pickup
3603	81-1 PICKUP	55.50 .. 64.50 Hz	59.50 Hz	81-1 Pickup
3604	81-1 DELAY	0.00 .. 600.00 sec	60.00 sec	81-1 Time Delay
3611	81 O/U FREQ. f2	ON: Alarm only ON: with Trip OFF	ON: Alarm only	81 Over/Under Frequency Prot. element f2
3612	81-2 PICKUP	45.50 .. 54.50 Hz	49.00 Hz	81-2 Pickup
3613	81-2 PICKUP	55.50 .. 64.50 Hz	57.00 Hz	81-2 Pickup
3614	81-2 DELAY	0.00 .. 600.00 sec	30.00 sec	81-2 Time Delay
3621	81 O/U FREQ. f3	ON: Alarm only ON: with Trip OFF	ON: Alarm only	81 Over/Under Frequency Prot. element f3

Addr.	Parameter	Setting Options	Default Setting	Comments
3622	81-3 PICKUP	45.50 .. 54.50 Hz	47.50 Hz	81-3 Pickup
3623	81-3 PICKUP	55.50 .. 64.50 Hz	59.50 Hz	81-3 Pickup
3624	81-3 DELAY	0.00 .. 600.00 sec	3.00 sec	81-3 Time delay
3631	81 O/U FREQ. f4	ON: Alarm only ON: with Trip OFF	ON: Alarm only	81 Over/Under Frequency Prot. element f4
3632	81-4 PICKUP	45.50 .. 54.50 Hz	51.00 Hz	81-4 Pickup
3633	81-4 PICKUP	55.50 .. 64.50 Hz	62.00 Hz	81-4 Pickup
3634	81-4 DELAY	0.00 .. 600.00 sec	30.00 sec	81-4 Time delay

2.9.4 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
5215	81 UnderV Blk	OUT	81 Undervoltage 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
5240	81-1 Time Out	OUT	81-1: Time Out
5241	81-2 Time Out	OUT	81-2: Time Out
5242	81-3 Time Out	OUT	81-3: Time Out
5243	81-4 Time Out	OUT	81-4: Time Out

2.10 Direct Local Trip

Any signal from an external protection or monitoring device can be coupled into the signal processing of the 7SD80 by means of a binary input. This signal may be delayed, alarmed and routed to one or several output relays. This signal can be delayed, alarmed and routed to one or several output relays.

2.10.1 Description

External Tripping of the Local Circuit Breaker

The external tripping can be switched on and off with a setting parameter and may be blocked via binary input. The tripping logic of the device ensures that the conditions for the tripping logic are satisfied.

The phase currents and the ground current must exceed a configurable threshold to activate the tripping logic of the device. The trip command can be delayed via a configurable time.

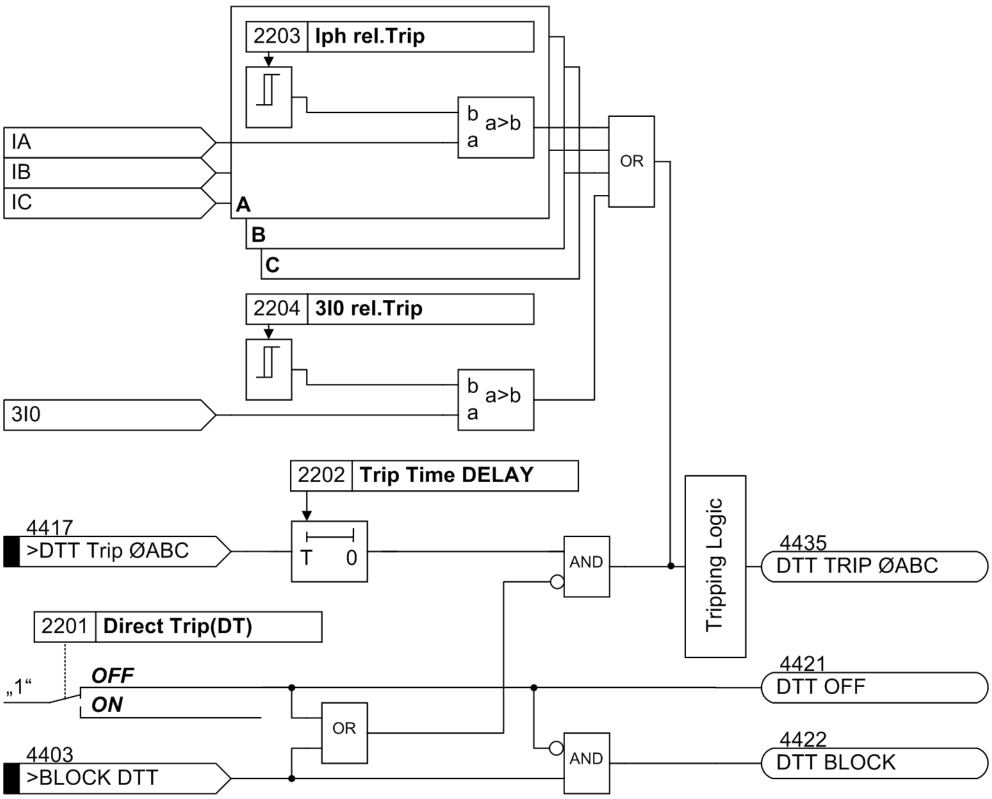


Figure 2-53 Logic diagram of the local external trip

2.10.2 Setting Notes

General

In order to use the direct and remote tripping functions, address 122 **DTT Direct Trip** must have been set to ***Enabled*** during the configuration of the device functional scope. At address 2201 **Direct Trip(DT)** it can also be switched ***ON*** or ***OFF***.

It is possible to set a trip delay for both the local external trip and the receive side of the remote trip in address 2202 **Trip Time DELAY**. This delay can be used as a safety margin, especially in case of local direct tripping.

Once a trip command has been issued, it is maintained for at least as long as the set minimum trip command duration **TMin TRIP CMD** which was set for the device in general in address 240 (Section 2.1.3). Reliable operation of the circuit breaker is therefore ensured, even if the initiating signal pulse is very short. This parameter can only be set in DIGSI at **Display Additional Settings**.

2.10.3 Settings

The table indicates region-specific default settings. Column C (configuration) indicates the corresponding secondary nominal current of the current transformer.

Addr.	Parameter	C	Setting Options	Default Setting	Comments
2201	Direct Trip(DT)		ON OFF	OFF	Direct Trip (DT)
2202	Trip Time DELAY		0.00 .. 30.00 sec; ∞	0.00 sec	Trip Time Delay
2203	Iph rel.Trip	1A	0.0 .. 25.0 A; ∞	0.0 A	Minimal Phase Current to release trip
		5A	0.0 .. 125.0 A; ∞	0.0 A	
2204	3I0 rel.Trip	1A	0.0 .. 25.0 A; ∞	0.0 A	Minimal 3I0 Current to release trip
		5A	0.0 .. 125.0 A; ∞	0.0 A	

2.10.4 Information List

No.	Information	Type of Information	Comments
4403	>BLOCK DTT	SP	>BLOCK Direct Transfer Trip option
4417	>DTT Trip ØABC	SP	>Direct Transfer Trip INPUT Phases ABC
4421	DTT OFF	OUT	Direct Transfer Trip is switched OFF
4422	DTT BLOCK	OUT	Direct Transfer Trip is BLOCKED
4435	DTT TRIP ØABC	OUT	DTT TRIP command Phases ABC

2.11 Automatic Reclosure Function 79 (Optional)

Experience shows that about 85% of the arc faults on overhead lines are extinguished automatically after being tripped by the protection. This means that the line can be connected again. Reclosing is performed by an automatic reclosing function (AR).

Automatic reclosing is only permitted on overhead lines because the possibility of extinguishing a fault arc automatically only exists there. It must not be used in any other case. If the protected object consists of a mixture of overhead lines and other equipment (e.g. overhead line in block with a transformer or overhead line/cable), it must be ensured that reclosing can only be performed in the event of a short circuit on the overhead line.

If the fault still exists after automatic reclosing (arc has not disappeared, there is a metallic fault), then the protective elements will re-trip the circuit breaker.

The 7SD80 can also be implemented with an external automatic reclosing device. In this case, the signal exchange between 7SD80 and the external reclosing device must be effected via binary inputs and outputs.

It is also possible to initiate the integrated auto reclose function by an external protection device (e.g. a backup protection). The use of two 7SD80 with automatic reclosing function or the use of one 7SD80 with an automatic reclosing function and a second protection with its own automatic reclosing function are equally possible.

2.11.1 Description

Reclosing following interruption by a short-circuit protection is performed by an automatic reclosing function (AR). An example of the normal time sequence of double reclosing is shown in the figure below.

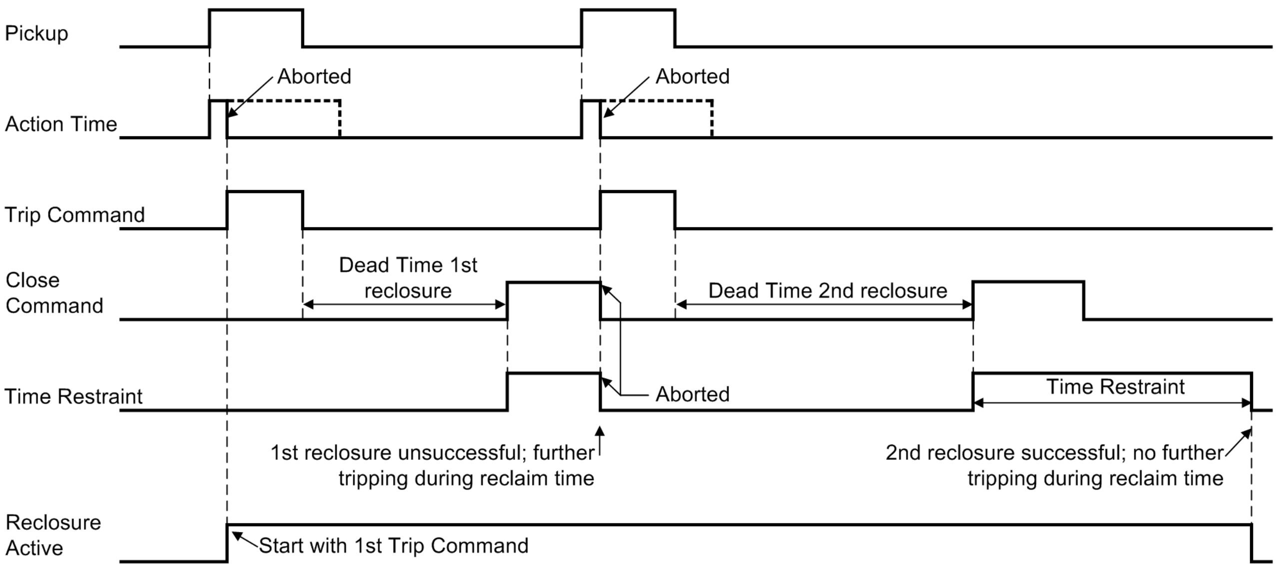


Figure 2-54 Timing diagram of a double-shot reclosure with action time (2nd reclosure successful)

The integrated automatic reclosing function allows up to 2 reclosing attempts using different parameters (action times and dead times).

Initiation

Initiation of the automatic reclosing function means storing the first trip signal of a power system fault that was generated by a protection function which operates with the automatic reclosing function, e.g. phase comparison protection or ground fault differential protection. In case of multiple reclosing attempts, initiation therefore only takes place once with the first trip command. This storing of the first trip signal is the prerequisite for all subsequent activities of the automatic reclosing function. The initiation is important if the first trip command only appears after an action time has expired (see below under „Action times“).

The automatic reclosing function is not started if the circuit breaker has not been ready for at least one TRIP-CLOSE-TRIP cycle at the instant of the first trip command. This can be achieved by setting parameters. For further information, please refer to „Interrogation of Circuit-Breaker Readiness“.

Via setting parameters you can specify whether the differential protection or the overcurrent protection work together with the automatic reclosing function or not. Furthermore, you can select whether external trip commands injected via binary inputs and/or the trip commands generated by transfer trip signals/remote tripping initiate the automatic reclosing function or not.

Those protection and monitoring functions of the device that do not respond to short circuits or similar conditions (e.g. overload protection) do not initiate the automatic reclosing function because reclosing would not be useful here. The circuit-breaker failure protection must not start the automatic reclosing function either.

Action Times

It is often desirable to prevent the readiness to reclose if the short circuit has been present for some time, e.g. because it is assumed that the arc has burned in to such an extent that it is not likely to extinguish itself automatically during the dead time. Also for reasons of selectivity (see above), faults that are usually cleared after a time delay should not lead to reclosing.

The automatic reclosing function of the 7SD80 can be operated with or without action times (configuration parameter **AR control mode**, address 134, see Section 2.1.1.2). No starting signal is necessary from the protection functions or external protection devices that operate without action time. Initiation takes place as soon as the first trip command appears.

When operating with action time, an action time is available for each reclose cycle. The action times are always started by the general starting signal (with logic OR combination of all internal and external protection functions which can start the automatic reclose function). If there is no trip command yet when the action time has expired, the corresponding automatic reclosing cycle cannot be executed.

For each reclosing cycle, you can specify whether or not it allows a start. Following the first general pickup, only those action times are relevant whose cycles allow starting because the other cycles are not allowed to initiate. By means of the action times and the permission to start the recloser (permission to be the first cycle that is executed), it is possible to determine which reclose cycles are executed depending on the time it takes the protection function to trip.

Operating Mode of the Automatic Reclose Function

The dead times — these are the times from elimination of the fault (drop out of the trip command or signaling via auxiliary contacts) to the initiation of the automatic close command — may vary depending on the automatic reclosing operating mode selected when determining the functional scope and the resulting signals of the starting protection functions.

In operating mode ***TRIP ...*** (with trip command ...) the dead time is set for 3-phase tripping.

In operating mode ***PICKUP ...*** (With PICKUP...) different dead times can be set for every reclosing cycle after 1-phase, 2-phase and 3-phase faults. Here the decisive factor is the pickup diagram of the protective functions at the instant the trip command disappears. This operating mode enables making the dead times dependent on the type of fault in the case of 3-pole reclose cycles.

Blocking the Reclosing Function

Different conditions lead to blocking of the automatic reclosing function. No reclosing is possible, for example, if it is blocked via a binary input. If the automatic reclosing function has not been started yet, it cannot be started at all. If a reclosing cycle is already in progress, dynamic lockout takes place (see below).

Each individual cycle may also be blocked via binary input. In this case the cycle concerned is declared as invalid and is skipped in the sequence of permissible cycles. If blocking takes place while the affected cycle is already running, this causes the reclosing to be canceled, i.e. no reclosing takes place even if other valid cycles have been parameterized.

Internal blocking states restricted to certain time periods are processed during the course of reclosing cycles:

The restraint time **T-RECLAIM** (address 3403) is started with each automatic reclosing command. The only exception is the ADT mode where the blocking time can be disabled by setting it to 0 s. If reclosing is successful, all the functions of the automatic reclosing function return to the quiescent state at the end of the restraint time; a fault after expiry of the blocking time is treated as a new fault in the system. If the restraint time is disabled in ADT mode, each new trip after reclosing is considered as a new fault. If one of the protection functions causes another trip during the restraint time, the next reclosing cycle will be started if multiple reclosing attempts have been set. If no further reclosing attempts are permitted, the last reclosing attempt is regarded as unsuccessful in case of another trip during the restraint time. The automatic reclosure is blocked dynamically.

The dynamic blocking locks the reclosure for the duration of the dynamic blocking time (0.5 s). This occurs, for example, after a final trip or other events which block the auto reclose function after it has been started. Restarting is blocked during this time. When this time expires, the automatic reclosing function returns to its quiescent state and is ready for a new fault in the network.

If the circuit breaker is closed manually (by the control discrepancy switch connected to a binary input, the local control functions or via one of the serial interfaces), the automatic reclosing is blocked for a manual-close-blocking time **BLOCK MC Dur.**, address 3404, . If a trip command occurs during this time, it can be assumed that a metallic short-circuit is present (e.g. closed earth switch). Every trip command within this time is therefore a final trip. With the user-definable logic functions (CFC) further control functions can be processed in the same way as a manual close command.

Scanning of the Readiness of the Circuit Breaker

A precondition for automatic reclosing following clearance of a short circuit is that the circuit breaker is ready for at least one OPEN-CLOSE-OPEN-cycle when the automatic reclosing circuit is started (i.e. at the time of the first trip command). The readiness of the circuit breaker is signaled to the device via the binary input „>Bkr1 Ready“ (no. 371). If no such signal is available, the circuit-breaker interrogation can be suppressed (presetting of address 3402) as automatic reclosing would otherwise not be possible at all.

In the event of a single cycle reclosure this interrogation is usually sufficient. Since, for example, the air pressure or the spring tension for the circuit-breaker mechanism drops after the trip, no further interrogation should take place.

Especially when multiple reclosing attempts are programmed, it is a good idea to monitor the circuit-breaker condition not only prior to the first but also before the second reclosing attempt. Reclosure will be blocked until the binary input indicates that the circuit breaker is ready to complete another CLOSE-TRIP cycle.

The time needed by the circuit breaker to regain the ready state can be monitored by the 7SD80. This monitoring time **CB TIME OUT** (address 3409) starts as soon as the CB indicates the not ready state. The dead time may be extended if the ready state is not indicated when it expires. However, if the circuit breaker does not indicate its ready status for a longer period than the monitoring time, reclosure is dynamically blocked (see also above under margin heading „Blocking the Reclosing Function“).

Processing the Auxiliary Contacts of the Circuit Breaker

If the circuit-breaker auxiliary contacts are connected to the device, the reaction of the circuit breaker is also checked for plausibility.

If the series connections of the normally open and normally closed contacts of the poles are connected, the circuit breaker is assumed to have all three poles open when the series connection of the normally closed contacts is closed (binary input „>52b Bkr1 3p Op“, no.411). All three poles are assumed closed when the series connection of the normally open contacts is closed (binary input „>52a Bkr1 3p Cl“, no. 410).

The device continuously checks the switching state of the circuit breaker: As long as the auxiliary contacts indicate that the CB is not closed in all 3 poles, the automatic reclosure function cannot be started. A close command is only issued if the circuit breaker tripped previously (from of the closed state).

The valid dead time begins if no trip command applies, or if the auxiliary contacts additionally indicate that the circuit breaker has opened.

Sequence of a 3-Pole Automatic Reclose Cycle

If the automatic reclosure function is ready, the fault protection trips for all faults inside the element selected for reclosure. The automatic reclosure function is started. When the trip command resets or the circuit breaker opens (auxiliary contact criterion) a configurable dead time is started. At the end of this dead time, the circuit breaker receives a close command. At the same time, the configurable blocking time is started. If, when configuring the protective functions, at address 134 **AR control mode** = ***with Pickup*** was set, different dead times can be parameterized depending on the type of fault recognized by the protection.

If the fault is cleared (successful reclosure), the restraint time expires and all functions return to their quiescent state. The fault is terminated.

If the fault has not been eliminated (unsuccessful reclosure), the short-circuit protection initiates a final trip following a protection stage active without reclosure. Any fault during the restraint time leads to a final trip.

After unsuccessful reclosure (final tripping) the automatic reclosure is blocked dynamically (see also margin heading „Reclose Block, above“).

The sequence above applies for single reclosure cycles. 7SD80 allow 2 reclosing cycles.

Multiple Automatic Reclosing Attempts

If a short circuit still exists after a reclosing attempt, one more reclosing attempt can be made.

The two reclosing cycles are independent of each other. Each has separate action and dead times and can be blocked separately via binary inputs.

The sequence is basically the same as described above. However, if the first reclosure attempt was unsuccessful, the reclosure function is not blocked, but instead the second reclose cycle is started. The appropriate dead time starts with the reset of the trip command or opening of the circuit breaker (pole) (auxiliary contact criterion). The circuit breaker receives a new close command after expiry of the dead time. At the same time the restraint time is started.

The restraint time is reset with each new trip command after reclosure and is started again with the next close command until the set maximum number of permissible automatic reclosing cycles has been reached.

If one of the two reclosing attempts is successful, i.e. the fault disappeared after reclosing, the blocking time expires and the automatic reclosing system is reset. The fault is terminated.

If no cycle is successful, the short-circuit protection initiates a final trip after the last permissible reclosing, following the grading time valid without reclosing. The automatic reclosing function is blocked dynamically (see also above under margin heading „Blocking the Reclosing Function“).

Handling of Evolving Faults

If reclose cycles are executed in the power system, particular attention must be paid to evolving faults.

Sequential faults are faults which occur during the dead time after clearance of the first fault.

To **detect** an evolving fault, you can select either the trip command of a protection function during the dead time or every further pickup as the criterion for an evolving fault.

It is possible to select the desired **response** of the internal automatic recloser following the detection of a sequential fault.

- **EV. FLT. MODE** ***Stops 79***:

  The reclosure is blocked as soon as an evolving fault is detected. There are no further reclosure attempts; the automatic reclosure is blocked dynamically (see also margin heading „Blocking reclosure“, above).

- **EV. FLT. MODE** ***starts 3p AR***:

  The separately settable dead time for sequential faults starts with the clearance of the sequential fault; after the dead time the circuit breaker receives a close command.

If reclosing is blocked due to an evolving fault without the protection device issuing a trip command (e.g. in the case of evolving fault detection with pickup), the device can send a trip command (intertrip).

Intertrip

The intertrip of the device acts immediately once the circuit-breaker auxiliary contacts signal an implausible circuit-breaker position.

The device trips via its tripping logic (Section 2.16). Trip commands from external devices (Section 2.10 or the reception of a remote trip (Section 2.13) act immediately on the tripping logic of the device.

Connecting an External Automatic Recloser

The interaction of the device with an external automatic recloser can be controlled via binary outputs:

501 „Relay PICKUP“	Start of protection device, general (if required by external recloser device.
511 „Relay TRIP“	Protection device trip.

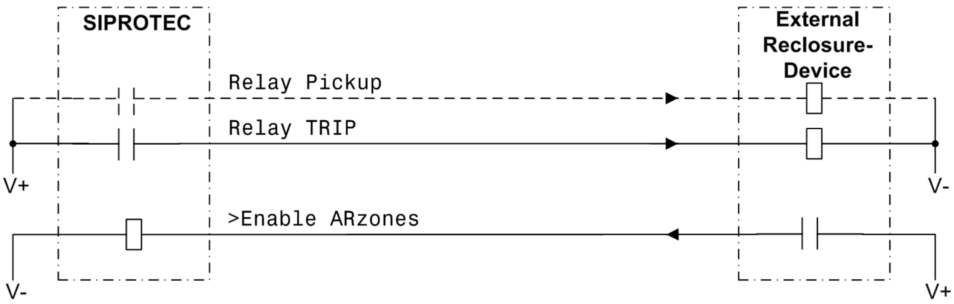


Figure 2-55 Connection example with external reclosure device for 3-pole AR

Control of the Internal Automatic Reclosure by an External Protection Device

The internal automatic reclosure function of the device can be controlled by an external protection device. This is of use, for example, on line ends with redundant protection or additional backup protection when the second protection is used for the same line end and has to work with the automatic reclosing function integrated in the 7SD80.

The binary inputs and outputs provided for this functionality must be considered in this case. In this context, it must be decided whether the internal auto reclose function is to be controlled by the starting (pickup) or by the trip command of the external protection (see also above at „Control Mode of the Automatic Reclosure").

The interaction is controlled via binary outputs and binary inputs:

2889 „`79 1.CycZoneRel`"	Internal automatic reclosure ready for the first reclose cycle, i.e. releases the element of the external protection decisive for reclosure, the corresponding output can be used for the second cycle. This output can be omitted if the external protection does not require an overreaching element (e.g. differential protection).
2716 „`>79 TRIP 3p`"	Trip signal

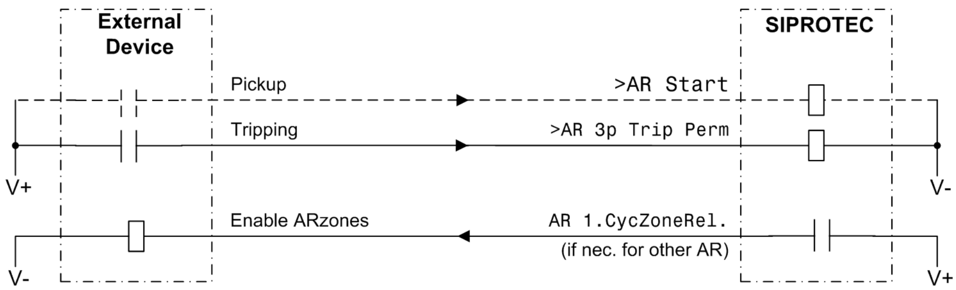


Figure 2-56 Connection example with external protection device for 3-pole reclosure; AR control mode = with TRIP

If the internal automatic reclose function is controlled by the **pickup**, the phase-dedicated pickup signals of the external protection must be connected if distinction shall be made between different types of fault. The general trip command then suffices for tripping (no. 2746). Figure 2-57 shows a connection example.

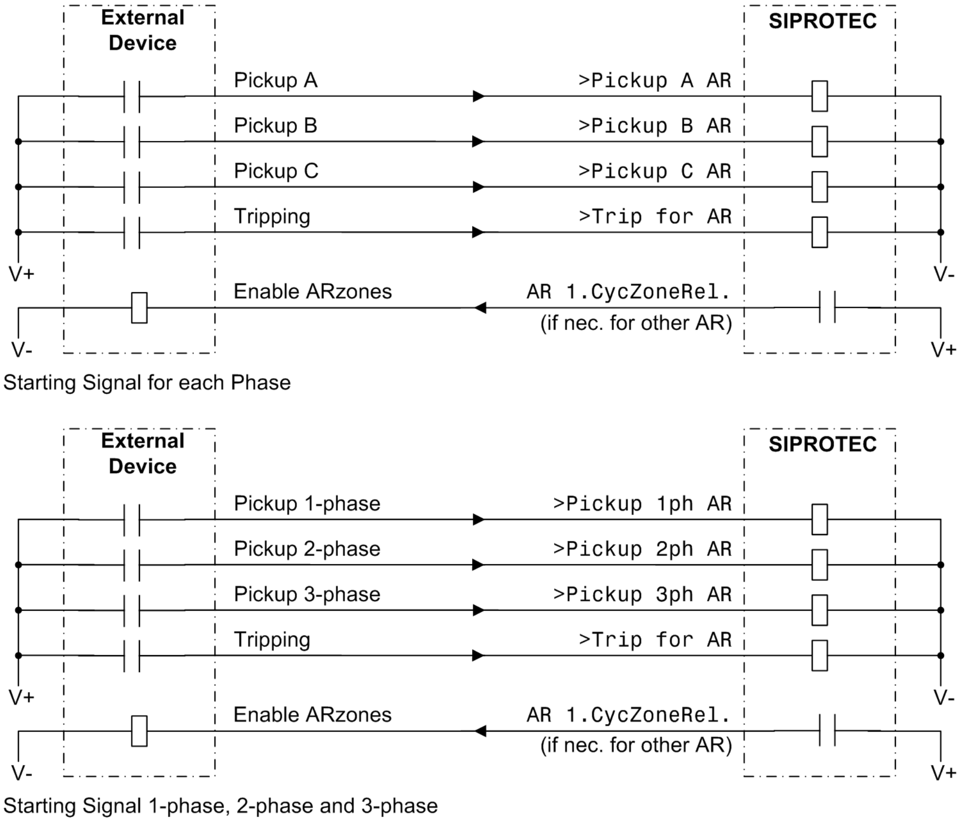


Figure 2-57 Connection example with external protection device for fault detection dependent dead time — dead time control by pickup signals of the protection device; AR control mode = with PICKUP

2.11.2 Setting Notes

If the automatic reclosing function is not required, it can be set to *Disabled* at address 133. All parameters for the settings of the automatic reclosing function are thus not accessible.

To use the internal automatic reclosing function, the type of reclosing must be specified at address 133 **79 Auto Recl.** and the **AR control mode** at address 134 when configuring the device scope of functions (section 2.1.1.2).

The 7SD80 allows up to 2 reclosing attempts with the integrated automatic reclosing function. Whereas the settings in address 3401 to 3425 apply commonly to all reclosing cycles, the individual settings of the two cycles are entered from address 3450 onwards.

The automatic reclosing function can be turned ***ON*** or ***OFF*** under address 3401 **FCT 79**.

A prerequisite for automatic reclosing taking place after a trip due to a short circuit is that the circuit breaker is ready for at least one OPEN-CLOSE-OPEN cycle at the time the automatic reclose circuit is started, i.e. at the time of the first trip command. The readiness of the circuit breaker is signaled to the device via the binary input „>Bkr1 Ready“ (no. 371). If no such signal is available, leave the setting under address 3402 **52? 1.TRIP** = ***NO*** because no automatic reclosing would be possible at all otherwise. If circuit-breaker interrogation is possible, you should set **52? 1.TRIP** = ***YES***.

Furthermore the circuit-breaker ready state can also be interrogated prior to every reclosure. This is set when setting the individual reclose cycles (see below).

To check the ready status of the circuit breaker is regained during the dead times, you can set a circuit-breaker ready monitor time under address 3409 **CB TIME OUT**. The time is set slightly longer than the recovery time of the circuit breaker after a TRIP–CLOSE–TRIP–cycle. If the circuit breaker is not ready again by the time this timer expires, no reclosure takes place, the automatic reclosure function is blocked dynamically.

Waiting for the circuit breaker to be ready again can lead to an increase of the dead times. To avoid uncontrolled prolongation, it is possible to set a maximum prolongation of the dead time, in this case in address 3411 **Max. DEAD EXT.**. This prolongation is unlimited if the setting ∞ is applied. This parameter can only be set in DIGSI at **Display Additional Settings**. Remember that longer dead times are only permissible after 3-pole tripping when no stability problems occur.

The restraint time **T-RECLAIM** (address 3403) is the time after which the fault is considered eliminated following successful reclosing. Re-tripping by a protective function within this time initiates the next reclose cycle in the event of multiple reclosure; if no further reclosure is permitted, the last reclosure is treated as unsuccessful. The restraint time must therefore be longer than the longest response time of a protective function which can start the automatic reclosing circuit.

A few seconds are generally sufficient. In areas with frequent thunderstorms or storms, a shorter blocking time may be necessary to avoid feeder lockout due to sequential lightning strikes or cable flashovers.

A longer restraint time should be chosen where circuit-breaker supervision is not possible (see above) during multiple reclosing attempts, e.g. because of missing auxiliary contacts and information on the circuit-breaker ready status. In this case, the restraint time should be longer than the time required for the circuit-breaker mechanism to be ready.

The blocking duration following manual close detection **BLOCK MC Dur.** (address 3404) must guarantee the circuit breaker to open and close reliably (0.5 s to 1 s). If a fault is detected by a protection function within this time after closing of the circuit breaker was detected, no reclosure takes place and a final trip command is issued. If this is not desired, set address 3404 to **0**.

The options for handling evolving faults are described in Section 2.11 under margin heading „Handling Evolving Faults“. You can define recognition of an evolving fault at address 3406 **EV. FLT. RECOG.**. **EV. FLT. RECOG.*with PICKUP*** means that during a dead time each **pickup** of a protection function will be interpreted as an evolving fault. With **EV. FLT. RECOG.*with TRIP*** a fault during a dead time is only interpreted as an evolving fault if it has led to a **trip command** by a protection function. This may also include trip commands which are received from an external device via a binary input or which have been transmitted from another end of the protected object. If an external protection device operates together with the internal auto-reclosure, evolving fault detection with pickup presupposes that a pickup signal from the external device is also connected to the 7SD80; otherwise an evolving fault can only be detected with the external trip command even if ***with PICKUP*** was set here.

The reaction to evolving faults can be selected under address 3407. **EV. FLT. MODE** ***Stops 79*** means that no reclosing takes place after detection of an evolving fault. This is recommended if stability problems are anticipated when reclosing after the 3-pole dead time. If a 3-pole reclose cycle is to be initiated by tripping of the evolving fault, set **EV. FLT. MODE** = ***starts 3p AR***. In this case, a separately adjustable 3-pole dead time is started with the trip command due to the evolving fault.

Address 3408 **T-Start MONITOR** monitors the reaction of the circuit breaker after a trip command. If the CB has not opened during this time (from the beginning of the trip command), the automatic reclosure is blocked dynamically. The criterion for circuit breaker opening is the position of the circuit-breaker auxiliary contact or the disappearance of the trip command. If a circuit-breaker failure protection (internal or external) is used on the feeder, this time should be shorter than the time delay of the circuit-breaker failure protection so that no reclosure takes place if the circuit breaker fails.

Note

To enable that the busbar is tripped by the breaker failure protection without preceding injection of the trip command (by AR or BF), the time set for 3408 **T-Start MONITOR** also has to be longer than the time set for 3906 **50BF-2 Delay**. In this case, the AR must be blocked by a signal from the BF to prevent the AR from reclosing after a busbar TRIP. It is recommended to connect the signal 1494 „50BF BusTrip“ to the AR input 2703 „>BLOCK 79“ via CFC.

Configuring the Automatic Reclose Function

This configuration concerns the interaction between the protection and supplementary functions of the device and the automatic reclosure function. The selection of functions of the device which are to start the automatic reclosure circuit and which are not to, is made here.

Address 3420	AR WITH DIFF, i.e. with differential protection
Address 3423	AR w/ INT.TRIP, i.e. with permissive underreach transfer trip (PUTT)
Address 3424	AR w/ DTT, i.e. with direct transfer trip
Address 3425	AR w/ 50(N)-B, i.e. with time overcurrent protection

For the functions which are to start the auto-reclosure function, the corresponding address is set to ***YES***, for the others to ***NO***. The other functions cannot start the automatic reclosure because reclosure is of little use here.

First Reclosing Cycle

Address 3450 **1.AR:START** is only available if the automatic reclosing function works in the operating mode with action time, i.e. address 134 **AR control mode** = ***PU w/ActionTime*** or ***Trip w/ActionT.*** was set during configuration of the protection functions (see Section 2.1.1.2). It determines whether the automatic reclosing function is started with the first cycle. This parameter and different action times allow you to control the effectiveness of the cycles (**AR control mode** = ***Trip ...***).

The action time **1.AR:ActionTime** (address 3451) is the time after initiation (fault detection) by any protective function which can start the automatic reclosure function within which the trip command must appear. If the command does not appear until after the action time has expired, there is no reclosure. Depending on the configuration of the protective functions the action time may also be omitted; this applies especially when an initiating protective function has no fault detection signal.

Using 134 **AR control mode**= ***TRIP ...*** you can set the dead time for the 3-pole reclosing cycle at address 3457 **1.AR:Dead 3Trip**. For 3-pole tripping the power system stability is the main concern. Since the de-energized line cannot transfer synchronizing energy, only short dead times are allowed. The usual values are 0.3 s to 0.6 s. If the device operates with a synchronism check device, a longer dead time may be tolerated under certain circumstances. Longer 3-pole dead times are also possible in radial networks.

When 134 **AR control mode** = ***Pickup ...***, it is possible to make the dead times dependent on the type of fault detected by the initiating protection function(s).

Table 2-3 AR control mode = **with PICKUP ...**

3453	1.AR:DeadT.1Flt	is the dead time after 1-phase pickup,
3454	1.AR:DeadT.2Flt	is the dead time after 2-phase pickup,
3455	1.AR:DeadT.3Flt	is the dead time after 3-phase pickup,

If the dead time is to be the same for all types of faults, set all three parameters the same. Note that these settings only cause different dead times for different pickups.

If, when setting the reaction to evolving faults (see above at „General“), you have set address 3407 **EV. FLT. MODE** ***starts 3p AR***, you can set a separate dead time for the 3-pole dead time after clearance of the evolving fault **1.AR:DeadT.EV.** (address 3458). Stability aspects are also decisive here. Normally the setting constraints are similar to address 3457 **1.AR:Dead 3Trip**.

Under address 3459 **1.AR:52? CLOSE** it can be determined whether the readiness of the circuit breaker ("circuit breaker ready") is interrogated before this first reclosure. With the setting ***YES***, the dead time may be extended if the circuit breaker is not ready for a CLOSE–TRIP–cycle when the dead time expires. The maximum extension that is possible is the circuit-breaker monitoring time; this time was set for all reclosure cycles together under address 3409 **CB TIME OUT** (see above). Details about the circuit-breaker monitoring can be found in the function description, Section 2.11, at margin heading „Interrogation of circuit-breaker ready state“.

Second Reclosing Cycle

If two cycles have been set in the configuration of the scope of protection functions, you can set individual reclosing parameters for the second cycle. The same options are available as for the first cycle. Again, only some of the parameters shown below will be available depending on the selections made during configuration of the scope of protection functions.

3461	2.AR:START	Start in second cycle generally allowed
3462	2.AR:ActionTime	Action time for the second cycle
3464	2.AR:DeadT.1Flt	Dead time after 1-phase pickup
3465	2.AR:DeadT.2Flt	Dead time after 2-phase pickup
3466	2.AR:DeadT.3Flt	Dead time after 3-phase pickup
3468	2.AR:Dead 3Trip	Dead time after 3-pole tripping
3469	2.AR:DeadT.EV.	Dead time after evolving fault
3470	2.AR:52? CLOSE	CB ready interrogation before reclosing

Notes on the Information Overview

The most important information about automatic reclosure is briefly explained insofar as it was not mentioned in the following lists or described in detail in the preceding text.

„>BLK 1.AR-cycle“ (No. 2742) to „>BLK 2.AR-cycle“ (No. 2743)

The respective auto-reclose cycle is blocked. If the blocking state already exists when the automatic reclosure function is initiated, the blocked cycle is not executed and may be skipped (if other cycles are permitted). The same applies if the automatic reclosure function is started (running) but not internally blocked. If the block signal of a cycle appears while this cycle is being executed (in progress) the automatic reclosure function is blocked dynamically; no further automatic reclosures cycles are then executed.

„79 1.CycZoneRel“ (No. 2889) and „79 2.CycZoneRel“ (No. 2890)

The automatic reclosure is ready for the respective reclosure cycle. This information indicates which cycle will be run next. For example, external protection functions can use this information to release accelerated or overreaching trip stages prior to the corresponding reclose cycle.

„79 is blocked“ (No. 2783)

The automatic reclosure is blocked (e.g. circuit breaker not ready). This information indicates to the operational information system that in the event of an upcoming system fault there will be a final trip, i.e. without reclosure. If the automatic reclosure has been started, this information does not appear.

„79 not ready“ (No. 2784)

The automatic reclosure is not ready for reclosure at the moment. In addition to the „79 is blocked“ (No. 2783) mentioned above there are also obstructions during the course of the auto-reclosure cycles such as „action time run out“ or „last reclaim time running“. This information is particularly helpful during testing because no protection test cycle with reclosure may be initiated during this state.

„79 in progress“ (No. 2801)

This information appears following starting of the auto reclose function, i.e. with the first trip command that can start the auto reclose function. If this reclosure was successful (or any in the case of multiple cycles), the information is reset with the expiry of the last restraint time. If no reclosure was successful or if reclosure was blocked, it ends with the last – the final – trip command.

2.11.3 Settings

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

Addr.	Parameter	Setting Options	Default Setting	Comments
3401	FCT 79	OFF ON	ON	79 Auto-Reclose Function
3402	52? 1.TRIP	YES NO	NO	52-ready interrogation at 1st trip
3403	T-RECLAIM	0.50 .. 300.00 sec	3.00 sec	Reclaim time after successful AR cycle
3404	BLOCK MC Dur.	0.50 .. 300.00 sec; 0	1.00 sec	AR blocking duration after manual close
3406	EV. FLT. RECOG.	with PICKUP with TRIP	with TRIP	Evolving fault recognition
3407	EV. FLT. MODE	Stops 79 starts 3p AR is ignored	starts 3p AR	Evolving fault (during the dead time)
3408	T-Start MONITOR	0.01 .. 300.00 sec	0.50 sec	AR start-signal monitoring time
3409	CB TIME OUT	0.01 .. 300.00 sec	3.00 sec	Circuit Breaker (CB) Supervision Time
3410	RemoteCl. Delay	0.00 .. 300.00 sec; ∞	0.20 sec	Send delay for remote close command
3411A	Max. DEAD EXT.	0.50 .. 300.00 sec; ∞	∞ sec	Maximum dead time extension
3420	AR WITH DIFF	YES NO	YES	AR with differential protection ?
3423	AR w/ INT.TRIP	YES NO	YES	AR with intertrip ?
3424	AR w/ DTT	YES NO	YES	AR with DTT (direct transfer trip)
3425	AR w/ 50(N)-B	YES NO	YES	AR with 50(N)-B (backup overcur-rent)
3450	1.AR:START	YES NO	YES	Start of AR allowed in this cycle
3451	1.AR:ActionTime	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3453	1.AR:DeadT.1Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults
3454	1.AR:DeadT.2Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults
3455	1.AR:DeadT.3Flt	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults
3457	1.AR:Dead 3Trip	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3458	1.AR:DeadT.EV.	0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3459	1.AR:52? CLOSE	YES NO	NO	52-ready interrogation before re-closing
3461	2.AR:START	YES NO	NO	AR start allowed in this cycle
3462	2.AR:ActionTime	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3464	2.AR:DeadT.1Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults

Addr.	Parameter	Setting Options	Default Setting	Comments
3465	2.AR:DeadT.2Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults
3466	2.AR:DeadT.3Flt	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults
3468	2.AR:Dead 3Trip	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3469	2.AR:DeadT.EV.	0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3470	2.AR:52? CLOSE	YES NO	NO	52-ready interrogation before reclosing

2.11.4 Information List

No.	Information	Type of In-formation	Comments
127	79 ON/OFF	IntSP	79 ON/OFF (via system port)
2701	>79 ON	SP	>79 ON
2702	>79 OFF	SP	>79 OFF
2703	>BLOCK 79	SP	>BLOCK 79
2711	>79 Start	SP	>79 External start of internal A/R
2716	>79 TRIP 3p	SP	>79: External 3pole trip for AR start
2727	>79 RemoteClose	SP	>79: Remote Close signal
2738	>BLOCK 3pole AR	SP	>79: Block 3pole AR-cycle
2739	>BLK 1phase AR	SP	>79: Block 1phase-fault AR-cycle
2740	>BLK 2phase AR	SP	>79: Block 2phase-fault AR-cycle
2741	>BLK 3phase AR	SP	>79: Block 3phase-fault AR-cycle
2742	>BLK 1.AR-cycle	SP	>79: Block 1st AR-cycle
2743	>BLK 2.AR-cycle	SP	>79: Block 2nd AR-cycle
2746	>Trip for AR	SP	>79: External Trip for AR start
2752	>Pickup 3ph AR	SP	>79: External pickup 3phase for AR start
2781	79 OFF	OUT	79: Auto recloser is switched OFF
2782	79 ON	IntSP	79: Auto recloser is switched ON
2783	79 is blocked	OUT	79: Auto recloser is blocked
2784	79 not ready	OUT	79: Auto recloser is not ready
2787	CB not ready	OUT	79: Circuit breaker 1 not ready
2788	79 T-CBreadyExp	OUT	79: CB ready monitoring window expired
2796	79 on/off BI	IntSP	79: Auto recloser ON/OFF via BI
2801	79 in progress	OUT	79 - in progress
2809	79 T-Start Exp	OUT	79: Start-signal monitoring time expired
2810	79 TdeadMax Exp	OUT	79: Maximum dead time expired
2818	79 Evolving Flt	OUT	79: Evolving fault recognition
2821	79 Td. evol.Flt	OUT	79 dead time after evolving fault
2840	79 Tdead 3pTrip	OUT	79 dead time after 3pole trip running
2843	79 Tdead 3pFlt	OUT	79 dead time after 3phase fault running
2844	79 1stCyc. run.	OUT	79 1st cycle running
2845	79 2ndCyc. run.	OUT	79 2nd cycle running
2851	79 Close	OUT	79 - Close command
2853	79 Close1.Cyc3p	OUT	79: Close command after 3pole, 1st cycle
2854	79 Close 2.Cyc	OUT	79: Close command 2nd cycle (and higher)
2861	79 T-Recl. run.	OUT	79: Reclaim time is running
2862	79 Successful	OUT	79 - cycle successful
2871	79 TRIP 3pole	OUT	79: TRIP command 3pole
2889	79 1.CycZoneRel	OUT	79 1st cycle zone extension release
2890	79 2.CycZoneRel	OUT	79 2nd cycle zone extension release
2894	79 Remote Close	OUT	79 Remote close signal send

2.12 Circuit-Breaker Test

2.12.1 CB Close Detection

During energization of the protected object, several measures may be required or desirable. Following a manual closure onto a short circuit, immediate trip of the circuit breaker is usually desired. This is done, e.g. in the overcurrent protection by bypassing the time delay of a current element. For each protection function which can be delayed, at least one element can be selected that will operate instantaneously in the event of closing, as mentioned in the relevant sections. See also Section 2.1.6.1 at margin heading „Circuit-Breaker Status“.

The manual closing command must be indicated to the device via a binary input. In order to be independent of the individual manual actuation, the command is set to a defined length in the device (adjustable with the address 1150 **SI Time Man.Cl**). This setting can only be changed using DIGSI at **Additional Settings**. The following figure shows the logic diagram.

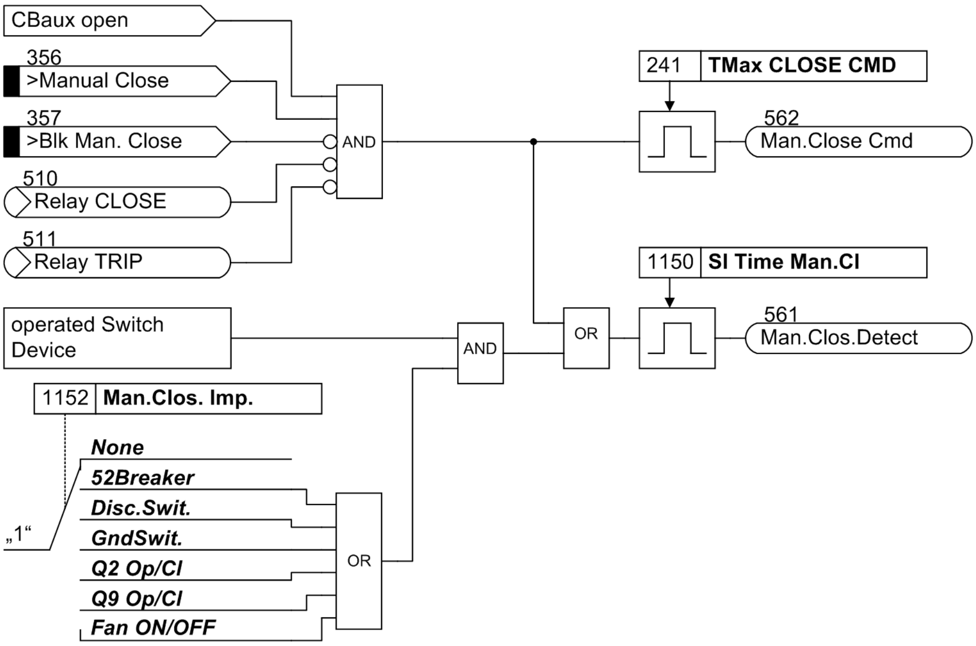


Figure 2-58 Logic diagram of the manual CLOSE procedure

Reclosing via the integrated local control or control using DIGSI can have the same effect as manual reclosure (parameter 1152 Section 2.1.6.1 under margin heading „Circuit-Breaker Status“.

If the device has an integrated automatic reclosure, the integrated manual closure logic of the 7SD80 automatically distinguishes between an external control command via the binary input and an automatic reclosure by the internal automatic reclosure so that the binary input „>Manual Close“ can be connected directly to the control circuit of the close coil of the circuit breaker (Figure 2-59). Each reclosure that is not initiated by the internal automatic reclosure function is interpreted as a manual reclosure, even it has been initiated by a control command from the device.

With the user-definable logic functions (CFC) further control functions can be processed in the same way as a manual close command.

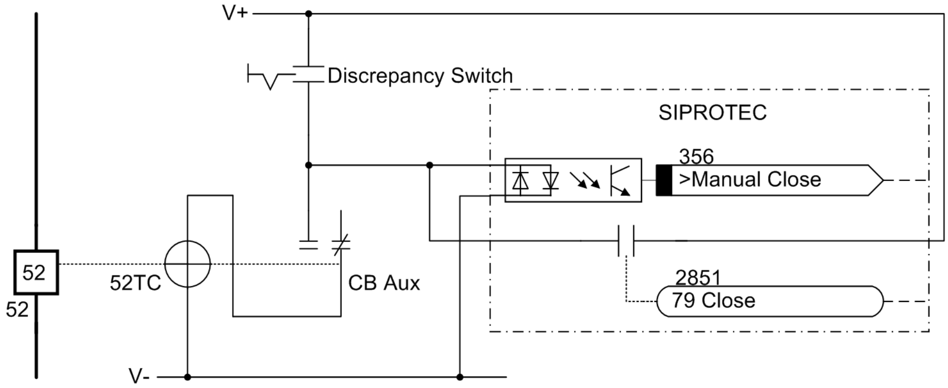


Figure 2-59 Manual closure with internal automatic reclosure

52 Circuit breaker

52TC Circuit-breaker trip coil

52 Aux Auxiliary contact of the circuit breaker

If, however, external close commands are possible which are not supposed to activate the manual close function (e.g. external recloser), the binary input „`>Manual Close`" must be triggered by a separate contact of the control switch (Figure 2-60).

If in that latter case a manual close command can also be given by means of an internal control command from the device, such a command must be combined with the manual CLOSE function via parameter 1152 **`Man.Clos. Imp.`** (Figure 2-58).

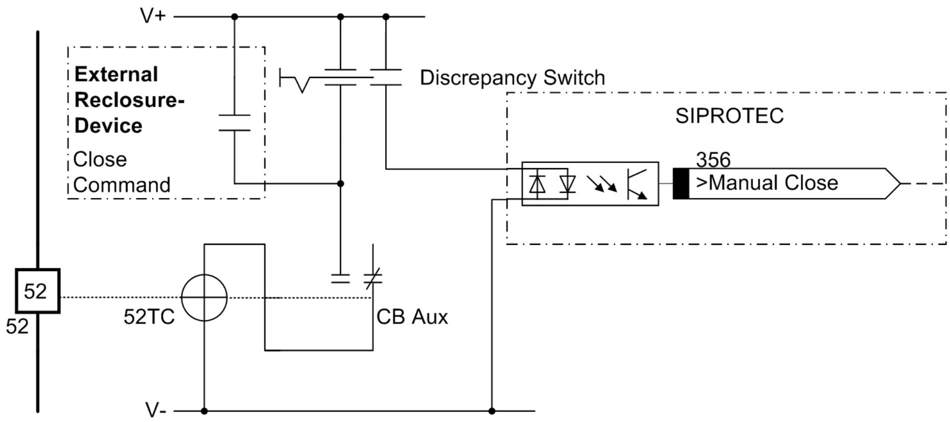


Figure 2-60 Manual closing with external automatic reclosure device

52 Circuit breaker

52TC Circuit-breaker trip coil

52 Aux Auxiliary contact of the circuit breaker

Besides the manual CLOSE detection, the device records any energization of the line via the integrated line energization detection. This function processes a change-of-state of the measured quantities as well as the position of the breaker auxiliary contacts. The current status of the circuit breaker is detected, as described in the following section at „Detection of the Circuit-Breaker Position". The criteria for the line energization detection change according to the local conditions of the measuring points and the setting of the parameter address 1134 **`Line Closure`** (see Section 2.1.6 at margin heading „Circuit-Breaker Status").

The phase currents and the phase-to-ground voltages are available as measuring quantities. A flowing current excludes that the circuit breaker is open (exception: a short-circuit between current transformer and circuit breaker). If the circuit breaker is closed, it may, however, still occur that no current is flowing. The voltages can only be used as a criterion for the de-energized line if the voltage transformers are installed on the feeder side. Therefore, the device only evaluates those measuring quantities that provide information on the status of the line according to address 1134.

But a change-of-state, such as a voltage jump from zero to a considerable value (address 1131 **PoleOpenVoltage**) or the occurrence of a considerable current (address 1130 **PoleOpenCurrent**), can be a reliable indicator for line energization as such changes can neither occur during normal operation nor in case of a fault. These settings can only be changed via DIGSI at **Display Additional Settings**.

The position of the auxiliary contacts of the circuit breakers indicates directly the position of the circuit breaker.

The detected energization is signaled through the indication „Line closure“ (no. 590). Parameter 1132**SI Time all Cl.** can be used to set the signal to a defined length. These settings can only be changed via DIGSI at **Display Additional Settings**. Figure 2-61 shows the logic diagram.

In order to avoid that an energization is detected mistakenly, the state „line open“, which precedes any energization, must apply for a minimum time (settable with the address 1133 **T DELAY SOTF**). The default setting for this enable delay is 250 ms. This setting can only be changed using DIGSI at **Display Additional Settings**.

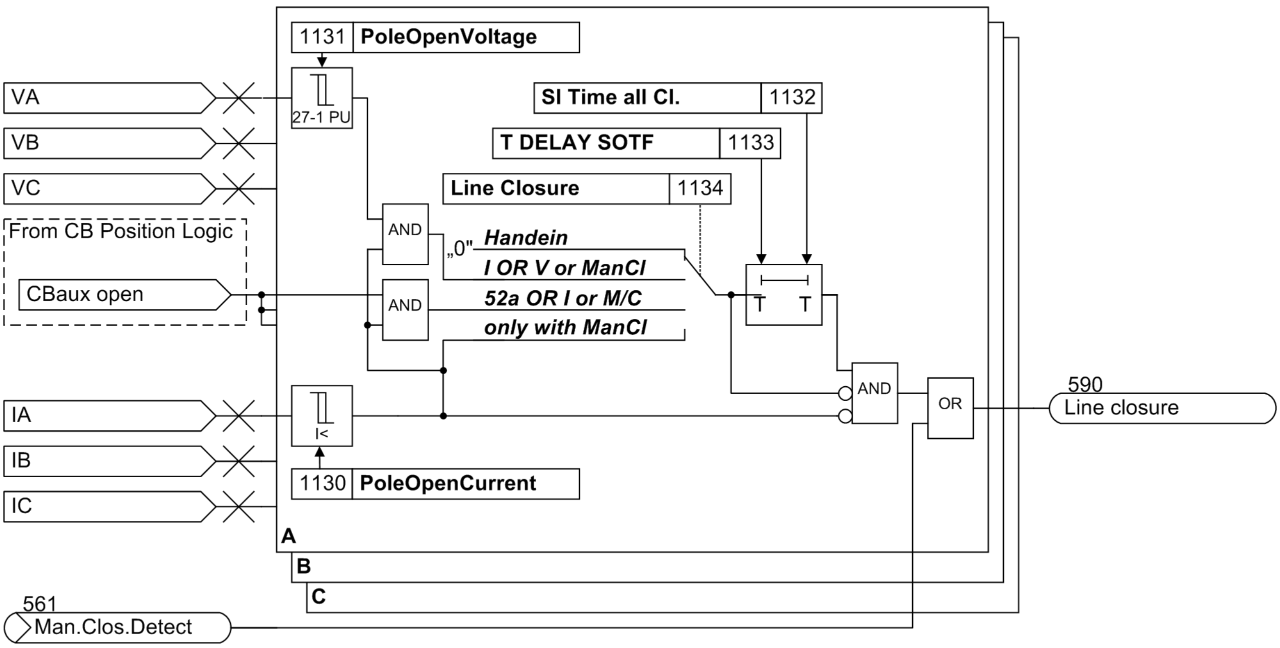


Figure 2-61 Generation of the energization signal

The line energization detection enables the time overcurrent protection to trip instantaneously after energization of the own line was detected.

2.12.2 Circuit-Breaker Position Detection

For Protection Purposes

Different protection and supplementary functions need information about the circuit-breaker status in order to operate optimally. This is helpful for

- the circuit-breaker failure protection (refer to Section 2.6),
- the verification of the dropout condition for the trip command (see Section „Terminating the Trip Command“).

A circuit-breaker position logic is incorporated in the device (Figure). Depending on the type of auxiliary contact(s) provided by the circuit breaker and the method in which these are connected to the device, there are several alternatives of implementing this logic.

In most cases, it is sufficient to send the status of the circuit breaker from the CB's auxiliary contacts over a binary input to the device. The NO auxiliary contact of the circuit breaker is connected to a binary input which must be routed to „`>52a 3p Closed`“ (no. 379).

If the series connection of the poles' auxiliary NC contacts is available, the corresponding binary input is routed to „`>52b 3p Open`“ (no. 380).

The output signals of the circuit-breaker position logic can be processed by the individual protection and supplementary functions. The output signals are blocked if the signals transmitted from the circuit breaker are not plausible: for example, the circuit breaker cannot be open and closed at the same time.

The evaluation of the measured quantities is according to the local conditions of the measuring points (see Section 2.1.6.1 at margin heading „Circuit-Breaker Status“).

The phase currents are available as measured quantities. A flowing current excludes that the circuit breaker is open (exception: a short circuit between current transformer and circuit breaker). If the circuit breaker is closed, it may, however, still occur that no current is flowing. The decisive setting for the evaluation of the measured quantities is **PoleOpenCurrent** (address 1130) for the presence of the currents.

In 7SD80 the position of the circuit-breaker poles detected by a device is also transmitted to the remote end device. Thus the circuit-breaker positions at both ends are known.

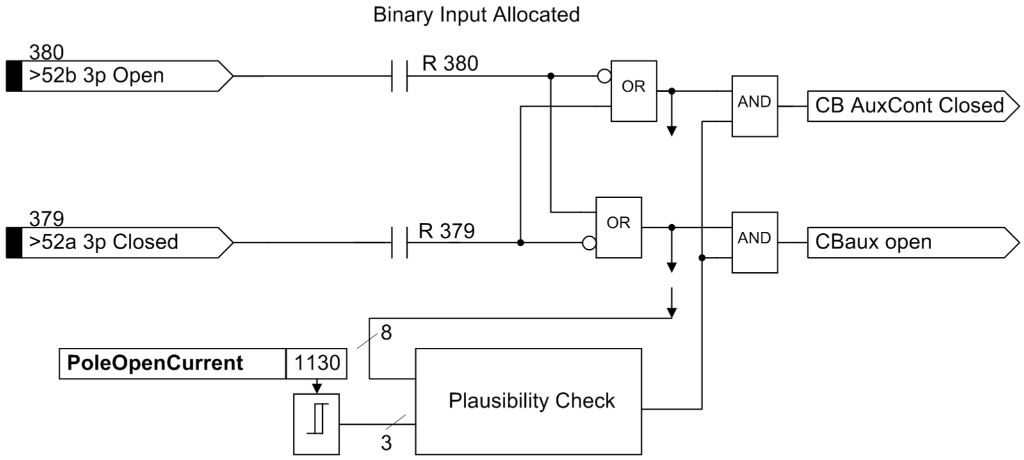


Figure 2-62 Circuit-breaker position logic

For Automatic Reclosing and Circuit-Breaker Test

Separate binary inputs comprising information on the position of the circuit breaker are available for the automatic reclosing function and the circuit-breaker test. This is important for

- the plausibility check before automatic reclosing (refer to Section 2.11),
- the trip circuit check with the help of the TRIP-CLOSE test cycle (refer to Section 2.12).

When using $1^1/_2$ or 2 circuit breakers in each feeder, the automatic reclosure function and the circuit-breaker test are referred to **one** circuit breaker. The feedback information of this circuit breaker can be connected separately to the device.

Separate binary inputs are available to this end which should be treated in the same way and configured additionally if necessary. These have a similar significance as the inputs described above for protection applications and are marked with „CB1 ...“ to distinguish them, i.e.:

- „`>52a Bkr1 3p Cl`“ (no. 410) for the series connection of the NO auxiliary contacts,
- „`>52b Bkr1 3p Op`“ (no. 411) for the series connection of the NC auxiliary contacts,

2.12.3 Circuit-Breaker Test

The 7SD80 differential protection enables the trip circuits and circuit breakers to be tested conveniently.

For the test, a 3-pole TRIP/CLOSE cycle and the close command „`CB1-TEST close`“ (7329) are performed via the test program.

The output indication „`CB1-TESTtripABC`“ (7328) must be routed to the command relays used to control the circuit-breaker coils.

The test is started using the operator panel on the front of the device or using the PC with DIGSI. The procedure is described in detail in the SIPROTEC 4 System Description. Figure 2-63 shows the chronological sequence of one TRIP-CLOSE test cycle. The set times are those stated in Section 2.1.3.1 for „Trip Command Duration“ and „Circuit-breaker Test“.

If the circuit-breaker auxiliary contacts forward the CB position to the device via binary inputs, the test cycle can only be initiated when the circuit breaker is closed.

The information on the circuit-breaker position is not automatically derived from the position logic according to the above section. For the circuit-breaker test, there are separate binary inputs for position feedback. These must be taken into consideration when routing the binary inputs.

The device generates indications that show the corresponding test status.

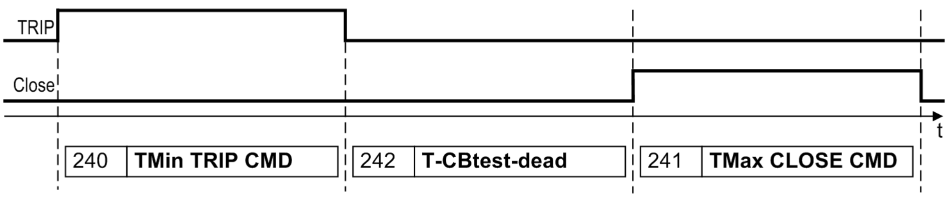


Figure 2-63 TRIP-CLOSE test cycle

2.12.4 Information List

No.	Information	Type of In-formation	Comments
-	CB1tst ABC	-	CB1-TEST trip/close Phases ABC
7328	CB1-TESTtripABC	OUT	CB1-TEST TRIP command ABC
7329	CB1-TEST close	OUT	CB1-TEST CLOSE command
7345	CB-TEST running	OUT	CB-TEST is in progress
7346	CB-TSTstop FLT.	OUT_Ev	CB-TEST canceled due to Power Sys. Fault
7347	CB-TSTstop OPEN	OUT_Ev	CB-TEST canceled due to CB already OPEN
7348	CB-TSTstop NOTr	OUT_Ev	CB-TEST canceled due to CB was NOT READY
7349	CB-TSTstop CLOS	OUT_Ev	CB-TEST canceled due to CB stayed CLOSED
7350	CB-TST .OK.	OUT_Ev	CB-TEST was successful

2.13 Direct Remote Trip and Transmission of Binary Information

2.13.1 Description

7SD80 allows up to 16 information items of any type to be transmitted from one device to another. Like the protection signals, these are transmitted with high priority.

The information items can be fed into the device via binary inputs. The integrated user-defined CFC logic allows the signals to be linked logically with one another or with other information items of the device's protection and monitoring functions. Also an internal indication can be assigned via CFC to a transmission input and transmitted to the remote end(s).

The up to 16 binary inputs „>Rem. Signal 1“ to „>Rem.Signal16“ must be routed and are available accordingly at „Rem.Sig 1 Rx“ etc. on the receiving side.

When allocating the binary inputs using DIGSI, you can give the information items to be transmitted individual names.

The device indications, e.g. „Master Login“, can be used to monitor the signals of the sending devices.

If a fault in the protection interface communication is detected, the time **Td ResetRemote** (address 4512) for resetting the remote signals is started. If the communication is interrupted, an incoming reception signal will maintain its status for that time.

No other settings are required for the transmission of binary information. The device sends the injected information to the device at the end of the protected object.

2.13.2 Information List

No.	Information	Type of In-formation	Comments
3549	>Rem. Signal 1	SP	>Remote Signal 1 input
3550	>Rem.Signal 2	SP	>Remote Signal 2 input
3551	>Rem.Signal 3	SP	>Remote Signal 3 input
3552	>Rem.Signal 4	SP	>Remote Signal 4 input
3553	>Rem.Signal 5	SP	>Remote Signal 5 input
3554	>Rem.Signal 6	SP	>Remote Signal 6 input
3555	>Rem.Signal 7	SP	>Remote Signal 7 input
3556	>Rem.Signal 8	SP	>Remote Signal 8 input
3557	>Rem.Signal 9	SP	>Remote Signal 9 input
3558	>Rem.Signal10	SP	>Remote Signal 10 input
3559	>Rem.Signal11	SP	>Remote Signal 11 input
3560	>Rem.Signal12	SP	>Remote Signal 12 input
3561	>Rem.Signal13	SP	>Remote Signal 13 input
3562	>Rem.Signal14	SP	>Remote Signal 14 input
3563	>Rem.Signal15	SP	>Remote Signal 15 input
3564	>Rem.Signal16	SP	>Remote Signal 16 input
3573	Rem.Sig 1 Rx	OUT	Remote signal 1 received
3574	Rem.Sig 2 Rx	OUT	Remote signal 2 received
3575	Rem.Sig 3 Rx	OUT	Remote signal 3 received
3576	Rem.Sig 4 Rx	OUT	Remote signal 4 received
3577	Rem.Sig 5 Rx	OUT	Remote signal 5 received
3578	Rem.Sig 6 Rx	OUT	Remote signal 6 received
3579	Rem.Sig 7 Rx	OUT	Remote signal 7 received
3580	Rem.Sig 8 Rx	OUT	Remote signal 8 received
3581	Rem.Sig 9 Rx	OUT	Remote signal 9 received
3582	Rem.Sig 10 Rx	OUT	Remote signal 10 received
3583	Rem.Sig 11 Rx	OUT	Remote signal 11 received
3584	Rem.Sig 12 Rx	OUT	Remote signal 12 received
3585	Rem.Sig 13 Rx	OUT	Remote signal 13 received
3586	Rem.Sig 14 Rx	OUT	Remote signal 14 received
3587	Rem.Sig 15 Rx	OUT	Remote signal 15 received
3588	Rem.Sig 16 Rx	OUT	Remote signal 16 received

2.14 Monitoring Functions

The device features comprehensive monitoring functions for both the hardware and the software. The measuring circuits are continuously checked for plausibility. Monitoring thus covers current transformers and voltage transformers to a large extent. Trip circuit supervision can be implemented using the available binary inputs.

2.14.1 Measurement Supervision

2.14.1.1 Hardware Monitoring

The device is monitored from the measuring inputs up to the command relays. Monitoring checks the hardware for malfunctions and disallowed conditions.

Voltages

Failure or switch-off of the supply voltage shuts off the device; an annunciation is output via 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 V–).

Buffer Battery

The buffer battery - which ensures operation of the internal clock and storage of counters and annunciations if the auxiliary voltage fails - is periodically checked for its charge status. If there is less than the allowed minimum voltage, the annunciation „`Fail Battery`“ is output.

Memory Components

All working memories (RAM) are checked during system start-up. If a malfunction occurs during that, the start-up 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 has taken place.

If a malfunction occurs, the processor system is restarted.

Sampling

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

Measured-Value Acquisition – Currents

Up to four input currents are measured by the device. If the three phase currents and the ground fault current from the current transformer neutral or a separated ground current transformer of the line to be protected are connected to the device, their digitized sum must be zero. Faults in the current circuit are recognized if

$I_F = |\underline{I}_A + \underline{I}_B + \underline{I}_C + k_I \cdot \underline{I}_E| > \Sigma$ **I THRESHOLD** $+ \Sigma$ **I FACTOR**$\cdot \Sigma\, |\, I\, |$

Factor k_I (address 221 **I4/Iph CT**) takes into account a possible different ratio of a separate I_E transformer (e.g. cable core balance current transformer). Σ **I THRESHOLD** and Σ **I FACTOR** are setting parameters.

The component Σ **I FACTOR** $\Sigma\, |\, I\, |$ takes into account the permitted current-proportional ratio errors of the input transducers which are particularly prevalent during large short-circuit currents (Figure 2-64). $\Sigma\, |\, I\, |$ is the sum of all currents:

$\Sigma\, |\, I\, | = |\underline{I}_A| + |\underline{I}_B| + |\underline{I}_C| + |k_I \cdot \underline{I}_E|$

Once a summation current fault is detected outside the context of a system disturbance, the differential protection is blocked. This fault is signaled as „Failure Σi“ (No. 289). In order to avoid a blocking due to transformation errors (saturation) in case of high fault currents, this monitoring function is not effective during a system fault.

Note

Current sum monitoring can operate properly only when the ground current of the protected line is fed to the fourth current measuring input (I_4) of the device. The I_4 transformer must have been configured with parameter **I4 transformer** (address 220) as ***In prot. line***.

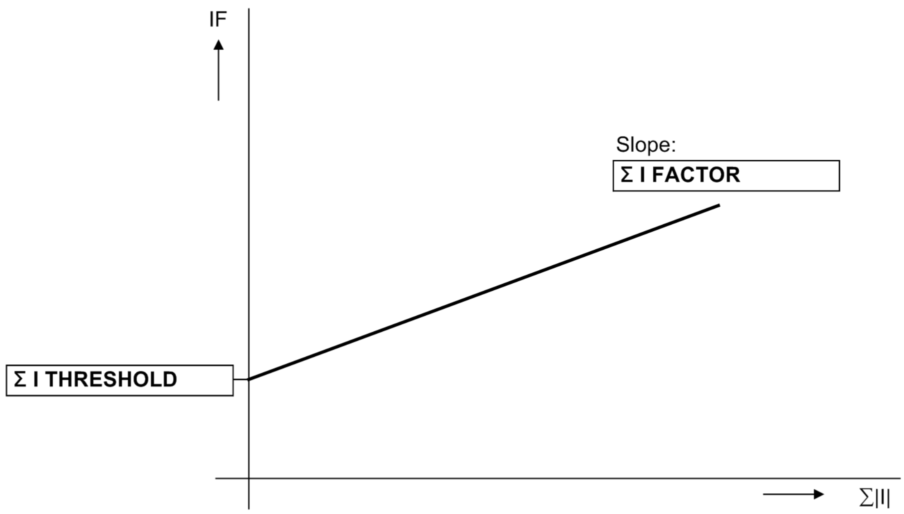


Figure 2-64 Current sum monitoring

2.14.1.2 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.

2.14.1.3 External Transformer Circuits

Interruptions or short circuits in the secondary circuits of the current and voltage transformers, as well as faults in the connections (important for 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.

Current Balance

During normal system operation (i.e. the absence of a fault), symmetry among the input currents is expected. The symmetry is monitored in the device with a magnitude comparison. The smallest phase current is compared to the largest phase current. Asymmetry is recognized if:

$|I_{min}| / |I_{max}| <$ **BAL. FACTOR I** as long as $I_{max} >$ **BALANCE I LIMIT**

Thereby I_{max} is the largest of the three phase currents and I_{min} the smallest. The balance factor **BAL. FACTOR I** (address 2905) represents the permitted imbalance of the phase currents while the limit value **BALANCE I LIMIT** (address 2904) is the lower limit of the operating range of this monitoring (see Figure 2-65). The dropout ratio is about 97%.

After a settable time (5 s - 100 s) this malfunction is signaled as „`Fail I balance`“ (no. 163).

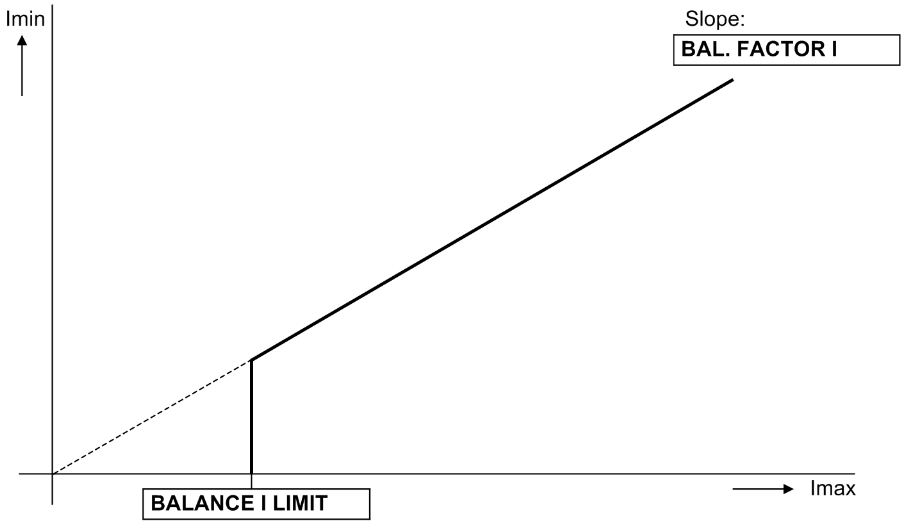


Figure 2-65 Current symmetry monitoring

Voltage Balance

During healthy system operation, a certain balance of the voltages can be assumed. The monitoring of the measured values in the device checks this balance. The smallest phase-to-phase voltage is compared to the largest. Imbalance is recognized if

$|V_{min}| / |V_{max}|$ < **BAL. FACTOR V** as long as $|V_{max}|$ > **BALANCE V-LIMIT**

Where V_{max} being the largest of the 3 phase-to-phase voltages and V_{min} the smallest. The balance factor **BAL. FACTOR V** (address 2903) represents the permitted imbalance of the conductor voltages while the limit value **BALANCE V-LIMIT** (address 2902) is the lower limit of the operating range of this monitoring (see Figure 2-66). The dropout ratio is about 97%.

After a settable time, this disturbance is signaled with „Fail V balance“ (no. 167).

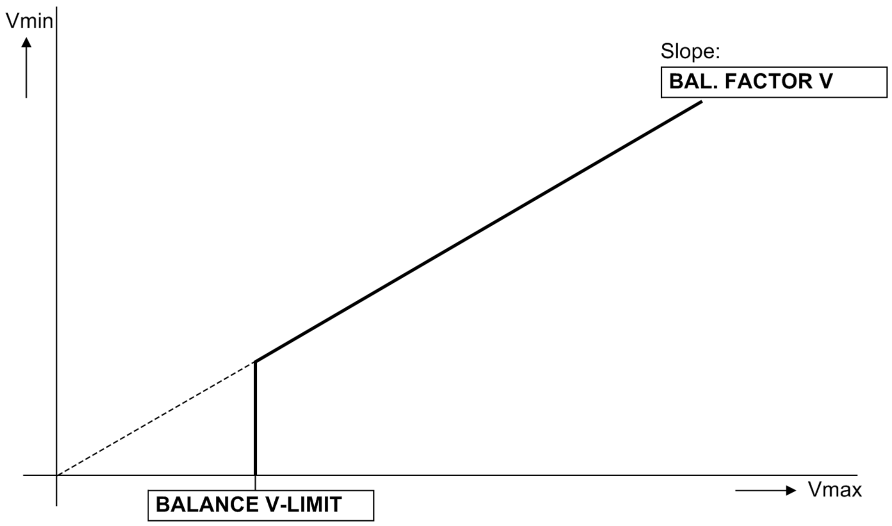


Figure 2-66 Voltage symmetry monitoring

Wire Break Monitoring

During steady-state operation the broken wire monitoring detects interruptions in the secondary circuit of the current transformers. In addition to the hazardous potential caused by high voltages in the secondary circuit, this kind of interruptions simulate differential currents to the differential protection, such as those evoked by faults in the protected object.

The broken wire monitoring function monitors the local phase currents of all three phases and the results of the broken wire monitoring supplied by the device at the other end of the protected object. At each sampling moment, the function checks whether there is a jump in one of the three phase currents; if there is, it generates the „suspected wire break“ signal.

There is a suspected local wire break if a jump has been detected in the affected phase and the current has dropped to 0 A.

WARNING!

If the CT secondary circuits are inadvertently opened while the broken wire monitoring is activated, the differential protection is blocked phase-selectively and does not trip anymore!

This state may give rise to hazardous overvoltages in the open CT circuit, which will not lead to a trip because the differential protection is blocked.

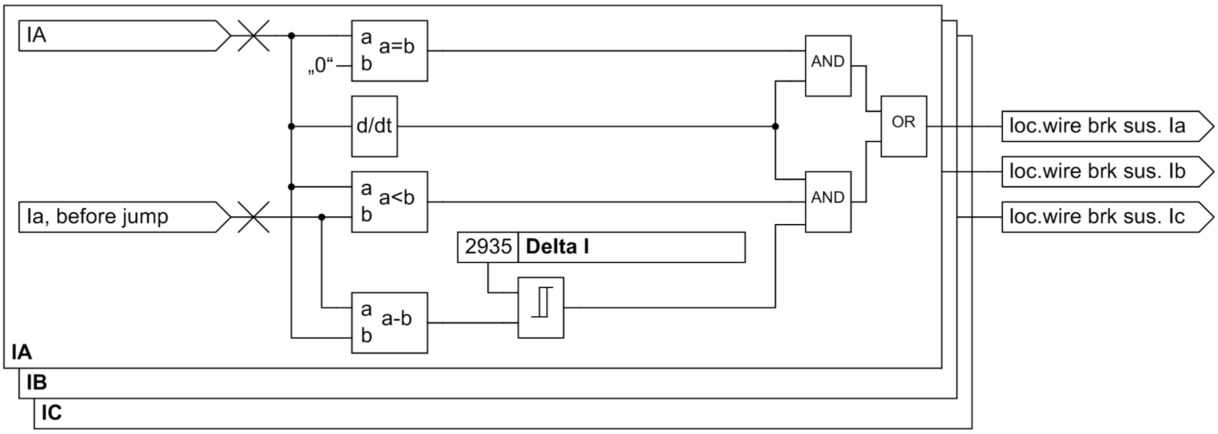


Figure 2-67 Generation of the local wire break

A wire break is signaled under the following conditions:

- A suspected local wire break has been detected.
- The logic for detecting the circuit-breaker position (see Section 2.16, Detection of the Circuit-Breaker Position) does not signal an open circuit-breaker pole. Broken wire detection is not possible if the circuit breaker is open. If the breaker position cannot be determined, a closed circuit breaker is assumed.
- The ground current is measured on the additional current transformer I_4. In this current channel and in all voltage channels, no jump must have been detected. Jumps in these channels indicate a genuine power system fault.
- In the other current channels, there must have been no jump without wire break detection. Jumps in the other current channels also suggest a power system fault, except if a suspected local wire break has been detected for the affected phases.
- The device at the other end of the protected object must not have signaled a jump. The jump information is transferred together with the differential protection measurements, so that this information is available simultaneously with the first run of the differential protection after the jump.
- In the phase, none of the devices of the protected object may have measured a phase current of more than 2 I_{Nom}. A phase current of such a magnitude is a certain indicator of a power system fault.

When a wire break has been detected according to the above criteria, it is signaled via the protection data interface to the device at the other end of the protected object and leads immediately to a wire break message. The differential protection functions are blocked as well if this has been configured.

In the event of a local wire break, the device generates the indication „Wire break I_X“ (No. 290, 291, 292).

If a wire break is detected at the other end of the protected object, the indication „Wire break at the other endI_X“ (No. 297, 298, 299) is generated.

If the broken wire monitoring is disabled, the message 295 „`Broken wire OFF`“ is output.

The broken wire monitoring is reset by the return of the phase current (I_{Lx} > 0.05 I_{Nom}) or by the binary input message 3270 „`>RESET BW`“. In 1-1/2 circuit-breaker arrangements, the function can only be reset by the binary input message because the current magnitude is no reliable criterion for a reset of the broken wire monitoring.

If the communication between the devices is disturbed, the device operates in emergency operation. The differential protection is not active. The wire-break detection only works with the local available information. Multipole wire break is not reported in emergency operation.

Note that electronic test devices do not simulate the correct behavior of broken wire so that pickup may occur.

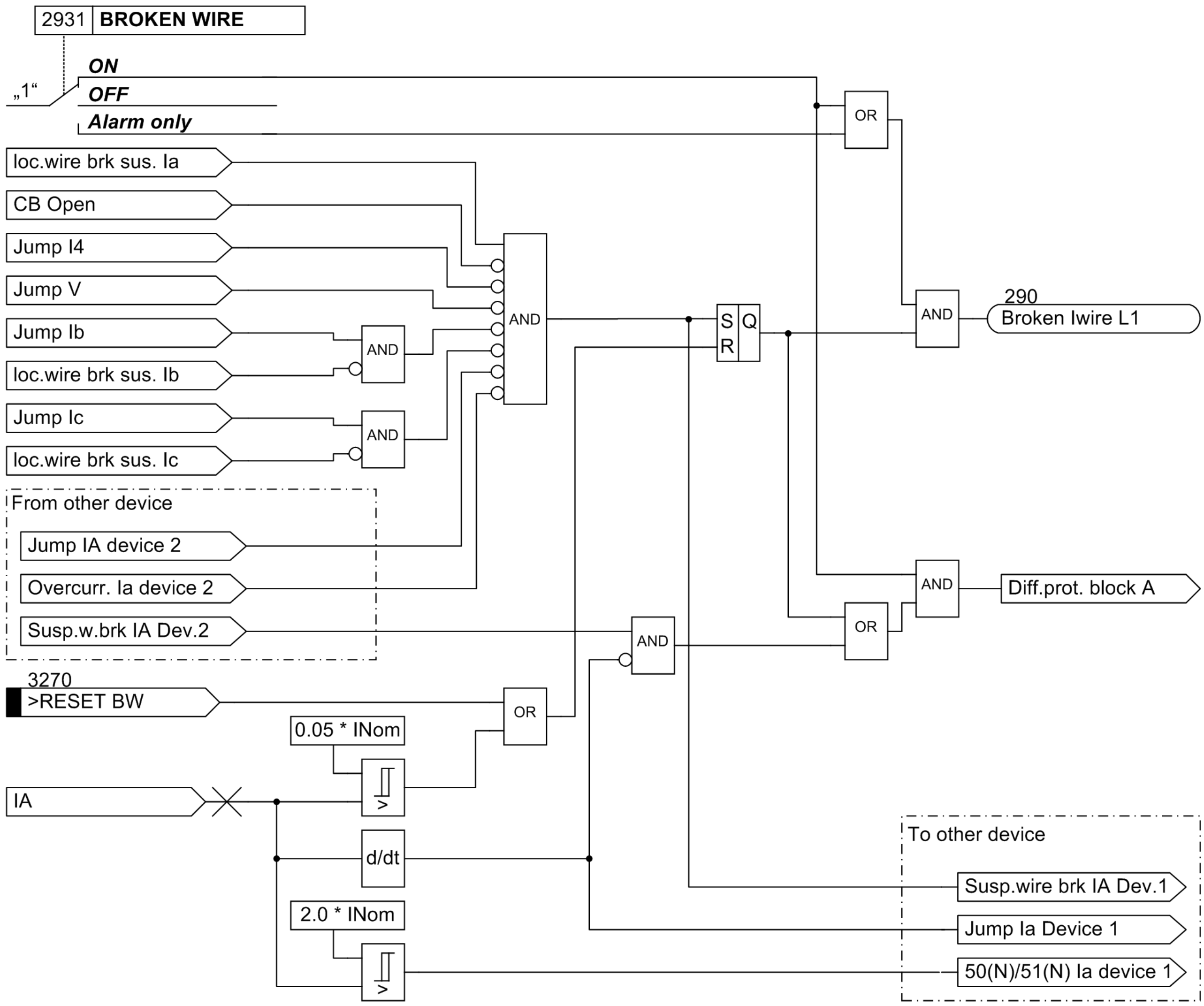


Figure 2-68 Broken-wire monitoring

Voltage Phase Rotation

Phase rotation of measured voltages is checked by verifying the phase sequences of the voltages

$\underline{V}_A$ leads $\underline{V}_B$ leads $\underline{V}_C$

This check takes place if each measured voltage has a minimum magnitude of

$|V_A|, |V_B|, |V_C| > 40 \text{ V}/\sqrt{3}$

. In case of negative phase rotation, the indication „`Fail Ph. Seq.`“ (no. 171) is issued.

Rapid Measuring Voltage Failure "Fuse Failure Monitor"

In the event of a measuring voltage failure due to a short circuit fault or a broken conductor in the voltage transformer secondary circuit, certain measuring loops may mistakenly see a voltage of zero. Simultaneously existing load currents may then cause spurious pickup.

If fuses are used instead of a secondary miniature circuit breaker (VT mcb) with connected auxiliary contacts, then the „fuse failure monitor“ can detect problems in the voltage transformer secondary circuit. Of course, the miniature circuit breaker and the „fuse failure monitor“ can be used at the same time.

Figure 2-69 and 2-70 show the logic of the „fuse-failure monitor“.

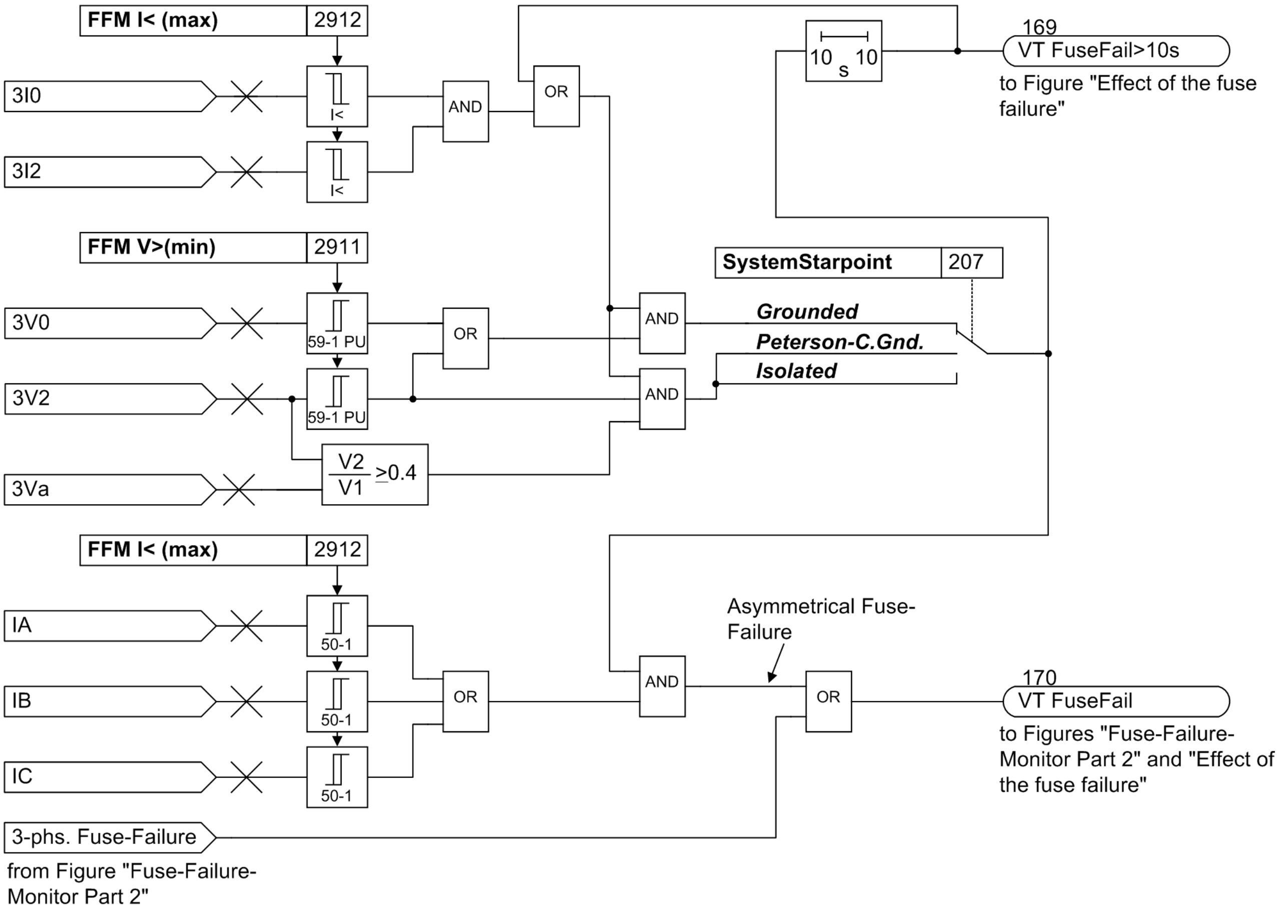


Figure 2-69 Fuse Failure Monitor part 1: detection of the asymmetrical measuring voltage failure

Unbalanced measuring voltage failure is characterized by voltage unbalance with simultaneous current balance. If there is substantial voltage unbalance of the measured values, without current unbalance being registered at the same time, this is suggestive of an unbalanced fault in the voltage transformer secondary circuit.

Voltage unbalance is detected by the fact that either the zero sequence voltage or the negative sequence voltage exceed a settable value **FFM V>(min)** (address 2911). The current is assumed to be sufficiently balanced if both the zero sequence as well as the negative sequence current are below the settable threshold **FFM I< (max)** (address 2912).

In ungrounded systems (address 207 **SystemStarpoint**), the zero sequence voltage is no reliable criterion since a considerable zero sequence voltage occurs also in case of a simple ground fault where a significant zero sequence current does not necessarily flow. Therefore, the zero sequence voltage is not evaluated in such systems but only the negative sequence voltage and the ratio of negative sequence voltage to positive sequence voltage.

As soon as this state is recognized, all functions that operate on the basis of undervoltage are blocked. The immediate blocking requires that current flows in at least one of the phases. The differential protection can be switched to emergency mode if the overcurrent protection is parameterized accordingly (see also Section 2.4).

The indication „VT FuseFail“ (no. 170) signals the immediate effect of the „fuse failure monitor“. To detect unbalanced measuring voltage failure, at least one phase current must exceed the value **FFM I< (max)** (address 2912).

If a zero sequence or negative sequence current occurs within 10 s after detecting the unbalanced measuring voltage failure, a short circuit is assumed to exist in the system and the signal „VT FuseFail“ is canceled immediately. If the zero sequence voltage or the negative sequence voltage exceeds the settable value **FFM V>(min)** (address 2911) for longer than 10 s, the signal „VT FuseFail>10s“ (no. 169) is generated. In this condition, dropout of the signal „VT FuseFail“ can no longer be accomplished by the increase of the zero sequence current or negative sequence current, but only by the voltages in the zero sequence and negative sequence system falling below a threshold value. The signal „VT FuseFail“ can also be generated independently of the magnitude of the phase currents.

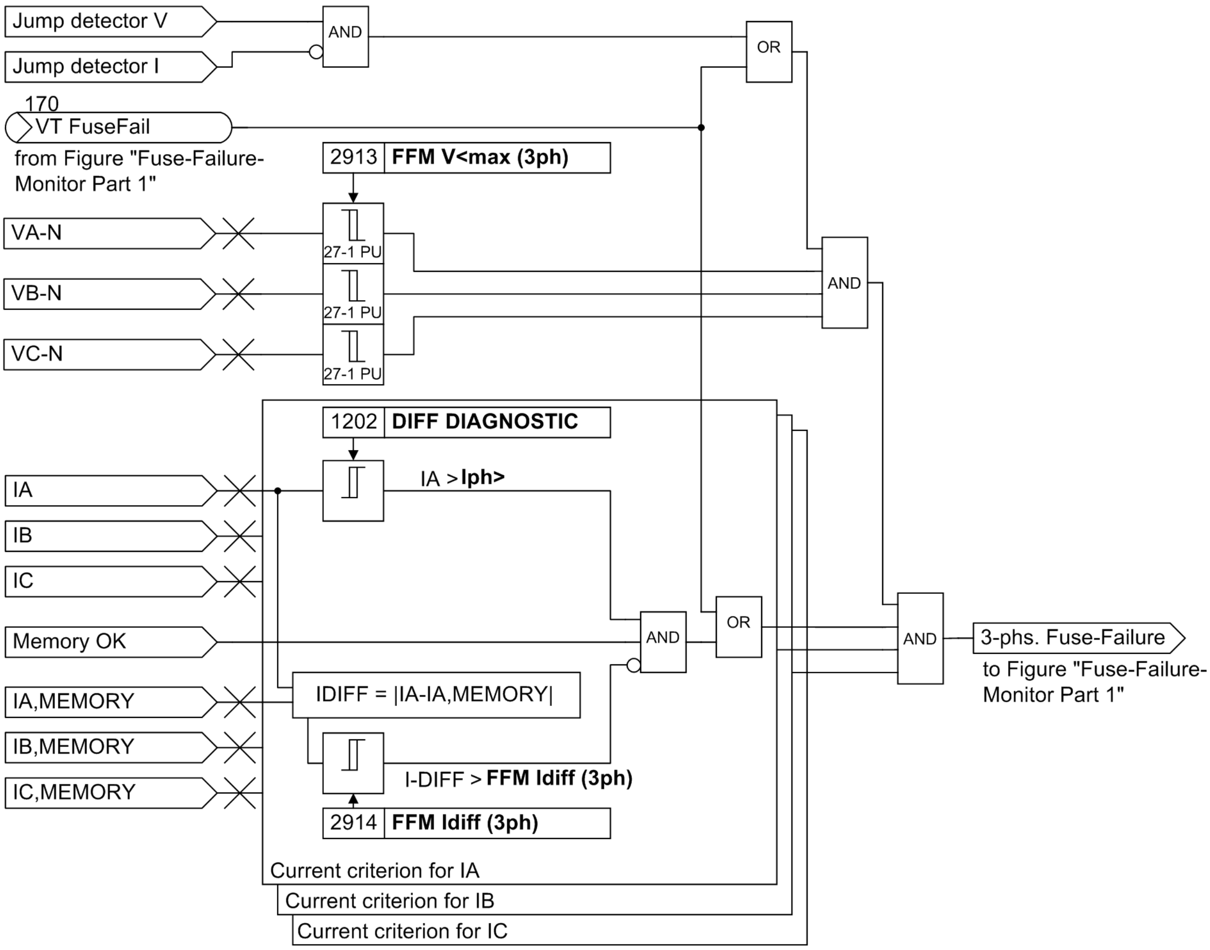


Figure 2-70 Fuse Failure Monitor part 2: detection of the 3-phase measuring voltage failure

A **3-phase failure of the secondary measuring voltages** can be distinguished from an actual system fault by the fact that the currents have no significant change in the event of a failure in the secondary measured voltage. For this reason, the current values are routed to a buffer so that the difference between present and stored current values can be analyzed to recognize the magnitude of the current differential (current differential criterion), cf. figure 2-70.

A 3-pole measuring voltage failure is detected if:

- All 3 phase-to-ground voltages assume a value smaller than the threshold value **FFM V<max (3ph)** (address 2913).
- The current differential in all 3 phases is smaller than the threshold value **FFM Idiff (3ph)** (address 2914).

If such a voltage failure is recognized, the protection functions that operate on the basis of undervoltage are blocked until the voltage failure is removed; afterwards the blocking is automatically removed. The definite time overcurrent protection as emergency function is possible during voltage failure, provided that the time overcurrent protection is parameterized accordingly (refer to Section 2.4).

A 3-pole measuring voltage failure is also detected in the absence of these criteria if the signal „`VT FuseFail`“ (no. 170) was previously generated due to an unbalanced measuring voltage failure. In this condition, measuring voltage failure is still detected if the 3 phase-to-ground voltage subsequently falls below the threshold value **`FFM V<max (3ph)`** (address 2913).

The effect of the signals „`VT FuseFail`“ (no. 170) and „`VT FuseFail>10s`“ (no. 169) on the protection function is described in the following section „Impact of the Measuring Voltage Failure“.

Additional Measuring Voltage Failure Monitoring „Fail V absent“

If no measuring voltage is available after power-on of the device (e.g. because the voltage transformers are not connected), the absence of the voltage can be detected and reported by an additional monitoring function. If the circuit-breaker auxiliary contacts are used, they should be used for monitoring as well. Figure 2-71 shows the logic diagram of the measuring voltage failure monitoring. A failure of the measuring voltage is detected if the following conditions are met at the same time:

- All 3 phase-to-ground voltages are smaller than **`FFM V<max (3ph)`**,
- At least 1 phase current is larger than **`PoleOpenCurrent`** or at least 1 circuit-breaker pole is closed (settable)
- No protection function has picked up
- This condition persists for a settable time **`T V-Supervision`** (default setting: 3 s).

The time **`T V-Supervision`** is required to prevent that a voltage failure is detected before the protection picks up.

If this monitoring function picks up, the indication „`Fail V absent`“ 168 is generated. The effect of this monitoring indication is described in the following section „Impact of the Measuring Voltage Failure“.

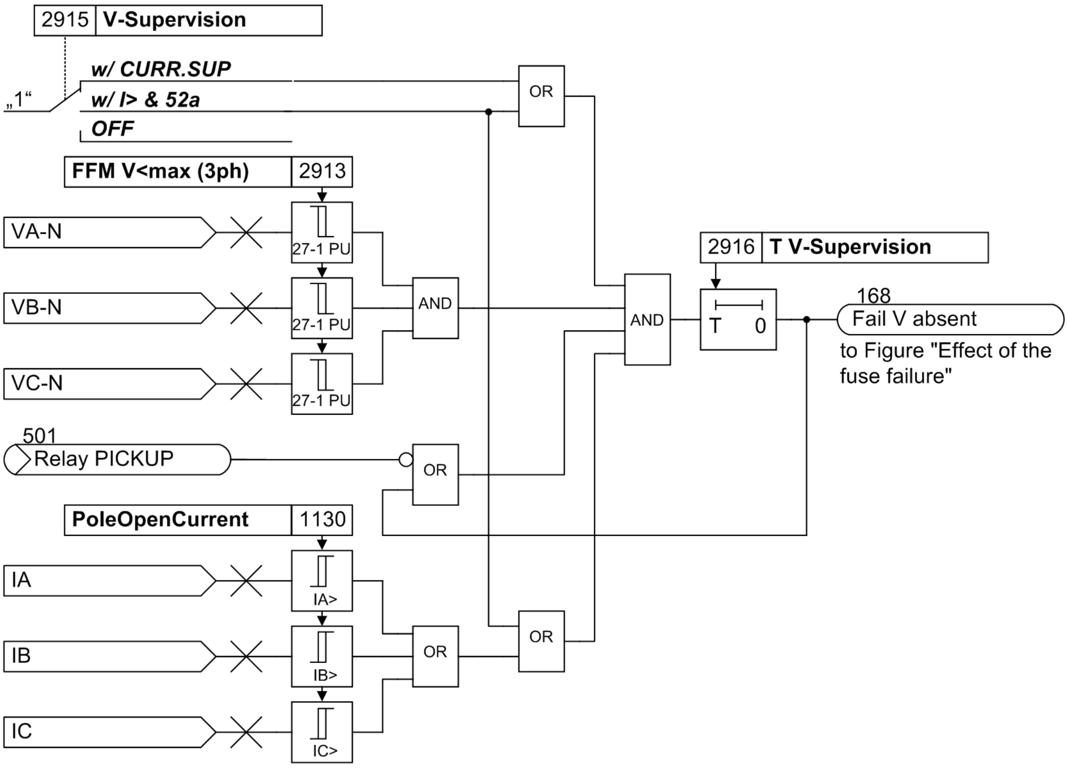


Figure 2-71 Logic diagram of the additional measuring-voltage failure detection „`Fail V absent`“

Impact of the Measuring Voltage Failure

In the event of a measuring voltage failure due to a short circuit or a broken conductor in the voltage transformer secondary circuit, individual or all measuring loops may mistakenly see a voltage of zero. Simultaneously existing load currents may then cause spurious pickup. When such a measuring voltage failure is detected, those protection functions are blocked whose measuring principle is based on undervoltage. The definite time overcurrent protection as emergency function is possible during voltage failure, provided that the time overcurrent protection is parameterized accordingly (refer to Section 2.4). In the event of a measuring voltage failure due to a short circuit or a broken conductor in the voltage transformer secondary circuit, individual or all measuring loops may mistakenly see a voltage of zero. Simultaneously existing load currents may then cause spurious pickup. When such a measuring voltage failure is detected, those protection functions are blocked whose measuring principle is based on undervoltage. The definite time overcurrent protection as emergency function is possible during voltage failure, provided that the time overcurrent protection is parameterized accordingly (refer to Section 2.4).

Figure 2-72 shows the effect on protection functions of measuring voltage failure detected by the „fuse failure monitor“ „`VT FuseFail`“ (no. 170), „`VT FuseFail>10s`“ (no. 169), additional measuring voltage failure monitoring „`Fail V absent`“ (no. 168) and binary input of voltage transformer miniature circuit breaker „`>FAIL:Feeder VT`“ (no. 361).

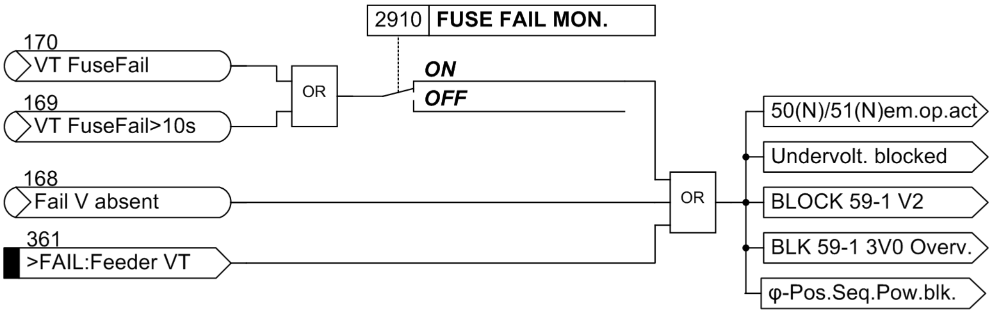


Figure 2-72 Impact of the measuring voltage failure

2.14.1.4 Fault Responses

Depending on the type of fault detected, an alarm is output, the processor system is restarted or the device is taken out of operation. After three unsuccessful restart attempts, the device is also shut down. The device ready relay drops out and indicates the device failure with its NC contact („life status contact“). The red „ERROR“ LED on the device front lights up, provided that there is an internal auxiliary voltage, and the green „RUN“ LED goes off. If the internal auxiliary voltage supply fails, all LEDs are dark. Table 2-4 shows a summary of the monitoring functions and the fault responses of the device.

Table 2-4 Summary of the Device's Fault Responses

Monitoring	Possible causes	Fault response	Indication (no.)	Output
Auxiliary voltage failure	External (aux. voltage) Internal (converter)	Device out of operation	All LEDs dark	DOK[2] drops out
Measured-value acquisition	Internal (converter or reference voltage)	Protection out of operation, alarm	ERROR „LED" „Error A/D-conv." (181)	DOK[2] drops out
Buffer battery	Internal (Buffer battery)	Indication	„Fail Battery" (177)	As routed
Hardware watchdog	Internal (processor failure)	Device out of operation	ERROR „LED"	DOK[2] drops out
Software watchdog	Internal (program sequence)	Restart attempt [1]	ERROR „LED"	DOK[2] drops out
Working memory ROM	Internal (RAM)	Restart attempt [1], Restart abort Device out of operation	LED flashes	DOK[2] drops out
Program memory RAM	Internal (EPROM)	Restart attempt [1]	ERROR „LED"	DOK[2] drops out
Settings memory	Internal (Flash-EPROM or RAM)	Restart attempt [1]	ERROR „LED"	DOK[2] drops out
Sampling frequency	Internal (clock generator)	Restart attempt [1]	ERROR „LED"	DOK[2] drops out
Adjustment values	Internal (EEPROM or RAM)	Indication: Using default values	„Alarm adjustm." (193)	As routed
Modules	Module does not comply with order number (MLFB)	Indications: Protection out of operation	„Error Board 1...5" (183 ... 187) and if applicable „Error A/D-conv.". (181)	DOK[2] drops out
Current sum	Internal (measured value acquisition)	Indication Total blocking of the differential protection	„Failure Σi" (289)	As routed
Current symmetry	External (power system or current transformer)	Indication	„Fail I balance" (163)	As routed
Broken wire	External (power system or current transformer)	Indication Phase-selective blocking of the differential protection	„Broken Iwire L1" (290), „Broken Iwire L2" (291), „Broken Iwire L3" (292)	As routed
Voltage symmetry	External (power system or voltage transformer)	Indication	„Fail V balance" (167)	As routed
Voltage phase sequence	External (power system or connection)	Indication	„Fail Ph. Seq." (171)	As routed
Voltage failure, 3-phase „Fuse Failure Monitor"	External (power system or connection)	Indication Undervoltage protection blocked, Frequency protection blocked	„VT FuseFail>10s" (169), „VT FuseFail" (170)	As routed
Voltage loss, „Fuse failure monitor"	External (voltage transformers)	Indication Undervoltage protection blocked,	„VT FuseFail>10s" (169), „VT FuseFail" (170)	As routed
Voltage failure, 3-phase	External (power system or connection)	Indication Undervoltage protection blocked,	„Fail V absent" (168)	As routed
Trip circuit supervision	External (trip circuit or control voltage)	Indication	„74TC Trip cir." (6865)	As routed

[1] Following three unsuccessful restarting attempts, the device is put out of operation

[2] DOK = „Device OK" = NC contact of the readiness relay = life contact

2.14.1.5 Setting Notes

General

The sensitivity of measured value monitoring can be modified. Default values which are sufficient in most cases are preset. If especially high operational asymmetries of the currents and/or voltages are anticipated during operation, or if it becomes apparent during operation that certain monitoring functions pick up sporadically, then the setting should be less sensitive.

The measurement supervision can be switched ***ON*** or ***OFF*** in address 2901 **MEASURE. SUPERV**.

Symmetry Monitoring

Address 2902 **BALANCE V-LIMIT** determines the limit voltage (phase-to-phase), above which the voltage symmetry monitor is effective. Address 2903 **BAL. FACTOR V** is the associated symmetry factor; that is, the slope of the symmetry characteristic curve. The indication „Fail V balance“ (no. 167) can be delayed at address 2908 **T BAL. V LIMIT**. These settings can only be changed via DIGSI at **Display Additional Settings**.

Address 2904 **BALANCE I LIMIT** determines the limit current above which the current symmetry monitor is effective. Address 2905 **BAL. FACTOR I** is the associated symmetry factor; that is, the slope of the symmetry characteristic curve. The indication „Fail I balance“ (no. 163) can be delayed at address 2909 **T BAL. I LIMIT**. These settings can only be changed via DIGSI at **Display Additional Settings**.

Summation Monitoring

Address 2906 **Σ I THRESHOLD** determines the limit current, above which the current sum monitor is activated (absolute portion, only relative to I_{Nom}). The relative portion (relative to the maximum conductor current) for activating the current sum monitor is set at address 2907 **Σ I FACTOR**. These settings can only be changed via DIGSI at **Display Additional Settings**.

Note

Current sum monitoring can operate properly only when the ground current of the protected line is fed to the fourth current measuring input (I_4) of the device. The I_4 transformer must have been configured as ***In prot. line*** via parameter **I4 transformer** (220), see Appendix at A.3.

Wire Break Monitoring

Wire break monitoring is enabled or disabled via parameter 2931 **BROKEN WIRE**. Only when set to ***ON***, is the differential protection function blocked. When set to ***Alarm only***, a broken wire is signaled but the protection functions are not blocked.

Asymmetrical Measuring Voltage Failure "Fuse Failure Monitor"

The settings for the „fuse failure monitor“ for non-symmetrical measuring voltage failure (address 2911 **FFM V>(min)**) are to be selected so that reliable activation occurs if a phase voltage fails, but not such that false activation occurs during ground faults in a grounded network. Address 2912 **FFM I< (max)** must be set as sensitive as required (with ground faults, below the smallest fault current). These settings can only be changed via DIGSI at **Display Additional Settings**.

In address 2910 **FUSE FAIL MON.**, the „fuse failure monitor“ can be switched ***OFF*** e.g. during asymmetrical testing.

3-Phase Measuring Voltage Failure "Fuse Failure Monitor"

The minimum voltage below which a 3-phase measured voltage failure is detected is set in address 2913 **FFM V<max (3ph)** unless a current step takes place simultaneously which exceeds the limit according to address 2914 **FFM Idiff (3ph)**. These settings can only be changed via DIGSI at **Display Additional Settings**.

In address 2910 **FUSE FAIL MON.**, the „fuse failure monitor“ can be switched ***OFF*** e.g. during asymmetrical testing.

Measured Voltage Failure Monitoring

In address 2915 **V-Supervision**, the measured voltage failure monitoring can be switched to ***w/ CURR.SUP***, ***w/ I> & 52a*** or ***OFF***. Address 2916 **T V-Supervision** is used to set the waiting time of the voltage failure monitoring. This setting can only be changed using DIGSI at **Additional Settings**.

2.14.1.6 Settings

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

The table indicates region-specific default settings. Column C (configuration) indicates the corresponding secondary nominal current of the current transformer.

Addr.	Parameter	C	Setting Options	Default Setting	Comments
2901	MEASURE. SUPERV		ON OFF	ON	Measurement Supervision
2902A	BALANCE V-LIMIT		10 .. 100 V	50 V	Voltage Threshold for Balance Monitoring
2903A	BAL. FACTOR V		0.58 .. 0.95	0.75	Balance Factor for Voltage Monitor
2904A	BALANCE I LIMIT	1A	0.10 .. 1.00 A	0.50 A	Current Threshold for Balance Monitoring
		5A	0.50 .. 5.00 A	2.50 A	
2905A	BAL. FACTOR I		0.10 .. 0.95	0.50	Balance Factor for Current Monitor
2906A	Σ I THRESHOLD	1A	0.10 .. 2.00 A	0.25 A	Summated Current Monitoring Threshold
		5A	0.50 .. 10.00 A	1.25 A	
2907A	Σ I FACTOR		0.00 .. 0.95	0.50	Summated Current Monitoring Factor
2908A	T BAL. V LIMIT		5 .. 100 sec	5 sec	T Balance Factor for Voltage Monitor
2909A	T BAL. I LIMIT		5 .. 100 sec	5 sec	T Current Balance Monitor
2910	FUSE FAIL MON.		ON OFF	ON	Fuse Failure Monitor
2911A	FFM V>(min)		10 .. 100 V	30 V	Minimum Voltage Threshold V>
2912A	FFM I< (max)	1A	0.10 .. 1.00 A	0.10 A	Maximum Current Threshold I<
		5A	0.50 .. 5.00 A	0.50 A	
2913A	FFM V<max (3ph)		2 .. 100 V	5 V	Maximum Voltage Threshold V< (3phase)

Addr.	Parameter	C	Setting Options	Default Setting	Comments
2914A	FFM Idiff (3ph)	1A	0.05 .. 1.00 A	0.10 A	Differential Current Threshold (3phase)
		5A	0.25 .. 5.00 A	0.50 A	
2915	V-Supervision		w/ CURR.SUP w/ I> & 52a OFF	w/ CURR.SUP	Voltage Failure Supervision
2916A	T V-Supervision		0.00 .. 30.00 sec	3.00 sec	Delay Voltage Failure Supervision
2931	BROKEN WIRE		ON OFF Alarm only	OFF	Fast broken current-wire supervision
2933	FAST Σ i SUPERV		ON OFF	ON	State of fast current summation supervis
2935A	ΔI min	1A	0.05 .. 1.00 A	0.10 A	Min. current diff. for wire break det.
		5A	0.25 .. 5.00 A	0.50 A	

2.14.1.7 Information List

No.	Information	Type of Information	Comments
161	Fail I Superv.	OUT	Failure: General Current Supervision
163	Fail I balance	OUT	Failure: Current Balance
164	Fail V Superv.	OUT	Failure: General Voltage Supervision
167	Fail V balance	OUT	Failure: Voltage Balance
168	Fail V absent	OUT	Failure: Voltage absent
169	VT FuseFail>10s	OUT	VT Fuse Failure (alarm >10s)
170	VT FuseFail	OUT	VT Fuse Failure (alarm instantaneous)
171	Fail Ph. Seq.	OUT	Failure: Phase Sequence
196	Fuse Fail M.OFF	OUT	Fuse Fail Monitor is switched OFF
197	MeasSup OFF	OUT	Measurement Supervision is switched OFF
289	Failure Σi	OUT	Alarm: Current summation supervision
290	Broken Iwire L1	OUT	Alarm: Broken current-wire detected L1
291	Broken Iwire L2	OUT	Alarm: Broken current-wire detected L2
292	Broken Iwire L3	OUT	Alarm: Broken current-wire detected L3
295	Broken wire OFF	OUT	Broken wire supervision is switched OFF
296	Σi superv. OFF	OUT	Current summation superv is switched OFF
297	ext.Brk.Wire ØA	OUT	Broken current-wire at other end ØA
298	ext.Brk.Wire ØB	OUT	Broken current-wire at other end ØB
299	ext.Brk.Wire ØC	OUT	Broken current-wire at other end ØC
3270	>RESET BW	SP	>RESET broken wire monitoring
3271	Broken Iwire a	IntSP	Alarm: Broken current-wire detected A
3272	Broken Iwire b	IntSP	Alarm: Broken current-wire detected B
3273	Broken Iwire c	IntSP	Alarm: Broken current-wire detected C

2.14.2 74TC Trip Circuit Supervision

The 7SD80 line protection is equipped with an integrated trip circuit supervision function. 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 routing of the binary inputs required for this does not comply with the selected monitoring mode, an alarm is given („TripC1 ProgFAIL ...“, with identification of the non-compliant circuit). 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. If single-pole tripping is possible, a separate trip circuit supervision can be implemented for each circuit-breaker pole provided the required binary inputs are available.

2.14.2.1 Method of Operation

Monitoring with Two Binary Inputs

When using two binary inputs, these are connected according to Figure 2-73, parallel to the associated trip contact on one side, and parallel to the circuit-breaker auxiliary contacts on the other.

A precondition for the use of the trip circuit supervision is that the control voltage for the circuit breaker is higher than the total of the minimum voltages drops at the two binary inputs ($V_{Ctrl} > 2 \cdot V_{BImin}$). Since at least 19 V are needed at each binary input, the supervision can only be used with a system control voltage higher than 38 V.

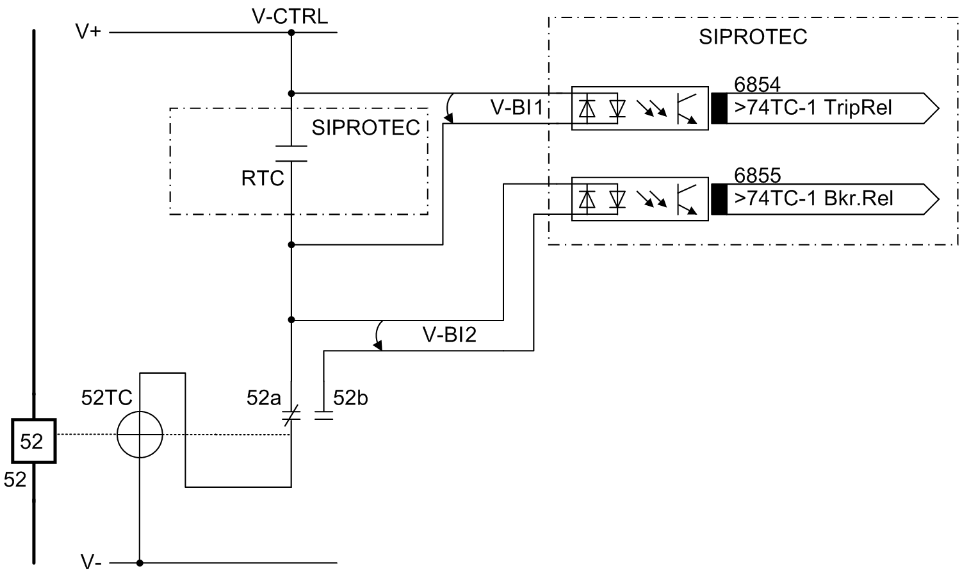


Figure 2-73 Principle of the trip circuit monitoring with two binary inputs

RTC	Relay trip contact
52	Circuit breaker
52TC	Circuit-breaker trip coil
52a	Circuit-breaker auxiliary contact (NO contact)
52b	Circuit-breaker auxiliary contact (NC contact)
V-CTRL	Control Voltage (tripping voltage)
V-BI1	Input voltage for first binary input
V-BI2	Input voltage for second binary input

Monitoring with two binary inputs does not only detect interruptions in the trip circuit and loss of control voltage, it also monitors 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 the following table), or faulted (logical condition „L“).

A state in which both binary inputs are not activated („L“) is only possible in intact trip circuits for a short transition period (trip relay contact closed but circuit breaker not yet open).

A continuous state of this condition is only possible when the trip circuit has been interrupted, a fault exists in the trip circuit, a loss of battery voltage occurs, or malfunctions occur with the circuit-breaker mechanism. Therefore, it is used as monitoring criterion.

Table 2-5 Condition Table for Binary Inputs, Depending on RTC and CB Position

No.	Command relay	Circuit breaker	52a contact	52b contact	BI 1	BI 2	Dynamic state	Static state
1	Open	ON	Closed	Open	H	L	Normal operation with circuit breaker closed	
2	Open	OFF	Open	Closed	H	H	Normal operation with circuit breaker open	
3	Closed	ON	Closed	Open	L	L	Transition or disturbance	Disturbance
4	Closed	OFF	Open	Closed	L	H	The command relay has success-fully activated the circuit breaker.	

The conditions of the two binary inputs are scanned periodically. A query takes place about every 500 ms. If three consecutive conditional checks detect an abnormality, an annunciation is reported (see Figure 2-74). The repeated measurements help to determine the delay of the alarm message and to avoid that an alarm is output during short-time transition periods. After the fault in the trip circuit is removed, the alarm is reset automatically after the same time.

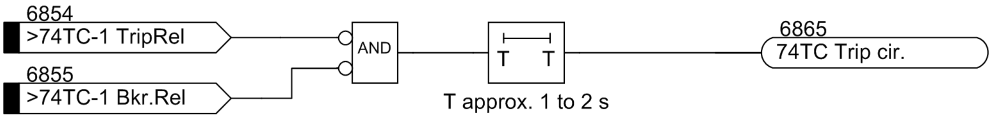


Figure 2-74 Logic diagram of the trip circuit monitoring with two binary inputs

Monitoring with One Binary Input

The binary input is connected in parallel to the respective command relay contact of the protection device according to Figure 2-75. The circuit-breaker auxiliary contact is bridged with a high-ohm substitute resistor R.

The control voltage for the circuit breaker should be at least twice as high as the minimum voltage drop at the binary input ($V_{Ctrl} > 2 \cdot V_{BImin}$). Since at least 19 V are necessary at the binary input, this supervision can be used with a system control voltage higher than 38 V.

A calculation example for the resistance shunt R is shown in the configuration notes in Section „Mounting and Connections“, margin „Trip Circuit Supervision“.

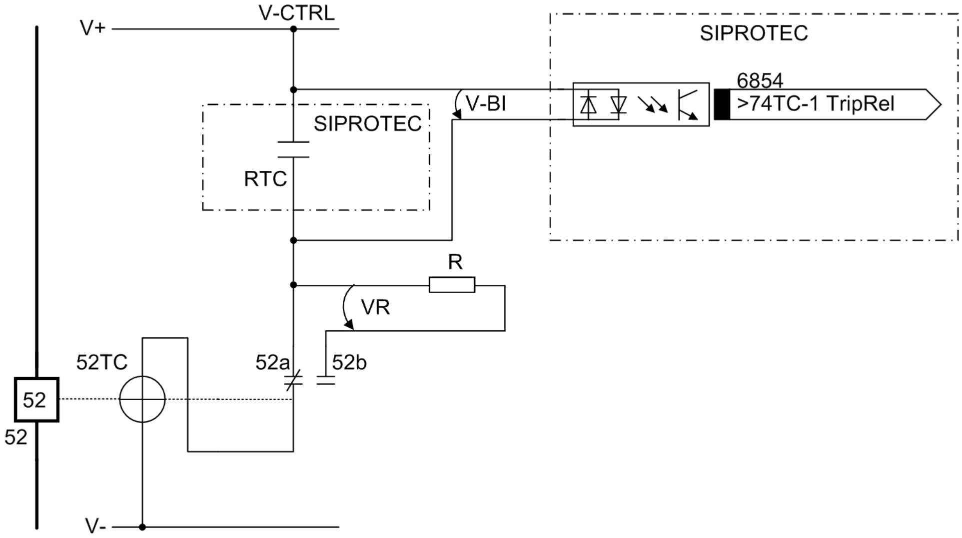


Figure 2-75 Principle of the trip circuit monitoring with one binary input

RTC	Relay trip contact
52	Circuit breaker
52TC	Circuit-breaker trip coil
52a	Circuit-breaker auxiliary contact (NO contact)
52b	Circuit-breaker auxiliary contact (NC contact)
V-CTRL	Control Voltage for trip circuit
V-BI	Input voltage for binary input
R	Bypass resistor
VR	Voltage at bypass resistor

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 circuit-breaker auxiliary contact (if the circuit breaker is closed) or through the bypass resistor R. Only as long as the trip contact is closed, the binary input is faulted and thereby deactivated (logical condition „L“).

If the binary input is permanently deactivated during operation, an interruption in the trip circuit or a failure of the (trip) control voltage can be assumed.

The trip circuit monitor does not operate during system faults. A momentary closed tripping contact does not lead to a failure message. If however other trip relay contacts from different devices are connected in parallel in the trip circuit, the failure alarm must be delayed by **Alarm Delay** (refer also to Figure 2-76). After the fault in the trip circuit is removed, the alarm is reset automatically after the same time.

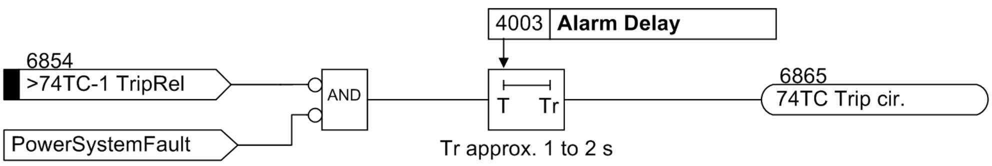


Figure 2-76 Logic diagram for trip circuit monitoring with one binary input

2.14.2.2 Setting Notes

General

The number of circuits to be monitored was set during the configuration in address 140 **74 Trip Ct Supv** (Section 2.1.1.2). If the trip circuit supervision is not used at all, the setting ***Disabled*** must be applied there.

The trip circuit supervision can be switched ***ON*** or ***OFF*** in address 4001 **FCT 74TC**. The number of binary inputs that shall be used in each of the monitored circuits is set in address 4002 **No. of BI**. If routing of the required binary inputs does not comply with the selected supervision mode, the alarm „TripCx ProgFAIL...“ is given (with identification of the non-compliant circuit).

Monitoring with One Binary Input

The alarm for monitoring with two binary inputs is always delayed by approx. 1 s to 2 s, whereas the time delay of the alarm for monitoring with one binary input can be set in address 4003 **Alarm Delay**. 1s to 2s are sufficient if only the 7SD80 device is connected to the trip circuits as the trip circuit supervision does not operate during a system fault. If, however, trip contacts from other devices are connected in parallel in the trip circuit, the alarm must be delayed such that the longest trip command duration can be reliably bridged.

2.14.2.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
4001	FCT 74TC	ON OFF	OFF	74TC TRIP Circuit Supervision
4002	No. of BI	1 .. 2	2	Number of Binary Inputs per trip circuit
4003	Alarm Delay	1 .. 30 sec	2 sec	Delay Time for alarm

2.14.2.4 Information List

No.	Information	Type of Information	Comments
6854	>74TC-1 TripRel	SP	>74TC-1 Trip circuit superv.:Trip Relay
6855	>74TC-1 Bkr.Rel	SP	>74TC-1 Trip circuit superv.:Breaker Rel
6856	>74TC-2 TripRel	SP	>74TC-2 Trip circuit superv.:Trip Relay
6857	>74TC-2 Bkr.Rel	SP	>74TC-2 Trip circuit superv.:Breaker Rel
6858	>74TC-3 TripRel	SP	>74TC-3 Trip circuit superv.:Trip Relay
6859	>74TC-3 Bkr.Rel	SP	>74TC-3 Trip circuit superv.:Breaker Rel
6861	74TC OFF	OUT	74TC Trip circuit supervision OFF
6865	74TC Trip cir.	OUT	74TC Failure Trip Circuit
6866	74TC-1 ProgFAIL	OUT	74TC-1 blocked. Binary input is not set
6867	74TC-2 ProgFAIL	OUT	74TC-2 blocked. Binary input is not set
6868	74TC-3 ProgFAIL	OUT	74TC-3 blocked. Binary input is not set

2.15 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.

2.15.1 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 2-6 and the derived protection functions are available.

Please note that no power values or frequency values are available if you are not using a voltage connection.

Table 2-6 Possible Protection Functions

Characteristic Group	Characteristic / Measured Quantity		Protective Function	ANSI No.	Mode of Operation	
					Three-phase	Single-phase
Current	I	RMS value of fundamental component	Overcurrent protection Undercurrent monitoring	50, 50G 37	X	X
	I_{rms}	True RMS (r.m.s. value)	Overcurrent protection Thermal overload protection Undercurrent monitoring	50, 50G 49 37	X	X
	$3I_0$	Zero sequence system	Time overcurrent protection, ground	50N	X	
	I1	Positive-sequence component			X	
	I2	Negative-sequence component	Negative sequence protection	46	X	
	I2/I1	Positive/negative sequence component ratio			X	
Frequency	f	Frequency	Frequency protection	81U/O	without phase reference	
	df/dt	Frequency change	Frequency change protection	81R		
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	
Power	P	Real power	Reverse power protection Power protection	32R, 32, 37	X	X
	Q	Reactive power	Power protection	32	X	X
	cos φ	Power factor	Power factor	55	X	X
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 2-77 illustrates the description.

Functional Logic

The function can be switched ***ON*** and ***OFF*** 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 on-site control („Control“ -> „Tagging“ -> „Set“). When blocked, the entire measuring element of the function and all running times and indications are reset. Blocking via on-site control can be important if the function is in a permanent pickup condition and reparameterizing it is therefore not possible. For characteristics based on voltages it is possible to block the function should a measuring voltage fail. The corresponding detection is accomplished via the internal device function „Measuring-voltage failure detection“ (FNo. 170 „VT FuseFail“; see Section 2.14.1). This blocking mechanism can be enabled or disabled via parameters. The corresponding parameter **BLK.by Vol.Loss** is only available if the characteristic is based on a voltage measurement.

When configuring the function as line protection or power supervision, the blocking will be effective for currents below 0.03 I_N.

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*** or ***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. This may be for example the typical operating principle of a three-phase time overcurrent protection. When operating single-phase, the function employs either a phase's measured quantity, which must be stated explicitly, (e.g. evaluating only the current in phase ***Ib***), the measured ground current ***In*** or the measured displacement voltage . 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 current and voltage measured values whether the function uses the rms value of the fundamental component or the normal r.m.s. 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.

Functional Logic

Figure 2-77 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.

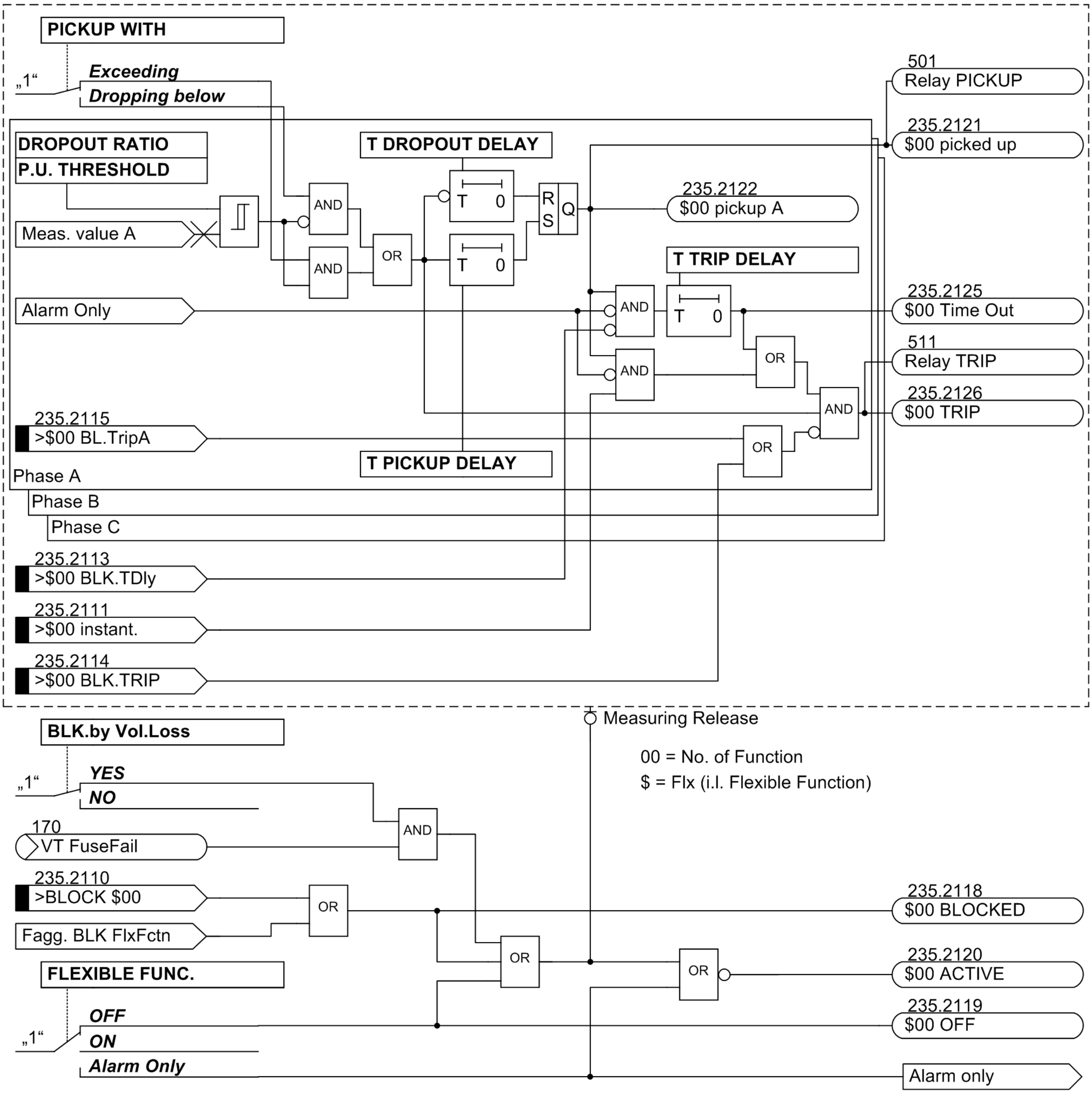


Figure 2-77 Logic diagram of the flexible protection functions

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 time delay 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 2-77.

Interaction with Other Functions

The flexible protection functions interact with a number of other functions such as the

- Breaker failure protection:

  The breaker failure protection is started automatically if the function initiates a trip. The trip will, however, only take place if the current criterion is met at this time, i.e. the set minimum current threshold (Power System Data 1) has been exceeded.

- With the Automatic Reclosure Function (AR):

  The AR cannot be started directly. To cooperate with AR, the trip command of the flexible function must be linked with the binary input FNo. 2716 „>79 TRIP 3p“ via CFC. To use an action time, the pickup of the flexible function must additionally be linked to the binary input FNo. 2711 „>79 Start“.

- Fuse-Failure-Monitor (see description at „Blocking Functions“).
- With inrush restraint:

  A direct cooperation with the inrush restraint is not possible. If a flexible function is to be blocked by the inrush restraint, this blocking must be configured via CFC. Furthermore, please note that the flexible function must be delayed by at least 20 ms to enable the inrush restraint to pick up reliably before the flexible function.

- With the overall device logic:

  The pickup indication of the flexible function is included in the general pickup, and the tripping in the general trip. All functionalities associated with the general pickup and general trip therefore also apply to the flexible function.

2.15.2 Setting Notes

The setting of the functional scope determines the number of flexible protection functions to be used (see Chapter 2.1.1). 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. A typical example is the three-phase operating time overcurrent protection.

Single-phase – functions evaluate only the individual measuring value. This can be an individual phase value (e.g. V_B) or a ground variable (V_N or I_N).

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

Measured Variable:

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 dependent on the mode of measured-value processing as predefined in parameter **OPERRAT. MODE** (see the following table).

Table 2-7 Parameter "Operating method" and "Measurand"

Parameter **OPERRAT. MODE** Setting	Parameter **MEAS. QUANTITY** Setting selection
1-phase, 3-phase	Current Voltage P forward P reverse Q forward Q reverse Power factor
without reference	Frequency df/dt rising df/dt falling Binary Input

Measurement Methods

The measurement methods shown in the following tables can be parameterized for the measurands current, voltage and power. Additionally, the dependencies of the available measurement methods on the parameterized operating method and measurand are shown.

Table 2-8 Parameter in the "Measurement Method" settings dialog, 3-phase operation

Operating Method	Measurand		Notes
3-phase	Current, voltage	Parameter **MEAS. METHOD** Setting selection	
		Fundamental component	The fundamental component is evaluated, harmonics are suppressed. This is the standard measurement method of the protection functions. Important: The voltage threshold is always parameterized as phase-to-phase voltage independently of parameter VOLTAGE SYSTEM.
		True RMS	The "true" RMS value is determined, i.e. harmonics are evaluated. This method is used, for instance, if a simple overload protection on the basis of current measurement is to be implemented, since harmonics contribute to thermal heating. Important: The voltage threshold is always parameterized as phase-to-phase voltage independently of parameter VOLTAGE SYSTEM.
		Positive-sequence system, negative-sequence system, zero-sequence system	To implement certain applications, the positive-sequence system or the negative-sequence system can be parameterized as measurement method. Examples are: - I2 (unbalanced load protection) - V2 (voltage unbalance) When selecting the zero-sequence system, additional zero current or zero voltage functions can be implemented that work independently of the ground quantities IN and VN measured directly through transformers. Important: The voltage threshold is always parameterized according to the definition of the balanced components independently of parameter VOLTAGE SYSTEM.
	Current	Ratio I2/I1	The ratio of the negative-sequence current to the positive-sequence current is evaluated.
	Voltage	Parameter **VOLTAGE SYSTEM** Setting selection	
		Phase-to-phase Phase-to-ground	You can select whether a 3-phase voltage function is to evaluate the phase-to-ground or the phase-to-phase voltage. When selecting phase-to-phase, these quantities are calculated from the phase-to-ground voltages. The selection is important, e.g., for 1-phase faults. If the faulted voltage collapses to zero, the affected phase-to-ground voltage is zero, whereas the affected phase-to-phase voltages collapse to the magnitude of a phase-to-ground voltage.

Note

We see a special behavior of the phase-selective pickup indications for the 3-phase voltage protection with phase-to-phase quantities, as the phase-selective pickup indication "Flx01 Pickup Lx" is assigned to the corresponding measured value channel "Lx".

Table 2-9 Parameter in the "Measurement Method" settings dialog, 1-phase operation

Operating Method	Measurand		Notes
1-phase	Current, voltage	Parameter **MEAS. METHOD** Setting selection	
		Fundamental component	The fundamental component is evaluated, harmonics are suppressed. This is the standard measurement method of the protection functions.
		True RMS	The „true“ RMS value is determined, i.e. harmonics are evaluated. This method is used, for instance, if a simple overload protection on the basis of current measurement is to be implemented, since harmonics contribute to thermal heating.
	Current	Parameter **CURRENT** Setting selection	
		IA IB IC IN INs	It is defined which current measuring channel is to be evaluated by the function. Depending on the device variant, either IN (normal ground current input) or INS (sensitive ground current input) is offered.
	Voltage	Parameter **VOLTAGE** Setting selection	
		VAB VBC VCA VAN VBN VCN	It is defined which voltage measuring channel is to be evaluated by the function. When selecting the phase-to-phase voltage, the threshold value must be set as phase-to-phase value; when selecting a phase-to-ground quantity, as phase-to-ground voltage.
	P forward, P reverse, Q forward, Q reverse	Parameter **POWER** Setting selection	
		IA VAN IB VBN IC VCN	It is defined which power measuring channel (current and voltage) is to be evaluated by the function.

The forward direction of the power (P forward, Q reverse) is in direction of the line. The parameter (1107 **P,Q sign**) for sign reversal of the power indication in the operational measured values is ignored by the flexible functions.

Parameter **PICKUP WITH** can be used to specify whether the function is to pick up when the set threshold value is exceeded or undershot.

Settings

The pickup thresholds, time delays 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 OFF-command time delay 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**. For protection applications this parameter is usually set to zero (default setting), because a protection function must pick up as quickly as possible. A setting other than zero can be useful if it is not desired that a fault record is opened each time a pickup threshold is briefly exceeded, e.g. for the power protection or if the function is used as monitoring function and not as protection function. If the ratio of the positive-sequence current to the negative-sequence current (I2/I1) is evaluated, the **T PICKUP DELAY** should at least be set to 20 ms.

When setting the power threshold values, it is important to take into consideration that a minimum current of 0.03 I_N is required for power calculation. The power calculation is blocked for lower currents.

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 (see Chapter 2.2 for more information). When utilizing the dropout time delay, it is recommended to set it to a shorter time than the OFF-command time delay in order to avoid both times to "race".

Parameter **BLK.by Vol.Loss** determines whether a function whose measured variable is based on a voltage measurement (measured quantities voltage, P forward, P reverse, Q forward, Q reverse and power factor), should be blocked in case of a measured voltage failure (set to ***YES***) or not (set to ***NO***).

The dropout ratio of the function can be selected in parameter **DROPOUT RATIO**. The standard dropout ratio of protection functions is 0.95 (default setting). If the function is used as power protection, a dropout ratio of at least 0.9 should be set. The same applies to the utilization of the symmetrical components of current and voltage. 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.

A permanent dropout difference of 0.1 Hz/s is used for the frequency change (df/dt) measurand. 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.

Further Information

The following instruction should be noted:

- As the power factor does not differentiate between capacitive and inductive, the sign of the reactive power may be used with CFC-help as an additional criterion.

2.15.3 Settings

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

The table indicates region-specific default settings. Column C (configuration) indicates the corresponding secondary nominal current of the current transformer.

Addr.	Parameter	C	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 Current Voltage P forward P reverse Q forward Q reverse Power factor Frequency df/dt rising df/dt falling Binary Input	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
0	CURRENT		Ia Ib Ic In In sensitive	Ia	Current
0	VOLTAGE		Please select Va-n Vb-n Vc-n Va-b Vb-c Vc-a	Please select	Voltage
0	POWER		Ia Va-n Ib Vb-n Ic Vc-n	Ia Va-n	Power
0	VOLTAGE SYSTEM		Phase-Phase Phase-Ground	Phase-Phase	Voltage System
0	P.U. THRESHOLD		0.03 .. 40.00 A	2.00 A	Pickup Threshold

Addr.	Parameter	C	Setting Options	Default Setting	Comments
0	P.U. THRESHOLD	1A	0.03 .. 40.00 A	2.00 A	Pickup Threshold
		5A	0.15 .. 200.00 A	10.00 A	
0	P.U. THRESHOLD		0.001 .. 1.500 A	0.100 A	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	1A	0.5 .. 10000.0 W	200.0 W	Pickup Threshold
		5A	2.5 .. 50000.0 W	1000.0 W	
0	P.U. THRESHOLD		-0.99 .. 0.99	0.50	Pickup Threshold
0	P.U. THRESHOLD		15 .. 100 %	20 %	Pickup Threshold
0	T TRIP DELAY		0.00 .. 3600.00 sec	1.00 sec	Trip Time Delay
0	T PICKUP DELAY		0.00 .. 60.00 sec	0.00 sec	Pickup Time Delay
0	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
0A	DO differential		0.02 .. 1.00 Hz	0.02 Hz	Dropout differential

2.15.4 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
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

2.16 Function Control

2.16.1 Pickup Logic for the Entire Device

Phase Segregated Fault Detection

The fault detection logic combines the fault detection (pickup) signals of all protection functions. The protection functions that allow phase segregated pickup the output is done in a phase segregated manner. If a protection function detects a ground fault, this is also output as a common device alarm. Thus the alarms „Relay PICKUP ØA“, „Relay PICKUP ØB“, „Relay PICKUP ØC“ and „Relay PICKUP G“ are available.

The above indications can be routed to LEDs or output relays. For some protection functions, also the picked up phases are available as a group indication for displaying fault indications locally or transmitting them to a PC or control center; only one group indication is displayed at a time and represents the entire pickup situation.

General Pickup

The pickup signals are combined with OR and lead to a general pickup of the device. It is signaled with the alarm „Relay PICKUP“. If no protection function of the device has picked up any longer, „Relay PICKUP“ disappears (message: „OFF“).

General device pickup is a precondition for a series of internal and external functions that occur subsequently. The following internal functions are controlled by general device pickup:

- Opening of fault case: From general device pickup to general device drop out, all fault messages are entered in the trip log.
- Initialization of fault storage: The storage and maintenance of fault values can also be made dependent on the occurrence of a trip command.
- Generation of spontaneous indications: Certain fault indications can be displayed as spontaneous indications (see margin heading „Spontaneous indications“). This indication can also be made dependent on the general device trip.
- Start action time of automatic reclosure (if available and used)

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

- Automatic reclose devices,
- Channel boost in conjunction with signal transmission by PLC,
- Further additional devices or similar.

Spontaneous Indications

Spontaneous displays are fault messages which appear in the display automatically following a general fault detection or trip command of the device. For the 7SD80, these messages include:

„Relay PICKUP“:	protective function that picked up;
„S/E/F TRIP“:	protection function which tripped (only device with graphic display);
„PU Time“:	Operating time from the general pickup to the dropout of the device, in ms;
„TRIP Time“:	the operating time from general pickup to the first trip command of the device, in ms;

2.16.2 Overall Tripping Logic of the Device

3-Pole Tripping

The device trips 3-pole in the event of a fault. The output function „`Relay TRIP`“ is used for to send the command to the circuit breaker.

General Trip

All trip signals for the protection functions are connected by OR and generate the indication „`Relay TRIP`“. This indication can be routed to LED or output relays.

Terminating the Trip Signal

A trip command once transmitted is stored (see Figure 2-78). At the same time, the minimum trip command duration **`TMin TRIP CMD`** is started. It ensures that the command is transmitted to the circuit breaker for a sufficient amount of time, even if the tripping protection function drops out very quickly. The trip commands can only be reset after all tripping protection functions have dropped out and after the minimum trip command time has elapsed.

A further condition for terminating the trip command is that the circuit breaker is recognized to be open. The function control of the device checks this condition by means of the circuit-breaker position feedback (Section „Detection of the Circuit-Breaker Position“) and the flow of current. In address `1130` the residual current **`PoleOpenCurrent`** is set which is certainly undershot when the circuit-breaker pole is open. Address `1135` **`Reset Trip CMD`** determines under which conditions a trip command is reset. If ***`CurrentOpenPole`*** is set, the trip command is reset as soon as the current disappears. It is important that the value falls below the setting in address `1130` **`PoleOpenCurrent`** (see above). If ***`Current AND 52a`*** is set, the circuit-breaker auxiliary contact must also send a message that the circuit breaker is open. This setting requires the position of the auxiliary contact to be routed via a binary input. If this additional condition is not required for resetting the trip command (e.g. if test sockets are used for protection testing), it can be switched off with the setting ***`Pickup Reset`***.

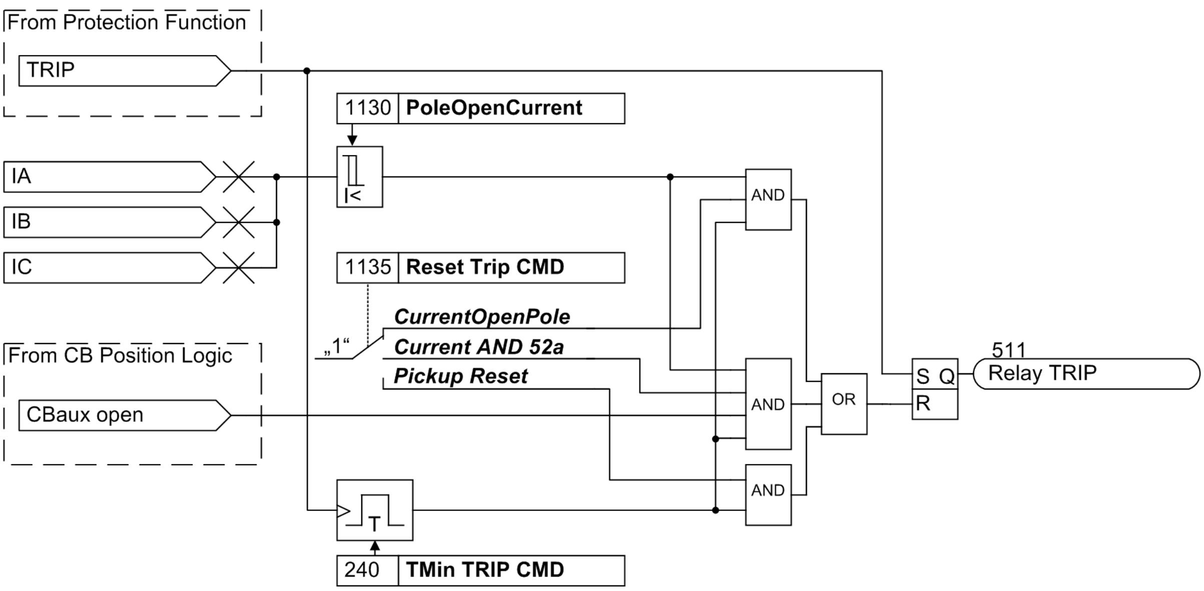


Figure 2-78 Storage and termination of the trip command

Reclosure Interlocking

After the circuit breaker has been tripped by a protection function, the reclosing must often be blocked until the cause for tripping of the protection function has been found. 7SD80 enables this via the integrated reclosure interlocking.

The interlocking state („LOCKOUT“) will be realized by an RS flipflop which is protected against auxiliary voltage failure (see Figure 2-79). The RS flipflop is set via binary input „>Lockout SET“ (no. 385). With the output indication „LOCKOUT“ (no. 530), if interconnected correspondingly, reclosing of the circuit breaker (e.g. for automatic reclosing, manual close signal, closing via control) can be blocked. The interlocking should only be reset manually via binary input „>Lockout RESET“ (no. 386) when the cause of the fault has been determined.

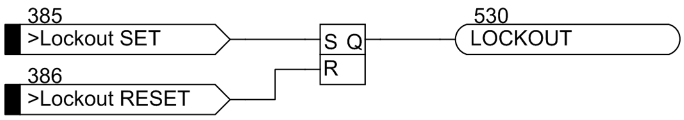


Figure 2-79 Reclosure interlocking

The conditions for reclosure interlocking and the control commands to be blocked can be parameterized. The correspondingly routed binary inputs and outputs are wired externally or linked via user-defined logic functions (CFC).

If, for example, each trip by the protection function has to cause a closing lock-out, then combine the tripping command „Relay TRIP“ (No. 511) with the binary input „>Lockout SET“. If automatic reclosure is applied, only the final trip of the protection function should activate reclosing lock-out. Please bear in mind that the message „Definitive TRIP“ (No. 536) applies only for 500°ms. Then combine the output alarm „Definitive TRIP“ (No. 536) with the interlocking input „>Lockout SET“, so that the interlocking function is not established when an automatic reclosure is still expected to come.

The output alarm „LOCKOUT“ can also be applied to interlock certain closing commands (externally or via CFC), e.g. by combining the output alarm with the binary input „>Blk Man. Close“ (No. 357) or by connecting the inverted alarm with the bay interlocking of the feeder.

The output alarm „LOCKOUT“ can also be applied to interlock certain closing commands (externally or via CFC), e.g. by combining the output alarm with the binary input „>Blk Man. Close“ (No. 357) or by connecting the inverted alarm with the bay interlocking of the feeder.

The reset input „>Lockout RESET“ (no. 386) resets the interlocking state. This input is initiated by an external device which is protected against unauthorized or unintentional operation. The interlocking state can also be controlled by internal sources using CFC, e.g. a function key, operation of the device or using DIGSI on a PC.

For each case please ensure that the corresponding logic operations, security measures, etc. are taken into account when routing the binary inputs and outputs and may have to be considered when creating the user-defined logic functions. See also the SIPROTEC 4 System Description.

Breaker Tripping Alarm Suppression

While every trip command by a protection function is final on a feeder without automatic reclosure, it is desirable, when using automatic reclosure, to prevent the operation detector of the circuit breaker (transient contact on the breaker) from sending an alarm if the trip of the breaker is not final (Figure 2-80).

To accomplish this, the signal from the circuit breaker can be routed via an output contact of the 7SD80 (output alarm „CB Alarm Supp“, no. 563) that is configured accordingly. In the idle state and when the device is turned off, this contact is closed permanently. This requires an output contact with normally closed contact to be routed. Which contact has to be routed depends on the device version. See also the general diagrams in the Appendix.

Prior to the command, with the internal automatic reclosure in the ready state, the contact opens so that no signal from the circuit breaker is forwarded. This is only the case if the device is equipped with internal automatic reclosure and if the latter was considered when configuring the protection functions (address 133).

Also when closing the breaker via the binary input „>Manual Close“ (No 356) or via the integrated automatic reclosure the contact is interrupted so that the breaker alarm is inhibited.

Further optional closing commands which are not sent via the device cannot be considered. Closing commands for control can be linked to the alarm suppression via the user-defined logic functions (CFC).

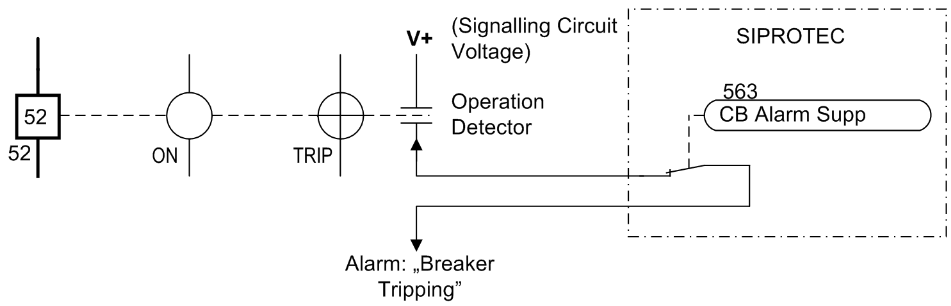


Figure 2-80 Breaker tripping alarm suppression

If the device issues a final trip command, the contact remains closed. This is the case, during the reclaim time of the automatic reclosure cycle, when the automatic reclosure is blocked or switched off or, due to other reasons is not ready for automatic reclosure (e.g. tripping only occurred after the action time expired).

Figure 2-81 shows time diagrams for manual trip and close as well as for short-circuit tripping with a single, failed automatic reclosure cycle.

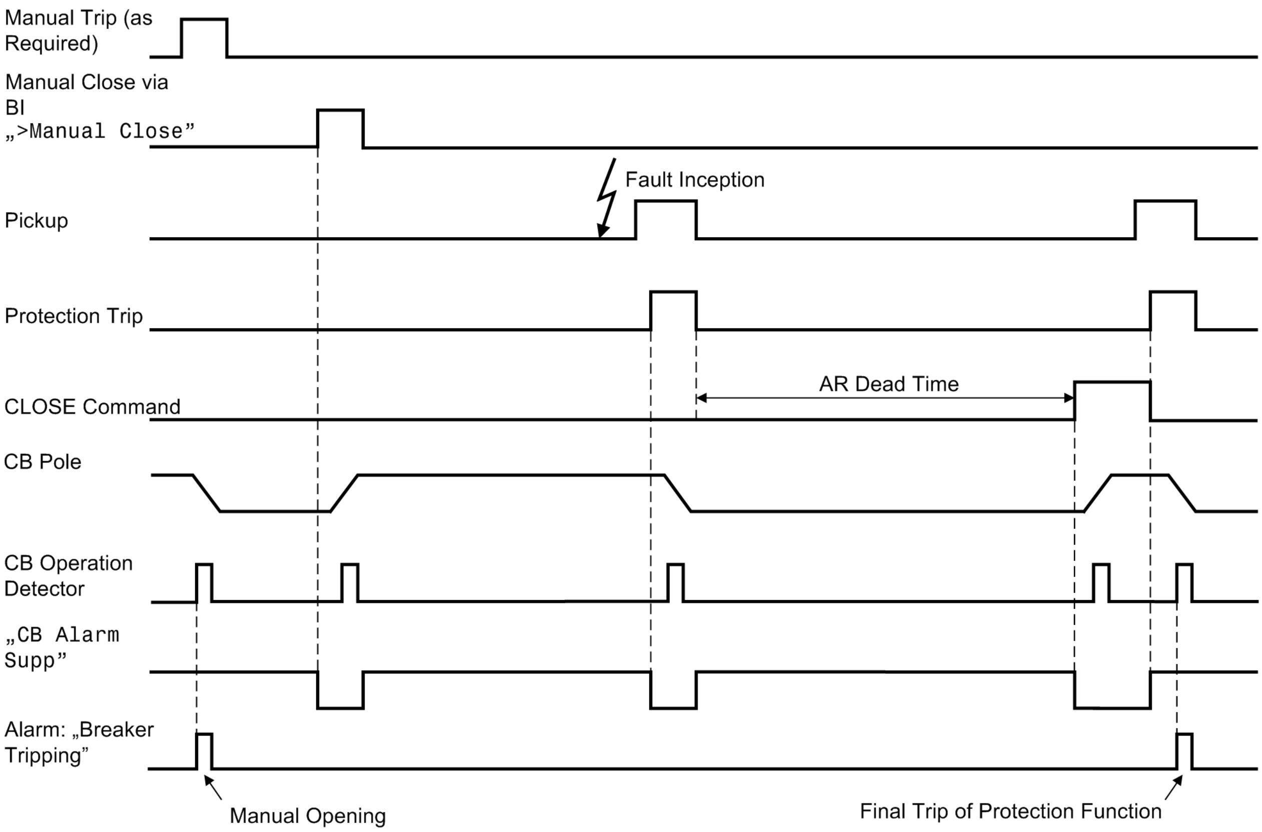


Figure 2-81 Breaker tripping alarm suppression — sequence examples

2.17 Additional Functions

2.17.1 Indications Processing

After the occurrence of a system fault, information regarding the response of the protective relay and the measured values is important for a detailed analysis. An information processing function in the device takes care of this.

The procedure for allocating information is described in the SIPROTEC 4 System Description.

Applications

- LEDs and Binary Outputs
- Information via Display Field of the Device or via PC
- Information to a Control Center

2.17.1.1 LEDs and Binary Outputs (Output Relays)

Important events and conditions are indicated via LEDs on the front cover. The device furthermore has output relays for remote signaling. Most of the messages and indications can be allocated, i.e. configured differently from the delivery condition. The Appendix of this manual deals in detail with the delivery condition and the allocation options.

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

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

- locally by pressing the LED key on the relay,
- remotely using a binary input configured for that purpose,
- via one of the serial interfaces,
- automatically at the beginning of a new pickup.

Condition messages should not be latched. They also cannot be reset until the criterion to be reported is canceled. This applies, for example, to messages from monitoring functions or similar.

A green LED indicates operational readiness of the relay ("RUN"); it 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 relay is blocked.

2.17.1.2 Information via Display Field or PC

Using the front PC interface or the port B at the bottom, 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 output on the display field at any time via the keypad or transferred to a PC via the operator 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 messages (trip log): messages from the last 8 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 as well as values of interrupted currents and accumulated fault currents.

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 Messages 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 Figure 2-82.

50-1 PICKUP	Protective Function that Picked up First;
50-1 TRIP	Protective Function that Tripped Last;
T - Pickup	Operating Time from General Pickup to Dropout;
T - TRIP	Operating Time from General Pickup to the First Trip Command;

Figure 2-82 Display of spontaneous messages in the display – example

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. If auto-reclosing occurs, then the network fault ends after the last reclosing shot, which means after a successful reclosing or lockout. Therefore the entire clearing process, including all reclosing shots, occupies only one trip log buffer. 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). Without auto-reclosing 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.

2.17.1.3 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.

2.17.2 Statistics

The number of trips initiated by 7SD80, the accumulated breaking currents resulting from trips initiated by protection functions and the number of close commands initiated by the automatic reclosure function are counted.

2.17.2.1 Description

Counters and Memories

The counters and memories of the statistics are saved by the device. Therefore, the information will not get lost in case the auxiliary voltage supply fails. The counters, however, can be reset to zero or to any value within the setting range.

Switching statistics can be viewed on the LCD of the device, or on a PC running DIGSI and connected to the operating or service interface.

A password is not required to read counter and stored values but is required to delete them. For more information see the SIPROTEC 4 System Description.

Number of Trips

This function counts the number of trips initiated by the device 7SD80.

Number of Automatic Reclosing Commands

If the device is equipped with the integrated automatic reclosure, the automatic close commands are also counted separately for each reclosure cycle.

Breaking Currents

Following each trip command the device registers the value of each current phase that was switched off in each pole. This information is then provided in the trip log and summated in a register. The maximum current that was switched off is also stored. Measured values are indicated in primary values.

Transmission Statistics

In 7SD80 the protection communication is registered in statistics. The runtimes of the information between the devices via the protection data interfaces (forth and back) are measured permanently. The values are kept stored in the Statistics folder. The availability of the transmission media is also reported. The availability is indicated in % / min and % / h. This enables an evaluation of the transmission quality.

2.17.2.2 Information List

No.	Information	Type of Information	Comments
1000	# TRIPs=	VI	Number of breaker TRIP commands
1027	Σ Ia =	VI	Accumulation of interrupted current Ph A
1028	Σ Ib =	VI	Accumulation of interrupted current Ph B
1029	Σ Ic =	VI	Accumulation of interrupted current Ph C
1030	Ia max. =	VI	max. fault current Phase A
1031	Ib max. =	VI	max. fault current Phase B
1032	Ic max. =	VI	max. fault current Phase C
2896	79 #Close1./3p=	VI	No. of 1st AR-cycle CLOSE commands,3pole
2898	79 #Close2./3p=	VI	No. of higher AR-cycle CLOSE commands,3p

2.17.3 Measurement During Operation

2.17.3.1 Description

A series of measured values and the values derived from them are available for on-site retrieval or for data transfer.

A precondition for a correct display of primary and percentage values is the complete and correct entry of the rated values of the instrument transformers and the power system as well as the transformation ratio of the current and voltage transformers in the ground paths.

Display of Measured Values

Operational measured values and metered values are determined in the background by the processor system. They can be called up on the front of the device, read out via the operator interface using a PC with DIGSI, or transferred to a control center via the system interface.

Table 2-10 shows a survey of the measured values of the local device. Depending on the version ordered, the connection of the device, and the configured protection functions, only a part of the listed measured values is available.

The displacement voltage $3V_0$ is calculated from the connected phase-to-ground voltages
$3V_0 = |\underline{V}_A + \underline{V}_B + \underline{V}_C|$.

The two devices connected via the protection interface(s) form a joint frequency value (constellation frequency). This value is displayed as the operational measured value „Frequency“. It allows to display a frequency even in devices in which local frequency measurement is not possible. The constellation frequency is also used by the differential protection for synchronizing the measured values. Locally operating functions always use the locally measured frequency.

For the thermal overload protection, the calculated overtemperatures are indicated in relation to the trip overtemperature. Overload measured values can appear only if the overload protection was configured ***Enabled***.

The power and operating values upon delivery are set such that power in line direction is positive. Active components in line direction and inductive reactive components in line direction are also positive. The same applies for the power factor cosφ.

It is occasionally desired to define the power drawn from the line (e.g. as seen from the consumer) positively. Using parameter 1107 **P,Q sign** the signs for these components can be inverted.

The computation of the operational measured values is also executed during an existent system fault in intervals of approx. 0.5s.

Table 2-10 Operational measured values of the local device

Measured Values		Primary	Second-ary	% referred to
I_A, I_B, I_C	Phase currents	A	A	Rated operational current [1)]
$3I_0$	Ground current	A	A	Rated operational current [1)]
$\varphi(I_A-I_B)$, $\varphi(I_B-I_C)$, $\varphi(I_C-I_A)$	Phase angle of the phase currents towards each other	°	–	–
I_1, I_2	Positive-, negative-sequence component of current	A	A	Rated operational current [1)]
V_{A-B}, V_{B-C}, V_{C-A}	Phase-to-phase voltages	kV	V	Nominal operational voltage [2)]
V_{A-N}, V_{B-N}, V_{C-N}	Phase-to-ground voltage	kV	V	Rated operational voltage / $\sqrt{3}$ [2)]
$3V_0$	Displacement voltage	kV	V	Rated operational voltage / $\sqrt{3}$ [2)]
$\varphi(V_A-V_B)$, $\varphi(V_B-V_C)$, $\varphi(V_C-V_A)$	Phase angle of the phase voltages towards each other	°	–	–
$\varphi(V_A-I_A)$, $\varphi(V_B-I_B)$, $\varphi(V_C-I_C)$	Phase angle of the phase voltages towards the phase currents	°	–	–
V_1, V_2	Positive and negative sequence component of the voltages	kV	V	Rated operational voltage / $\sqrt{3}$ [2)]
S, P, Q	Apparent, active and reactive power	MVA, MW, MVAR	–	$\sqrt{3}\cdot V_N\cdot I_N$ Rated operational quantities [1)2)]
cos φ	Power factor	(abs)	(abs)	–
f	Frequency (constellation frequency)	Hz	Hz	Rated frequency
Θ_A/Θ_{TRIP}, Θ_B/Θ_{TRIP}, Θ_C/Θ_{TRIP}	Thermal value of each phase, referred to the tripping value	%	–	Trip overtemperature
Θ/Θ_{TRIP}	Resulting thermal value, referred to the tripping value, calculated according to the set method	%	–	Trip overtemperature

1) according to address 1104

2) according to address 1103

3) considering the factor 221 I4/Iph CT

2.17.3.2 Information List

No.	Information	Type of Information	Comments
601	Ia =	MV	Ia
602	Ib =	MV	Ib
603	Ic =	MV	Ic
610	3I0 =	MV	3I0 (zero sequence)
611	3I0sen=	MV	3I0sen (sensitive zero sequence)
612	Ig =	MV	Ig (grounded transformer)
613	3I0par=	MV	3I0par (parallel line neutral)
619	I1 =	MV	I1 (positive sequence)
620	I2 =	MV	I2 (negative sequence)
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
631	3V0 =	MV	3V0 (zero sequence)
634	V1 =	MV	V1 (positive sequence)
635	V2 =	MV	V2 (negative sequence)
641	P =	MV	P (active power)
642	Q =	MV	Q (reactive power)
643	PF =	MV	Power Factor
644	Freq=	MV	Frequency
645	S =	MV	S (apparent power)
684	Vo =	MV	Vo (zero sequence)
801	Θ/Θtrip =	MV	Temperat. rise for warning and trip
802	Θ/Θtrip A=	MV	Temperature rise for phase A
803	Θ/Θtrip B=	MV	Temperature rise for phase B
804	Θ/Θtrip C=	MV	Temperature rise for phase C
7731	Φ I AB=	MV	PHI I AB (local)
7732	Φ I BC=	MV	PHI I BC (local)
7733	Φ I CA=	MV	PHI I CA (local)
7734	Φ V AB=	MV	PHI V AB (local)
7735	Φ V BC=	MV	PHI V BC (local)
7736	Φ V CA=	MV	PHI V CA (local)
7737	Φ VI A=	MV	PHI VI A (local)
7738	Φ VI B=	MV	PHI VI B (local)
7739	Φ VI C=	MV	PHI VI C (local)

2.17.4 Differential Protection Values

2.17.4.1 Measured Values of the Differential Protection

The differential and restraint current values of the differential protection can be displayed at the front of the device, read out via the operating interface using a PC with DIGSI, or transferred to a control center via the system interface.

Table 2-11 Measured values of the differential protection

Measured Values		referred to
„Diff3I0=“	Calculated restraint currents of the zero sequence system	% rated operational current
„Rest3I0=“	Calculated differential current of the zero sequence system	I/InO

2.17.4.2 Information List

No.	Information	Type of Information	Comments
7748	Diff3I0=	MV	Diff3I0 (Differential current 3I0)
32226	Rest3I0=	MV	Rest3I0(% Operational nominal current)

2.17.5 Constellation Measured Values

2.17.5.1 Description

The measured values of the constellation of both possible devices are shown here by evaluating the device (see table 2-12). Information on the second device is given in the Appendix.

The computation of this measured values constellation is also executed during an existent system fault in an interval of approx. 0.5 s.

The current/voltage measured locally is assumed as reference value for the angle. The angle values of the remote ends are referred to the locally measured value.

Examples for the current in a constellation with 2 ends:

Current IA at the local end 98 % angle 0°

Current IA at the local end 98 % angle 180°

The device addresses allow differentiating the devices. This procedure allows current transformer polarity reversal to be detected immediately and the line angle (if voltages are available) to be read.

Table 2-12   Measured values constellation for device 1

No.	Information	Type of Information	Comments
7761	„Relay ID“	MV	Device address of the device
7762	„I A_opN=“	MV	IA (% of nominal operational current)
7763	„ΦI A=“	MV	Angle IA_remote <-> IA_local
7764	„I B_opN=“	MV	IB (% of nominal operational current)
7765	„ΦI B=“	MV	Angle IB_remote <-> IB_local
7766	„I C_opN=“	MV	IC (% of nominal operational current)
7767	„ΦI C=“	MV	Angle IC_remote <-> IC_local
7769	„V A_opN=“	MV	VA (% of nominal operational voltage)
7770	„ΦV A=“	MV	Angle VA_remote <-> VA_local
7771	„V B_opN=“	MV	VB (% of nominal operational voltage)
7772	„ΦV C=“	MV	Angle VB_remote <-> VB_local
7773	„V C_opN=“	MV	VC (% of nominal operational voltage)
7774	„ΦV C=“	MV	Angle VC_remote <-> VC_local

2.17.6 Min/Max Measurement Setup

Minimum and maximum values are calculated by the 7SD80. Time and date of the last update of the values can also be read out.

2.17.6.1 Description

Minimum and Maximum Values

The minimum and maximum values for the three phase currents I_x, the three phase voltages V_{x-N}, the phase-to-phase voltages V_{xy}, the positive sequence component I_1 and V_1, the active power P, reactive power Q, and apparent power S, the frequency, and the power factor cos φ a formed as primary values including the date and time they were last updated.

The minimum and maximum values of the long-term mean values listed in the next section are also calculated.

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.

2.17.6.2 Setting Notes

Minimum and Maximum Values

The minimum and maximum values can be reset automatically at a programmable point in time. This feature can be activated by setting address 2811 **MinMax cycRESET** to ***YES***.

At address 2812 **MiMa RESET TIME** you can define the point of time when resetting takes place (minute of the day).

Address 2813 **MiMa RESETCYCLE** allows you to define the resetting cycle (in days).

At address 2814 **MinMaxRES.START** you can define when the cyclic process of forming the minimum and maximum values begins (in days, counted from the time of parameterization).

2.17.6.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
2811	MinMax cycRESET	NO YES	YES	Automatic Cyclic Reset Function
2812	MiMa RESET TIME	0 .. 1439 min	0 min	MinMax Reset Timer
2813	MiMa RESETCYCLE	1 .. 365 Days	7 Days	MinMax Reset Cycle Period
2814	MinMaxRES.START	1 .. 365 Days	1 Days	MinMax Start Reset Cycle in

2.17.6.4 Information List

No.	Information	Type of In-formation	Comments
-	ResMinMax	IntSP_Ev	Reset Minimum and Maximum counter
395	>I MinMax Reset	SP	>I MIN/MAX Buffer Reset
396	>I1 MiMaReset	SP	>I1 MIN/MAX Buffer Reset
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
400	>P MiMa Reset	SP	>P MIN/MAX Buffer Reset
401	>S MiMa Reset	SP	>S MIN/MAX Buffer Reset
402	>Q MiMa Reset	SP	>Q MIN/MAX Buffer Reset
403	>Idmd MiMaReset	SP	>Idmd MIN/MAX Buffer Reset
404	>Pdmd MiMaReset	SP	>Pdmd MIN/MAX Buffer Reset
405	>Qdmd MiMaReset	SP	>Qdmd MIN/MAX Buffer Reset
406	>Sdmd MiMaReset	SP	>Sdmd MIN/MAX Buffer Reset
407	>Frq MiMa Reset	SP	>Frq. MIN/MAX Buffer Reset
408	>PF MiMaReset	SP	>Power Factor MIN/MAX Buffer Reset
837	IAdmdMin	MVT	I A Demand Minimum
838	IAdmdMax	MVT	I A Demand Maximum
839	IBdmdMin	MVT	I B Demand Minimum
840	IBdmdMax	MVT	I B Demand Maximum
841	ICdmdMin	MVT	I C Demand Minimum
842	ICdmdMax	MVT	I C Demand Maximum
843	I1dmdMin	MVT	I1 (positive sequence) Demand Minimum
844	I1dmdMax	MVT	I1 (positive sequence) Demand Maximum
845	PdMin=	MVT	Active Power Demand Minimum
846	PdMax=	MVT	Active Power Demand Maximum
847	QdMin=	MVT	Reactive Power Demand Minimum
848	QdMax=	MVT	Reactive Power Demand Maximum
849	SdMin=	MVT	Apparent Power Demand Minimum
850	SdMax=	MVT	Apparent Power Demand Maximum
851	Ia Min=	MVT	Ia Min
852	Ia Max=	MVT	Ia Max
853	Ib Min=	MVT	Ib Min
854	Ib Max=	MVT	Ib Max

No.	Information	Type of In-formation	Comments
855	Ic Min=	MVT	Ic Min
856	Ic Max=	MVT	Ic Max
857	I1 Min=	MVT	I1 (positive sequence) Minimum
858	I1 Max=	MVT	I1 (positive sequence) Maximum
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
869	Vb-cMax=	MVT	Vb-c Max
870	Vc-aMin=	MVT	Vc-a Min
871	Vc-aMax=	MVT	Vc-a Max
874	V1 Min =	MVT	V1 (positive sequence) Voltage Minimum
875	V1 Max =	MVT	V1 (positive sequence) Voltage Maximum
880	Smin=	MVT	Apparent Power Minimum
881	Smax=	MVT	Apparent Power Maximum
882	fmin=	MVT	Frequency Minimum
883	fmax=	MVT	Frequency Maximum
1040	Pmin Forw=	MVT	Active Power Minimum Forward
1041	Pmax Forw=	MVT	Active Power Maximum Forward
1042	Pmin Rev =	MVT	Active Power Minimum Reverse
1043	Pmax Rev =	MVT	Active Power Maximum Reverse
1044	Qmin Forw=	MVT	Reactive Power Minimum Forward
1045	Qmax Forw=	MVT	Reactive Power Maximum Forward
1046	Qmin Rev =	MVT	Reactive Power Minimum Reverse
1047	Qmax Rev =	MVT	Reactive Power Maximum Reverse
1048	PFminForw=	MVT	Power Factor Minimum Forward
1049	PFmaxForw=	MVT	Power Factor Maximum Forward
1050	PFmin Rev=	MVT	Power Factor Minimum Reverse
1051	PFmax Rev=	MVT	Power Factor Maximum Reverse
10102	3V0min =	MVT	Min. Zero Sequence Voltage 3V0
10103	3V0max =	MVT	Max. Zero Sequence Voltage 3V0

2.17.7 Demand Measurement Setup

The long-term averages are calculated and output by the 7SD80.

2.17.7.1 Description

Long-Term Averages

The long-term averages of the three phase currents I_x, the positive sequence components I_1 for the three phase currents, and the real power P, reactive power Q, and apparent power S are calculated within a set period of time and indicated in primary values.

For the long-term averages mentioned above, the length of the time window for averaging and the frequency with which it is updated can be set.

2.17.7.2 Setting Notes

Averaging

The selection of the time period for measured value averaging is set using the parameter 2801 **DMD Interval** in the corresponding setting group from A to D at **MEASUREMENT.** The first number specifies the averaging time window in minutes while the second number gives the frequency of updates within the time window. ***15 Min., 3 Subs***, for example, means: Averaging over time for all measured values that arrive within a time window of 15 minutes. The output is updated every 15/3 = 5 minutes.

Address 2802 **DMD Sync.Time** allows you to specify whether the time period of averaging selected at address 2801 starts on the hour (***On The Hour***) or whether it is synchronized with any of the other times (***15 After Hour***, ***30 After Hour*** or ***45 After Hour***).

If the settings for averaging are changed, the measured values stored in the buffer are deleted, and new results for the average calculation are only available after the set time period has passed.

2.17.7.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
2801	DMD Interval	15 Min., 1 Sub 15 Min., 3 Subs 15 Min.,15 Subs 30 Min., 1 Sub 60 Min., 1 Sub	60 Min., 1 Sub	Demand Calculation Intervals
2802	DMD Sync.Time	On The Hour 15 After Hour 30 After Hour 45 After Hour	On The Hour	Demand Synchronization Time

2.17.7.4 Information List

No.	Information	Type of Information	Comments
833	I1 dmd=	MV	I1 (positive sequence) Demand
834	P dmd =	MV	Active Power Demand
835	Q dmd =	MV	Reactive Power Demand
836	S dmd =	MV	Apparent Power Demand
963	Ia dmd=	MV	I A demand
964	Ib dmd=	MV	I B demand
965	Ic dmd=	MV	I C demand
1052	Pdmd Forw=	MV	Active Power Demand Forward
1053	Pdmd Rev =	MV	Active Power Demand Reverse
1054	Qdmd Forw=	MV	Reactive Power Demand Forward
1055	Qdmd Rev =	MV	Reactive Power Demand Reverse

2.17.8 Set Points (Measured Values)

2.17.8.1 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.

2.17.8.2 Information List

No.	Information	Type of Information	Comments
-	I Admd>	LV	I A dmd>
-	I Bdmd>	LV	I B dmd>
-	I Cdmd>	LV	I C dmd>
-	I1dmd>	LV	I1dmd>
-	|Pdmd|>	LV	|Pdmd|>
-	|Qdmd|>	LV	|Qdmd|>
-	|Sdmd|>	LV	|Sdmd|>
-	|PF|<	LV	|Power Factor|<
273	SP. I A dmd>	OUT	Set Point Phase A dmd>
274	SP. I B dmd>	OUT	Set Point Phase B dmd>
275	SP. I C dmd>	OUT	Set Point Phase C dmd>
276	SP. I1dmd>	OUT	Set Point positive sequence I1dmd>
277	SP. |Pdmd|>	OUT	Set Point |Pdmd|>
278	SP. |Qdmd|>	OUT	Set Point |Qdmd|>
279	SP. |Sdmd|>	OUT	Set Point |Sdmd|>
285	SP. PF(55)alarm	OUT	Set Point 55 Power factor alarm

2.17.9 Energy

Metered values for real and reactive power are determined by the processor system in the background. They can be called up at the front of the device, read out via the operating interface using a PC with DIGSI, or transferred to a central master station via the system interface.

2.17.9.1 Energy Metering

7SD80 integrates the calculated power as a function of time and then provides the results under Measured Values. The components as listed in Table 2-13 can be read out. The signs of the operating values depend on the setting at address 1107 **P,Q sign** (see Section 2.17.3 under margin heading „Display of Measured Values“).

Please take into consideration that 7SD80 is, above all, a protection device. The accuracy of the metered values depends on the instrument transformers (normally protection core) and the device tolerances. The metering is therefore not suited for tariff purposes.

The counters can be reset to zero or any initial value (see also SIPROTEC 4 System Description).

Table 2-13 Operational metered values

Measured Values		primary
W_p+	Real power, output	kWh, MWh, GWh
W_p–	Real power, input	kWh, MWh, GWh
W_q+	Reactive power, output	kVARh, MVARh, GVARh
W_q–	Reactive power, input	kVARh, MVARh, GVARh

2.17.9.2 Setting Notes

Retrieving Parameters

The SIPROTEC 4 System Description describes in detail how to read out the statistical counters via the device front panel or DIGSI. The values are added up in direction of the protected object provided the direction was set as „forward“ (address 201).

2.17.9.3 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)
916	WpΔ=	-	Increment of active energy
917	WqΔ=	-	Increment of reactive energy
924	Wp+=	MVMV	Wp Forward
925	Wq+=	MVMV	Wq Forward
928	Wp-=	MVMV	Wp Reverse
929	Wq-=	MVMV	Wq Reverse

2.18 Breaker Control

A control command process is integrated in the SIPROTEC 4 device 7SD80 to coordinate the operation of circuit breakers and other equipment in the power system.

Control commands can originate from four command sources:

- Local operation using the keypad of the device (except for variant without operator panel)
- Operation using DIGSI
- Remote operation via network control center or substation controller (e.g. SICAM)
- Automatic functions (e.g., using a binary input)

Switchgear with single and multiple busbars are supported. The number of switchgear devices to be controlled is, basically, limited by the number of binary inputs and outputs present. High security against inadvertent device operations can be ensured if interlocking checks are enabled. A standard set of optional interlocking checks is provided for each command issued to circuit breakers/switchgear.

2.18.1 Control Device

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

Prerequisites

The number of switchgear devices to be controlled is limited by the

– existing binary inputs

– existing binary outputs.

2.18.1.1 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 Chapter 2.19.

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).

2.18.1.2 Information List

No.	Information	Type of Information	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
-	52 Open	IntSP	Interlocking: 52 Open
-	52 Close	IntSP	Interlocking: 52 Close
-	Disc.Open	IntSP	Interlocking: Disconnect switch Open
-	Disc.Close	IntSP	Interlocking: Disconnect switch Close
-	GndSw Open	IntSP	Interlocking: Ground switch Open
-	GndSw Cl.	IntSP	Interlocking: Ground switch Close
-	Q2 Op/Cl	CF_D2	Q2 Open/Close
-	Q2 Op/Cl	DP	Q2 Open/Close
-	Q9 Op/Cl	CF_D2	Q9 Open/Close
-	Q9 Op/Cl	DP	Q9 Open/Close
-	Fan ON/OFF	CF_D2	Fan ON/OFF
-	Fan ON/OFF	DP	Fan ON/OFF
31000	Q0 OpCnt=	VI	Q0 operationcounter=
31001	Q1 OpCnt=	VI	Q1 operationcounter=
31002	Q2 OpCnt=	VI	Q2 operationcounter=
31008	Q8 OpCnt=	VI	Q8 operationcounter=
31009	Q9 OpCnt=	VI	Q9 operationcounter=

2.18.2 Command Types

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

2.18.2.1 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 are issued to establish internal settings, e.g. deleting / presetting the switching authority (remote vs. local), a parameter set changeover, data transmission block to the SCADA interface, and measured value setpoints.
- 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

2.18.3 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:

2.18.3.1 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)

2.18.4 Switchgear Interlocking Protection

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

2.18.4.1 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 /1/.

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 reprogramming the settings with password prompt
- 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.

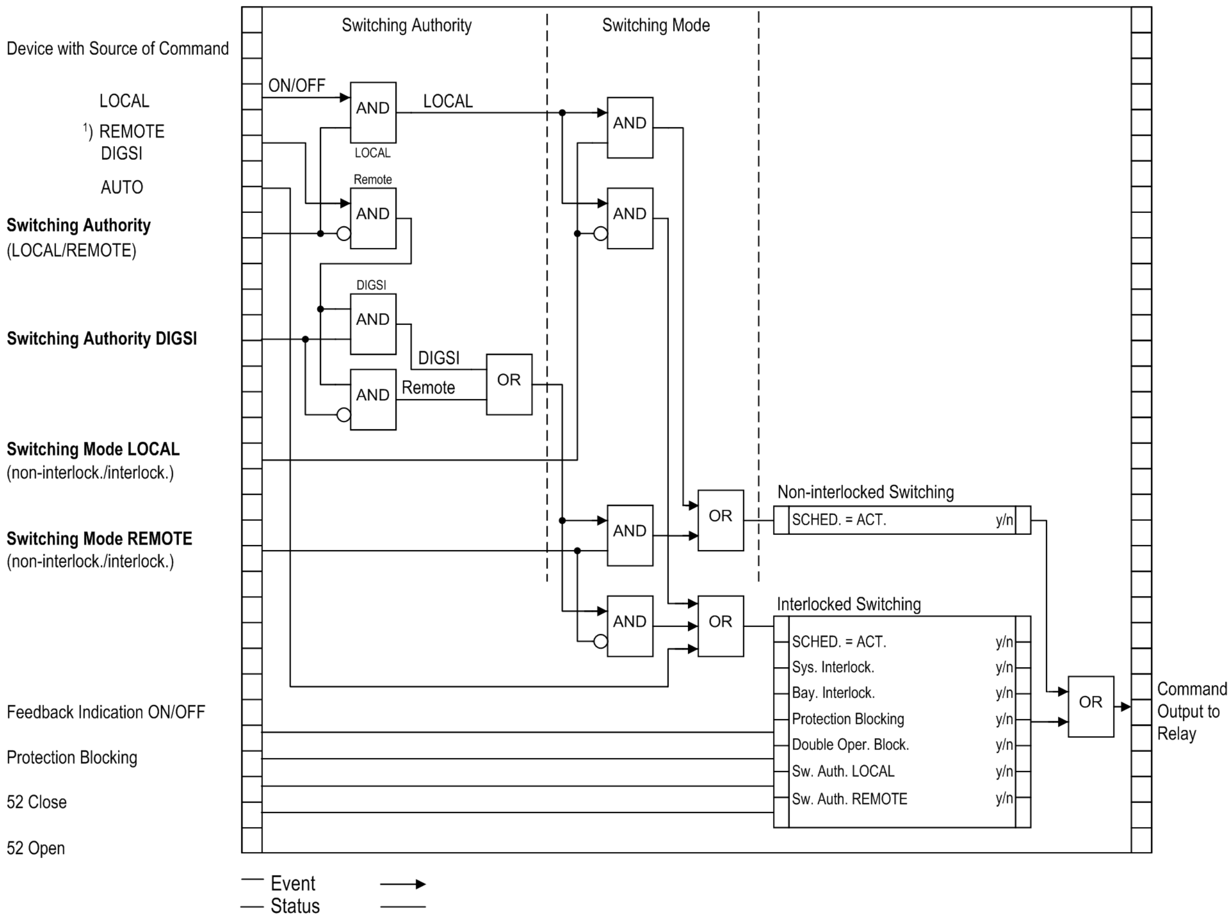
```
EVENT LOG
---------------------
19.06.01 11:52:05,625
Q0            CO+ Close

19.06.01 11:52:06,134
Q0            FB+ Close
```

Figure 2-83 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. Please be aware, activation of thermal overload protection elements or sensitive ground fault detection can create and maintain a fault condition status, and can therefore block CLOSE commands. If the interlocking is removed, consider that, on the other hand, the restart inhibit for motors will not automatically reject a CLOSE command to the motor. Therefore, a restart inhibit must be provided by other means, e.g. by a bay interlocking using CFC.
- 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 (for devices without key switch via 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 key switch or 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 control command (command with command source REMOTE) is only allowed if the Key Switch (for devices without key switch via configuration) is set to REMOTE.



¹) Source REMOTE also includes SAS.
(LOCAL Command using substation controller
REMOTE Command using remote source such as SCADA through controller to device.)

Figure 2-84 Standard interlockings

The following figure shows the configuration of the interlocking conditions using DIGSI.

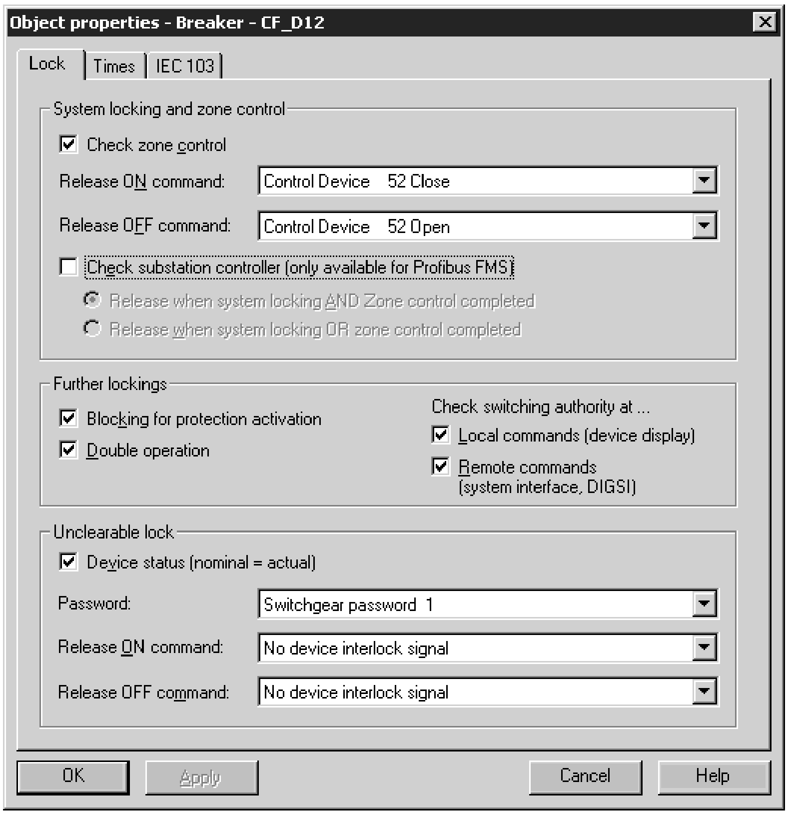


Figure 2-85 DIGSI dialog box for setting the interlocking conditions

On devices with operator panel, the display shows the configured interlocking reasons. They are marked with letters explained in the following table.

Table 2-14 Command types and corresponding messages

Interlocking Commands	Abbrev.	Display
Switching Authority	L	L
System interlocking	S	A
Zone controlled	Z	Z
SET = ACTUAL (switch direction check)	P	P
Protection blocking	B	B

The following figure shows all interlocking conditions (which usually appear in the display of the device) for three switchgear items with the relevant abbreviations explained in the previous table. All parameterized interlocking conditions are indicated.

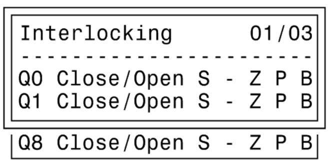
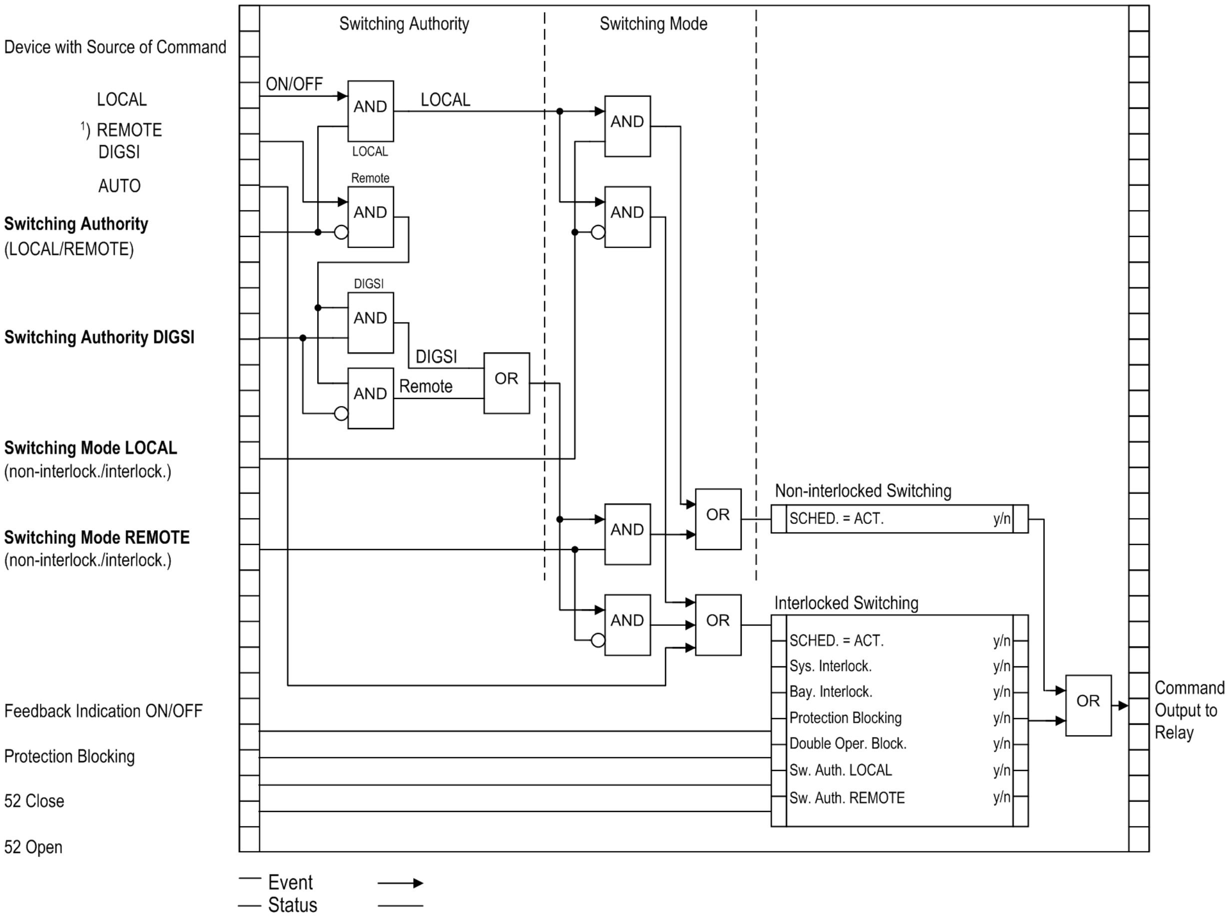


Figure 2-86 Example of configured interlocking conditions

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: CLOSE commands are rejected with interlocked switches, as soon as one of the protection functions of the device has opened a fault case. OPEN commands, in contrast, can always be executed. Please be aware that pickup of overload protection elements can also open and maintain a fault, and can therefore block CLOSE commands.
- 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 switch command from local control (command with source LOCAL) is only allowed if local control is enabled at the device (by configuration).
- Switching authority DIGSI: Switching commands that are issued locally or remotely via DIGSI (command with source DIGSI) are only allowed if remote control is enabled at the device (by configuration). If a DIGSI computer logs on to the device, it leaves a 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 switching command (command with source REMOTE) is only allowed if remote control is enabled at the device (by configuration).



¹) Source REMOTE also includes SAS.
(LOCAL Command using substation controller
REMOTE Command using remote source such as SCADA through controller to device.)

Figure 2-87 Standard interlockings

The following figure shows the configuration of the interlocking conditions using DIGSI.

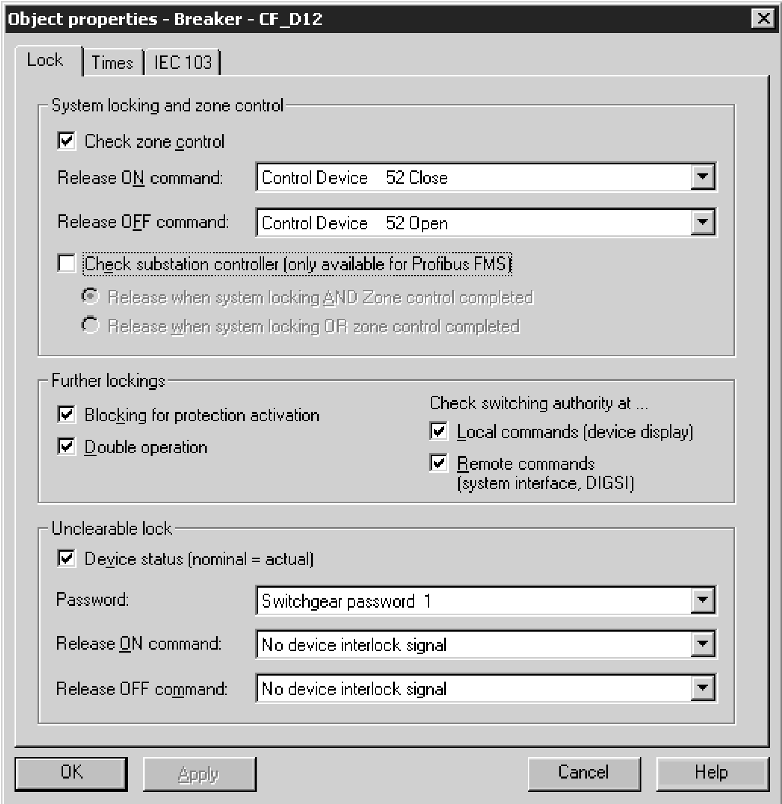


Figure 2-88 DIGSI dialog box for setting the interlocking conditions

The configured interlocking causes are displayed on the device display. They are marked by letters explained in the following table.

Table 2-15 Command types and corresponding messages

Interlocking Commands	Abbrev.	Display
Switching Authority	L	L
System interlocking	S	A
Zone controlled	Z	Z
SET = ACTUAL (switch direction check)	P	P
Protection blocking	B	B

Control Logic using CFC

For the bay interlocking a control logic can be structured via the 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. 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 7SD80, 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" object is used for interlocking or enabling operation via DIGSI. This allows for local as well as remote DIGSI connections. When a (local or remote) DIGSI PC logs on to the device, it enters its virtual device number (VD). Only commands with this VD (when switching authority = OFF or REMOTE) are accepted by the device. When the DIGSI PC logs off again, the VD is canceled.

Commands are checked for their source CS and the device settings and compared to the current status set in the objects "Switching authority" and "Switching authority DIGSI".

Configuration

Switching authority available	y/n (create appropriate object)
Switching authority DIGSI available:	y/n (create appropriate object)
Specific device (e.g. switchgear)	Switching authority LOCAL (check for LOCAL status): y/n
Specific device (e.g. switchgear)	Switching authority REMOTE (check for LOCAL, REMOTE or DIGSI commands): y/n

Table 2-16 Interlocking logic

Current switching authority status	Switching authority DIGSI	Command issued with CS[3]=LOCAL	Command issued with CS=LOCAL or REMOTE	Command issued with CS=DIGSI
LOCAL (ON)	Not registered	Enabled	Interlocked [2] - "Switching authority LOCAL"	Interlocked - "DIGSI not registered"
LOCAL (ON)	Registered	Enabled	Interlocked [2] - "Switching authority LOCAL"	Interlocked [2] - "Switching authority LOCAL"
REMOTE (OFF)	Not registered	Interlocked [1] - "Switching authority REMOTE"	Enabled	Interlocked - "DIGSI not registered"
REMOTE (OFF)	Registered	Interlocked [1] - "Switching authority DIGSI"	Interlocked [2] - "Switching authority DIGSI"	Enabled

[1] also "Enabled" for: "Switching Authority LOCAL (check for LOCAL status): n"

[2] also "Enabled" for: "Switching authority REMOTE (check for LOCAL, REMOTE or DIGSI commands): n"

[3] CS = command source

CS = Auto:

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

Switching Mode

The switching mode serves for activating or deactivating the configured interlocking conditions at the time of the switching operation.

The following switching modes (local) are defined:

- For local commands (CS = LOCAL)
  - locked (normal) or
  - unlocked (unlatched) switching.

With a 7SD80, 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:

- For remote or DIGSI commands (CS = LOCAL, REMOTE or DIGSI)
  - locked or
  - unlocked (unlatched) switching. Here, deactivation of the interlocking is accomplished via a separate unlocking command.
  - For commands from CFC (CS = Auto), 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 message (tagging), 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").

2.18.5 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.

2.18.5.1 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/ .

2.19 Notes on Device Operation

The operation of the 7SD80 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.

2.19.1 Different operation

Pushbuttons of the Control Panels

Pushbutton	Function/meaning
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 7SD80 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 >)

```
MAIN MENU           04/05
---------------------
Annunciation      ->  1
Measurement       ->  2
Control           ->  3
Parameter         ->  4
```

Figure 2-89 Inverse representation of the current selection

In part, the sixth line is used for representing e.g. the active parameter group.

```
PARAMETER          01/08
---------------------
Functional Scope  ->  01
Allocation        ->  02
--------------------
active Setting Group   A
```

Figure 2-90 Representation of the active parameter group (line 6)

■

Mounting and Commissioning 3

This chapter is intended for experienced commissioning staff. The staff must be familiar with the commissioning of protection and control systems, with power systems management and with the relevant safety rules and guidelines. Under certain circumstances, it may become necessary to adapt parts of the power system hardware. Some of the primary tests require the protected line or equipment to carry load.

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3.1 Mounting and Connections

General

WARNING!

Warning of improper transport, storage, installation, and application of the device.

Non–observance can result in death, personal injury or substantial property damage.

Trouble-free and safe use of this device depends on proper transport, storage, installation, and application of the device according to the warnings in this instruction manual.

Of particular importance are the general installation and safety regulations for work in a high-voltage environment (for example, IEEE, ANSI, VDE, 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 is checked as recommended in the SIPROTEC 4 System Description. The compliance of these data is verified with the Power System Data.

Connection Variants

General Diagrams are shown in Appendix A.2. Connection examples for current transformer and voltage transformer circuits are provided in Appendix A.3. It must be checked that the setting of the **P.System Data 1**, Subsection 2.1.3.1, was made in accordance with the device connections.

Currents

In Appendix A.3 examples for the possibilities of the current transformer connections in dependence on network conditions are displayed.

For normal connection, address 220 **I4 transformer** = ***In prot. line*** must be set and furthermore, address 221 **I4/Iph CT** = ***1.000***.

When using separate ground current transformers, address 220 **I4 transformer** = ***In prot. line*** must be set. The factor 221 **I4/Iph CT** may deviate from ***1***. For calculation hints, please refer to Section 2.1.3.1 at „Current Transformer Connection“. Please observe that 2-CT-connection is permitted only for isolated or compensated networks.

Voltage Connection Examples

This section is only relevant if the measured voltages are connected to the device, a condition that was already set during the configuration (address 144 **V-TRANSFORMER**, see Section 2.1.1.2)

Connection examples for current and voltage transformer circuits are provided in Appendix A.3.

Binary Inputs and Outputs

The connections to the system depend on the possible allocation of the binary inputs and outputs, i.e. how they are assigned to the system. The default settings of the device are listed in Tables A.5 in the Appendix. Check also that the labelings on the front correspond to the allocated indication functions.

Changing Setting Groups with Binary Inputs

If binary inputs are used to change setting groups, please observe the following:

- To enable the control of 4 possible setting groups 2 binary inputs have to be available. 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.
- To control two setting groups, one binary input set for „>Set Group Bit0“ is sufficient since the binary input „>Set Group Bit1“, which is not assigned, is considered to be not controlled.
- The status of the signals controlling the binary inputs to activate a particular setting group must remain constant as long as that particular group is to remain active.

The following Table shows the relationship between binary inputs and the setting groups A to D. Principal connection diagrams for the two binary inputs are illustrated in the following Figure 3-1. 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

Yes = energized

Table 3-1 Changing Setting Groups with Binary Inputs

Binary Input		**Active Group**
>Set Group Bit 0	**>Set Group Bit 1**	
No	No	Group A
Yes	No	Group B
No	Yes	Group C
Yes	Yes	Group D

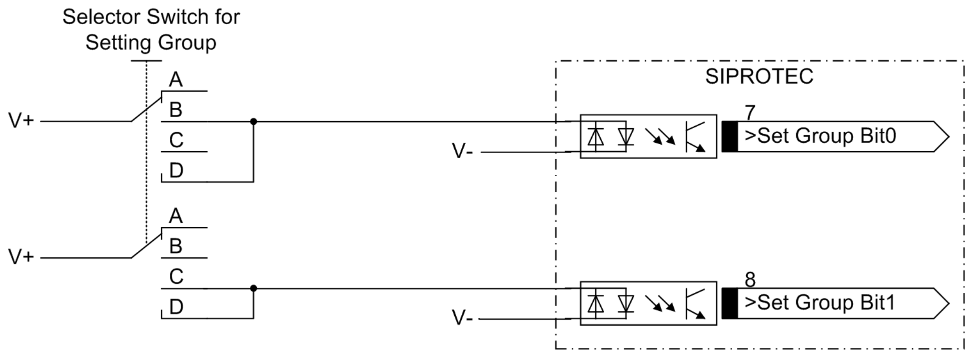

Figure 3-1 Connection diagram (example) for setting group switching with binary inputs

Trip Circuit Supervision

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 two binary inputs are used for the trip circuit supervision, these binary inputs must be isolated, i.o.w. not be communed with each other or with another binary input.

If one binary input is used, a bypass resistor R must be used (refer to Figure 3-2). This resistor R is connected in series with the second circuit breaker auxiliary contact (Aux2), to also allow the detection of a trip circuit failure when the circuit breaker auxiliary contact 1 (Aux1) is open, and the command relay contact has reset. The value of this resistor must be such that in the circuit breaker open condition (therefore Aux1 is open and Aux2 is closed) the circuit breaker trip coil (TC) is no longer picked up and binary input (BI1) is still picked up if the command relay contact is open.

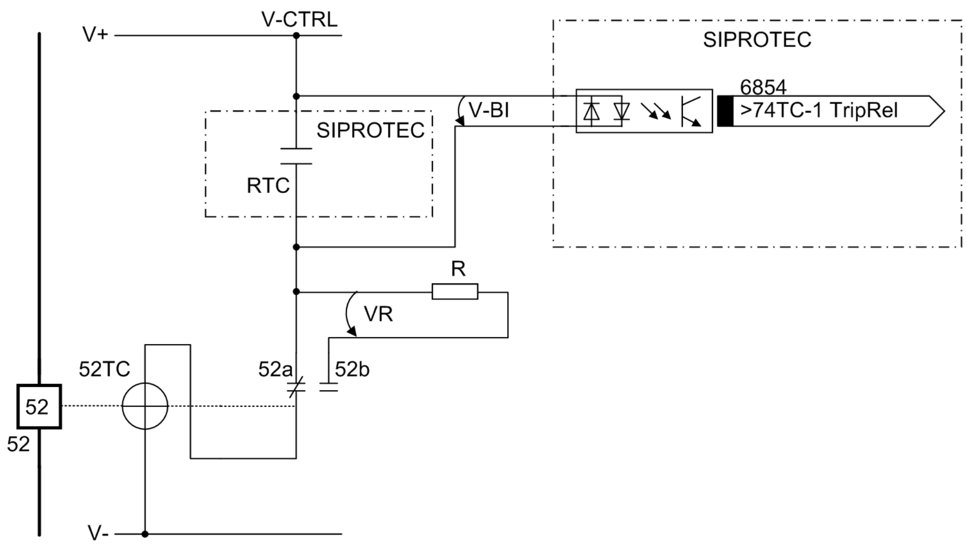

Figure 3-2 Principle of the trip circuit monitoring with one binary input

RTC	Relay trip contact
52	Circuit breaker
52TC	Circuit-breaker trip coil
52a	Circuit-breaker auxiliary contact (NO contact)
52b	Circuit-breaker auxiliary contact (NC contact)
V-CTRL	Control Voltage for trip circuit
V-BI	Input voltage for binary input
R	Bypass resistor
VR	Voltage at bypass resistor

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:

$$R = \frac{R_{max} + R_{min}}{2}$$

In order that the minimum voltage for controlling the binary input is ensured, R_{max} is derived as:

$$R_{max} = \left(\frac{V_{CTR} - V_{BI\ min}}{I_{BI\ (High)}}\right) - R_{CBTC}$$

To keep the circuit breaker trip coil energized in the above case, R_{min} is derived as:

$$R_{min} = R_{CBTC} \cdot \left(\frac{V_{CTR} - V_{CBTC\ (LOW)}}{V_{CBTC\ (LOW)}}\right)$$

$I_{BI\ (HIGH)}$	Constant current with activated BI (= 0.25 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 $R_{max} < R_{min}$, the calculation has to be repeated with the next smaller threshold $V_{BI\ min}$. This threshold is determined via the parameters 260 **Threshold BI 1** to 266 **Threshold BI 7** The settings ***Thresh. BI 176V***, ***Thresh. BI 88V***, ***Thresh. BI 19V*** are possible.

For the power consumption of the resistance:

$$P_R = I^2 \cdot R = \left(\frac{V_{CTR}}{R + R_{CBTC}}\right)^2 \cdot R$$

Example

$I_{BI\ (HIGH)}$	0.25 mA (SIPROTEC 4 7SD80)
$V_{BI\ min}$	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)

$$R_{max} = \left(\frac{110\ V - 19\ V}{0.25\ mA}\right) - 500\ \Omega = 363.5\ k\Omega$$

$$R_{min} = \left(\frac{110\ V - 2\ V}{2\ V}\right) \cdot 500\ \Omega = 27\ k\Omega$$

$$R = \frac{R_{max} + R_{min}}{2} = 195.25\ k\Omega$$

The closest standard value 200 kΩ is selected; the following applies for the power:

$$P_R = \left(\frac{110\ V}{200\ k\Omega + 0.5\ k\Omega}\right)^2 \cdot 200\ k\Omega \geq 60\ mW$$

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 to 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 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. To do so, open the elastic holders of the terminal blocks in pairs with a flat screwdriver and remove the terminal blocks to the back. When reinstalling the device, insert the terminal blocks back into the device like assembled terminals (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.

First fully unscrew the two housing screws in the top and bottom part of the covering cap and carefully pull the entire electronic block out of the housing (see "Installation or replacement of a SIPROTEC 4 communication module" in the "Interface Modules" section).

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.

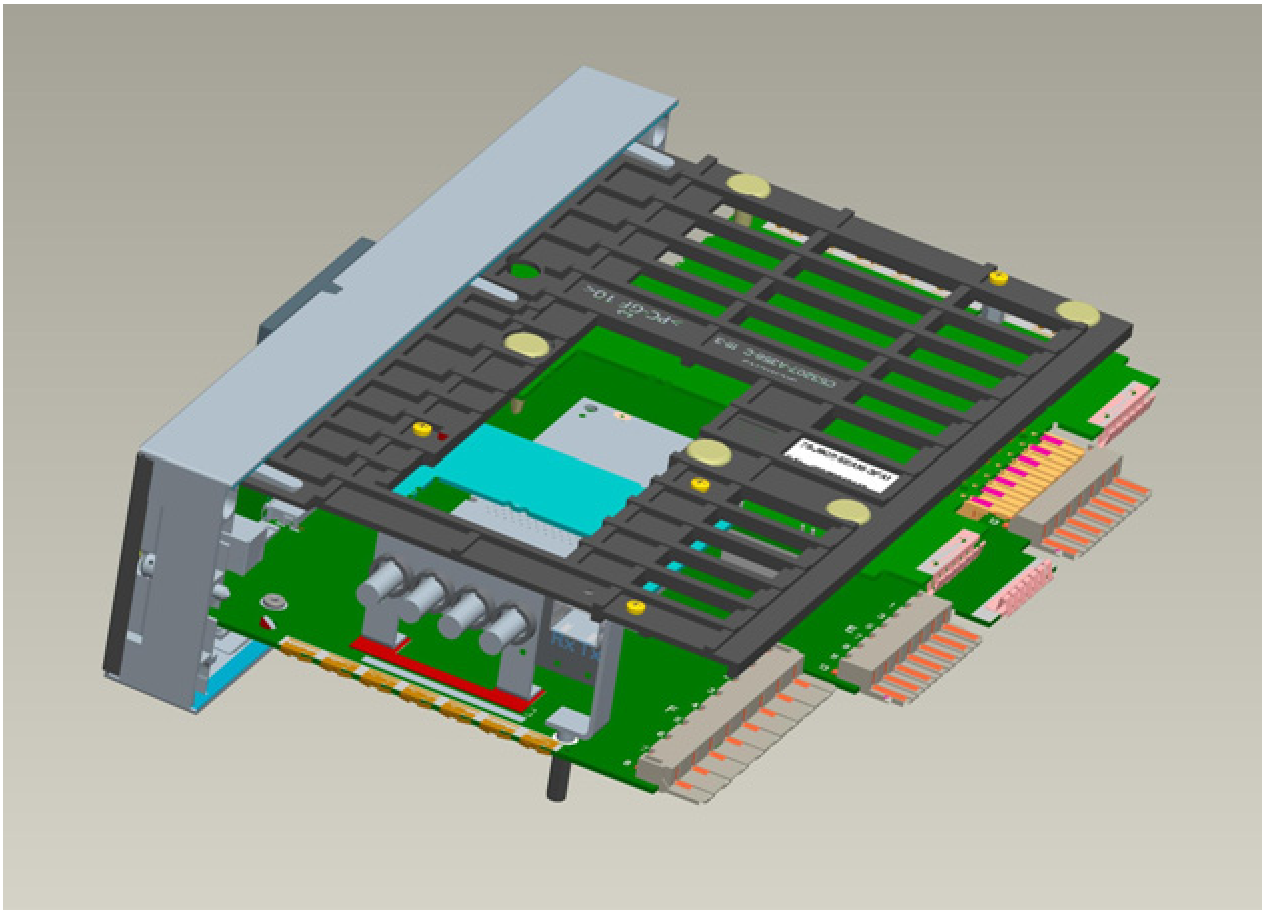

Figure 3-3 Electronic block without housing

Replacing the Fuse

The fuse holder is located at the edge of the basic I/O board close to the power supply connection.

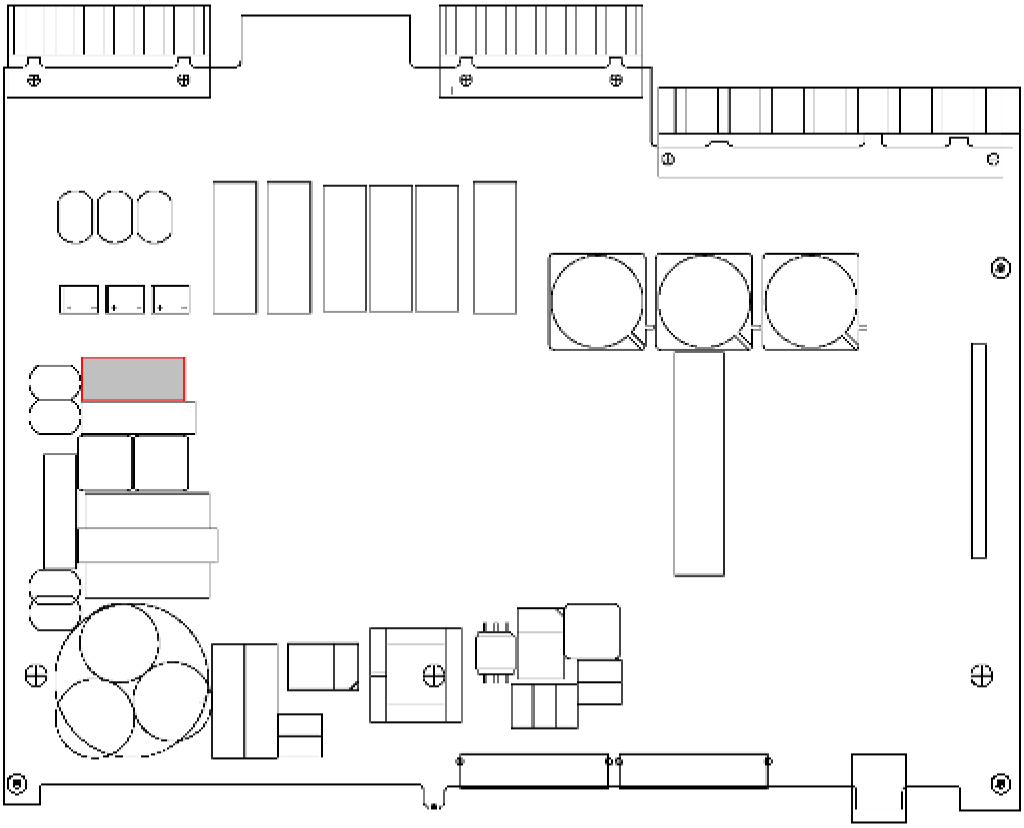

Figure 3-4 Placing the fuse

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 capacity 1500 A / 300 VDC

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).

3.1.2.2 Connections of the Current Terminals

Fixing Elements

The fixing elements for the transformer connection are part of the current terminal (housing side). They have a stress-crack- and corrosion-resistant alloy. The head shape of the terminal screw allows for using a flat screw-driver (5.0 x 1.0 mm) or a crosstip screwdriver (PZ2). We recommend PZ2.

Cable Lugs and Wire Cross-sections

There are two connection options: the connection of single wires and the connection with a ring lug. Only copper wires may be used.

We recommend ring lugs with the following dimensions:

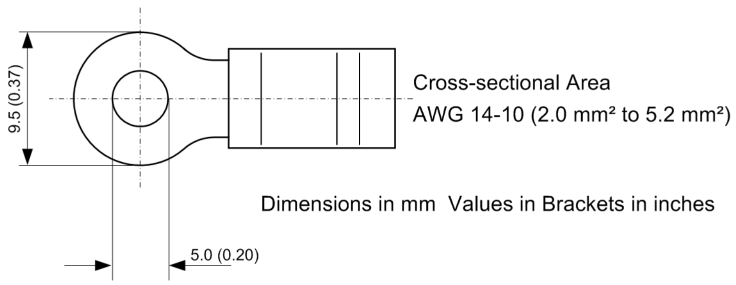

Figure 3-5 Ring lug

For complying with the required insulation clearances, insulated ring lugs have to be used. Otherwise, the crimp zone has to be insulated with corresponding means (e.g. by pulling a shrink-on sleeve over).

We recommend ring lugs of the PIDG range from Tyco Electronics.

Two ring lugs can be mounted per connection.

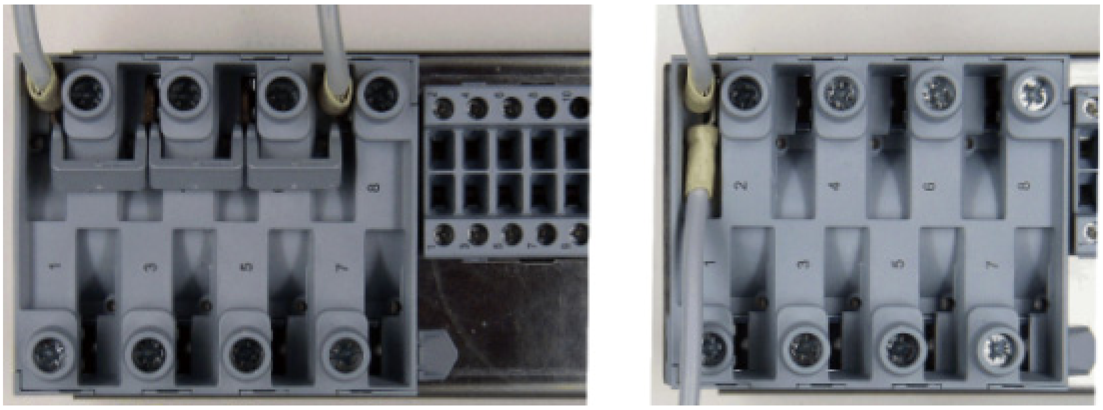

Figure 3-6 Current transformer connection

As single wires, solid conductors as well as stranded conductors with conductor sleeves can be used. Up to two single wires with identical cross-sections can be used per connection.

Alternatively jumpers (Order No. C53207-A406-D193-1) can be used with terminal points in a stacked arrangement. When using jumpers, only ring lugs are allowed.

When connecting single wires, the following cross-sections are allowed:

Cable cross-section:	AWG 14-10 (2.0 mm^2 to 5.2 mm^2)
Connector sleeve with plastic collar	L = 10 mm (0.39 in) or L = 12 mm (0.47 in)
Stripping length: (when used without conductor sleeve)	15 mm (0.59 in) Use exclusively solid copper conductors.

Mechanical Requirements

The fixing elements and the connected components are designed for the following mechanical requirements:

Permissible tightening torque at the terminal screw	2.7 Nm (23.9 lb.in) With solid conductors the allowed maximum tightening torque is 2 Nm
Permissible traction per connected conductor	80 N based on IEC 60947-1 (VDE 660, Part 100)

3.1.2.3 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 = 10 mm (0.39 in) or 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)

3.1.2.4 Interface Modules

General

The 7SD80 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. 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.

Protection Interfaces

The 7SD80 features a CU protection interface and/or an optical fiber protection interface depending on the ordering code.

When using the CU protection interface, you have to provide for an external transformer at the input of the long-distance line cable, which provides protection against high induced voltages.

For example:

Regulating transformer (ordering code)	PCM transformer 6 kV contacting via solder lugs (C53207-A406-D195-1) or PCM transformer 20 kV (screw terminals for ring cable lug (7XR9516))
Frequency range	6 kHz to 2000 kHz
Transformation ratio	1:1 (150 Ω:150 Ω)
Effective attenuation	< 0.5 dB
Fault attenuation	> 20 dB
UL listed	No

Note

The PROT CU communication interface is protected by a protective circuit (surge arrester) on the primary side. Therefore, checking the insulation at terminals D1 and D2 is not possible at a later time. Component testing is performed with AC 70 V. For type tests without protective circuit, voltage immunity is tested with AC 1.9 kV.

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

Installation is only possible alone or before installing the optical fiber protection interface.

If an optical fiber protection data interface exists, it has to be removed before installing the SIPROTEC 4 communication module. As shown in the following illustration, the parts shown in the lower left section (Z angle, plastic column) have to be removed to this end. First loosen the three screws for this purpose.

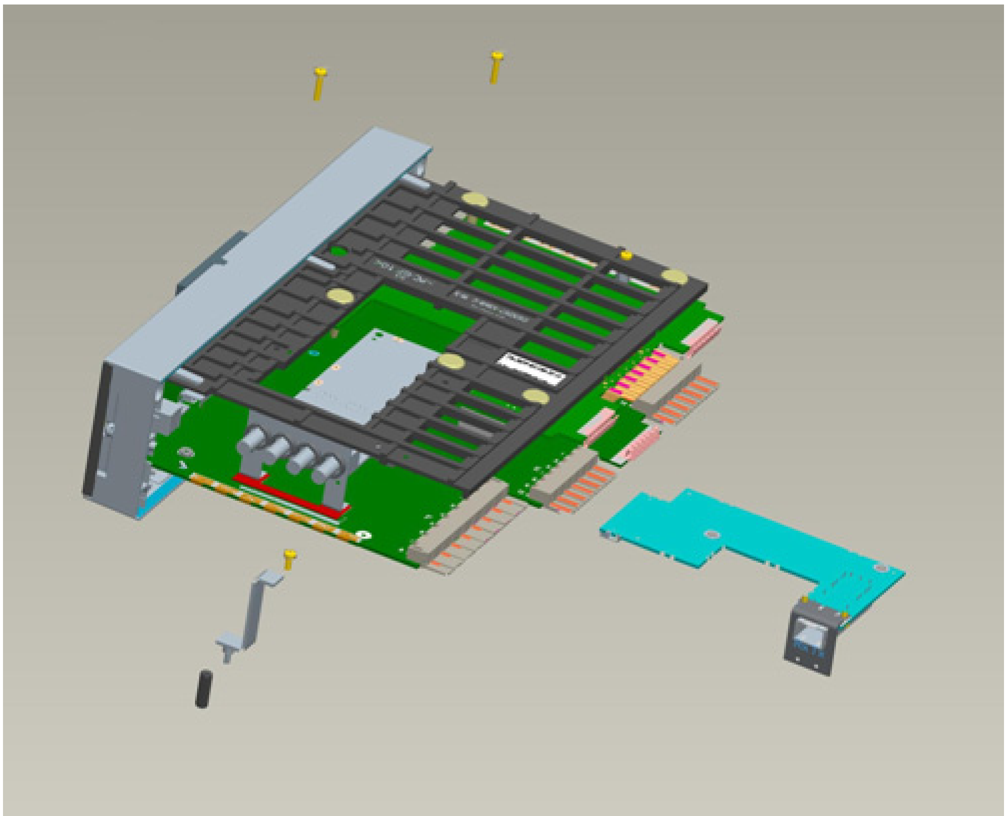

Figure 3-7 Dismounting the FO protection data interface

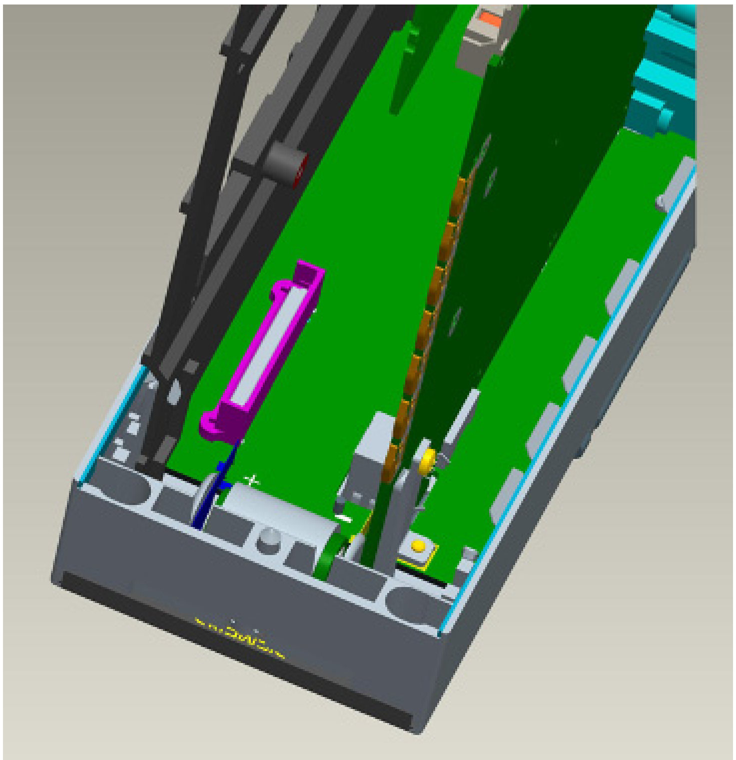

Figure 3-8 7SD80 device with adapter

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.

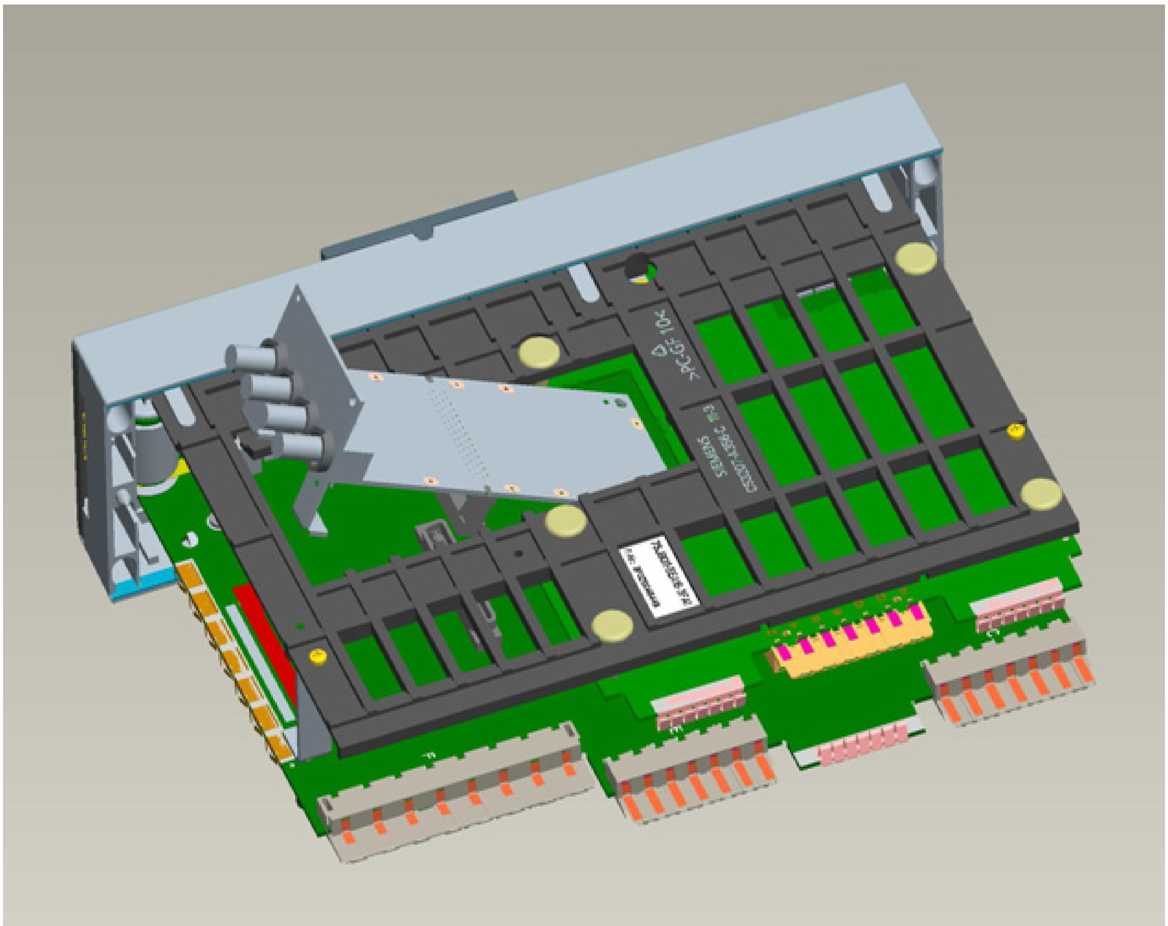

Figure 3-9 Installation of a SIPROTEC 4 communication module

The device can now be reassembled again (see Section Reassembly).

3.1.2.5 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:

Remove the protective caps of the optical modules before inserting these.

The connections of the communication modules point at the bottom of the housing. If there is no communication module, orient yourself to the connections for the current terminal. These connections are located on the side of the printed circuit board pointing at the device bottom.

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 careful 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.

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 current and voltage terminal blocks again and lock them in place!

3.1.3 Installation

3.1.3.1 General

The 7SD80 relay has a housing size 1/6. The housing has 2 covers and 4 fixing holes each at the top and bottom (see Figure 3-10 and Figure 3-11).

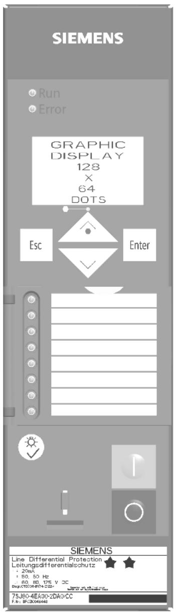

Figure 3-10 Housing with covers

Figure 3-11 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 4.19.
- 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 mm^2.
- 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 current and voltage terminals on the rear of the device in the Sections „Connections of the Current Terminals“ and „Connections of the Voltage Terminals“ must be strictly observed.

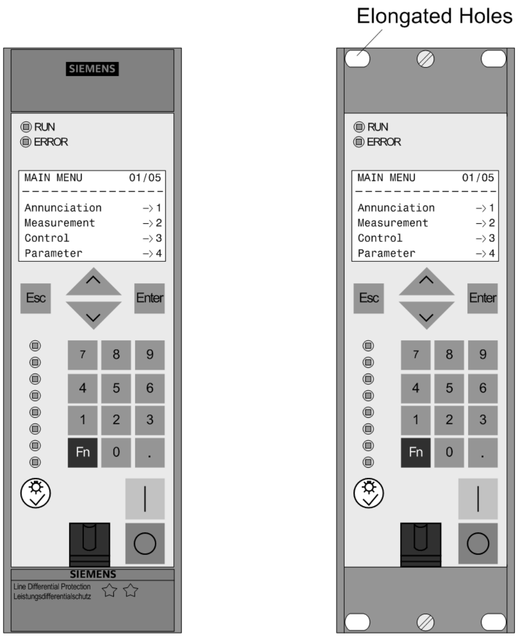

Figure 3-12 Panel flush mounting of a 7SD80

3.1.3.3 Cubicle Mounting

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 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 mm^2.
- 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 current and voltage terminals at the rear of the device in the Sections „Connections of the Current Terminals“ and „Connections of the Voltage Terminals“ must be strictly observed.

Note

Observe the bending radius of the conductors at the modules. Therefore, make sure that there is sufficient downward clearance when flush mounting the control cabinet. There must be a clearance of at least 4 to 6 inches under the device.

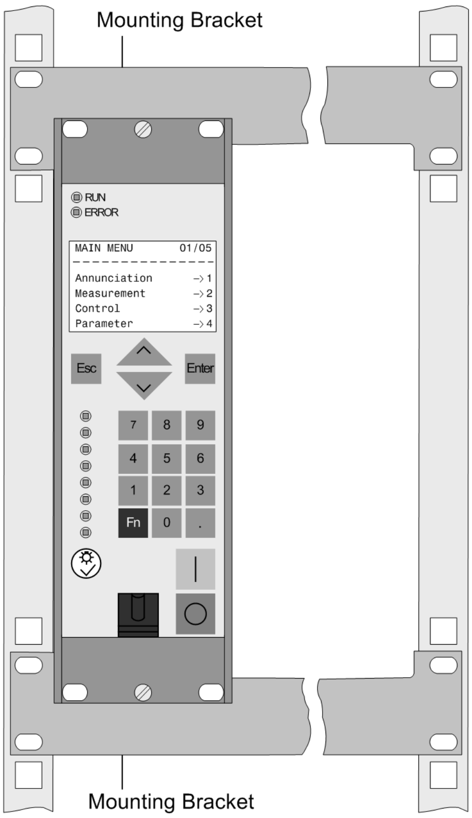

Figure 3-13 Example installation of a 7SD80 in a rack or cubicle

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 .
- 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 current and voltage terminals at the rear of the device in the Sections „Connections of the Current Terminals“ and „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 4.19.

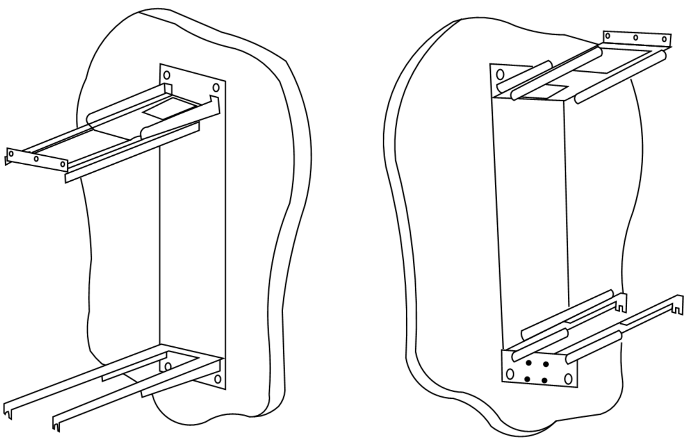

Figure 3-14 Mounting rails for panel surface mounting

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.

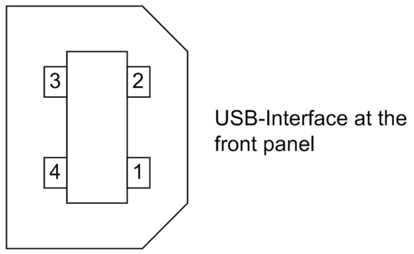

Figure 3-15 USB interface

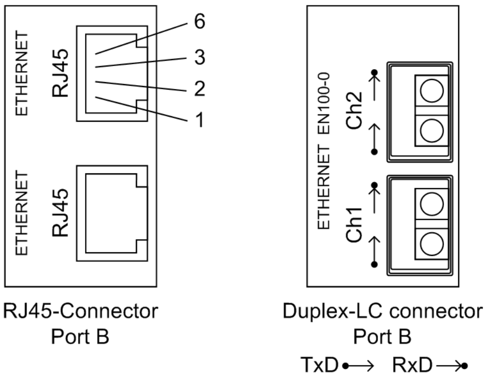

Figure 3-16 Ethernet connections at the device bottom side

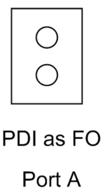

Figure 3-17 FO protection data interface at the device bottom side, port A

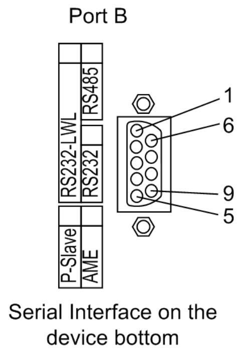

Figure 3-18 Serial interface at the device bottom

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

Protection data interface optical fiber cable with LC duplex connector.

The order numbers of the exchange modules are listed in the Appendix in Section A.1, Accessories.

Connections at port B

Table 3-3 Assignments of the port B sockets

Pin No.	RS232	RS232 time synchronization [2]	RS485	Profibus DP, RS485	Modbus RS485 DNP3.0 RS485	Ethernet EN 100	IEC 60870–5–103 redundant
1	Shield (with shield ends electrically connected)					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	GND	C/C' (GND)	C/C' (GND)	GND1	—	–
6	–	–	–	+5 V (max. load < 100 mA)	VCC1	Rx–	–
7	RTS	–	– [1]	–	–	—	–
8	CTS	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!

[2] For time synchronization via RS232, the X11 jumper must be in position 1-2.

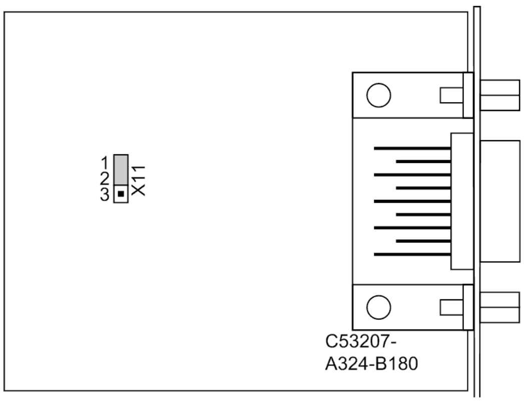

Figure 3-19 Position of jumper X11 on the RS 232 interface

With data cables, the connections are designated according to DIN 66020 and ISO 2110:

- TxD = Data output
- RxD = Data input
- RTS = Request to send
- 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.

Protection Data Interfaces - Copper

Connect the copper protection data interfaces (electrical) to terminal block D using copper conductors.

Fiber-optic Cables

WARNING!

Laser Radiation!

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 Protection Data Communication

The protection data communication usually goes directly from device to device either via electrical connection or optical fiber.

Optical Fibers, Directly

WARNING!

Warning of laser rays!

Non-observance of the following measure can result in death, personal injury or substantial property damage.

Do not look directly into the fiber-optic elements, not even with optical devices! Laser Class 3A according to EN 60825-1.

The direct optical fiber connection is visually controlled by means of an optical fiber connector. There is one connection for each direction. Therefore the output of the one device must be connected to the input of the other device and vice versa. Transmission and receiving connections are identified with the symbols ▪⟶ for transmit and ⟶• for receive. Important is the visual check of assignment of the transmitter and reception channels.

Further Connections

For further connections a visual control is sufficient for the time being. Electrical and functional controls are performed during commissioning (see the following main section).

3.2.3 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).

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 in order to check the system connections:

- Protective switches for the power supply and the measured voltages must be opened.
- Check the continuity of all current and voltage transformer connections against the system and connection diagrams:
  - Are the current transformers grounded properly?
  - Are the polarities of the current transformer connections the same?
  - Is the phase relationship of the current transformers correct?
  - Are the voltage transformers grounded properly?
  - Are the polarities of the voltage transformers correct?
  - Is the phase relationship of the voltage transformer connections correct?
  - Is the polarity for current input I_4 correct (if used)?
- Check the functions of all test switches that are installed for the purposes of secondary testing and isolation of the device. Of particular importance are „test switches " in current transformer circuits. Be sure these switches short-circuit the current transformers when they are in the test mode.
- 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.
- Remove the voltage from the power supply by opening the protective switches.
- Disconnect the measuring test equipment; restore the normal power supply connections.
- 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.

Screw terminals for connection modules:

The connection module is available in 8-pin design for current connections and in 14-pin design for voltage connections.

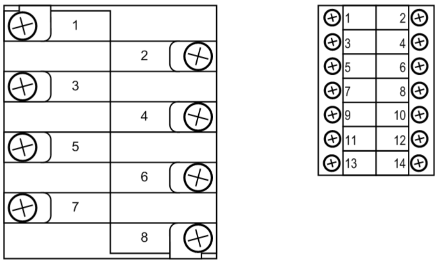

Figure 3-20 Current and voltage terminals

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 A.6).

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 Checking Time Synchronization

If external time synchronization sources are used, the data of the time source (antenna system, time generator) are checked (see Subsection 4.1.4 under „Time Synchronization“). A correct function (IRIG B, DCF77) is recognized in such a way that 3 minutes after the startup of the device the clock status is displayed as „`synchronized`“, accompanied by the message „`Alarm Clock OFF`“.

Table 3-4 Time status

No.	Status text	Status
1	–– –– –– ––	synchronized
2	–– –– –– ST	
3	–– –– ER ––	not synchronized
4	–– –– ER ST	
5	–– NS ER ––	
6	–– NS –– ––	
Legend: –– NS –– –– –– –– ER –– –– –– –– ST		 time invalid time fault summertime

If a correct GPS signal is received by a connected GPS receiver, the indication „OFF“ is displayed 3 seconds after device startup. The pin assignment of the time synchronization interface is indicated in the above table „Assignment of the port B sockets“.

3.3.3 Testing the System Interface (at Port B)

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.

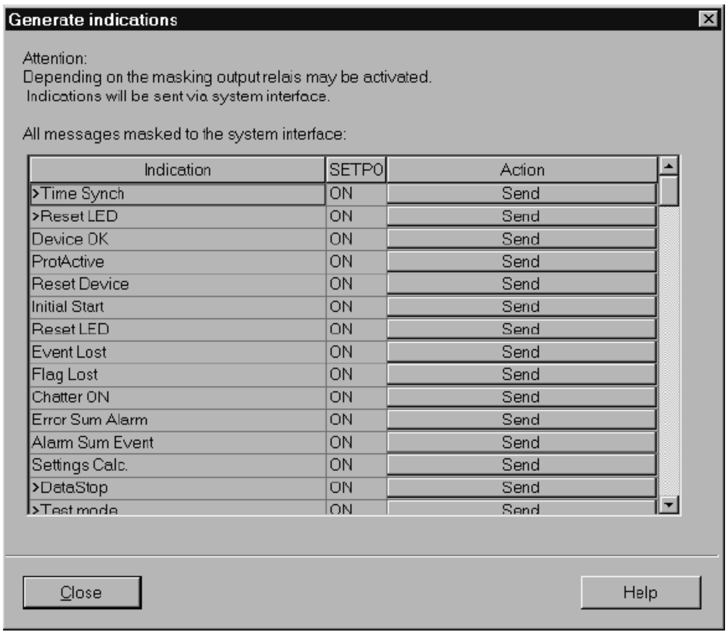

Figure 3-21 System interface test with the dialog box: Creating messages - example

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 **SET-POINT 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.

Test in Command Direction

The information transmitted in command direction must be indicated by the central station. Check whether the reaction is correct.

3.3.4 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 DIGSI Manager

For the protection device to be able to access the new communication module, a change has to be made in the parameter set in DIGSI Manager.

In **DIGSI 4 Manager**, select the SIPROTEC device in your project and select the menu item "Edit" - "Object properties..." to open the `"Properties - SIPROTEC 4 Device"` dialog box (see following Figure). In the `"Communication Modules"` tab, select an interface for the `"11. Port B"` (bottom side of device) using the pull-down button. Select "Additional Protocols, see MLFB Ext." for Profibus DP, Modbus or DNP3.0.

The type of communication module for port B can be specified in the `"Additional Information"` dialog box using the button "L.: ...".

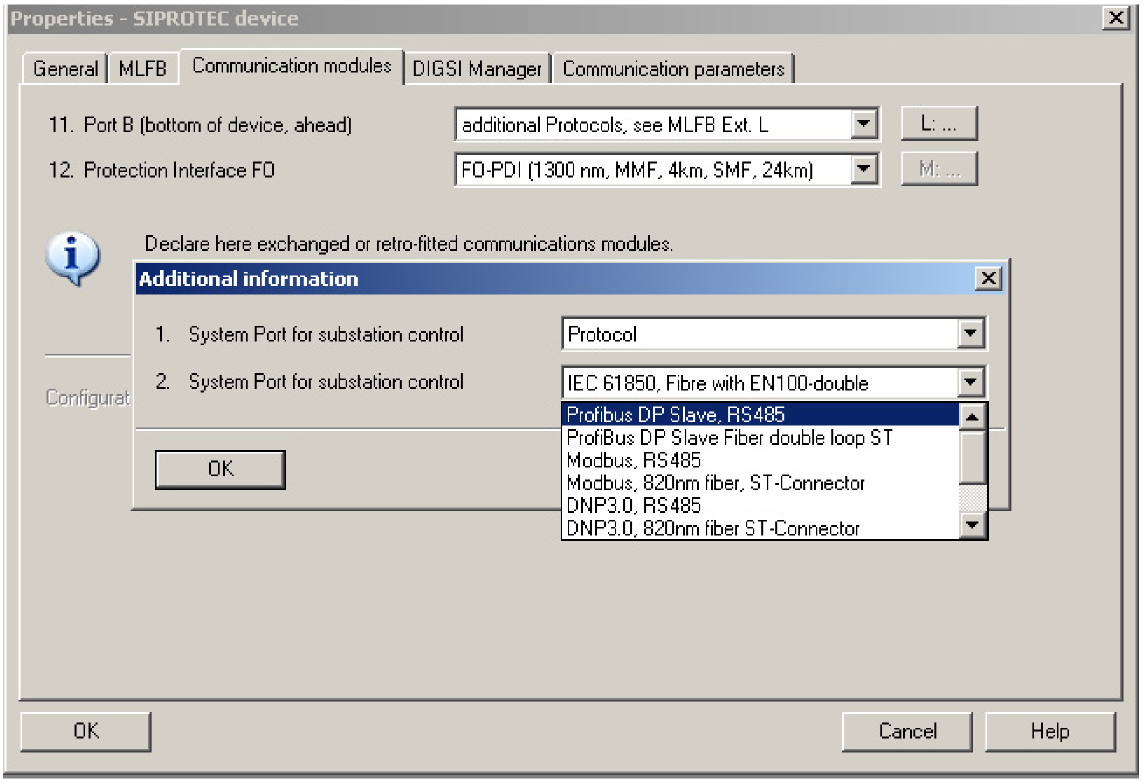

Figure 3-22 DIGSI 4.3: Profibus DP protocol selection (example)

Mapping File

For Profibus DP, Modbus, DNP3.0 and VDEW Redundant, a matching bus mapping has to be selected.

For the selection of the mapping file please open the SIPROTEC device in DIGSI and choose the function „`Interfaces`” in „`Parameter`” (see Figure 3-23).

The dialog box **"Interface parameters"** offers the following dialog elements in the properties tab **"Additional protocols on the device"**:

- Display of the selected communication module
- Selection box **"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

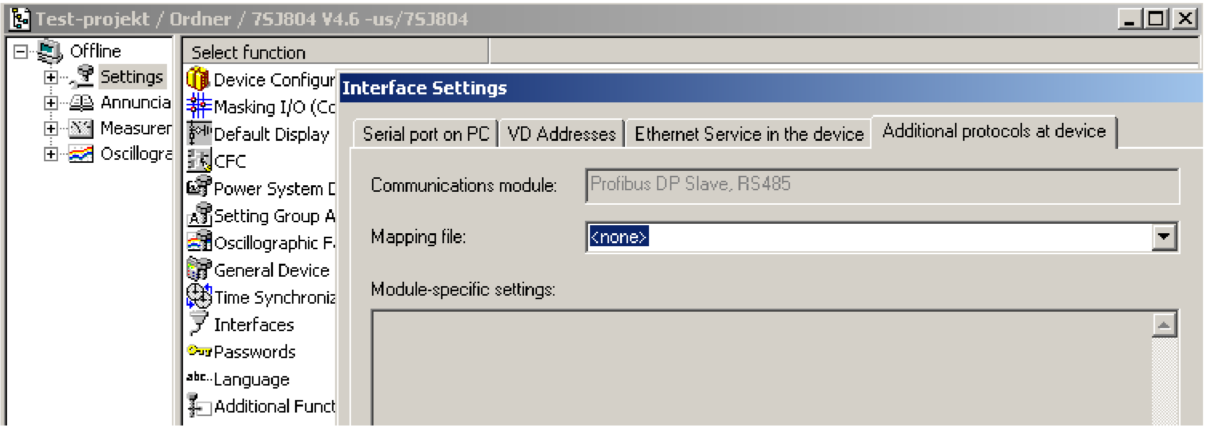

Figure 3-23 DIGSI 4.3: Selection of a mapping file and setting of bus-specific parameters

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"

In the edit field `"Module-specific settings"`, only change the numbers in the lines not starting with "//" and observe the semicolon at the end of the lines.

Further changes in the edit field might lead to an error message when closing the dialog box **"Interface parameters"**.

Please 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 3-24). 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".

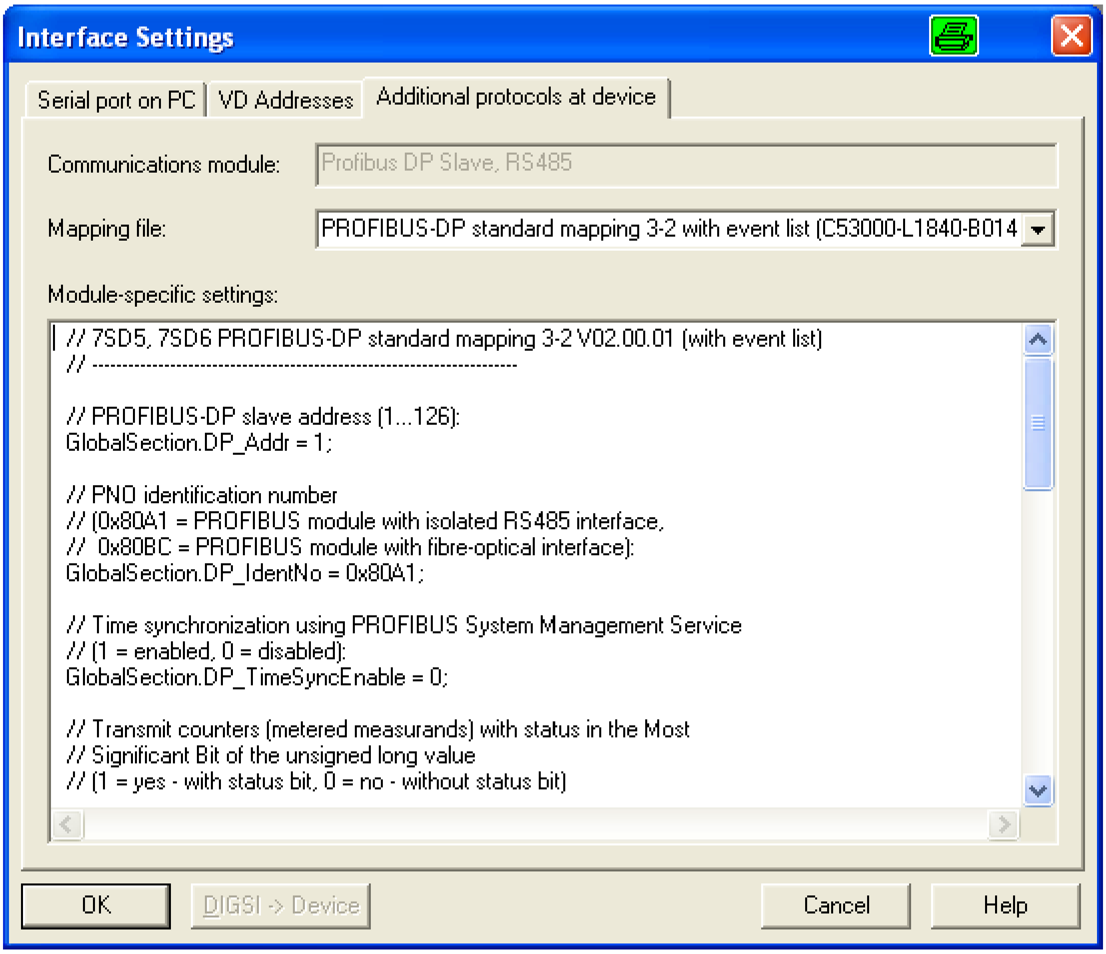

Figure 3-24 Module-specific settings

Then, transfer the data to the protection device (see the following figure).

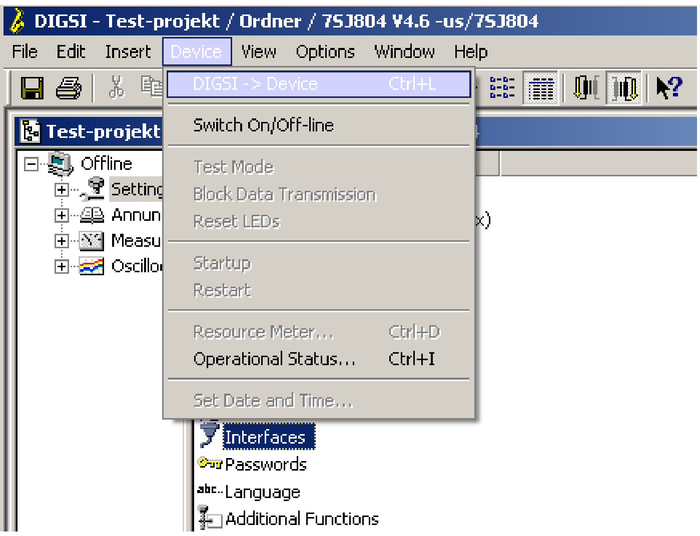

Figure 3-25 Transmitting data

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.

3.3.5 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 light-emitting 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.

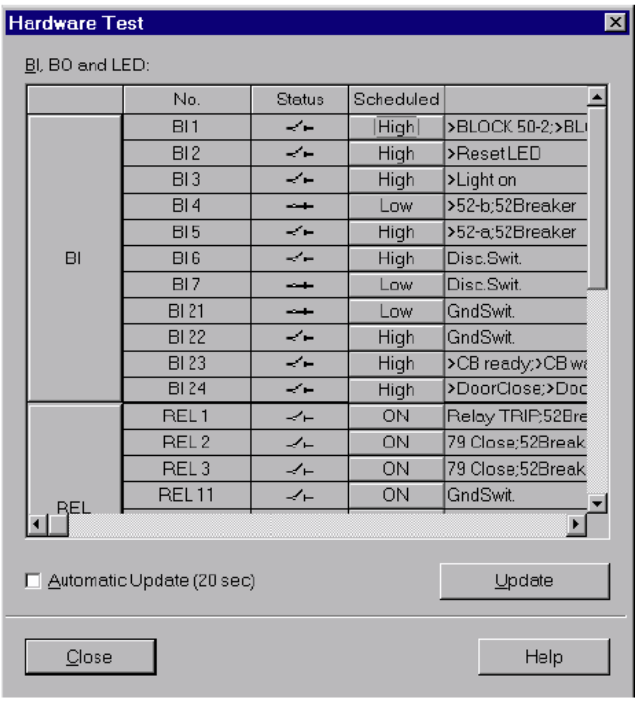

Figure 3-26 Test of the binary inputs/outputs — example

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 7SD80 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 7SD80 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.

3.3.6 Checking the Protection Data Communication

General

You can check the device communication from the PC using DIGSI.

You can either connect the PC directly to the device on-site using the front operator interface or the service interface port B of the PC (Figure 3-27). Or you can log into the device using a modem via the service interface (example in Figure 3-29).

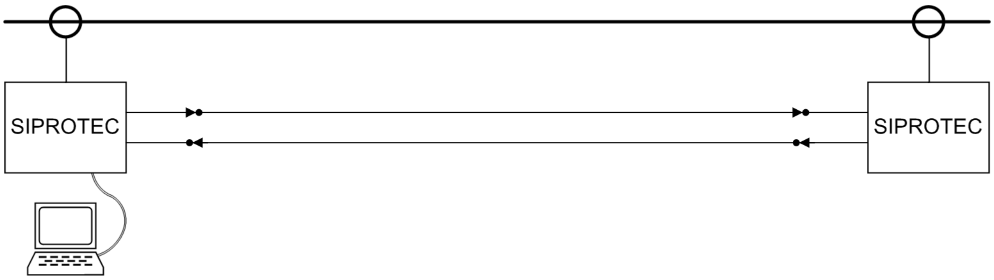

Figure 3-27 Direct connection of the PC to the device - basic example

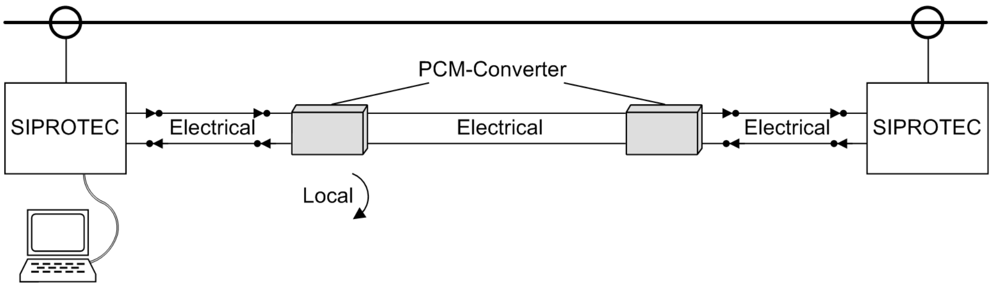

Figure 3-28 Direct connection of the PC to the device using the CU protection data interface – basic example

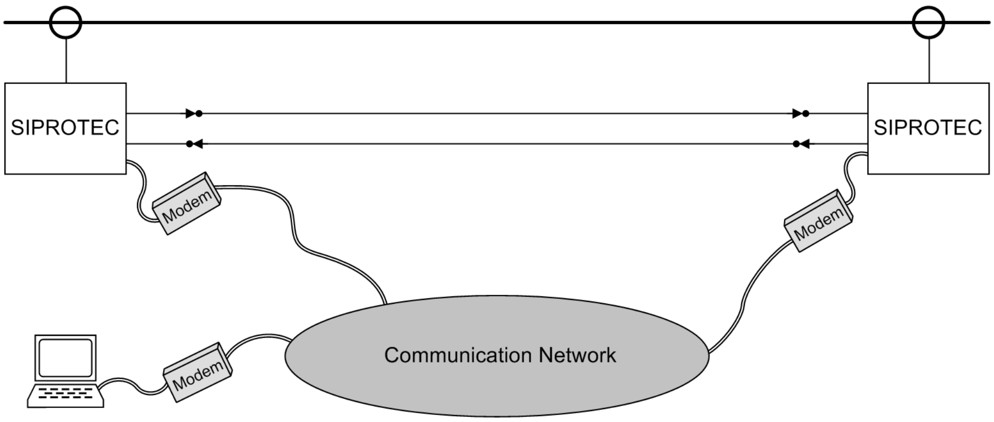

Figure 3-29 Connection of the PC via modem - basic example

Checking a Connection Using Direct Link

In case of an optical fiber link (as shown in Figure 3-27 or 3-29) or via copper conductor link, this connection is checked as follows:

- Both devices at the link ends have to be switched on.
- Check in the event log or in the spontaneous annunciations:
  - If the message „`PDI FO con. to.`“ (protection data interface connected with no. 3243) is provided with the device index of the other device in case of an optical fiber conductor, a link has been established and one device has recognized the other.
  - If the message „`PDI Cu con. to.`“ (protection data interface connected with no. 3244) is provided with the device index of the other device in case of a copper connection, a link has been established and one device has recognized the other.
  - The device indicates „`Slave Login`“, no. 3492 or „`Master Login`“, no. 3491 if the other device has been detected.
- In case of an incorrect communication link, the indication „`PDI FO faulty`“ (no. 3230) or „`PDI Cu faulty`“ (no. 3232) is displayed. In this case, check the connection again:
  - Are the connections correct and not swapped?
  - Are the cables free from mechanical damage, intact and the connectors locked?
  - Otherwise repeat the verification.

Continue with the margin heading „Consistency of Connection and Parameterization“.

Consistency of Connection and Parameterization

Having performed the above checks, the linking of a device pair has been completely tested and connected to auxiliary supply voltage. Now the devices contact each other on their own account.

- Check now the Event Log or in the spontaneous annunciations of the device where you are working:
  - Indication no. 3243 „`PDI FO con. to.`“ (protection interface connected with).
  - If the parameterization of the devices is consistent, i.e. the requirements have been observed when setting the function scope (Section 2.1.1), the power system data 1 (2.1.3.1), the power system data 2 (2.1.6.1), the protection interface parameters (Section 2.1.8.2), the fault indication for the verified interface also disappears, i.e. no. 3230 „`PDI FO faulty`“ or no. 3232 „`PDI Cu faulty`“. The communication and consistency check has thus been completed.

Availability of the Protection Data Interfaces

The quality of protection data transmission depends on the availability of the protection data interfaces and the transmission. Therefore, check the statistic information of the device.

Check the following information:

- Indication no. 7753 „FO A/m“ (availability per minute) and indication no. 7754 „FO A/h“ (availability per hour) indicate the availability of protection data interface 1. The value of no. 7753 „FO A/m“ should attain a minimum availability of 99.85% after two minutes of operation. The value of no. 7754 „FO A/h“ should attain a minimum availability of 99.85% after one hour of operation.

If these values are not attained, the protection communication should be checked.

3.3.7 Tests for Circuit Breaker Failure Protection

General

If the device provides a breaker failure protection and if this is used, the integration of this protection function in the system must be tested under practical conditions.

Due to the variety of application options and the available system configurations, it is not possible to make a detailed description of the necessary tests. It is important to observe local conditions and protection and system drawings.

Before starting the circuit breaker tests it is recommended to isolate the circuit breaker of the tested feeder at both ends, i.e. line isolators and busbar isolators should be open so that the breaker can be operated without risk.

Caution!

Also for tests on the local circuit breaker of the feeder a trip command to the surrounding circuit breakers can be issued for the busbar.

Non–observance of the following measure can result in minor personal injury or property damage.

Therefore, primarily it is recommended to interrupt the tripping commands to the adjacent (busbar) breakers, e.g. by interrupting the corresponding pickup voltages.

Before the breaker is finally closed for normal operation, the trip command of the feeder protection routed to the circuit breaker must be disconnected so that the trip command can only be initiated by the breaker failure protection.

Although the following lists do not claim to be complete, they may also contain points which are to be ignored in the current application.

Auxiliary Contacts of the CB

The circuit breaker auxiliary contact(s) form an essential part of the breaker failure protection system in case they have been connected to the device. Make sure the correct assignment has been checked.

External Initiation Conditions

If the breaker failure protection can be started by external protection devices, the external start conditions must be checked. Therefore, check first how the parameters of the breaker failure protection are set. See Section 2.6.2, addresses 3901 onwards.

In order for the breaker failure protection to be started, a current must flow at least via the monitored phase and ground. This may be a secondary injected current.

After every start, the message „50BF Start“ (FNo 1461) must appear in the spontaneous or fault annunciations.

For three-pole starting:

- Three-pole starting by trip command of the external protection:

  Binary input functions „>50BF Start 3p“ and, if necessary, „>50BF release“ (in or spontaneous or fault messages). Trip command (dependent on settings).

Switch off test current.

If start is possible without current flow:

- Starting by trip command of the external protection without current flow:

  Binary input functions „>50BF STARTw/oI“ and, if necessary, „>50BF release“ (in or spontaneous or fault messages). Trip command (dependent on settings).

Busbar Tripping

For testing the distribution of the trip commands in the substation in the case of breaker failures it is important to check that the trip commands to the adjacent circuit breakers are correct.

The adjacent circuit breakers are those of all feeders which must be tripped in order to ensure interruption of the fault current should the local breaker fail. These are therefore the circuit breakers of all feeders which feed the busbar or busbar section to which the feeder with the fault is connected.

A general detailed test guide cannot be specified because the layout of the adjacent circuit breakers largely depends on the system topology.

In particular with multiple busbars, the trip distribution logic for the adjacent circuit breakers must be checked. Here it should be checked for every busbar section that all circuit breakers which are connected to the same busbar section as the feeder circuit breaker under observation are tripped, and no other breakers.

Tripping of the Remote End

If the trip command of the circuit breaker failure protection must also trip the circuit breaker at the remote end of the feeder under observation, the transmission channel for this remote trip must also be checked. This is done together with transmission of other signals according to Sections „Testing of the Pilot Protection Scheme with ...“ further below.

Termination

All temporary measures taken for testing must be undone, e.g. especially switching states, interrupted trip commands, changes to setting values or individually switched off protection functions.

3.3.8 Checking the Instrument Transformer Connections of One Line End

If secondary test equipment is connected to the device, it is to be removed or, if applying, test switches should be in normal operation position.

Note

It must be taken into consideration that tripping can occur even at the opposite end of the protected object if connections were made wrong.

Before energizing the object to be protected at one end, short-circuit protection must be ensured at least at the feeding ends. If a separate backup protection (e.g. time overcurrent protection) is available, it has to be put into operation and switched to alert first.

Voltage and Phase Rotation Check

If the device is connected to voltage transformers, these connections are checked using primary values. For devices without voltage transformer connection the rest of this margin heading may be omitted.

The voltage transformer connections are individually tested at either end of the object to be protected. At the other end, the circuit breaker initially remains open.

- Having closed the circuit breaker, none of the measurement monitoring functions in the device must respond.
  - If there was a fault indication, however, the Event Log or spontaneous indications could be checked to investigate the reason for it.
  - At the indication of balance monitoring there might actually be asymmetries of the primary system. If they are part of normal operation, the corresponding monitoring function is set less sensitive (see Section 2.14.1 under margin heading „Symmetry Monitoring“).

  The voltages can be read as primary and secondary values on the display at the front, or called up in the PC via the operator or service interface, and compared with the actual measured quantities. Besides the magnitudes of the phase-to-ground and the phase-to-phase voltages, the phase differences of the voltages are also displayed so that the correct phase sequence and polarity of individual transformers can also be seen.
- The voltage magnitudes should be almost equal. All three angles φ (V_{Lx}–V_{Ly}) must be approximately 120°.
  - If the measured quantities are not plausible, the connections must be checked and revised after switching off the line. If the phase difference between two voltages is 60° instead of 120°, one voltage must be polarity-reversed. The same applies if there are phase-to-phase voltages which are almost equal to the phase-to-ground voltages instead of having a value that is $\sqrt{3}$ larger. The measurements are to be repeated after correcting the connections.
  - In general, the phase rotation is a clockwise phase rotation. If the system has an anti-clockwise phase rotation, this must be identical at all ends of the protected object. The phase assignment of the measured quantities has to be checked and, if required, corrected after the line has been isolated. The measurement must then be repeated.
- Open the miniature circuit breaker of the feeder voltage transformers. 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 Event Log and in the spontaneous indications that the VT mcb trip was noticed (indication „`>FAIL:Feeder VT`“ „ON“, no. 361). It has to be assured beforehand that the position of the VT mcb is connected to the device via a binary input.

- Close the VT mcb again: The above indication appears in the spontaneous indications as „OFF“, i.e. „`>FAIL:Feeder VT`“ „OFF“.
  - If one of the indications does not appear, check the connection and routing of these signals.
  - If the „ON“ state and the „OFF“ state are swapped, the contact type (H-active or L-active) must be checked and corrected.
- The protected object is switched off again.
- This check must be performed at both ends.

Current Test

The connections of the current transformers are tested with primary values. A load current of at least 5% of the rated operational current is required. Any direction is possible.

This test cannot replace visual inspection of the correct current transformer connections. Therefore, the inspection according to Section „Checking the System Connections“ is a prerequisite.

- After closing the circuit breakers, none of the measured value monitoring functions in the 7SD80 must respond. If there was a fault indication, however, the Event Log or spontaneous indications could be checked to investigate the reason for it.
  - If current summation errors occur, check the matching factors (see Section 2.1.3 at margin heading „Connection of the Currents“).
  - At the indication of balance monitoring there might actually be asymmetries of the primary system. If they are part of normal operation, the corresponding monitoring function is set less sensitive (see Section 2.14.1 under margin heading „Symmetry Monitoring“).

  The currents can be read as primary and secondary values on the display at the front, or called up in the PC via the operator or service interface, and compared with the actual measured quantities. The absolute values as well as the phase differences of the currents are indicated so that the correct phase sequence and polarity of individual transformers can also be seen.
- The current amplitudes must be approximately the same. All three angles φ (I_{Lx}–I_{Ly}) must be approximately 120°.
  - If the measured values are not plausible, the connections must be checked and corrected after switching off the protected object and short-circuiting the current transformers. If, for example, the phase difference between two currents is 60° instead of 120°, one of the currents must have a reversed polarity. The same is the case if a substantial ground current $3I_0$ occurs:

    $3\ I0 \approx$ phase current $\rightarrow$ one or two phase currents are missing;

    $3\ I0 \approx$ twice the phase current $\rightarrow$ one or two phase currents have a reversed polarity.
- The measurements are to be repeated after correcting the connections.

Polarity Check

If the device is connected to voltage transformers, the local measured values already allow a polarity check.

A load current of at least 5% of the rated operational current is still required. Any direction is possible but must be known.

- With closed circuit breakers, the power values are viewed as primary and secondary values on the front display panel or via the operator or service interface with a personal computer.
- The measured power values on the actual device or in DIGSI enable you to verify that they correspond to the load direction (Figure 3-30):

  P positive, if active power flows into the protected object,

  P negative, if active power flows towards the busbar,

  Q positive, if (inductive) reactive power flows into the protected object,

  Q negative, if reactive power flows toward the busbar.

  Therefore, the power results and their components must have opposite signs at both ends.

  It must be taken into consideration that high charging currents, which might occur with long overhead lines or with cables, are capacitive, i.e. correspond to a negative reactive power into the line. In spite of a resistive-inductive load, this may lead to a slightly negative reactive power at the feeding end whereas the other end shows an increased negative reactive power. The lower the load current for the test, the higher the significance of this influence. In order to get unambiguous results, you should increase the load current if necessary.

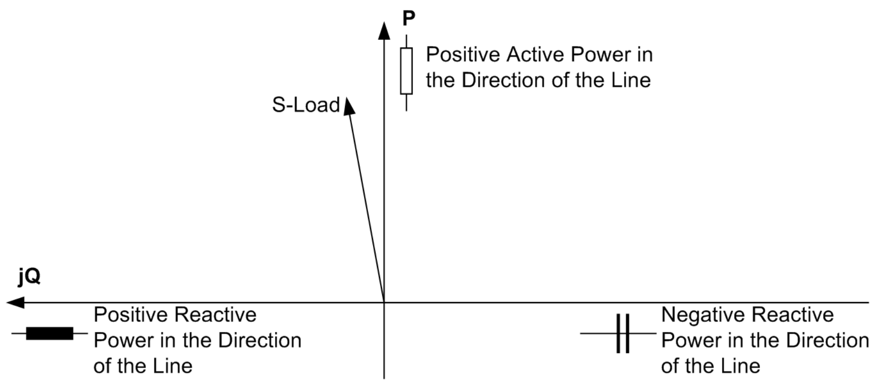

Figure 3-30 Apparent load power

- The power measurement provides an initial indication as to whether the measured values of one end have the correct polarity.
  – If the reactive power is correct but the active power has the wrong sign, cyclic phase swapping of the currents (right) or of the voltages (left) might be the cause.
  – If the active power direction is correct but the reactive power has the wrong sign, cyclic phase swapping of the currents (left) or of the voltages (right) might be the cause.
  – If both the real power as well as the reactive power have the wrong sign, the polarity in address 201 **CT Starpoint** must be checked and rectified.

  The phase angles between currents and voltages must also be conclusive. All three phase angles φ (V_{Lx}–I_{Lx}) must be approximately the same and represent the operating status. In the event of power in the direction of the protected object, they correspond to the current phase displacement (cos φ positive); in the event of power in the direction of the busbar they are higher by 180° (cos φ negative). However, charging currents might have to be taken into consideration (see above).
- The measurements may have to be repeated after correcting the connections.
- The above described tests of the measured values also have to be performed at the other end of the tested current path. The current and voltage values as well as the phase angles of the other end can also be read out locally as percentage values. Please observe that currents flowing through the object (without charging currents) ideally have opposite signs at both ends, i.e. they are turned by 180°.
- The protected object is now switched off, i.e. the circuit breakers are opened.

Polarity Check for the Current Measuring Input I_4

If the standard connection of the device is used whereby current input I_4 is connected in the neutral of the set of current transformers (refer also to the connection circuit diagram in the Appendix A.3), then the correct polarity of the ground current path in general automatically results.

If, however, the current I_4 is derived from a separate summation CT an additional direction check with this current is necessary.

Otherwise the test is done with a disconnected trip circuit and primary load current. It must be noted that during all simulations that do not exactly correspond with situations that may occur in practice, the non-symmetry of measured values may cause the measured value monitoring to pick up. This must therefore be ignored during such tests.

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.

I_4 from Own Line

To generate a delta voltage, the broken delta winding of one phase in the voltage transformer set (e.g. A) is bypassed (refer to Figure 3-31). If no connection on the g–n windings of the voltage transformer is available, the corresponding phase is open circuited on the secondary side. Via the current path only the current from the current transformer in the phase from which the voltage in the voltage path is missing, is connected; the other CTs are short-circuited. If the line carries resistive-inductive load, the protection is in principle subjected to the same conditions that exist during a ground fault in the direction of the line.

The voltages can be read on the display at the front, or called up in the PC via the operator or service interface, and compared with the actual measured quantities as primary or secondary values. The absolute values as well as the phase differences of the voltages are indicated so that the correct phase sequence and polarity of individual transformers can also be seen.

The same manipulation is carried out with the current and voltage transformers at the other end.

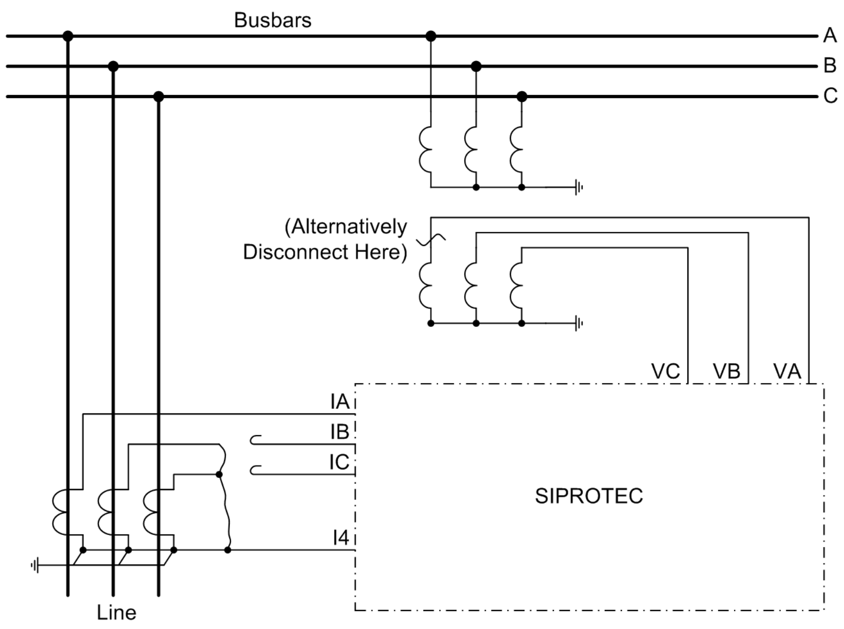

Figure 3-31 Polarity check for I_4, Example for a current transformer set in Holmgreen configuration

If the current flows towards the protected object according to the circuit in Figure 3-31, the currents I_B and I_C are virtually zero. A ground current $3I_0$ of the approximately same level as I_A occurs. Accordingly, the voltage V_{AGnd} is missing and a zero sequence voltage $3V_0$ appears.

In the event of a polarity fault, $3I_0$ is in opposite phase with I_A or the zero voltage $3V_0$ supplements the other two voltages to a voltage star. Open the circuit breakers, short-circuit current transformers and set current and voltage transformer connections right and repeat the test.

Note

If parameters were changed for this test, they must be returned to their original state after completion of the test !

3.3.9 Checking the Instrument Transformer Connections of Two Line Ends

Measured Values Constellation

The constellation measured values enable you to also check the transformers at the opposite end. The current/voltage measured locally is assumed as reference value for the angle. The angle values of the remote ends are referred to the locally measured value.

Examples for the current in a constellation with 2 ends:

Current IA at the local end 98 % angle 0°

Current IA at the opposite end 98 % angle 180° (max. +/- 10° depending on the capacitive charging current and the power flow)

For more information, see the Section 2.17.5 Constellation measured values.

3.3.10 Checking the Pilot Protection for Internal and External Remote Tripping

The 7SD80 provides the possibility to transmit a remote trip signal to the opposite line end if a signal transmission path is available for this purpose. This remote trip signal may be derived from both an internally generated trip signal as well as from any signal coming from an external protection or control device.

If an internal signal is used, the initiation of the transmitter must be checked. If the signal transmission path is the same and has already been checked as part of the previous sections, it does not need to be checked again here. Otherwise the initiating event is simulated and the response of the circuit breaker at the opposite line end is verified.

For remote transmission, the external command input is employed on the receiving line end; it is therefore a prerequisite that: **DTT Direct Trip** is set to ***Enabled*** in address 122 and **Direct Trip(DT)** to ***ON*** at address 2201. If the signal transmission path is the same and has already been checked as part of the previous subsections, it needs not be checked again here. A function check is sufficient, whereby the externally derived command is executed. For this purpose the external tripping event is simulated and the response of the circuit breaker at the opposite line end is verified.

3.3.11 Testing User-defined Functions

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.

Naturally, general test procedures cannot be given. Rather, the configuration of these user defined functions and the necessary associated conditions must be known and verified. Of particular importance are possible interlocking conditions of the switchgear (circuit breakers, isolators, etc.).

3.3.12 Trip and Close Test with the Circuit Breaker

The circuit breaker and tripping circuits can be conveniently tested by the device 7SD80.

The procedure is described in detail in the SIPROTEC 4 System Description.

If the check does not produce the expected results, the cause may be established from the text in the display of the device or the PC. If necessary, the connections of the circuit breaker auxiliary contacts must be checked:

It must be noted that the binary inputs used for the circuit breaker auxiliary contacts must be assigned separately for the CB test. This means it is not sufficient that the auxiliary contacts are allocated to the binary inputs FNo. to , 379 and 380 (according to the possibilities of the auxiliary contacts); additionally, the corresponding FNo. to or 410 and/or 411 must be allocated (according to the possibilities of the auxiliary contacts. In the CB test only the latter ones are analyzed. See also Section 2.12. Furthermore, the ready state of the circuit breaker for the CB test must be indicated to the binary input with FNo. 371.

3.3.13 Switching Check for the Configured Equipment

Switching via Command Input

If the configured equipment was not switched sufficiently in the hardware test already described, configured equipment must be switched on and off from the device via the integrated control element. The feedback information on the circuit breaker position injected via binary inputs is to be read out at the device and compared with the actual breaker position.

The switching procedure is described in the SIPROTEC 4 System Description (Order no. E50417-H1176-C151) The switching authority must be set in correspondence with the source of commands used. With the switch mode it is possible to select between interlocked and non-interlocked switching. Note that non-interlocked switching constitutes a safety risk.

Switching from a Remote Control Center

If the device is connected to a remote substation via a system (SCADA) 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.

3.3.14 Triggering Oscillographic Recording for Test

In order to test the stability of the protection during switch-on procedures also, switch-on trials can also be carried out at the end. Oscillographic records obtain the maximum information about the behavior of the protection.

Prerequisite

Along with the capability of storing fault recordings via pickup of the protection function, the 7SD80 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 „`FltRecSta`“ must be allocated to a binary input. Triggering of the recording is done e.g. via the binary input on switch-on of the protection object.

An oscillographic recording that is externally triggered (that is, without a protective element pickup or device trip) is processed by the device as a normal oscillographic recording, and has a number for establishing a sequence. However, these recordings are not displayed in the fault indication buffer, as they are not fault events.

Start Triggering Oscillographic Recording

In order to start a test measurement recording via DIGSI, select in the left of the window the operator function **Test**. Double-click in the list view the entry **Test Wave Form** (see Figure 3-32).

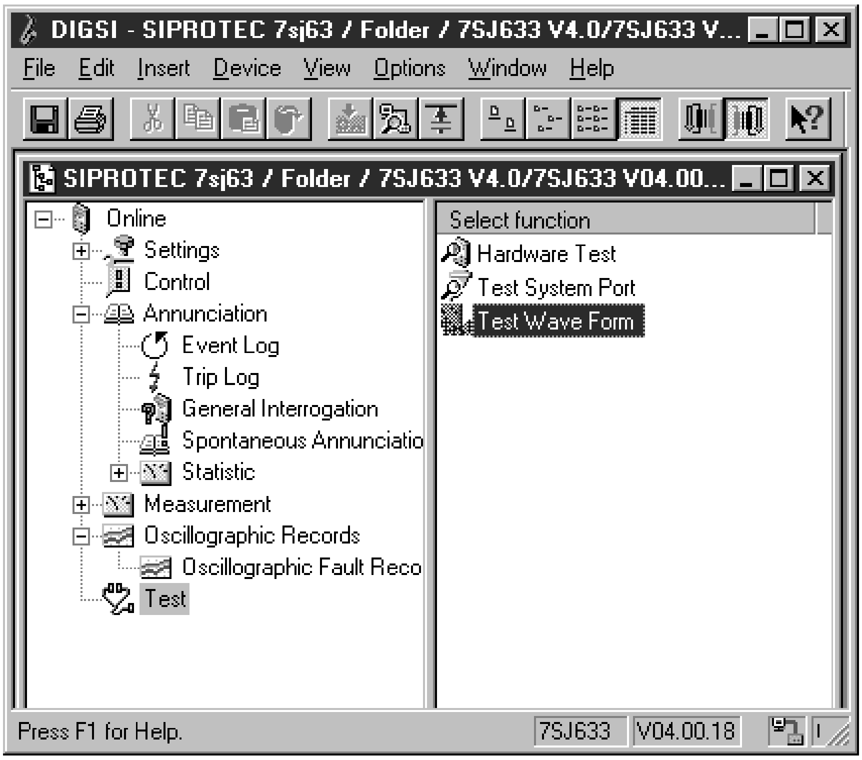

Figure 3-32 Test Wave Form window in DIGSI - Example

Oscillographic recording is immediately started. During the recording, an annunciation is output in the left area of the status line. Bar segments additionally indicate the progress of the procedure.

The SIGRA or the Comtrade Viewer program is required to view and analyze 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!

Inadmissible 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 setting values should be checked again, if they were modified during the tests. Check if protection, control and auxiliary functions to be found with the configuration parameters are set correctly (Section 2.1.1, Functional Scope). All desired elements and functions must be set ***ON***. Ensure that a copy of the setting values is stored on the PC.

The user should check the device-internal clock and set/synchronize it if necessary, provided that it is not synchronized automatically. Refer to the SIPROTEC 4 System Description for more information on this.

The indication buffers are deleted under **Main Menu** → **Annunciation** → ***Set***/***Reset***, so that in the future they only contain information on actual events and states. 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).

The counters of the operational measured values (e.g. operation counter, if available) are reset under **Main Menu** → **Measurement** → ***Reset*** (see also 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 (e.g. display of operational measured values).

Clear the LEDs on the front panel by pressing the LED key, so that they only show real events and states. In this context, saved output relays are reset, too. 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. If the LEDs display states relevant by that moment, these LEDs, of course, stay lit.

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.

■

Technical Data 4

This chapter provides the technical data of the device SIPROTEC 7SD80 and its individual functions, including the limit values that may not be exceeded under any circumstances. The electrical and functional data for the maximum functional scope are followed by the mechanical specifications with dimensioned drawings.

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4.1 General Device Data

4.1.1 Analog Inputs

Current 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 current	I_{Nom}	1 A or 5 A	
Ground current, sensitive	I_{Ns}	$\leq 1.6 \cdot I_{Nom}$ linear range [1)]	
Burden per phase and ground path - at I_{Nom} = 1 A - at I_{Nom} = 5 A - for sensitive ground fault detection at 1 A		 ≤ 0.05 VA ≤ 0.3 VA ≤ 0.05 VA	
Load capacity current path - thermal (rms) - dynamic (peak value)		 500 A for 1 s 150 A for 10 s 20 A continuous 1250 A (half-cycle)	
Load capacity input for sensitive ground fault detection I_{Ns} [1)]			
- thermal (rms) - dynamic (peak value)		300 A for 1 s 100 A for 10 s 15 A continuous 750 A (half-cycle)	

1) only in models with input for sensitive ground fault detection (see ordering data in Appendix A.1)

Voltage inputs

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

DC 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
7SD80	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	

AC Voltage

Voltage supply via an integrated converter		
Nominal auxiliary AC voltage V_H	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 115 VAC / 230 VAC)	< 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	
7SD80	3, 5, 7 (configurable) depending on ordering code	
Range of rated direct voltage	24 V to 250 V	
Current input, energized (independent of the control voltage)	approx. 0.4 mA	
Pickup time Response time binary output after trigger signal from binary input	approx. 3 ms approx. 9 ms	
Dropout time Response time binary output after trigger signal from binary input	approx. 4 ms approx. 5 ms	
Secured switching thresholds	(adjustable)	
For rated voltages	DC 24 V to 125 V	V high > DC 19 V V low < DC 10 V
For rated voltages	DC 110 V to 250 V	V high > DC 88 V V low < DC 44 V
For rated voltages	DC 220 V and 250 V	V high > DC 176 V V low < DC 88 V
Maximum admissible voltage	300 V DC	
Input interference suppression	220 V induced above 220nF at a recovery time between two switching operations ≥ 60 ms	

Output Relay

Signal/command relay, alarm relay		
Quantity and data	depending on the order variant (configurable)	
Order variant	NO contact	Changeover contact
7SD80	5, 8 depending on ordering code	2 (+ 1 life contact not configurable)
Switching capability MAKE	1000 W / 1000 VA	
Switching capability BREAK	40 W or 30 VA at L/R ≤ 40 ms	
Switching voltage AC and DC	250 V	
Permissible current per contact (continuous)	5 A	
Permissible current per contact (close and hold)	30 A for 1 s (NO contact)	
Interference suppression capacitor at the relay outputs 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

Protection Data Interfaces

See Section 4.2 „Protection Data Interfaces“

Operator 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
Operation	With DIGSI
Transmission speed	up to 12 Mbit/s max.
Bridgeable distance	5 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 (also for time synchronization)		
	Connection	Back case bottom, mounting location "B", 9-pin DSUB socket
	Test voltage	500 V; 50 Hz
	Transmission speed	min. 1 200 Bd, max. 115 000 Bd; factory setting 9 600 Bd
	Bridgeable distance	16.40 yd
RS485		
	Connection	Back case bottom, mounting location "B", 9-pin DSUB socket
	Test voltage	500 V; 50 Hz
	Transmission speed	min. 1 200 Bd, max. 115 000 Bd; factory setting 9 600 Bd
	Bridgeable distance	Max. 0.62 miles
Optical fiber cable		
	Optical connector type	ST connector
	Connection	Back case bottom, mounting location "B"
	Optical wavelength	λ = 820 nm
	Laser Class 1 according to EN 60825-1/-2	When using glass fiber 50/125 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. 0.93 miles
	Character idle state	Configurable; factory setting „Light off“

IEC 60870-5-103 redundant RS485		
	Isolated interface for data transfer to a control center	
	Connection	Back case bottom, mounting location "B", RJ45 socket
	Test voltage	500 V; 50 Hz
	Transmission speed	min. 2 400 Bd, max. 57 600 Bd; factory setting 19 200 Bd
	Bridgeable distance	Max. 0.62 miles
Profibus RS485 (DP)		
	Connection	Back housing bottom, mounting location "B", 9-pin D-sub socket via straight Profibus connector (6KG1500-0EA02)
	Test voltage	500 V; 50 Hz
	Transmission speed	Up to 1.5 MBd
	Bridgeable distance	1 000 m (0.62 miles) at ≤ 93.75 kBd 546.81 yd at ≤ 187.5 kBd 218.72 yd at ≤ 1.5 MBd
Profibus FO (DP)		
	FO connector type	ST connector Double ring
	Connection	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. 0.93 miles
DNP3.0 /MODBUS RS485		
	Connection	Back case bottom, mounting location "B", 9-pin DSUB socket
	Test voltage	500 V; 50 Hz
	Transmission speed	Up to 19.200 Baud
	Bridgeable distance	Max. 0.62 miles
DNP3.0 /MODBUS FO		
	FO connector type	ST connector transmitter/receiver
	Connection	Back case bottom, rear mounting location "B"
	Transmission speed	Up to 19.200 Baud
	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. 0.93 miles

Ethernet electrical (EN 100) for IEC61850 and DIGSI		
	Connection	Back case bottom, mounting location "B", 2 x RJ45 socket 100BaseT in acc. with IEEE802.3
	Test voltage (with regard to the socket)	500 V; 50 Hz
	Transmission speed	100 Mbit/s
	Bridgeable distance	21.87 yd
Ethernet electrical (EN 100) for IEC61850 and DIGSI		
	Connection	Back case bottom, mounting location "B", LC connector 100BaseF in acc. with IEEE802.3
	Transmission speed	100 Mbit/s
	Optical wavelength	1300 nm
	Bridgeable distance	Max. 1.24 miles

4.1.5 Electrical Tests

Standards

Standards:	IEC 60255 IEEE Std C37.90, see individual functions VDE 0435 for more standards see also individual functions

Insulation Tests

Standards:	IEC 60255-27 and IEC 60870-2-1
High voltage test (routine test). All circuits except power supply, binary inputs, communication interfaces and CU protection data interface	2.5 kV; 50 Hz
High voltage test (routine test). Auxiliary voltage and binary inputs	3.5 kV DC
High voltage test (routine test): isolated communication interfaces (A and B)	500 V; 50 Hz
Voltage test (routine test) CU protection data interface [1)]	DC 70 V
Impulse voltage test (type test), all processor circuits against each other and against the grounding terminal (except communication interface and CU protection data interface) category III	5 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), all processor circuits against the internal electronics (except communication interface and CU protection data interface)	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), all processor circuits against the CU protection data interface [2)]	6 kV (peak value); 1.2 µs/50 µs; 0.5 J; 3 positive and 3 negative impulses at intervals of 1 s
Voltage test (type test) only CU protection data interface against all processor circuits [2)]	DC 3.5 kV
Voltage test (type test) only CU protection data interface against protective grounding terminal [3)]	1.9 kV; 50 Hz

[1)] Protection circuits through surge arresters on the primary side

[2)] (type test) not against protective conductor and internal electronic components. Protection circuits through surge arresters on the primary side

[3)] Voltage test without surge arresters (only type test), see also Section 3.1 Mounting and Connections

EMC Tests for Immunity (Type Tests)

Standards:		IEC 60255-6 and -22, (product standards) IEC/EN 61000-6-2 VDE 0435 For more standards, see the individual tests.
1 MHz test, class III IEC 60255-22-1, IEC 61000-4-18, IEEE C37.90.1		2.5 kV (Peak); 1 MHz; τ = 15 µs; 400 Surges per s; Test duration 2 s; R_i = 200 Ω
Electrostatic discharge, class IV IEC 60255-22-2, IEC 61000-4-2		8 kV contact discharge; 15 kV air discharge, both polarities; 150 pF; R_i = 330 Ω
Irradiation with HF field, amplitude-modulated, class III IEC 60255-22-3, IEC 61000-4-3		10 V/m; 80 MHz to 1 GHz; 1.4 GHz to 2.7 GHz 80 % AM; 1 kHz
Fast transient disturbances/burst, class IV IEC 60255-22-4, IEC 61000-4-4, IEEE C37.90.1		4 kV; 5 ns/50 ns; 5 kHz; burst length = 15 ms; repetition rate 300 ms; both polarities: R_i = 50 Ω; test duration 1 min
High-energy surge voltages installation class III IEC 60255-22-5, IEC 61000-4-5		Impulse: 1.2 µs/50 µs
	Auxiliary voltage	Common mode: 4 kV; 12 Ω; 9 µF Diff. mode: 1 kV; 2 Ω; 18 µF
	Measuring inputs and relay outputs	Common mode: 4 kV; 42 Ω; 0.5 µF Diff. mode: 1 kV; 42 Ω; 0.5 µF
	Binary inputs	Common mode: 4 kV; 42 Ω; 0.5 µF Diff. mode: 1 kV; 42 Ω; gas-filled tube
	CU protection interface, unscreened, a and b	Common mode: 4 kV; 42 Ω; gas-filled tube
	CU protection interface, screened	Common mode: 4 kV; 2 Ω; coupling into shield
Line-conducted high frequency, amplitude-modulated, class III IEC 60255-22-6, IEC 61000-4-6		10 V: 150 kHz to 80 MHz: 80 % AM: 1 kHz
Power system frequency magnetic field IEC 61000-4-8; class IV;		30 A/m; continuous; 300 A/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; 80 MHz to 1GHz; 100 % pulse 1 Hz rep. rate 50% duty cycle
Damped oscillations IEC 61000-4-18		2.5 kV (peak); 100 kHz; 40 pulses per s; test duration 2 s; Ri = 200 Ω

EMC Tests for Noise Emission Test (Type Test)

Standard:	IEC/EN 61000-6-4
Radio noise voltage to lines, only auxiliary voltage IEC-CISPR 11	150 kHz to 30 MHz Limit Class A
Interference field strength IEC-CISPR 11	30 MHz to 1000 MHz Limit Class A

4.1.6 Mechanical Stress Tests

Vibration and Shock Stress during Stationary Operation

Standards:	IEC 60255-21 and IEC 60068
Oscillation IEC 60255-21-1, Class II; IEC 60068-2-6	Sinusoidal 10 Hz to 60 Hz: ± 0.075 mm amplitude; 60 Hz to 150 Hz: 1g acceleration frequency sweep rate 1 octave/min 20 cycles in 3 orthogonal axes.
Shock IEC 60255-21-2, Class I; IEC 60068-2-27	Semi-sinusoidal 5 g acceleration, duration 11 ms, each 3 shocks in both directions of the 3 axes
Seismic Vibration IEC 60255-21-3, Class II; 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 60255-6
Type test (in acc. with IEC 60068-2-1 and -2, Test Bd for 16 h)	–25 °C to +85 °C or –13 °F to +185 °F
Permissible temporary operating temperature (tested for 96 h)	–20 °C to +70 °C or –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 Design

Case	7XP20
Dimensions	see dimensional drawings, Section 4.19

Device	Case	Size	Weight
7SD80**-*B	for panel surface mounting	$^{1}/_{6}$	4.5 kg (9.9 lb)
7SD80**-*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 1x for voltage terminal
Degree of pollution, IEC 60255-27	2

4.1.10 UL Certification Conditions

Output Relays	24 VDC	5 A General Purpose
	48 VDC	0.8 A General Purpose
	240 VDC	0.1 A General Purpose
	240 VAC	5 A General Purpose
	120 VAC	1/3 hp
	250 VAC	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 Protection Interfaces and Connections

Differential Protection

Number of devices for one protected object (=number of ends delimited by the current transformer)	2

Protection Interfaces

Connection optical fiber	Port „A“
Connection electrical	Voltage terminal „D1“ and "D2"
Connection modules for protection data interface, depending on the order variant:	

Optical protection data interface:	
Maximum distance monomode fiber	14.91 miles
Maximum distance multimode fiber[1)]	2.49 miles
Protocol	Full duplex
Connector type	Duplex LC connector, SFF (IEC 61754-20 standard)
Maximum baudrate	512 kbit/s
Transmission rate	min. -15 dBm_{avg} max. -8 dBm_{avg}
Receiver sensitivity (maximum)	-31 dBm_{avg}
Optical wavelength	1310 nm
Optical budget	16.0 dB
Laser Class 1 according to EN 60825-1/-2	Using monomode fiber 9 µm/125 µm
Range	You should assume a path attenuation of 0.5 dB/km (0.8 dB/miles) for monomode and multimode fiber. For multimode fiber you must additionally take the product of the bandwidth lengths into consideration.

1) When using multimode fiber, a monomode patch cable is used on the sending side; a multimode patch cable is used on the receiving side (mode conditioning patch cable).

Electrical protection data interface:	
Maximum distance	16 km (9.94 miles) (for AWG 19 / 0.65 mm^2)
Maximum transmission rate	128 kbit/s
Telecommunication cable or communication cable	twin-wire, e.g. A-2Y(L)2Y cable
Cable attenuation	< 40 dB (for 80 kHz)

Ranges determined during tests [1]				
Mode	Transmission rate [kbit/s]	maximum range [km]	Attenuation [db]	Signal noise ratio (SNR) [db]
Telephone wire A-2Y(L)2Y 20x2x0.8 twisted, fully screened				
01	64	20	42	12
02	128	18	42	11
03	64	20	39	7
04	128	20	42	6
05	128	16	33	9
06	128	14	28	6
Signal line A-2Y2YB2Y 20x1x1.4 PE insulation material, single wires not twisted, fully screened				
01	64	6	10	36
02	128	6	13	21
03	64	20	23	20
04	128	6	10	30
05	128	14	18	16
06	128	20	23	9
PVC line NYY-J 16x1.5 PVC insulation material, single wires not twisted				
01	64	8	14	11
02	128	6	14	30
03	64	16	24	19
04	128	6	11	30
05	128	12	18	13
06	128	16	24	8

1) A multi-wire cable of 1 km length was used to determine the maximum range. The cables were wound on cable reels. The 1 km wires were connected in series to obtain the maximum length. Twisted pair cables allow the use of several similar communication devices (e.g. 3 pairs of 7SD80) within one cable. You should use twisted pair cables to minimize possible interference. Considerable restrictions may occur due to crosstalk effects when using signal cables or underground cables (no telecommunication cables, e.g. auxiliary protection cables with high capacitance per unit length) which are used by several communication devices. The values determined here are examples. The actually possible range depends on the properties of the cable, the number of joints and splices.

To select the modes of the Cu protection interface connection, please observe the following criteria:			
	The connection must be established in the selected mode.		
	The number of message errors (per minute and/or per hour) should be as small as possible (operational measured value).		
	Mode	Signal noise ratio, S/N (the higher this value the better)	Attenuation, D (the smaller this value the better)
	01 and 02	≥ 12 db	≤ 40 dB
	03 and 04	≥ 6 db	≤ 40 dB
	05 and 06	≥ 6 db	≤ 30 dB
	(the signal noise ratio and the attenuation are operational measured values)		
It can be possible to select several modes for a cable. Due the smaller disturbance sensitivity, modes 01 and 03 are recommended. We recommend the following for the lines listed here as examples:			
	Line 1 (telephone line): Mode 03 (largest range 20 km)		
	Line 2 (signal line): Mode 06 (largest range 20 km for high transmission rates)		
	Line 3 (PVC line): Mode 03 (Range 16 km if SNR is good. The high attenuation is due to the range here)		

4.3 87 Differential Protection Phase Comparison Protection

Pickup Values

Differential current, dynamic; 87L Idyn>	I_{Nom} = 1 A	0.20 A to 4.00 A	Increments 0.01 A
	I_{Nom} = 5 A	1.00 A to 20.00 A	
Differential current when switching onto a fault; 87L Idyn close>	I_{Nom} = 1 A	0.20 A to 4.00 A	Increments 0.01 A
	I_{Nom} = 5 A	1.00 A to 20.00 A	
Differential current, static; 87L Isteady>	I_{Nom} = 1 A	0.50 A to 4.00 A	Increments 0.01 A
	I_{Nom} = 5 A	2.50 A to 20.00 A	

Operating Times

The operating times depend on the communication speed. The following data require a transmission rate of 512 kbit/s.		
Pickup time with infeed at both ends approx.		15 ms to 40 ms
Pickup times with infeed at both ends approx.		35 ms to 40 ms
Command time approx.		15 ms to 90 ms
Start time at 50 Hz. approx.		51 ms
Frequency range		45 Hz to 55 Hz at 50 Hz 55 Hz to 65 Hz at 60 Hz 25 Hz to 45 Hz at 50 Hz 30 Hz to 55 Hz at 60 Hz if only the static element is active
Tolerances	I_{Nom} = 1 A	20 mA
	I_{Nom} = 5 A	100 mA

Time Delaytime delays

Tripping delay	87L Trip Delay	0.00 s to 0.10 s	Increments 0.01 s
Expiry tolerances		1 % of set value or 10 ms	
The set times are pure time delays.			

Emergency Operation

Communication failure	See section „Time Overcurrent Protection“

Frequency Operating Range

Operating Range	$0.8 \leq f/f_N \leq 1.2$ stable when starting machine

Pickup Characteristic

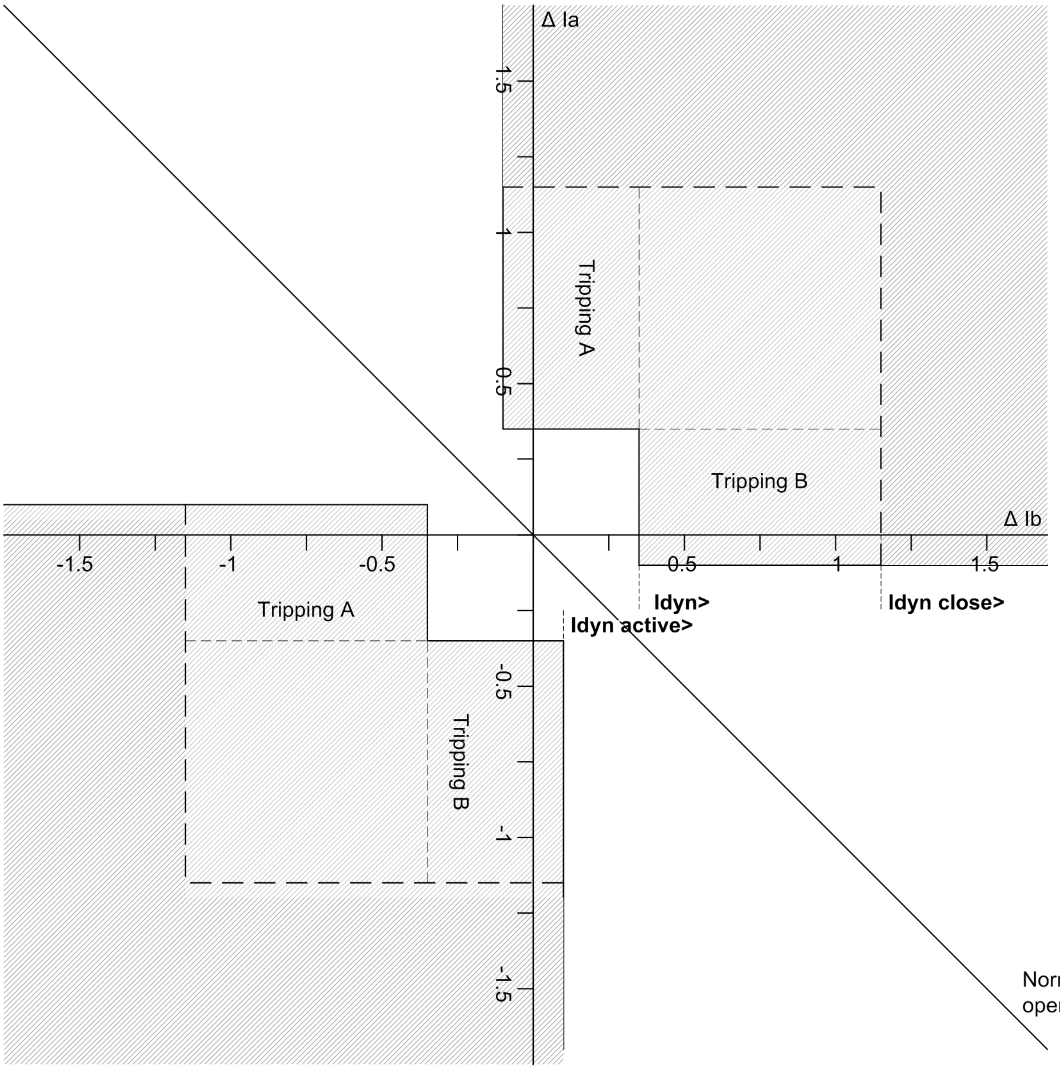


Figure 4-1 Dynamic pickup characteristic

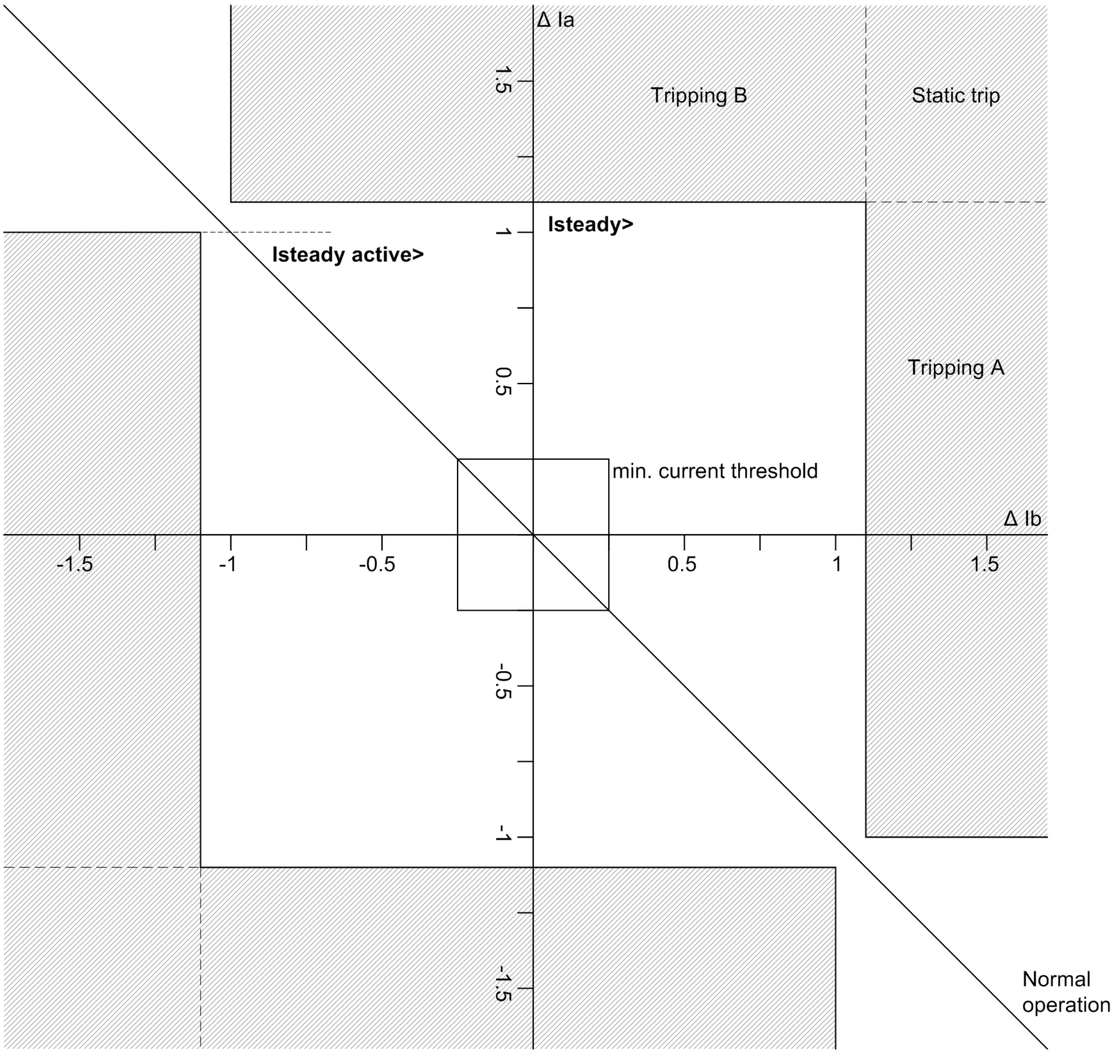


Figure 4-2 Static pickup characteristic

4.4 Ground Fault Differential Protection in Grounded Systems

Pickup Values

Differential current; 87N L: I-DIFF>	I_{Nom} = 1 A	0.10 A to 20.00 A	Increments 0.01 A
	I_{Nom} = 5 A	0.50 A to 100.00 A	

Operating Times

The operating times depend on the communication speed. The following data require a transmission rate of 512 kbit/s.		
Pickup/trip times of the 87N L: I-DIFF> element at 50 Hz or 60 Hz approx.	minimum	35 ms
	typical	37 ms
	maximum	40 ms
Dropout times of the I87N L: I-DIFF> element approx.	minimum	30 ms
	typical	32 ms
	maximum	34 ms
Differential current		5 % of setting value or 1 % I_{Nom}
Delay of the 87N L: I-DIFF> element approx.		1 % of setting value or 10 ms
Frequency range		45 Hz to 55 Hz at 50 Hz 55 Hz to 65 Hz at 60 Hz 25 Hz to 45 Hz at 50 Hz 30 Hz to 55 Hz at 60 Hz Increased tolerances

Time Delays

Tripping delay	87L Trip Delay	0.00 s to 0.10 s	Increments 0.01 s
Expiry tolerances		1 % of setting value or 10 ms	
The set times are pure time delays.			

Emergency Operation

Communication failure	See section „Time Overcurrent Protection“

Frequency Operating Range

Operating Range	$0.8 \leq f/f_N \leq 1.2$ stable at machine startup (f = 0 to f_N)

Standard Precision of Operational Measured Values

The standard accuracy of the operational measured values of the ground fault differential protection of ± 0.5 % of the rated operational current is ensured up to a transformer error adjustment of 2:1.

4.5 Ground Fault Differential Protection in Resonant-grounded / Isolated Systems

Pickup Values

Differential current; 87N L: IN(s)>	I_{Nom} = 1 A	0.003 A to 1.000 A	Increments 0.001 A

Operating Times

The operating times depend on the communication speed. The following data require a transmission rate of 512 kbit/s.		
Pickup/trip times of the 87N L: IN(s)> element at 50 Hz or 60 Hz approx.	minimum	24 ms to 29 ms
Dropout times of the I87N L: I-DIFF> element approx.	minimum	35 ms to 50 ms
Minimum current for direction determination		5 % of setting value or 1 % I_{Nom}
Delay of the 87N L: I-DIFF> element approx.		1 % of setting value or 10 ms
Frequency range		45 Hz to 55 Hz at 50 Hz 55 Hz to 65 Hz at 60 Hz 25 Hz to 45 Hz at 50 Hz 30 Hz to 55 Hz at 60 Hz Increased tolerances

Time Delays

Tripping delay	87N L:TripDelay	0.00 s to 320 s	Increments 0.01 s
Expiry tolerances		1 % of setting value or 10 ms	
The set times are pure time delays.			

Frequency Operating Range

Operating Range	$0.8 \le f/f_N \le 1.2$ stable at machine start-up (f = 0 to f_N)

4.6 Breaker Intertrip and Remote Tripping- Direct Local Trip

Breaker Intertrip and Remote Tripping

Transfer trip of the opposite end for single-end tripping	can be switched on/off

External Direct Trip

Operating time, total	approx. 6 ms	
Trip time delay Trip Time DELAY	minimum	14 ms
	typical	17 ms
	maximum	20 ms
Dropout times	minimum	25 ms
	typical	27 ms
	maximum	29 ms
Expiry tolerances	1 % of setting value or 10 ms	
The set times are pure time delays		

Remote Trip

Tripping of the remote ends by a command injected via binary inputs The command times depend on the communication speed. The following data require a transmission rate of 512 kbit/s for the optical fiber protection interface.			
Operating times, total approx.	minimum		10 ms
	typical		13 ms
	maximum		15 ms
Dropout times	minimum		26 ms
	typical		27 ms
	maximum		29 ms
Tripping delay	85 DT: TD-BI	0.00 s to 30.00 s	Increments 0.01 s
Trip time prolongation	85 DT:T-PROL BI	0.00 s to 30.00 s	Increments 0.01 s
Expiry tolerances		1 % of setting value or 10 ms	
The set times are pure time delays.			

4.7 Time Overcurrent Protection

Operating Modes

As emergency overcurrent protection or backup overcurrent protection	
Emergency Overcurrent Protection	Effective when the differential protection system is blocked (e.g. because of a failure of the device communication)
Backup overcurrent protection	operates independent of any events

Characteristic Curves

Definite dime stages (definite)	I_{Ph}>, $3I_0$>, I_{Ph}>>, $3I_0$>>, I_{Ph}>>>, $3I_0$>>>, $I_{Ph}>_{dir}$, $3I_0>_{dir}$, $I_{Ph}>>_{dir}$, $3I_0>>_{dir}$
Inverse time elements	I_P, $3I_{0P}$; I_{Pdir}, $3I_{0Pdir}$; a characteristic curve according to Figure 4-3 to 4-5 can be selected.

High-Set Current Elements

Pickup value 50-B1 PICKUP (phases)	for I_{Nom} = 1 A	0.10 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 125.00 A or ∞ (ineffective)	
Pickup value 50N-B1 PICKUP (ground)	for I_{Nom} = 1 A	0.05 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 125.00 A or ∞ (ineffective)	
Pickup value (directional phases)	for I_{Nom} = 1 A	0.10 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 125.00 A or ∞ (ineffective)	
Delays (directional elements)		0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
		0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Delay 50-B1 DELAY (phases)		0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Delay 50N-B1 DELAY (ground)		0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Dropout ratio		approx. 0.93 for $I/I_{Nom} \geq 0.5$	
Pickup times		minimum	30 ms
		typical	32 ms
		maximum	35 ms
Dropout times		minimum	33 ms
		typical	35 ms
		maximum	38 ms
Tolerances	Currents	3 % of setting value or 1 % nominal current	
	Times	1 % of setting value or 10 ms	
The set times are pure time delays			

Overcurrent Elements

Pickup value 50-B2 PICKUP (phases)	for I_{Nom} = 1 A	0.10 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 125.00 A or ∞ (ineffective)	
Pickup value 50N-B2 PICKUP (ground)	for I_{Nom} = 1 A	0.05 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 125.00 A or ∞ (ineffective)	
Delays	50-B2 DELAY	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
	50N-B2 DELAY	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Pickup value 50-STUB PICKUP (phases)	for I_{Nom} = 1 A	0.10 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 125.00 A or ∞ (ineffective)	
Pickup value 50N-STUB PICKUP (ground)	for I_{Nom} = 1 A	0.05 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 125.00 A or ∞ (ineffective)	
Delays	50-STUB DELAY	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
	50N-STUB DELAY	0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Pickup value (directional phases)	for I_{Nom} = 1 A	0.10 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 125.00 A or ∞ (ineffective)	
Pickup value (Earth directional)	for I_{Nom} = 1 A	0.05 A to 25.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 125.00 A or ∞ (ineffective)	
Delays (directional elements)		0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
		0.00 s to 30.00 s or ∞ (ineffective)	Increments 0.01 s
Dropout ratio		approx. 0.93 for $I/I_{Nom} \geq 0.5$	
Pickup times		approx. 30 ms	
Dropout times		approx. 30 ms	
Tolerances	Currents	3 % of setting value or 1 % nominal current	
	Times	1 % of setting value or 10 ms	
The set times are pure time delays			

Inverse Time Current Elements (IEC)

Pickup value 51-B PICKUP (phases)	for I_{Nom} = 1 A	0.10 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 20.00 A or ∞ (ineffective)	
Pickup value 51N-B PICKUP (ground)	for I_{Nom} = 1 A	0.05 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 20.00 A or ∞ (ineffective)	
Time multipliers	51-B TD IEC (phases)	0.05 s to 3.00 s or ∞ (ineffective)	Increments 0.01 s
	51N-B TD IEC (ground)	0.05 s to 3.00 s or ∞ (ineffective)	Increments 0.01 s
Additional time delays	51-B AddT-DELAY (phases)	0.00 s to 30.00 s	Increments 0.01 s
	51N-B AddTdelay (ground)	0.00 s to 30.00 s	Increments 0.01 s
Tolerances			
Pickup, dropout thresholds I_P, $3I_{0P}$		3 % of setting value or 1 % of nominal current	
Pickup time $2 \le I/I_P \le 20$ and $T_{IP} \ge 1$ s Pickup time $2 \le I/3I_{0P} \le 20$ and $T_{3I0P} \ge 1$ s		5 % of setting value ± 15 ms 5 % of setting value ± 15 ms	
defined times		1 % of setting value or 10 ms	
Pickup value 67-TOC PICKUP (directional phases)	for I_{Nom} = 1 A	0.10 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 20.00 A or ∞ (ineffective)	
Pickup value 67N-TOC PICKUP (Earth directional)	for I_{Nom} = 1 A	0.05 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 20.00 A or ∞ (ineffective)	
Time multipliers (directional elements)	67-TOC TD IEC (phases)	0.05 s to 3.00 s or ∞ (ineffective)	Increments 0.01 s
	67N-TOC TD IEC (ground)	0.05 s to 3.00 s or ∞ (ineffective)	Increments 0.01 s
Additional time delays (directional elements)	67-TOC AddTDel. (phases)	0.00 s to 30.00 s	Increments 0.01 s
	67N-TOC AddTDel (ground)	0.00 s to 30.00 s	Increments 0.01 s
Tolerances (directional elements)			
Pickup, dropout thresholds I_{Pdir}, $3I_{0Pdir}$		3 % of setting value or 1 % of nominal current	
Pickup time $2 \le I/I_{Pdir} \le 20$ and $T_{IPdir} \ge 1$ s Pickup time $2 \le I/3I_{0Pdir} \le 20$ and $T_{3I0Pdir} \ge 1$ s		5 % of setting value ± 15 ms 5 % of setting value ± 15 ms	
defined times		1 % of setting value or 10 ms	
Characteristics		See Figure 4-3	
defined times		1 % of setting value or 10 ms	

Inverse Time Elements (ANSI)

Pickup value 51-B PICKUP (phases)	for I_{Nom} = 1 A	0.10 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 20.00 A or ∞ (ineffective)	
Pickup value 51N-B PICKUP (ground)	for I_{Nom} = 1 A	0.05 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 20.00 A or ∞ (ineffective)	
Time multipliers	51-B TD ANSI (phases)	0.50 s to 15.00 s or ∞ (ineffective)	Increments 0.01 s
	51N-B TD ANSI (ground)	0.50 s to 15.00 s or ∞ (ineffective)	Increments 0.01 s
Additional time delays	51-B AddT-DELAY (phases)	0.00 s to 30.00 s	Increments 0.01 s
	51N-B AddTdelay (ground)	0.00 s to 30.00 s	Increments 0.01 s
Tolerances			
Pickup, dropout thresholds I_P, $3I_{0P}$		3 % of setting value or 1 % of nominal current	
Pickup time $2 \leq I/I_P \leq 20$ and $D_{IP} \geq 1$ s Pickup time $2 \leq I/3I_{0P} \leq 20$ and $D_{3I0P} \geq 1$ s		5 % of setting value ± 15 ms 5 % of setting value ± 15 ms	
defined times		1 % of setting value or 10 ms	
Pickup value 67-TOC PICKUP (directional phases)	for I_{Nom} = 1 A	0.10 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 20.00 A or ∞ (ineffective)	
Pickup value 67N-TOC PICKUP (Earth directional)	for I_{Nom} = 1 A	0.05 A to 4.00 A or ∞ (ineffective)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 20.00 A or ∞ (ineffective)	
Time multipliers (directional elements)	67-TOC TD ANSI (phases)	0.50 s to 15.00 s or ∞ (ineffective)	Increments 0.01 s
	67N-TOC TD ANSI (ground)	0.50 s to 15.00 s or ∞ (ineffective)	Increments 0.01 s
Additional time delays (directional elements)	67-TOC AddTDel. (phases)	0.00 s to 30.00 s	Increments 0.01 s
	67N-TOC AddTDel (ground)	0.00 s to 30.00 s	Increments 0.01 s
Tolerances (directional elements)			
Pickup, dropout thresholds I_{Pdir}, $3I_{0Pdir}$		3 % of setting value or 1 % of nominal current	
Pickup time $2 \leq I/I_{Pdir} \leq 20$ and $D_{IPdir} \geq 1$ s Pickup time $2 \leq I/3I_{0Pdir} \leq 20$ and $D_{3I0Pdir} \geq 1$ s		5 % of setting value ± 15 ms 5 % of setting value ± 15 ms	
Characteristics		see Figure 4-4 and 4-5	
defined times		1 % of setting value or 10 ms	

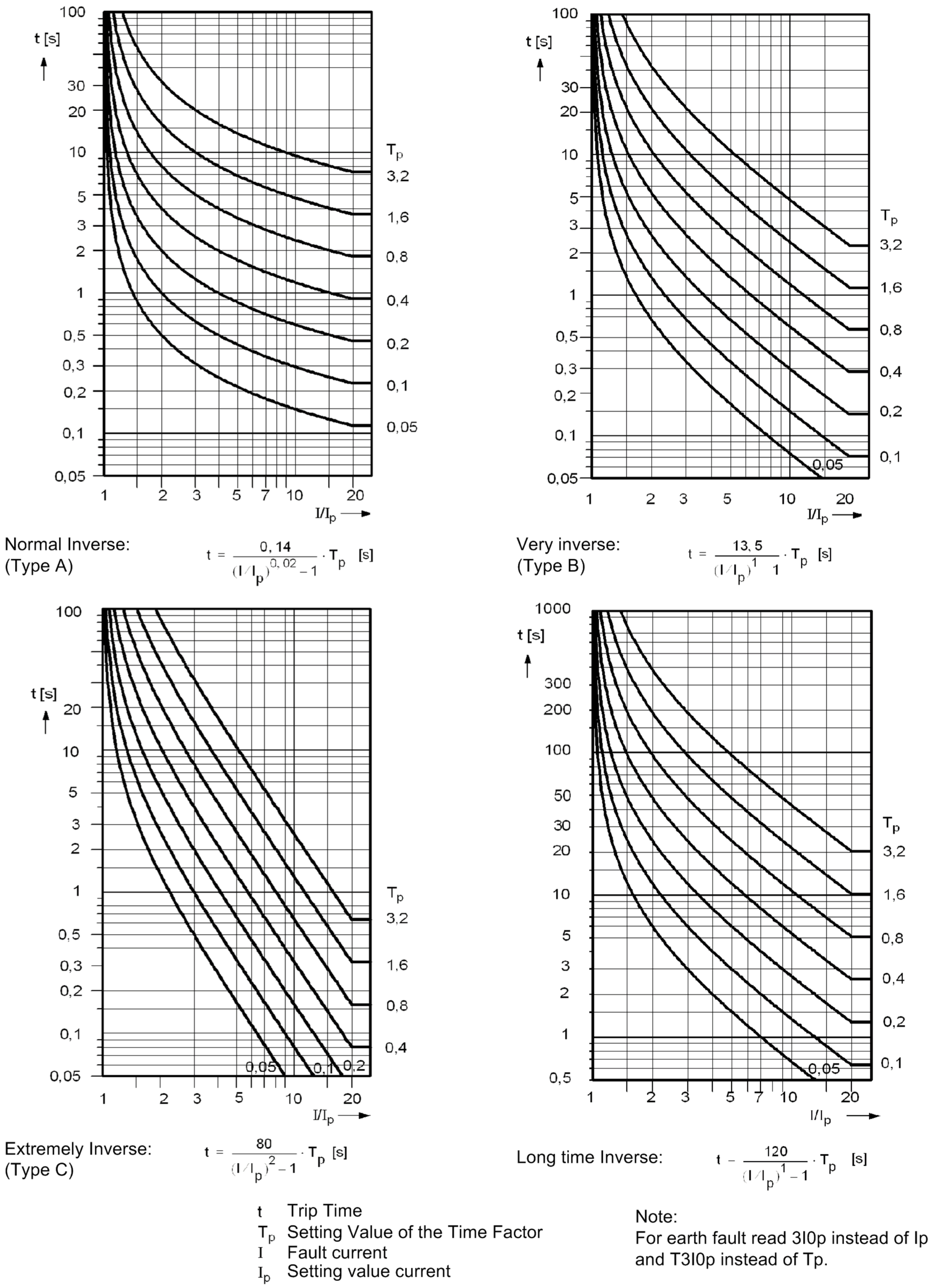
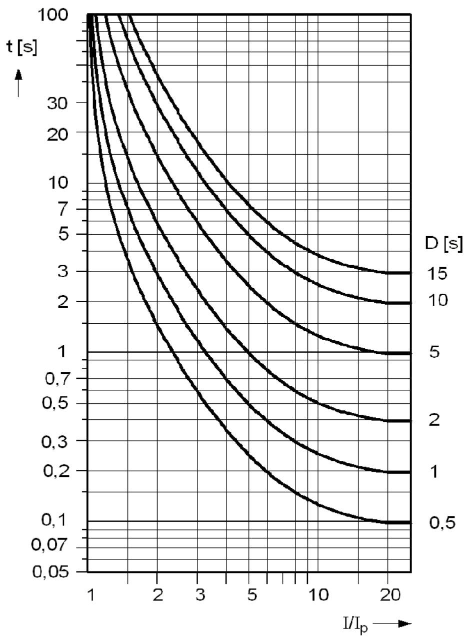
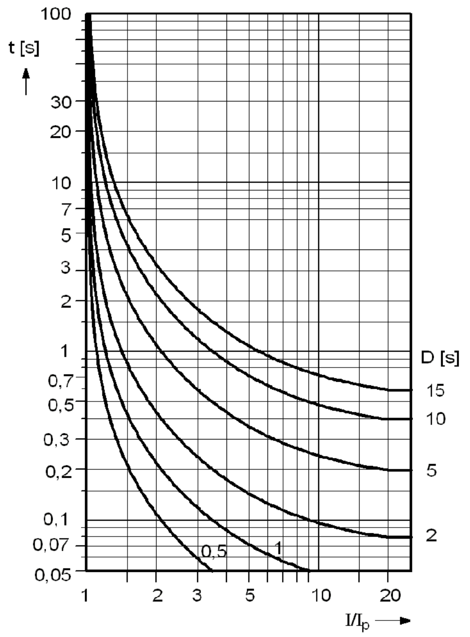


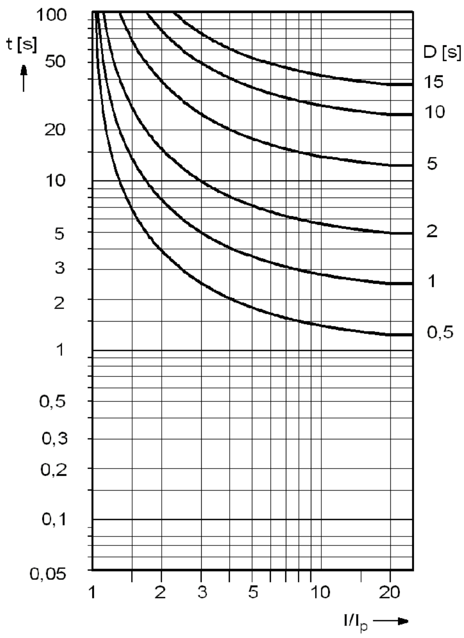
Figure 4-3 Trip time characteristics of inverse time overcurrent elements, acc. IEC (phases and ground)



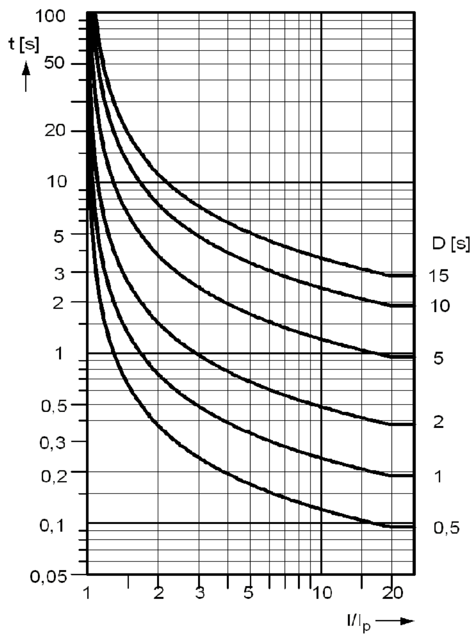
INVERSE $t = \left(\frac{8{,}9341}{(I/I_p)^{2{,}0938} - 1} + 0{,}17966 \right) \cdot D$ [s]



SHORT INVERSE $t = \left(\frac{0{,}2663}{(I/I_p)^{1{,}2969} - 1} + 0{,}03393 \right) \cdot D$ [s]

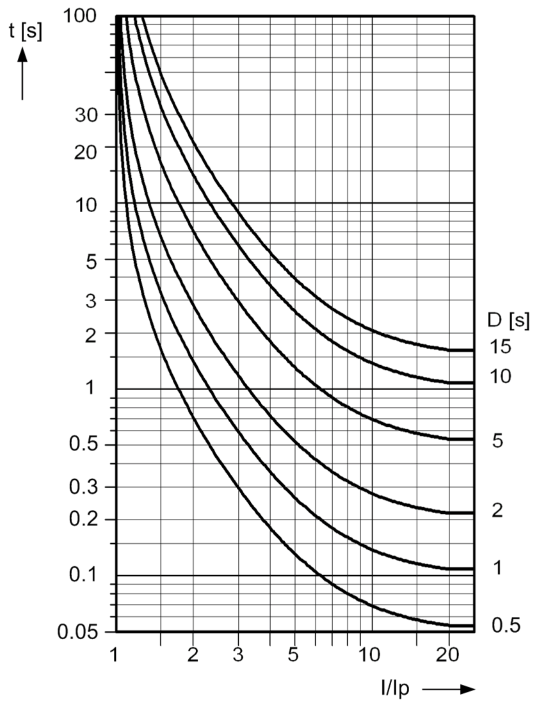


LONG INVERSE $t = \left(\frac{5{,}6143}{(I/I_p) - 1} + 2{,}18592 \right) \cdot D$ [s]



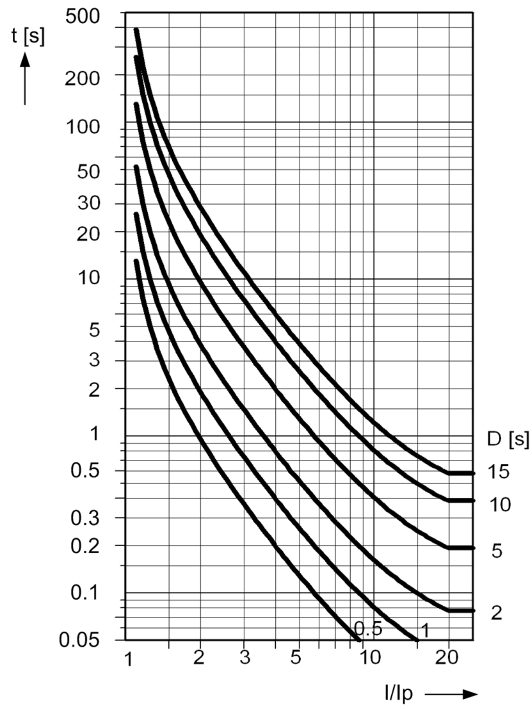
MODERATELY INVERSE $t = \left(\frac{0{,}0103}{(I/I_p)^{0{,}02} - 1} + 0{,}0228 \right) \cdot D$ [s]

Figure 4-4 Trip time characteristics of inverse time overcurrent element, acc. ANSI/IEEE (phases and ground)



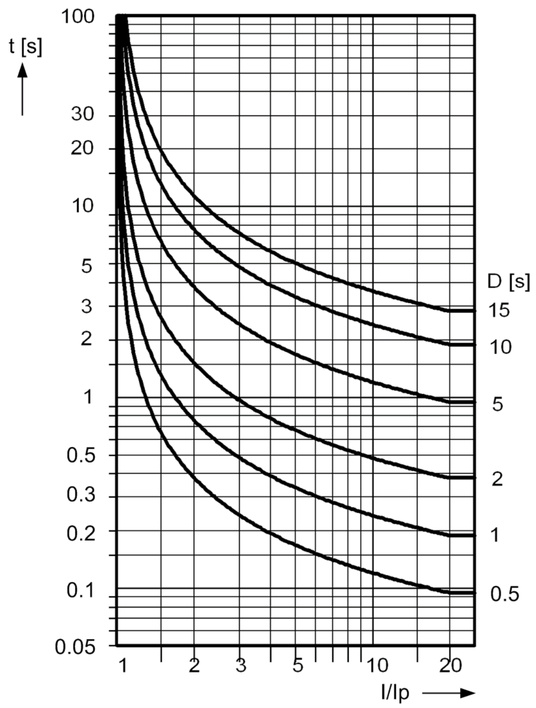
VERY INVERSE:

$$t = \left(\frac{3{,}922}{(I/I_p)^2 - 1} + 0{,}0982 \right) \cdot D[s]$$



EXTREMELY INVERSE

$$t = \left(\frac{5{,}64}{(I/I_p)^2 - 1} + 0{,}02434 \right) \cdot D[s]$$



DEFINITE INVERSE

$$t = \left(\frac{0{,}4797}{(I/I_p)^{1{,}5625} - 1} + 0{,}21359 \right) \cdot D[s]$$

t Trip Time
D Setting value time multiplier
I Fault current
Ip Setting value current

Note:
For earth fault read 3I0p instead of Ip and D3I0p instead of D.

Figure 4-5 Trip time characteristics of inverse time overcurrent element, acc. ANSI/IEEE (phases and ground)

4.8 Inrush Current Restraint Breaker Intertrip and Remote Tripping

Phase Comparison Protection

Restraint ratio 2. Inrush stabilization I_{2fN}/I_{fN}		0 % to 45 %	Increments 1 %
Max. current for restraint	I_{Nom} = 1 A	1.1 A to 25.0 A	Increments 0.1 A
	I_{Nom} = 5 A	5.5 A to 125.0 A	
Crossblock function		can be switched on/off	
Max. action time for crossblock CROSSB 2HM		0.00 s to 60.00 s or 0 (crossblock deactivated) or ∞ (active until dropout)	Increments 0.01 s

Restricted Earth Fault Protection

Restraint ratio 2. Inrush stabilization I_{2fN}/I_{fN}		0 % to 45 %	Increments 1 %
Max. current for restraint	I_{Nom} = 1 A	1.1 A to 25.0 A	Increments 0.1 A
	I_{Nom} = 5 A	5.5 A to 125.0 A	
Crossblock function		can be switched on/off	
Max. action time for crossblock CROSSB 2HM		0.00 s to 60.00 s or 0 (crossblock deactivated) or ∞ (active until dropout)	Increments 0.01 s

4.9 Circuit-Breaker Failure Protection (Optional)

Circuit Breaker Supervision

Current-flow Monitoring	for I_{Nom} = 1 A	0.05 A to 20.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 100.00 A	
Zero sequence current monitoring	for I_{Nom} = 1 A	0.05 A to 20.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 100.00 A	
Dropout ratio		approx. 0.95	
Tolerance		5 % of setting value or 1 % of nominal current	
Monitoring of circuit breaker auxiliary contact position			
for three-pole tripping		binary input for CB auxiliary contact	
Note: The circuit breaker failure protection can also operate without the indicated circuit breaker auxiliary contacts, but the function range is then reduced. Auxiliary contacts are necessary for the circuit breaker failure protection for tripping without or with a very low current flow (e.g. Buchholz protection) and for stub fault protection and circuit breaker pole discrepancy supervision.			

Initiation Conditions

For circuit breaker failure protection	Internal or external 1-pole trip [1)] Internal or external 3-pole trip [1)] Internal or external 3-pole trip without current [1)]

[1)] Via binary inputs

Times

Pickup time	Approx. 5 ms with measured quantities present Approx. 20 ms after switch-on of measured quantities	
Drop-off time, internal (overshoot time)	≤ 15 ms at sinusoidal measured values, ≤ 25 ms maximal	
Time delays for all elements	0.00 s to 30.00 s; ∞	Increments 0.01 s
Tolerance	1 % of setting value or 10 ms	

End Fault Protection

With signal transmission to the opposite line end		
Time delay	0.00 s to 30.00 s; ∞	Increments 0.01 s
Tolerance	1 % of setting value or 10 ms	

Pole Discrepancy Supervision

Initiation criterion	Not all poles are closed or open	
Monitoring time	0.00 s to 30.00 s; ∞	Increments 0.01 s
Tolerance	1 % of setting value or 10 ms	

4.10 Thermal Overload Protection 49

Setting Ranges

Factor k according to IEC 60255-8		0.10 to 4.00	Increments 0.01
Time Constant τ_{th}		1.0 min to 999.9 min	Increments 0.1 min
Thermal Alarm $\Theta_{Alarm}/\Theta_{Trip}$		50% to 100% of the trip overtemperature	Increments 1 %
Current alarm element I_{Alarm}	for I_{Nom} = 1 A	0.10 A to 4.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 20.00 A	

Calculation Method

Calculation method temperature rise	Maximum temperature rise of 3 phases Average of temperature rise of 3 phases Temperature rise from maximum current

Trip Characteristic

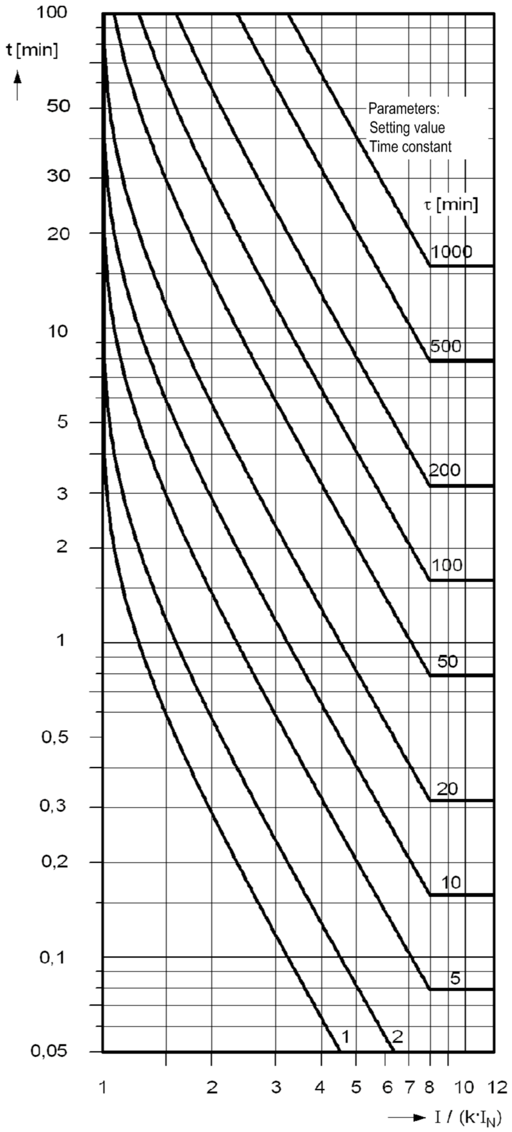
Tripping characteristic for $(I/k \cdot I_N) \leq 8$	$t = \tau \cdot \ln \frac{\left(\frac{I}{k \cdot I_N}\right)^2 - \left(\frac{I_{pre}}{k \cdot I_N}\right)^2}{\left(\frac{I}{k \cdot I_N}\right)^2 - 1}$
Meaning of abbreviations:	t Tripping time τ Temperature rise time factor I Load current I_{pre} Previous load current k Setting factor according to IEC 60255-8 I_N Rated current of protected object

Drop-off to Pick-up Ratio

Θ/Θ_{Trip}	Drops out with Θ_{Alarm}
Θ/Θ_{Alarm}	Approx. 0.99
I/I_{Alarm}	Approx. 0.97

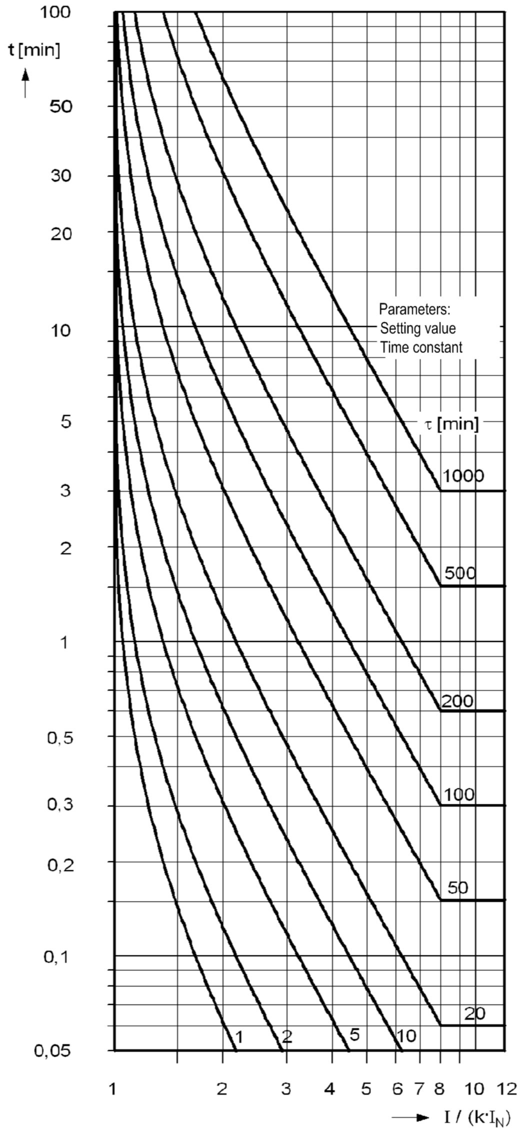
Tolerances

Referring to $k \cdot I_N$	2 % or 1 % of rated current; Class 2 according to IEC 60255-8
Ralating to tripping time	3 % or 1 s for $I/(k \cdot I_N) > 1.25$; class 3 according to IEC 60255-8



without pre-load:

$$t = \tau \cdot ln \frac{\left(\frac{I}{k \cdot I_N}\right)^2}{\left(\frac{I}{k \cdot I_N}\right)^2 - 1} \quad [\text{min}]$$



with 90 % pre-load:

$$t = \tau \cdot ln \frac{\left(\frac{I}{k \cdot I_N}\right)^2 - \left(\frac{I_{pre}}{k \cdot I_N}\right)^2}{\left(\frac{I}{k \cdot I_N}\right)^2 - 1} \quad [\text{min}]$$

Figure 4-6 Trip time characteristics of the overload protection

4.11 Voltage Protection (Optional)

Overvoltages Phase-to-Ground

Overvoltage V_{Ph}>>		1.0 V to 170.0 V; ∞	Increments 0.1 V
Delay $T_{VPh>>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Overvoltage V_{Ph}>		1.0 V to 170.0 V; ∞	Increments 0.1 V
Delay $T_{VPh>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		0.30 to 0.99	Increments 0.01
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Overvoltages Phase-to-Phase

Overvoltage V_{PhPh}>>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{VPhPh>>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Overvoltage V_{PhPh}>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{VPhPh>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		0.30 to 0.99	Increments 0.01
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Overvoltage Positive Sequence System V_1

Overvoltage V_1>>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{V1>>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Overvoltage V_1>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{V1>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		0.30 to 0.99	Increments 0.01
Compounding		can be switched on/off	
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Overvoltage Negative Sequence System V_2

Overvoltage V_2>>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{V2>>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Overvoltage V_2>		2.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{V2>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		0.30 to 0.99	Increments 0.01
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Overvoltage Zero Sequence System $3V_0$

Overvoltage $3V_0$>>		1.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{3V0>>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Overvoltage $3V_0$>		1.0 V to 220.0 V; ∞	Increments 0.1 V
Delay $T_{3V0>}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		0.30 to 0.99	Increments 0.01
Pickup time			
With repeated measurement		approx. 75 ms	
Without repeated measurement		approx. 40 ms	
Dropout time			
With repeated measurement		approx. 75 ms	
Without repeated measurement		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Undervoltages Phase-to-Ground

Undervoltage V_{Ph}<<		1.0 V to 100.0 V	Increments 0.1 V
Delay $T_{VPh<<}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Undervoltage V_{Ph}<		1.0 V to 100.0 V	Increments 0.1 V
Delay $T_{VPh<}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		1.01 to 1.20	Increments 0.01
Current criterion		can be switched on/off	
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Undervoltages Phase-to-Phase

Undervoltage V_{PhPh}<<		1.0 V to 175.0 V	Increments 0.1 V
Delay $T_{VPhPh<<}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Undervoltage V_{PhPh}<		1.0 V to 175.0 V	Increments 0.1 V
Delay $T_{VPhPh<}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		1.01 to 1.20	Increments 0.01
Current criterion		can be switched on/off	
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

Undervoltage Positive Sequence System V_1

Undervoltage V_1<<		1.0 V to 100.0 V	Increments 0.1 V
Delay $T_{V1<<}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Undervoltage V_1<		1.0 V to 100.0 V	Increments 0.1 V
Delay $T_{V1<}$		0.00 s to 100.00 s; ∞	Increments 0.01 s
Dropout ratio		1.01 to 1.20	Increments 0.01
Current criterion		can be switched on/off	
Pickup time		approx. 40 ms	
Dropout time		approx. 35 ms	
Tolerances	Voltages	3 % of setting value or 1 V	
	Times	1 % of setting value or 10 ms	

4.12 Frequency Protection (Optional)

Frequency Elements

Quantity	4, depending on setting effective on f< or f>

Pickup Values

f> or f< adjustable for each element		
For f_{Nom} = 50 Hz	45.50 Hz to 54.50 Hz	Increments 0.01 Hz
For f_{Nom} = 60 Hz	55.50 Hz to 64.50 Hz	Increments 0.01 Hz

Times

Pickup times f>, f<	approx. 85 ms	
Dropout times f>, f<	approx. 30 ms	
Time delays T	0.00 s to 600.00 s	Increments 0.01 s
The set times are pure time delays. Note on drop-off times: Drop-off was enforced by current = 0 A and voltage = 0 V. Enforcing the drop-off by means of a frequency change below the drop-off threshold extends the drop-off times.		

Dropout Difference

$\Delta f = \lvert$ pickup value - dropout value $\rvert$	0.02 Hz to 1 Hz

Operating Ranges

In voltage range	approx. 0.65 · V_N up to 230 V (phase-phase)
In frequency range	25 Hz to 70 Hz

Tolerances

Frequencies f>, f< in specific range ($f_N \pm 10$ %)	15 MHz in range V_{PhPh}: 50 V to 230 V
Time delays T(f<, f>)	1 % of setting value or 10 ms

4.13 Automatic Reclosing (Optional)

Automatic Reclosures

Number of reclosures	max. 2	
Type (depending on order variant)	3-pole	
Control	with pickup or trip command	
Action times Initiation possible without pickup and action time	0.01 s to 300.00 s; ∞	Increments 0.01 s
Dead times prior to reclosure separately for all types and all cycles	0.01 s to 1800.00 s; ∞	Increments 0.01 s
Dead times after evolving fault recognition	0.01 s to 1800.00 s	Increments 0.01 s
Blocking time after reclosure	0.50 s to 300.00 s	Increments 0.01 s
Blocking time after dynamic blocking	0.5 s	
Blocking time after manual closing	0.50 s to 300.00 s; 0	Increments 0.01 s
Start signal monitoring time	0.01 s to 300.00 s	Increments 0.01 s
Circuit breaker monitoring time	0.01 s to 300.00 s	Increments 0.01 s

4.14 Transmission of Binary Information and Commands

Remote Indications

Number of possible remote indications		16
The operating times depend on the communication speed. The following data require a transmission rate of 512 kbit/s for the optical fiber protection interface. The operating times refer to the entire signal path from entry via binary inputs until output of commands via output relays.		
Operating times, total approx.	typical	20 ms +/- 5 ms
Dropout times, total approx.	typical	15 ms

4.15 Monitoring Functions

Measured Values

Current sum		$I_F = \| \underline{I}_A + \underline{I}_B + \underline{I}_C + k_I \cdot \underline{I}_G \| >$ SUM.I Threshold $\cdot I_N$ + SUM.FactorI $\cdot \Sigma \| I \|$	
- SUM.ILimit	for I_{Nom} = 1 A	0.10 A to 2.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 10.00 A	Increments 0.01 A
- SUM.FACTOR I		0.00 to 0.95	Increments 0.01
Current symmetry		$\| I_{min} \|/\| I_{max} \|$ < BAL.FACTOR.I as long as I_{max}/I_N > BAL.ILIMIT/I_N	
- BAL.FACTOR.I		0.10 to 0.95	Increments 0.01
- BAL.ILIMIT	for I_{Nom} = 1 A	0.10 A to 1.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 5.00 A	Increments 0.01 A
- T BAL.ILIMIT		5 s to 100 s	Increments 1 s
Broken conductor		one conductor without current, the others with current (monitoring of current transformer circuits on current step change in one phase without residual current)	
Voltage Balance		$\| V_{min} \|/\| V_{max} \|$ < BAL.FACTOR.V as long as $\| V_{max} \|$ > BAL.VLIMIT	
- BAL.FACTOR.V		0.58 to 0.95	Increments 0.01
- BAL.VLIMIT		10 V to 100 V	Increments 1 V
- T BAL.VLIMIT		5 s to 100 s	Increments 1 s
Voltage phase sequence		$\underline{V}_A$ leads $\underline{V}_B$ leads $\underline{V}_C$ as long as $\| \underline{V}_A \|, \| \underline{V}_B \|, \| \underline{V}_C \| > 40\ V/\sqrt{3}$	
non-symmetrical voltages (Fuse failure monitoring)		$3 \cdot V_0$ > FFM V> OR $3 \cdot V_2$ > FFM V> AND at the same time $3 \cdot I_0$ < FFM I< AND $3 \cdot I_2$ < FFM I<	
- FFM V>		10 V to 100 V	Increments 1 V
- FFM I<	for I_{Nom} = 1 A	0.10 A to 1.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 5.00 A	Increments 0.01 A
three-phase measuring voltage failure (Fuse failure monitoring)		All V_{Ph-G} < FFM VMEAS < AND at the same time all ΔI_{Ph} < FFM I_{delta} AND All I_{Ph} > (I_{Ph}> (Dist.)) OR All V_{Ph-G} < FFM VMEAS < AND at the same time All I_{Ph} < (I_{Ph}> (Dist.)) AND All I_{Ph} > 40 mA	
- FFM VMEAS <		2 V to 100 V	Increments 1 V
- FFM I_{delta}	for I_{Nom} = 1 A	0.05 A to 1.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 5.00 A	Increments 0.01 A
- T V-Monitoring (waiting time for additional measured voltage failure monitoring)		0.00 s to 30.00 s	Increments 0.01 s
- T VT mcb		0 ms to 30 ms	Step 1 ms

Trip Circuit Supervision

Number of supervised trip circuits	1 to 3	
Operation of each trip circuit	With 1 binary input or with 2 binary inputs	
Pickup and dropout time	approx. 1 to 2 s	
Settable time delay for operation with 1 binary input	1 s to 30 s	Increments 1 s

4.16 Flexible Protection Functions

Measured Values / Modes of Operation

Three-phase	I, $3I_0$, I1, I2, I2/I1, V, $3V_0$, V1, V2, P forward, P reverse, Q forward, Q reverse, cosφ
Single-phase	I, I_N, I_{Ns},I_{N2}, V, V_N,V_x, P forward, P reverse, Q forward, Q reverse, cosφ
Without fixed phase reference	f, df/dt, binary input
Measurement method for I, 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:			
Current I, I_1, I_2, $3I_0$, I_N	for I_N = 1 A	0.05 A to 40.00 A	Increments 0.01 A
	for I_N = 5 A	0.25 A to 200.00 A	
Relationship I_2/I_1		15 % to 100 %	Increments 1%
Sensitive ground current I_{Ns}		0.001 A to 1.500 A	Increments 0.001 A
Voltage V, V_1, V_2, $3V_0$		2.0 V to 260.0 V	Increments 0.1 V
Displacement voltage V_N		2.0 V to 200.0 V	Increments 0.1 V
Power P, Q	for I_N = 1 A	2.0 W to 10000 W	Increment 0.1 W
	for I_N = 5 A	10 W to 50000 W	
Power factor cosφ		-0.99 to +0.99	Increments 0.01
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
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
Pickup delay for I_2/I_1		0.00 s to 28800.00 s	Increments 0.01 s
Command time delay		0.00 s to 3600.00 s	Increments 0.01 s
Dropout delay		0.00 s to 60.00 s	Increments 0.01 s

Function Limits

Power measurement three-phase	for I_{Nom} = 1 A	Positive sequence system current > 0.03 A
	for I_{Nom} = 5 A	Positive sequence system current > 0.15 A
Power measurement single-phase	for I_{Nom} = 1 A	Phase current > 0.03 A
	for I_{Nom} = 5 A	Phase current > 0.15 A
Relationship I_2/I_1 measurement	for I_{Nom} = 1 A	Positive or negative sequence system current > 0.1 A
	for I_{Nom} = 5 A	Positive or negative sequence system current > 0.5 A

Times

Pickup times:	
Current, voltage (phase quantities) for 2 times the setting value for 10 times the setting value	 approx. 30 ms approx. 20 ms
Current, voltage (symmetrical components) for 2 times the setting value for 10 times the setting value	 approx. 40 ms approx. 30 ms
Power typical maximum (small signals and threshold values)	 approx. 120 ms approx. 350 ms
Power factor	300 to 600 ms
Frequency	approx. 100 ms
Frequency change for 1.25 times the setting value	approx. 220 ms
Binary input	approx. 20 ms
Dropout times:	
Current, voltage (phase quantities)	< 20 ms
Current, voltage (symmetrical components)	< 30 ms
Power typical maximum	 < 50 ms < 350 ms
Power factor	< 300 ms
Frequency	< 100 ms
Frequency change	< 200 ms
Binary input	< 10 ms

Tolerances

Pickup thresholds:		
Current	for I_{Nom} = 1 A	3% of setting value or 15 mA
	for I_{Nom} = 5 A	3% of setting value or 75 mA
Current (symmetrical components)	for I_{Nom} = 1 A	4% of setting value or 20 mA
	for I_{Nom} = 5 A	4% of setting value or 100 mA
Current (I_2/I_1)		4% of setting value
Voltage		3% of setting value or 0.2 V
Voltage (symmetrical components)		4% of setting value or 0.2 V
Power	for I_{Nom} = 1 A	3% of setting value or 0.5 W
	for I_{Nom} = 5 A	3% of setting value or 2.5 W
Power factor		3°
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 (41 °F) ≤ Θ_{amb} ≤ 55 °C (131 °F)	0.5 %/10 K
Frequency in 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 %

4.17 User-defined Functions (CFC)

Function Modules and Possible Assignments to Task Levels

Function Module	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	Flash 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	Measured value comparison	X	X	X	X
CONNECT	Connection	–	X	X	X
COUNTER	Counter	X	X	X	X
CV_GET_STATUS	Information status of the metered value, decoder	X	X	X	X
D_FF	D- Flipflop	–	X	X	X
D_FF_MEMO	Status Memory for Restart	X	X	X	X
DI_GET_STATUS	Information status double point indication, decoder	X	X	X	X
DI_SET_STATUS	Double point indication with status, encoder	X	X	X	X
DI_TO_BOOL	Double Point to Boolean (conversion)	–	X	X	X
DINT_TO_REAL	DoubleInt after real, adapter	X	X	X	X
DIST_DECODE	Double point indication with status, decoder	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
LIVE_ZERO	Live zero monitoring, nonlinear characteristic	X	–	–	–
LONG_TIMER	Timer (max.1193h)	X	X	X	X
LOOP	Feedback Loop	X	X	X	X
LOWER_SETPOINT	Lower Limit	X	–	–	–
MUL	Multiplication	X	X	X	X
MV_GET_STATUS	Information status measured value, decoder	X	X	X	X
MV_SET_STATUS	Measured value with status, encoder	X	X	X	X
NAND	NAND - Gate	X	X	X	X

NEG	Negator	X	X	X	X
NOR	NOR - Gate	X	X	X	X
OR	OR - Gate	X	X	X	X
REAL_TO_DINT	Real after DoubleInt, adapter	X	X	X	X
REAL_TO_UINT	Real after U-Int, adapter	X	X	X	X
RISE_DETECT	Rising edge detector	X	X	X	X
RS_FF	RS- Flipflop	–	X	X	X
RS_FF_MEMO	Status memory for restart	X	X	X	X
SI_GET_STATUS	Information status single point indication, decoder	X	X	X	X
SI_SET_STATUS	Single point indication with status, encoder	X	X	X	X
SQUARE_ROOT	Root Extractor	X	X	X	X
SR_FF	SR- Flipflop	–	X	X	X
SR_FF_MEMO	Status memory for restart	X	X	X	X
ST_AND	AND gate with status	X	X	X	X
ST_NOT	Negator 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	U-Int to real, adapter	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	Comments
Maximum number of all CFC charts considering all task levels	32	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 charts considering one task level	16	Only Error Message (evolving fault in processing procedure)
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 inputs of one chart for each task level (number of unequal information items of the left border per task level)	400	Only fault annunciation; here the number of elements of the left border per task level is counted. Since the same information is indicated at the border several times, only unequal information is to be counted.
Maximum number of reset-resistant flipflops D_FF_MEMO, RS_FF_MEMO, SR_FF_MEMO	350	When the limit is exceeded, a fault indication is output by the device. Consequently, the device is put into monitoring mode. The red ERROR-LED lights up.

Device-specific Limits

<table>
<tr><th>Description</th><th>Limit</th><th>Comments</th></tr>
<tr><td>Maximum number of simultaneous changes of the chart inputs per task level</td><td>50</td><td rowspan="2">When the limit is exceeded, an error message is output by the device. Consequently, the device is put into monitoring mode. The red ERROR-LED lights up.</td></tr>
<tr><td>Maximum number of chart outputs per task level</td><td>150</td></tr>
</table>

Additional Limits

<table>
<tr><th colspan="5">Additional limits [1)] for the following 4 CFC blocks:</th></tr>
<tr><th>Task Level</th><td colspan="4"></td></tr>
<tr><td></td><td>TIMER[2) 3)]</td><td>TIMER_SHORT[2) 3)]</td><td>CMD_CHAIN</td><td>D_FF_MEMO</td></tr>
<tr><td>MW_BEARB</td><td></td><td></td><td></td><td rowspan="4">350</td></tr>
<tr><td>PLC1_BEARB</td><td rowspan="2">15</td><td rowspan="2">30</td><td rowspan="2">20</td></tr>
<tr><td>PLC_BEARB</td></tr>
<tr><td>SFS_BEARB</td><td></td><td></td><td></td></tr>
</table>

1) When the limit is exceeded, a fault indication is output by the device. Consequently, the device is put into monitoring mode. The red ERROR-LED lights up.

2) TIMER and TIMER_SHORT share the available timer resources. The relation is TIMER = 2 · system timer and TIMER_SHORT = 1 · system timer. The following condition applies for the maximum number of timers: (2 · number of TIMERs + number of TIMER_SHORTs) < 20. The LONG_TIMER is not subject to this condition.

3) The time values for the blocks TIMER and TIMER_SHORT must not be selected shorter than the time resolution of the device of 5 ms, as 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)	10 000
PLC1_BEARB (Slow PLC Processing)	1 900
PLC_BEARB (Fast PLC Processing)	200
SFS_BEARB (switchgear interlocking)	10 000

1) When the sum of TICKS of all blocks exceeds the limits before-mentioned, an error message is output by CFC.

Processing Times in TICKS required by the Individual Elements

Individual Element		Number of TICKS
Block, basic requirement		5
Each input more than 3 inputs for generic modules		1
Connection to an input signal		6
Connection to an output signal		7
Additional for each chart		1
Operating sequence module	CMD_CHAIN	34
Flipflop	D_FF_MEMO	6
Loop module	LOOP	8
Decoder	DM_DECODE	8
Dynamic OR	DYN_OR	6
Addition	ADD	26
Subtraction	SUB	26
Multiplication	MUL	26
Division	DIV	54
Square root	SQUARE_ROOT	83
Timer	TIMER_SHORT	8
Timer	LONG_TIMER	11
Blinker lamp	BLINK	11
Counter	COUNTER	6
Adapter	REAL_TO_DINT	10
Adapter	REAL_TO_UINT	10
Alarm	ALARM	21
Comparison	COMPARE	12
Decoder	DIST_DECODE	8

4.18 Additional Functions

Operational Measured Values

Operational Measured Values for Currents	I_A; I_B; I_C; $3I_0$; I_1; I_2; I_Y in A primary and secondary and in % $I_{NOperation}$
Tolerance	1.5 % of measured value, or 1 % of I_N
Phase angles of currents	f(I_A-I_B); f(I_B-I_C); f(I_C-I_A) in °
Tolerance	1° at rated current
Operational measured values for voltages	V_{A-N}, V_{B-N}, V_{C-N}; $3V_0$, V_0, V_1, V_2, V_{1Ko} in kV primary, in V secondary or in % $V_{NOp}/\sqrt{3}$
Tolerance	1.5 % of measured value, or 0.5 % of IV_{Nom}
Operational measured values for voltages	V_{EN}; in V secondary
Tolerance	1.5 % of measured value, or 0.5 % of V_N
Operational measured values for voltages	V_{A-B}, V_{B-C}, V_{C-A} in kV primary, in V secondary or in % V_{NOp}
Tolerance	1.5 % of measured value, or 0.5 % of V_N
Phase angle of voltages	f(V_A-V_B); f(V_B-V_C); f(V_C-V_A) in °
Tolerance	1 ° at nominal voltage
Phase angle for voltages and currents	f(V_A-I_A); f(V_B-I_B); f(V_C-I_C) in °
Tolerance	1° at nominal voltage and nominal current
Operational Measured Values for Powers	S; P; Q (apparent, active and reactive power) in MVA; MW; Mvar primary and % S_N (operational nominal power) = $\sqrt{3} \cdot V_N \cdot I_N$
Tolerance for S	1.5 % of S_N at I/I_N and V/V_N in range 50 % to 120 %
Tolerance for P	2 % of P_N at I/I_N and V/V_N in range 50 % to 120 % and ABS(cos φ) in range ≥ 0.7
Tolerance for Q	2 % of Q_N at I/I_N and V/V_N in range 50 % to 120 % and ABS(cos φ) in range ≥ 0.7
Operating Measured Value for Power Factor	cos φ
Tolerance	0.02
Counter values for energy	W_p+, W_q+; W_p-; W_q- (active and reactive energy) In kWh (MWh or GWh) and in kVARh (MVARh or GVARh)
Tolerance at nominal frequency	5 % for $I > 0.5\ I_N$, $V > 0.5\ V_N$ and $\lvert \cos\varphi \rvert \geq 0.707$
Operating measured values for frequency	f in Hz and % f_N
Range	10 Hz to 75 Hz
Tolerance	20 MHz in range f_N ± 10 % at nominal values
Measured values of the differential protection	$I_{DIFF3I0;}$ in % $I_{Noperation}$ $I_{STAB3IO}$ in I/I_{NO} (in grounded systems only)
Thermal Measured Values	Θ_A/Θ_{TRIP}; Θ_B/Θ_{TRIP}; Θ_C/Θ_{TRIP}; Θ/Θ_{TRIP} related to tripping temperature rise
Remote measured values for currents	I_A; I_B; I_C of the remote end in A primary φ(I_A); φ(I_B); φ(I_C), (remote versus local) in °
Remote measured values for voltages	V_A; V_B; V_C of the remote end in kV primary φ(V_A); φ(V_B); φ(V_C), (remote versus local) in °

Operational Log

Capacity	200 records

Fault Logging

Capacity	8 fault records with up to 600°entries max. and up to 100 signals as binary signal traces (markers)

Fault Recording

maximum 8 fault records saved by buffer battery also through 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)
Scanning rate at 50 Hz Scanning rate at 60 Hz	1 instantaneous value per 1.0 ms 1 instantaneous value per 0.83 ms

Statistics (Serial Protection Data Interface)

Availability of transmission for applications with protection data interface	Availability in %/min and %/h
Time delay of transmission	Resolution 0.01 ms

Switching Statistics

Number of automatic reclosures initiated by the device	Separately for 1st AR cycle and for all further cycles
Total of interrupted currents	separately for each breaker pole
Maximum interrupted current	separately for each breaker pole

Real-Time Assignment and Backup Battery

Resolution for operational events	1 ms
Resolution for fault events	1 ms
Buffer battery	Type: 3 V/1 Ah, Type CR 1/2 AA self-discharging time approx. 10 years

Commissioning Aids

Operational measured values Circuit breaker / switch test

Clock

Time synchronization		DCF 77/IRIG-B signal (telegram format IRIG-B000) Binary input Communication
Operating modes of time synchronization		
No.	Operating mode	Comments
1	**Internal**	Internal synchronization using RTC (presetting)
2	**IEC 60870-5-103**	External synchronization using system interface (IEC 60870-5-103)
3	**Time signal IRIG B**	External synchronization via IRIG B (telegram format IRIG-B000)
4	**Time signal DCF 77**	External synchronization using DCF 77
5	**Pulse via binary input**	External synchronization with pulse via binary input

4.19 Dimensions

4.19.1 Panel Flush Mounting and Cabinet Flush Mounting (Housing Size 1/6)

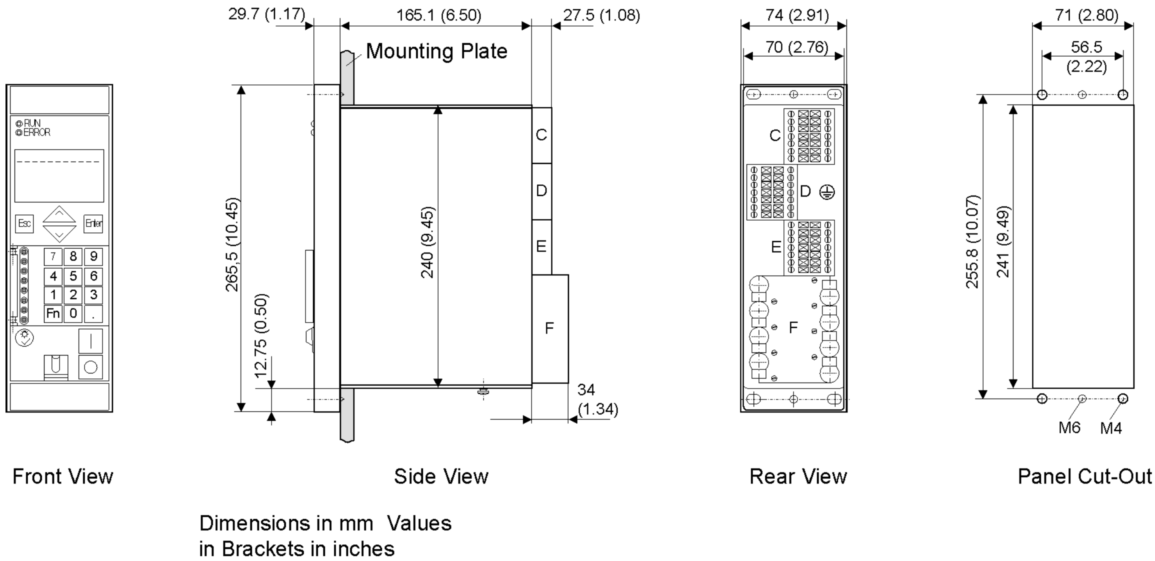


Figure 4-7 Dimensional drawing of a 7SD80 for panel flush mounting and cabinet flush mounting (housing size $^{1}/_{6}$)

Note: A set of mounting brackets (consisting of upper and lower mounting rail) (order no. C73165-A63-D200-1) is required for cabinet flush mounting.

Provide for sufficient space at the device bottom side or below the device to accommodate the cables of the communication modules.

4.19.2 Panel Surface Mounting (Housing Size 1/6)

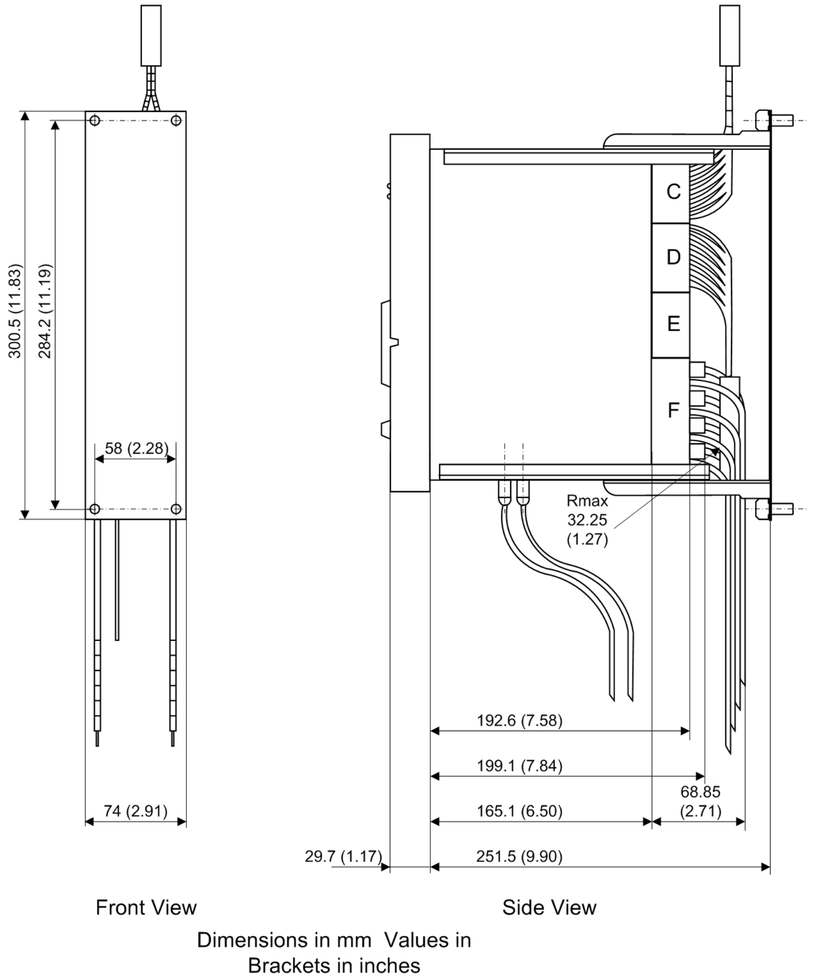


Figure 4-8 Dimensional drawing of a 7SD80 for panel surface mounting (housing size $^1/_6$)

4.19.3 Bottom View

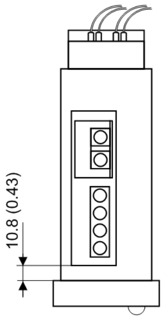


Figure 4-9 Bottom view of a 7SD80 (housing size 1/6)

■

Appendix A

This appendix is primarily a reference for the experienced user. This section provides ordering information for the models of this device. Connection diagrams indicating the terminal connections of the models of this device are included. Following the general diagrams are diagrams that show the proper connections of the devices to primary equipment in many typical power system configurations. Tables with all settings and all information available in this device equipped with all options are provided. Default settings are also given.

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A.1 Ordering Information and Accessories

A.1.1 Ordering Information

A.1.1.1 7SD80 V4.6

Line Differential Protection						6	7		8	9	10	11	12		13	14	15	16		Supplement		
	7	**S**	**D**	**8**	**0**			–						–		F			+			

Measuring inputs, BO/BI, protection interface	Pos. 6
1/6 19" housing; 4 x I, 3 BI, 5 BO (2 changeover contacts), 1 life status contact, Protection interface optical fiber for monomode (24 km) (14.9 mi.)/multimode fiber (4 km) (2.5 mi.), LC duplex connector	1
1/6 19" housing; 4 x I, 7 BI, 8 BO (2 changeover contacts), 1 life status contact, Protection interface optical fiber for monomode (24 km) (14.9 mi.)/multimode fiber (4 km) (2.5 mi.), LC duplex connector	2
1/6 19" housing; 4 x I, 5 BI, 8 BO (2 changeover contacts), 1 life status contact, Protection interface copper (2-wire connection, twisted)	3
1/6 19" housing; 4 x I, 3 x V, 3 BI, 5 BO (2 changeover contacts), 1 life status contact, Protection interface optical fiber for monomode (24 km)/multimode fiber (4 km), LC duplex connector	5
1/6 19" housing; 4 x I, 3 x V, 7 BI, 8 BO (2 changeover contacts), 1 life status contact, Protection interface optical fiber for monomode (24 km)/multimode fiber (4 km), LC duplex connector	6
1/6 19" housing; 4 x I, 3 x V, 5 BI, 8 BO (2 changeover contacts), 1 life status contact, Protection interface copper (2-wire connection, twisted)	7

Measuring inputs, default settings (BOLD)	Pos. 7
I_{ph} = **1 A** / 5 A , I_N = **1 A** / 5 A	1
I_{ph} = **1 A**, I_{Ns} (sensitive) = 0.001 A to 1.6 A / 0.005 A to 8 A	2

Auxiliary voltage (power supply)	Pos. 8
DC 24 V / 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-mounted housing, screw-type terminals	B
Flush mounting case, screw-type terminals	E

Region-specific language default settings and function versions	Pos. 10
Region DE, IEC, language German (language can be changed) standard face plate	A
Region world, IEC/ANSI, language English (language can be changed), standard face plate	B
Region US, ANSI, language US - English (language can be changed), US face plate	C

Port B (bottom side of device, front)	Pos. 11
not equipped	0
IEC60870-5-103 or DIGSI4/modem or time synchronization input, electrical RS232	1
IEC60870-5-103 or DIGSI4/modem or time synchronization input, electrical RS485	2
IEC60870-5-103 or DIGSI4/modem, optical 820 nm, ST connector	3
For further interface options, see the following additional information	9

Additional information for additional ports (bottom side of device, front, port B)	Supple-ment
Profibus DP Slave, electrical RS485	+ L 0 A
Profibus DP Slave, optical, double ring, ST connector	+ L 0 B
Modbus, electrical RS485	+ L 0 D
Modbus, 820 nm, optical, ST connector	+ L 0 E
DNP3.0, electrical RS485	+ L 0 G
DNP3.0, optical, 820 nm, ST connector	+ L 0 H
IEC 60870-5-103, redundant, electrical RS485, RJ45 connector	+ L 0 P
IEC61850, 100Mbit Ethernet, 2 electrical ports, RJ45 connector	+ L 0 R
IEC61850, 100Mbit Ethernet, 2 optical ports, LC-duplex- connector	+ L 0 S

Converter	Order number	Use
SIEMENS OLM[1)]	6GK1502–2CB10	for single ring
SIEMENS OLM[1)]	6GK1502–3CB10	for twin ring

[1)] The converter requires an operating voltage of 24 VDC. If the available operating voltage is > 24 VDC the additional power supply 7XV5810–0BA00 is required.

Additional communication interfaces for port A (bottom side of device, rear)	Pos. 12
no additional [1)]	0
Redundant optical fiber protection interface to 2-wire protection interface Protection interface optical fiber for monomode (24 km) (14.9 mi.)/multimode fiber (4 km) (2.5 mi.), LC duplex connector [2)]	7

[1)] Already equipped with optical fiber protection interface if MLFB pos. 6 = 1,2,5 or 6,

[2)] Deliverable only in combination with 6th position = 3 or 7,

Measurement / Fault Recording	Pos. 13
With fault recording	1
With fault recording, average values, min/max values	3

Protection functions		Pos. 15
ANSI No.	Description	
Basic design (included in all versions)		A
87L/87N L	Line differential protection (phase comparison and 3I0 differential protection) [1]	
	Inrush current detection	
50 TD/51	Overcurrent protection phase 50-1, 50-2, 50-3, 51	
50N TD/51N	Overcurrent protection ground 50N-1, 50N-2, 50N-3, 51N	
49	Thermal overload protection (49)	
74TC	Trip circuit supervision	
50BF	Circuit-breaker failure protection	
86	Lockout	
	Circuit breaker transfer trip	
	External trip initiation	
	Cold load pickup (dynamic setting changes)	
	Monitoring functions	
	Circuit breaker test	
	Circuit breaker control	
	Flexible protection functions from current, voltage [2], power [2]	
27/59	Undervoltage/overvoltage 27, 59 [2]	
81 U/O	Underfrequency / overfrequency [2]	
Basic design + directional overcurrent protection phase and directional ground fault protection [1] [3]		B
67	Overcurrent protection, directional phase $\angle$(V, I) 67-1, 67-2, 67-TOC	
67N	Ground fault protection, directional $\angle$(V, I) 67N-1, 67N-2, 67N-TOC	
Basic design + ground fault differential protection in resonant-grounded/isolated systems [3] [4]		C
87Ns L	Ground fault differential protection in resonant-grounded/isolated systems	
Basic design + directional overcurrent protection phase and directional ground fault protection + ground fault differential protection in resonant-grounded/isolated systems [3] [4]		E
67	Overcurrent protection, directional phase $\angle$(V, I) 67-1, 67-2, 67-TOC	
67N	Ground fault protection, directional $\angle$(V, I) 67N-1, 67N-2, 67N-TOC	
87Ns L	Ground fault differential protection in resonant-grounded/isolated systems	

[1] MLFB position 7 = 1 required (I_{ph} = 1A / 5A, I_N =1A / 5A)

[2] function available if MLFB Position 6 = 5, 6 or 7 (voltage transformer)

[3] MLFB position 6 = 5, 6 or 7 required (voltage transformer)

[4] MLFB position 7 = 2 required (I_{ph} = 1A / 5A, I_{Ns} (sensitive) = 0.001 A to 1.6 A / 0.005 A to 8 A)

Additional functions		Pos. 16
	without	0
Bin	Transmission of 16 binary signals (via protection interface)	1
79	with automatic reclosing (AR)	2
Bin/79	Transmission of 16 binary signals (via protection interface) and with automatic reclosing (AR)	5

A.1.2 Accessories

Optical Attenuators / Optical Fiber Cables

Designation	Order number
1 set of optical attenuators (2 pieces)	7XV5107-0AA00
optical fiber cables[1)]	6XV8100

1) Optical fiber cables with different connectors in various lengths and designs. For information, please address your Siemens contact.

Isolating Transformer (not UL-listed)

PCM transformer 6 kV (contacting via solder lugs)	C53207-A406-D195-1
PCM transformer 20 kV (screwed connections for ring-type lug)	7XR9516

Replacement Modules for Interfaces

RS232	C53207-A351-D641-1
RS485	C53207-A351-D642-1
optical fiber 820 nm	C53207-A351-D643-1
Profibus DP RS485	C53207-A351-D611-1
Profibus DP double ring	C53207-A351-D613-1
Profibus FMS RS485	C53207-A351-D603-1
Profibus FMS double ring	C53207-A351-D606-1
DNP 3.0 RS485	C53207-A351-D631-1
DNP 3.0 820 nm	C53207-A351-D633-1
Ethernet electrical (EN100)	C53207-A351-D675-2
Ethernet optical (EN100)	C53207-A351-D678-1

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

Voltage terminal block C or block E	C53207-A406-D181-1
Voltage terminal block D (inverse print)	C53207-A406-D182-1
Current terminal block 4xI	C53207-A406-D185-1
Current terminal block 3xI,1xINs (sensitive)	C53207-A406-D186-1
Current terminal short circuit links, 3 pieces	C53207-A406-D193-1
Voltage terminal short circuit links, 6 pieces	C53207-A406-D194-1

A.2 Terminal Assignments

A.2.1 7SD80 — Housing for Panel Flush Mounting, Cabinet Flush Mounting and Panel Surface Mounting

7SD801*

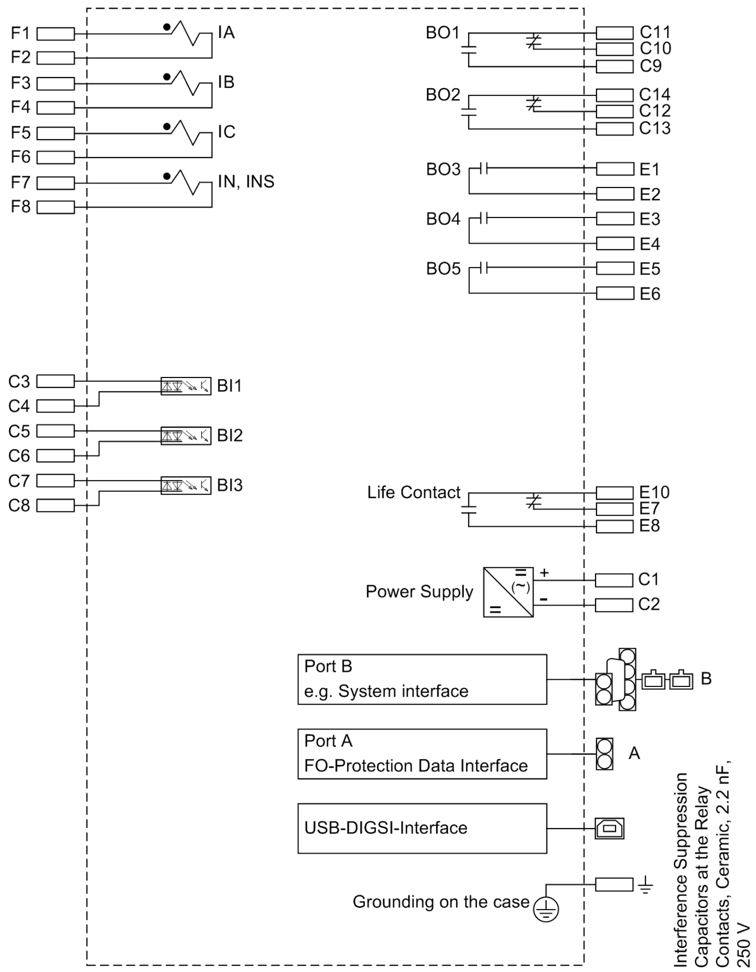

Figure A-1 Overview diagram 7SD801*

7SD802*

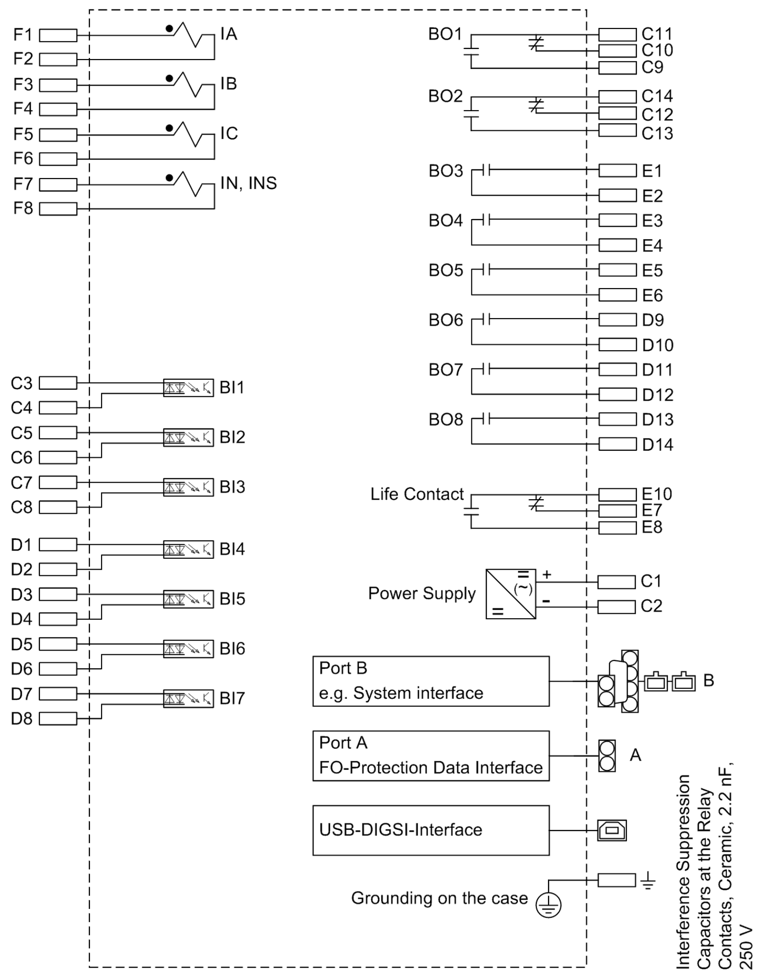

Figure A-2 Overview diagram 7SD802*

7SD803*

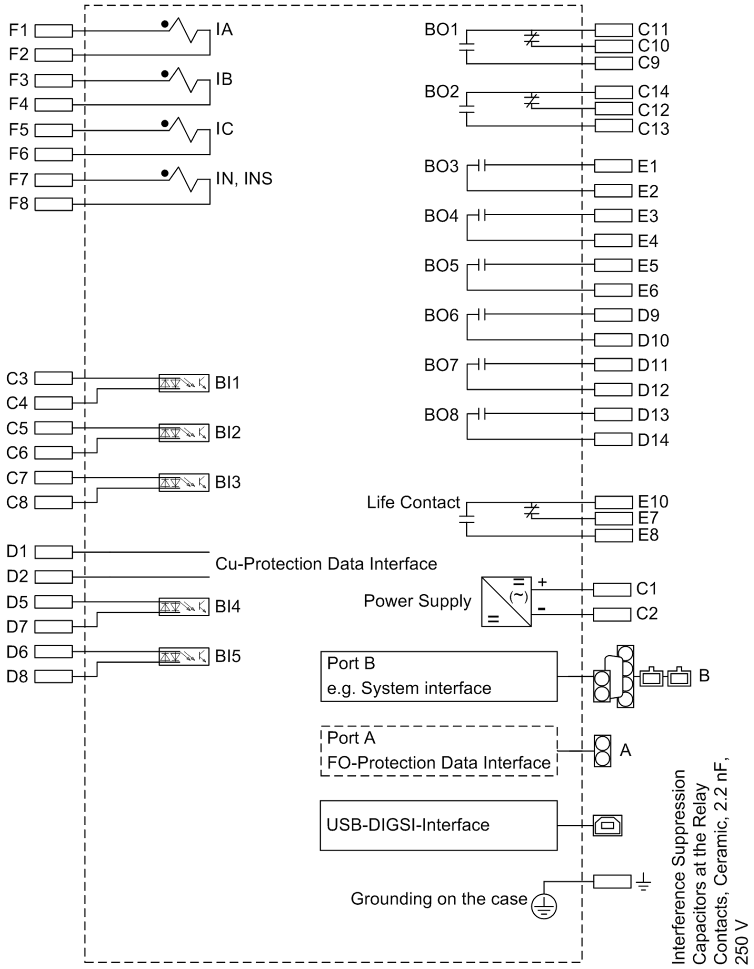

Figure A-3 Connection diagram 7SD803*

The optical fiber interface at port A can only be delivered if the 12th digit equals 7.

7SD805*

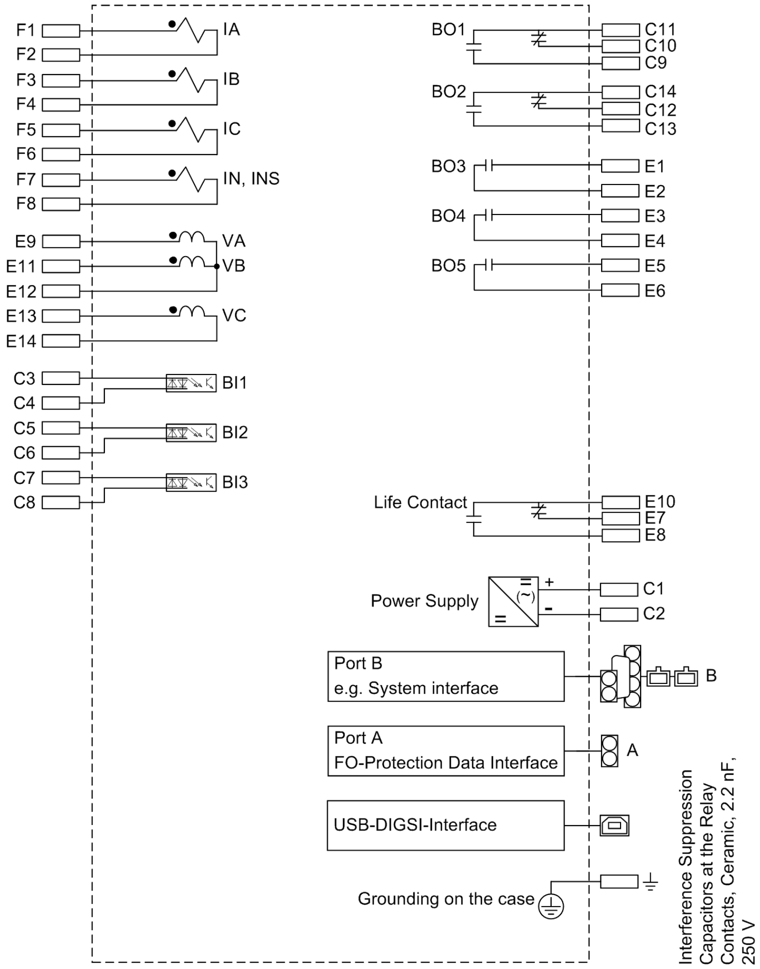

Figure A-4 Overview diagram 7SD805*

7SD806*

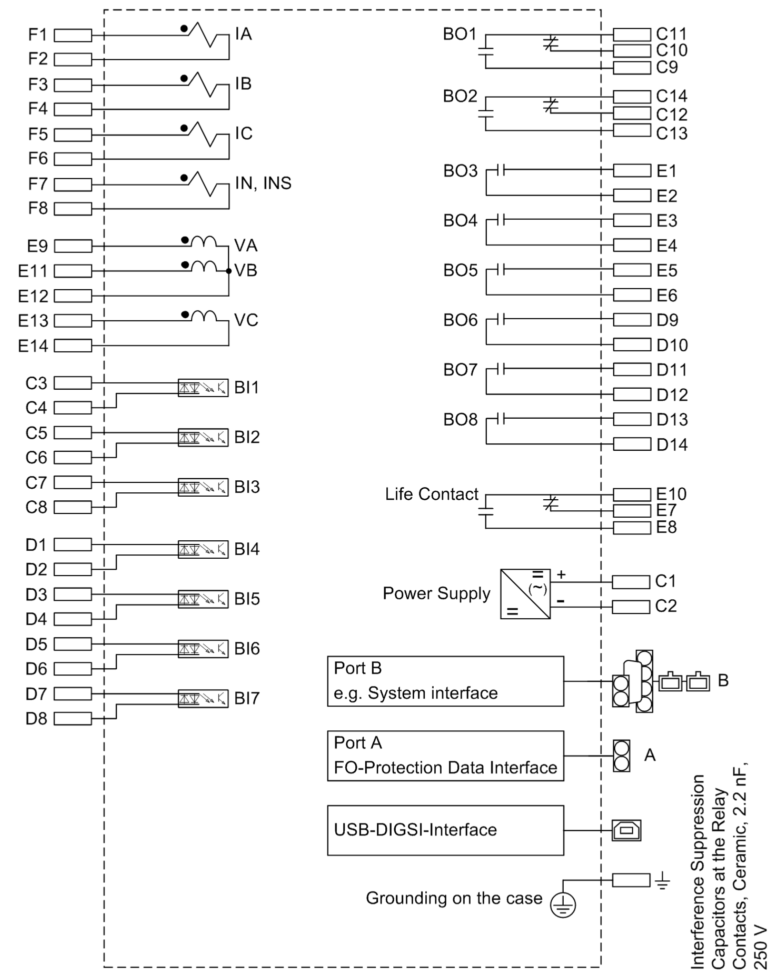

Figure A-5 Overview diagram 7SD806*

7SD807*

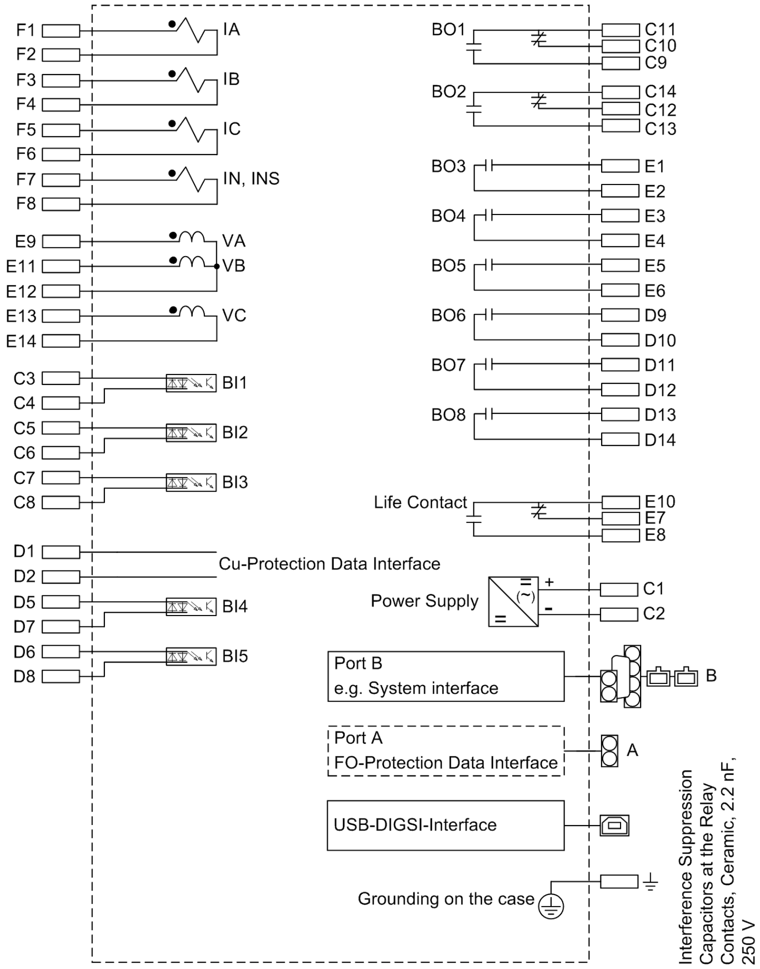

Figure A-6 Connection diagram 7SD807*

The optical fiber interface at port A can only be delivered if the 12th digit equals 7.

A.3 Connection Examples

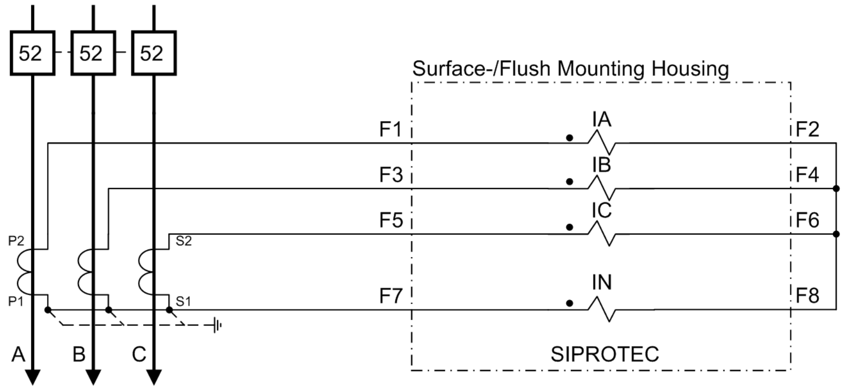

Figure A-7 Current transformer connections to three current transformers and neutral-point current (ground current) (Holmgreen connection) standard connection, suitable for all power systems (neutral point in line direction)

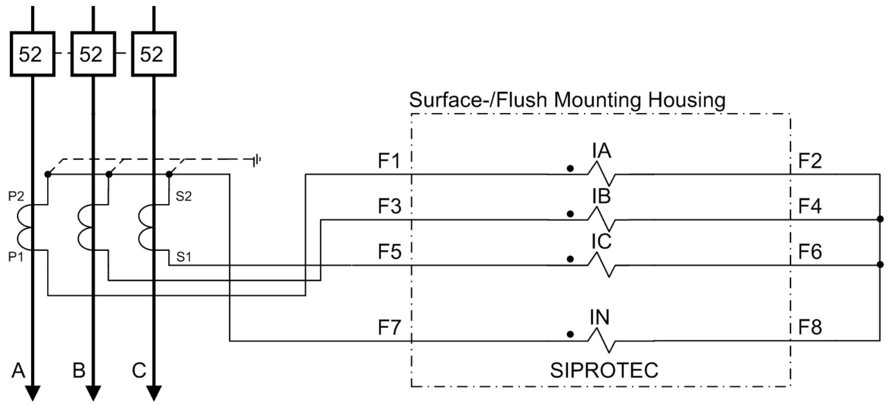

Figure A-8 Current transformer connections to three current transformers and neutral-point current (ground current) (Holmgreen connection) standard connection, suitable for all power systems (neutral point in busbar direction)

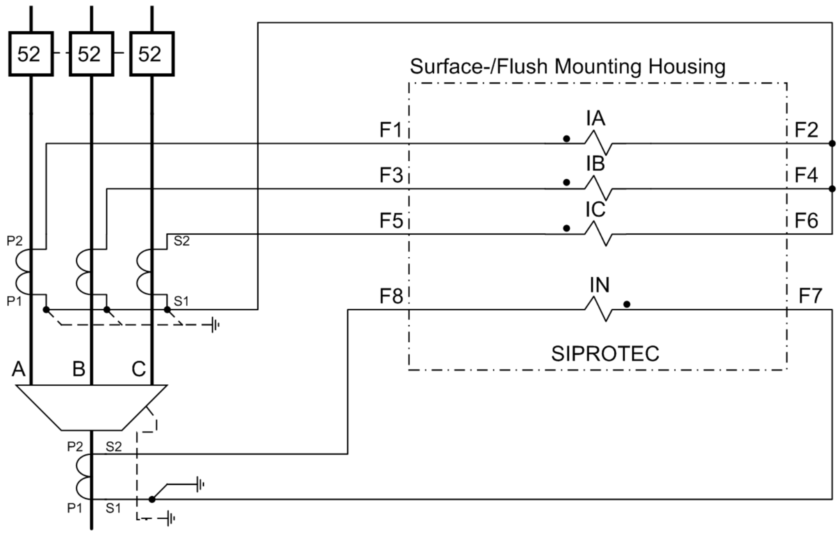

Figure A-9 Current transformer connections to three current transformers, ground current from additional summation current transformer – preferably for effectively or low-resistance grounded networks

Important: Grounding of the cable shield must be effected at the cable side

Note: The switchover of the current polarity (address 201) also reverses the polarity of the current input IN!

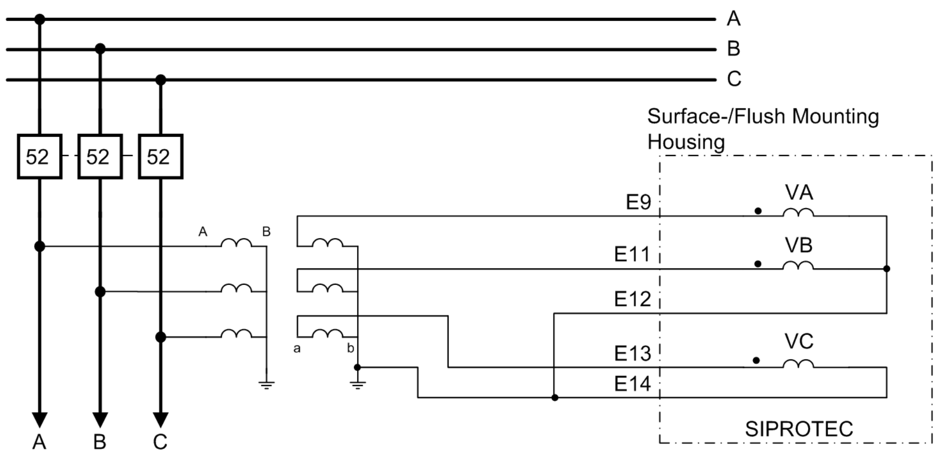

Figure A-10 Example for the connection type "VAN, VBN, VCN" with voltage connection on the feeder side

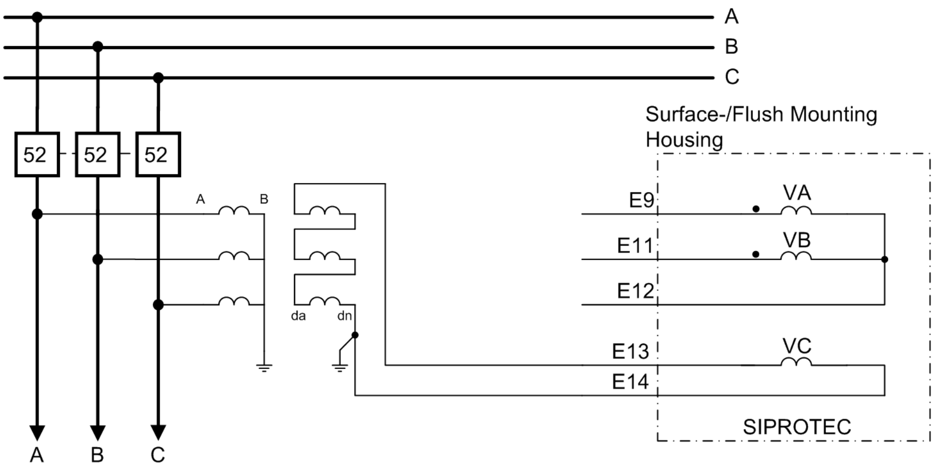

Figure A-11 V0 connection

A.4 Current Transformer Requirements

A.4.1 Current Transformer Ratio:

Maximum ratio between primary currents of the current transformers at both ends of the protected object.	$0.25 \geq I_{pn\text{-}local} / I_{pn\text{-}remote} \leq 4$
Note: The maximum ratio can also be selected greater or smaller. It may be that the sensitivity of the differential protection indicated in the technical data are no longer observed.	$I_{pn\text{-}local}$: Primary rated transformer current of the local device $I_{pn\text{-}remote}$: Primary rated transformer current of the remote device

A.4.2 Overcurrent Factors

Required minimum effective accuracy limiting factor	$K'_{SSC} \geq 1.2 \frac{I_{SSC\text{-}max\_(ext.\ Fault)}}{I_{pN}}$ and $K'_{SSC\ min} = 30$
	K'_{SSC} Effective symmetrical short-circuit current factor K_{SSC}: Specified symmetrical short-circuit current factor (example: Current transformer 5P20: $K_{SSC} = 20$) $I_{SSC\ \text{-}max(ext.\ fault)}$: maximum through-flowing short-circuit current I_{pn}: Primary transformer rated current
	$K'_{SSC} \geq K_{SSC} \frac{R_{CT} + R_b}{R_{CT} + R'_b}$ $\frac{R_{CT} + R_b}{R_{CT} + R'_b} > 4$ then $\frac{R_{CT} + R_b}{R_{CT} + R'_b} = 4$ R_{CT}: Secondary direct current winding resistance of the current transformer at 75 °C R_b: Rated burden resistance of the current transformer R'_b: Connected burden resistance at the current transformer (usually resistance of the current transformer feed cable + burden resistance of the protection device)
Example: Current transformer: 5P40, 5 VA $I_{sn} = 1$ A $I_{pn} = 500$ A $R_b = 5\ \Omega = 5\ \text{VA} / I_{sn}^2$ $R_{CT} = 3\ \Omega$ R'_b : 0.6 Ω $I_{SSC\text{-}max(ext.\ fault)}$: 20 kA	$K'_{SSC} = 40 \frac{3\Omega + 5\Omega}{3\Omega + 0.6\Omega} = 88.9$ $K'_{SSC} \geq 1.2 \frac{20\ \text{kA}}{500\ \text{A}} = 48$ 88.9 > 48 and 88.9 > 30 transformer OK!
I_{sn}: Secondary transformer rated current	

A.4.3 Class Conversion

Table A-1 Conversion into other classes

British Standard BS 3938	$V_K = \frac{(R_{Ct} + R_b) \cdot I_{sn}}{1.3} \cdot K_{SSC}$	
ANSI/IEEE C 57.13, Class C	$V_{s.t.max} = 20 \cdot I_{sn} \cdot R_b \cdot \frac{K_{SSC}}{20}$ I_{sn} = 5 A (typical value)	
	with	
	V_k	Knee-point voltage
	R_{Ct}	Internal burden
	R_B	Rated burden
	I_{sn}	Secondary rated transformer current
	K_{SSC}	Rated overcurrent factor
	$V_{s.t.max}$	sec. terminal voltage at 20 I_{pn}

Note

Detailed information on the transformer design is available on the Internet. (www.siprotec.de)

A.4.4 Core Balance Current Transformer

General

The requirements for core balance current transformers are determined by the function „sensitive ground fault detection“.

The recommendations are given according to the standard IEC 60044-1.

Requirements

Maximum difference of the primary rated currents of the core balance current transformer:	$0.33 \geq I_{pn\text{-}local} / I_{pn\text{-}remote} \leq 3$
Select the primary rated current of the core balance current transformer so that ground current flowing in the ground fault of the subnetwork is transmitted by the core balance current transformer.	
Transmission ratio, typical Depending on the specific power system and the magnitude of the maximum ground fault current, a different ratio may have to be selected.	60 / 1
Overcurrent limiting factor	FS = 10
Minimum power	1.2 VA
Maximum connected burden – For secondary current thresholds ≥ 20 mA – For secondary current thresholds < 20 mA	 ≤ 1.2 VA (≤ 1.2 Ω) ≤ 0.4 VA (≤ 0.4 Ω)

Class Accuracy

Table A-2 Minimum required class accuracy depending on the neutral point grounding and the operation of the function

Neutral point	Isolated	Resonant-grounded system
Function directional	Class 1	Class 1

An angle correction may have to be parameterized at the device for particularly small ground fault currents (see Description of the „sensitive ground fault detection“).

A.5 Default Settings

A.5.1 LEDs

Table A-3 Preset LED displays

LEDs	Default function	Function No.	Description
LED1	Relay TRIP	511	Relay GENERAL TRIP command
LED2	Relay PICKUP ØA	503	Relay PICKUP Phase A
LED3	Relay PICKUP ØB	504	Relay PICKUP Phase B
LED4	Relay PICKUP ØC	505	Relay PICKUP Phase C
LED5	Relay PICKUP G	506	Relay PICKUP GROUND
LED6	87(N)L Gen.TRIP 85 DT Gen. TRIP	32125 3517	87(N)L General TRIP 85 DT: General TRIP
LED7	Emer. mode	2054	Emergency mode
LED8	Alarm Sum Event Failure Σi	160 289	Alarm Summary Event Alarm: Current summation supervision

A.5.2 Binary Input

Table A-4 Binary input presettings for all devices and ordering variants

Binary Input	Default function	Function No.	Description
BI1	>85 DT 3pol	3504	>86 DT: >Intertrip 3 pole signal input
BI2	>87L block >87N L block	32100 32120	>87L Protection blocking signal >87N L Protection blocking signal
BI3	>BLOCK 50-STUB >BLOCK 50N-STUB	7130 7132	>BLOCK 50-STUB >BLOCK 50N-STUB
BI4	>Rem. Signal 1	3549	>Remote Signal 1 input
BI5	>52a 3p Closed >52a Bkr1 3p Cl	379 410	>52a Bkr. aux. contact (3pole closed) >52a Bkr1 aux. 3pClosed (for AR,CB-Test)
BI6	>52b 3p Open >52b Bkr1 3p Op	380 411	>52b Bkr. aux. contact (3pole open) >52b Bkr1 aux. 3p Open (for AR,CB-Test)
BI7	>Manual Close	356	>Manual close signal

A.5.3 Binary Output

Table A-5 Output Relay Presettings for All Devices and Ordering Variants

Binary Output	Default function	Function No.	Description
BO1	Emer. mode	2054	Emergency mode
BO2	Alarm Sum Event	160	Alarm Summary Event
BO3	Relay PICKUP	501	Relay PICKUP
BO4	Relay TRIP	511	Relay GENERAL TRIP command
BO5	Relay TRIP	511	Relay GENERAL TRIP command
BO6	Rem.Sig 1 Rx	3573	Remote signal 1 received
BO7	PDI FO faulty PDI Cu faulty	3230 3232	PDI FO failure PDI Cu failure
BO8	-	-	-

A.5.4 Function Keys

Table A-6 Applies to All Devices and Ordered Variants

Function Keys	Default function
F1	Display of operational indications
F2	Display of the primary operational measured values
F3	Overview of the last 8 fault indications
F4	no default value

A.5.5 Default Display

A number of pre-defined measured value pages are available depending on the device type. The start page of the default display appearing after startup of the device can be selected in the device data via parameter 640 **Start image DD**.

for the 6-line display of the 7SD80

Side 1

```
A :400A    12:20.0kV
B :400A    23:20.0kV
C :400A    31:20.0kV
N :  0A    N : 0.0kV
SN:  0A
f : 50.0Hz
```

Side 2

```
% :  IL   VPh-N  VPh-Ph
A :100.0 100.0  100.0
B :100.0 100.0  100.0
C :100.0 100.0  100.0

f : 50.0Hz
```

Side 3

```
I1:400A
V1: 11.5kV
P : 13.8MV
Q :  0.0MVAR
S : 13.8MVA
cosφ: 1.00
```

Side 4

```
P:13.8MW   U12:20.0kV
Q:0.0MVAR  U23:20.0kV
S:13.8MVA  U31:20.0kV
f:50.0Hz   IA :400A
           IB :400A
cosφ:1.00  IC :400A
```

Side 5

```
A :400A
B :400A
C :400A
N :  0A
SN:  0A
f : 50.0Hz
```

Figure A-12 Default display of the 7SD80 for models with V without extended measured values

For V0/I0 φ measurement, the measured ground current INB is shown under N and the ground current IN or INs under Ns.

Side 1
```
A :400A    12:20.0kV
B :400A    23:20.0kV
C :400A    31:20.0kV
N :  0A    N : 0.0kV
SN:  0A
f : 50.0Hz
```

Side 2
```
% :  IL   VPh-N  VPh-Ph
A :100.0 100.0  100.0
B :100.0 100.0  100.0
C :100.0 100.0  100.0

f : 50.0Hz
```

Side 3
```
I1:400A
V1: 11.5kV
P : 13.8MV
Q :  0.0MVAR
S : 13.8MVA
cosφ: 1.00
```

Side 4
```
P:13.8MW   A12:20.0kV
Q:0.0MVAR  A23:20.0kV
S:13.8MVA  A31:20.0kV
f:50.0Hz   IA :400A
           IB :400A
cosφ:1.00  IC :400A
```

Side 5
```
A :400A    MAX400A
B :400A    MAX400A
C :400A    MAX400A
N :  0A
SN:  0A
f : 50.0Hz
```

Side 6
```
A :400A
B :400A
C :400A
N :  0A
SN:  0A
f : 50.0Hz
```

Figure A-13 Default display of the 7SD80 for models with V with extended measured values

Side 1
```
A :400A      100%
B :400A      100%
C :400A      100%
N :  0A
SN:  0A
f : 50.0Hz
```

Figure A-14 Default display of the 7SD80 for models without V and extended measured values

```
Side 1
A :400A       100%
B :400A       100%
C :400A       100%
N :  0A
SN:  0A
f : 50.0Hz

Side 2
A :400A    MAX400A
B :400A    MAX400A
C :400A    MAX400A
N :  0A
SN:  0A
f : 50.0Hz
```

Figure A-15 Default display of the 7SD80 for models without V with extended measured values

```
   PDI-Cu  LEVEL
S/N:  xxdB   A: xxdB
  PDI-Cu TELEGRAMS
       Tx    Rx-Bad
/sec. xxxxx  xxxxx
/min. xxxxx  xxxxx
```

Figure A-16 Default display of the device with Cu protection interface

```
   PDI-FO  LEVEL
Lrx: -xxdBm  A: xxdB
  PDI-FO TELEGRAMS
       Tx    Rx-Bad
/sec. xxxxx  xxxxx
/min. xxxxx  xxxxx
```

Figure A-17 Default display of the device with fiber-optic protection interface

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.

50-1 PICKUP	Protective Function that Picked up First;
50-1 TRIP	Protective Function that Tripped Last;
T - Pickup	Operating Time from General Pickup to Dropout;
T - TRIP	Operating Time from General Pickup to the First Trip Command;

Figure A-18 Representation of spontaneous messages on the device display

A.5.6 Pre-defined CFC Charts

Device and System Logic

A negator block of the slow logic (PLC1-BEARB) is created from the binary input „DataStop“ into the internal single point indication „UnlockDT“.

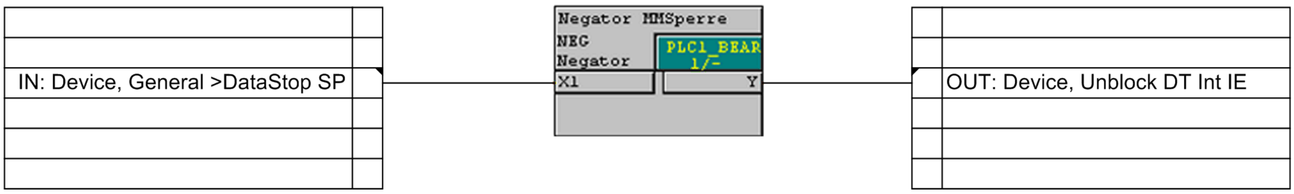

Figure A-19 Connection of input and output

A.6 Protocol-dependent Functions

Protocol → Function ↓	IEC 60870-5-103, single	IEC 60870-5-103, redundant	IEC 61850 Ethernet (EN 100)	Profibus DP	DNP3.0 Modbus ASCII/RTU
Operational measured values	Yes	Yes	Yes	Yes	Yes
Metered values	Yes	Yes	Yes	Yes	Yes
Fault recording	Yes	Yes	Yes	No	No
Remote protection setting	No	Yes	Yes	No	No
User-defined indications and switch-ing objects	Yes	Yes	Yes	Yes	Yes
Time synchronization	Yes	Yes	Yes	Yes	Yes
Messages with time stamp	Yes	Yes	Yes	Yes	Yes
Commissioning aids					
Data transmission stop	Yes	Yes	Yes	No	No
Creating test messag-es	Yes	Yes	Yes	No	No
Physical mode	Asynchronous	Asynchronous	Synchronous	Asynchronous	Asynchronous
Transmission mode	cyclic/event	cyclic/event	cyclic/event	cyclic	cyclic/event(DNP) cyclic(Modbus)
Baud rate	1,200 to 115,000	2,400 to 57,600	Up to 100 MBaud	Up to 1.5 MBaud	2400 to 19200
Type	– RS232 – RS485 – Fiber-optic cables	– RS485	Ethernet TP	– RS485 – Fiber-optic cables (double ring)	– RS485 – Fiber-optic cables

A.7 Functional Scope

Addr.	Parameter	Setting Options	Default Setting	Comments
103	Grp Chge OPTION	Disabled Enabled	Disabled	Setting Group Change Option
112	87 DIFF.PROTEC.	Enabled Disabled	Enabled	87 Differential protection
122	DTT Direct Trip	Disabled Enabled	Disabled	DTT Direct Transfer Trip
124	50HS SOTF	Disabled Enabled	Disabled	50HS Instantaneous SOTF
126	Back-Up O/C	Disabled 50(N) 51(N) IEC 50(N) 51(N)ANSI 50(N) 67(N) IEC 50(N) 67(N)ANSI	50(N) 51(N) IEC	Backup overcurrent
133	79 Auto Recl.	Disabled 1 AR-cycle 2 AR-cycles	Disabled	79 Auto-Reclose Function
134	AR control mode	PU w/ActionTime PU w/o ActionT. Trip w/ActionT. Trip w/oActionT	Trip w/ActionT.	Auto-Reclose control mode
136	81 O/U	Disabled Enabled	Disabled	81 Over/Underfrequency Protection
137	27/59	Disabled Enabled	Disabled	27, 59 Under/Overvoltage Protection
139	50BF	Disabled Enabled enabled w/ 3I0>	Disabled	50BF Breaker Failure Protection
140	74 Trip Ct Supv	Disabled 1 trip circuit 2 trip circuits 3 trip circuits	Disabled	74TC Trip Circuit Supervision
142	49	Disabled Enabled	Disabled	49 Thermal Overload Protection
144	V-TRANSFORMER	Not connected connected ONLY VN	connected	Voltage transformers

Addr.	Parameter	Setting Options	Default Setting	Comments
617	ServiProt (CM)	Disabled T103 DIGSI TIME SYNCH	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

A.8 Settings

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

The table indicates region-specific default settings. Column C (configuration) indicates the corresponding secondary nominal current of the current transformer.

Addr.	Parameter	Function	C	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 Current Voltage P forward P reverse Q forward Q reverse Power factor Frequency df/dt rising df/dt falling Binary Input	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	CURRENT	Flx		Ia Ib Ic In In sensitive	Ia	Current
0	VOLTAGE	Flx		Please select Va-n Vb-n Vc-n Va-b Vb-c Vc-a	Please select	Voltage
0	POWER	Flx		Ia Va-n Ib Vb-n Ic Vc-n	Ia Va-n	Power
0	VOLTAGE SYSTEM	Flx		Phase-Phase Phase-Ground	Phase-Phase	Voltage System
0	P.U. THRESHOLD	Flx		0.03 .. 40.00 A	2.00 A	Pickup Threshold
0	P.U. THRESHOLD	Flx	1A	0.03 .. 40.00 A	2.00 A	Pickup Threshold
			5A	0.15 .. 200.00 A	10.00 A	
0	P.U. THRESHOLD	Flx		0.001 .. 1.500 A	0.100 A	Pickup Threshold
0	P.U. THRESHOLD	Flx		2.0 .. 260.0 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	1A	0.5 .. 10000.0 W	200.0 W	Pickup Threshold
			5A	2.5 .. 50000.0 W	1000.0 W	
0	P.U. THRESHOLD	Flx		-0.99 .. 0.99	0.50	Pickup Threshold
0	P.U. THRESHOLD	Flx		15 .. 100 %	20 %	Pickup Threshold
0	T TRIP DELAY	Flx		0.00 .. 3600.00 sec	1.00 sec	Trip Time Delay
0	T PICKUP DELAY	Flx		0.00 .. 60.00 sec	0.00 sec	Pickup Time Delay
0	T PICKUP DELAY	Flx		0.00 .. 60.00 sec	0.00 sec	Pickup Time Delay

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
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
0A	DROPOUT RATIO	Flx		0.70 .. 0.99	0.95	Dropout Ratio
0A	DROPOUT RATIO	Flx		1.01 .. 3.00	1.05	Dropout Ratio
0A	DO differential	Flx		0.02 .. 1.00 Hz	0.02 Hz	Dropout differential
201	CT Starpoint	P.System Data 1		towards Line towards Busbar	towards Line	CT Starpoint
203	Vnom PRIMARY	P.System Data 1		0.4 .. 500.0 kV	10.0 kV	Rated Primary Voltage
204	Vnom SECONDARY	P.System Data 1		80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
205	CT PRIMARY	P.System Data 1		10 .. 20000 A	400 A	CT Rated Primary Current
206	CT SECONDARY	P.System Data 1		1A 5A	1A	CT Rated Secondary Current
207	SystemStarpoint	P.System Data 1		Grounded Peterson-C.Gnd. Isolated	Grounded	System Starpoint is
220	I4 transformer	P.System Data 1		Not connected In prot. line	In prot. line	I4 current transformer is
221	I4/Iph CT	P.System Data 1		0.010 .. 5.000	1.000	Matching ratio I4/Iph for CT's
230	Rated Frequency	P.System Data 1		50 Hz 60 Hz	50 Hz	Rated Frequency
240A	TMin TRIP CMD	P.System Data 1		0.02 .. 30.00 sec	0.10 sec	Minimum TRIP Command Duration
241A	TMax CLOSE CMD	P.System Data 1		0.01 .. 30.00 sec	1.00 sec	Maximum Close Command Duration
242	T-CBtest-dead	P.System Data 1		0.00 .. 30.00 sec	0.10 sec	Dead Time for CB test-autoreclosure
260	Threshold BI 1	P.System Data 1		Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 1
261	Threshold BI 2	P.System Data 1		Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 2
262	Threshold BI 3	P.System Data 1		Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 3
263	Threshold BI 4	P.System Data 1		Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 4
264	Threshold BI 5	P.System Data 1		Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 5
265	Threshold BI 6	P.System Data 1		Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 6
266	Threshold BI 7	P.System Data 1		Thresh. BI 176V Thresh. BI 88V Thresh. BI 19V	Thresh. BI 176V	Threshold for Binary Input 7
301	ACTIVE GROUP	Change Group		Group A Group B Group C Group D	Group A	Active Setting Group is
302	CHANGE	Change Group		Group A Group B Group C Group D Binary Input Protocol	Group A	Change to Another Setting Group
402A	WAVEFORMTRIGGER	Osc. Fault Rec.		Save w. Pickup Save w. TRIP Start w. TRIP	Save w. Pickup	Waveform Capture
403A	WAVEFORM DATA	Osc. Fault Rec.		Fault event Pow.Sys.Flt.	Fault event	Scope of Waveform Data
410	MAX. LENGTH	Osc. Fault Rec.		0.30 .. 5.00 sec	2.00 sec	Max. length of a Waveform Capture Record

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
411	PRE. TRIG. TIME	Osc. Fault Rec.		0.05 .. 0.50 sec	0.25 sec	Captured Waveform Prior to Trigger
412	POST REC. TIME	Osc. Fault Rec.		0.05 .. 0.50 sec	0.10 sec	Captured Waveform after Event
415	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
615	Spont. FltDisp.	Device, General		NO YES	NO	Spontaneous display of flt.an-nunciations
625A	T MIN LED HOLD	Device, General		0 .. 60 min; ∞	0 min	Minimum hold time of latched LEDs
640	Start image DD	Device, General		image 1 image 2 image 3 image 4 image 5 image 6 image 7 image 8	image 1	Start image Default Display
650	PDI Test Mode	Device, General		OFF ON	OFF	PDI Test Mode
1103	FullScaleVolt.	P.System Data 2		0.4 .. 500.0 kV	10.0 kV	Measurem:FullScaleVolt-age(Equipm.rating)
1104	FullScaleCurr.	P.System Data 2		10 .. 20000 A	400 A	Measurem:FullScaleCur-rent(Equipm.rating)
1107	P,Q sign	P.System Data 2		not reversed reversed	not reversed	P,Q operational measured values sign
1130A	PoleOpenCurrent	P.System Data 2	1A	0.05 .. 1.00 A	0.10 A	Pole Open Current Threshold
			5A	0.25 .. 5.00 A	0.50 A	
1131A	PoleOpenVoltage	P.System Data 2		2 .. 70 V	30 V	Pole Open Voltage Threshold
1132A	SI Time all Cl.	P.System Data 2		0.01 .. 30.00 sec	0.10 sec	Seal-in Time after ALL closures
1133A	T DELAY SOTF	P.System Data 2		0.05 .. 30.00 sec	0.25 sec	minimal time for line open before SOTF
1134	Line Closure	P.System Data 2		only with ManCl I OR V or ManCl 52a OR I or M/C I or Man.Close	only with ManCl	Recognition of Line Closures with
1135	Reset Trip CMD	P.System Data 2		CurrentOpenPole Current AND 52a Pickup Reset	CurrentOpenPole	RESET of Trip Command
1150A	SI Time Man.Cl	P.System Data 2		0.01 .. 30.00 sec	0.30 sec	Seal-in Time after MANUAL clo-sures
1152	Man.Clos. Imp.	P.System Data 2		(Setting options depend on configuration)	None	MANUAL Closure Impulse after CONTROL
1201	87L PCC-Prot.	87 Diff. Prot.		OFF ON	ON	Phase current comparison pro-tection
1202	87L Idyn>	87 Diff. Prot.	1A	0.20 .. 20.00 A; ∞	0.33 A	Dynamic trip threshold
			5A	1.00 .. 100.00 A; ∞	1.65 A	
1203	87L Idyn close>	87 Diff. Prot.	1A	0.20 .. 20.00 A; ∞	0.33 A	Dynamic trip threshold line closure
			5A	1.00 .. 100.00 A; ∞	1.65 A	
1204	87L Isteady>	87 Diff. Prot.	1A	0.50 .. 20.00 A; ∞	1.33 A	Steady pick up threshold
			5A	2.50 .. 100.00 A; ∞	6.65 A	
1205	87L I min	87 Diff. Prot.	1A	0.10 .. 20.00 A; ∞	1.00 A	Minimal phase current
			5A	0.50 .. 100.00 A; ∞	5.00 A	
1206	87L Trip Delay	87 Diff. Prot.		0.00 .. 0.10 sec	0.00 sec	Trip Delay
1207	87L Man. Close	87 Diff. Prot.		DELAYED UNDELAYED	DELAYED	Trip response after manual close
1208	87L: T EFdetect	87 Diff. Prot.		0.00 .. 32.00 sec	0.00 sec	Evolving fault detect.time 1ph faults
1214	87L:Inrush blk.	87 Diff. Prot.		NO YES	NO	Inrush blocking
1221	87N L: Protect.	87 Diff. Prot.		OFF ON Alarm Only	ON	87N L protection

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
1222	87N L: I-DIFF>	87 Diff. Prot.	1A	0.10 .. 20.00 A	0.30 A	3I0-DIFF> Pickup value
			5A	0.50 .. 100.00 A	1.50 A	
1224A	87N L: T-DELAY	87 Diff. Prot.		0.00 .. 300.00 sec; ∞	0.00 sec	3I0-DIFF Trip time delay
1225A	87N L: I>RELEAS	87 Diff. Prot.	1A	0.00 .. 20.00 A	0.00 A	Min.current to release 3I0-DIFF-Trip
			5A	0.00 .. 100.00 A	0.00 A	
1226	87N L: 3V0>	87 Diff. Prot.		5 .. 150 V	50 V	3V0> pickup
1227	87N L:Vph-g min	87 Diff. Prot.		10 .. 100 V	40 V	Vph-g min of faulted phase
1228	87N L:Vph-g max	87 Diff. Prot.		10 .. 100 V	75 V	Vph-g max of healthy phases
1229	87N L: IN(s)>	87 Diff. Prot.		0.003 .. 1.000 A	0.050 A	IN(s)> to release directional element
1230	87N L:TD-F.det.	87 Diff. Prot.		0.00 .. 320.00 sec	1.00 sec	Time delay for fault detection
1231	87N L:TripDelay	87 Diff. Prot.		0.00 .. 320.00 sec	0.00 sec	Trip Delay
1233	CT Err. I1	87 Diff. Prot.		0.003 .. 1.600 A	0.050 A	Current I1 for CT Angle Error
1234	CT Err. F1	87 Diff. Prot.		0.0 .. 5.0 °	0.0 °	CT Angle Error at I1
1235	CT Err. I2	87 Diff. Prot.		0.003 .. 1.600 A	1.000 A	Current I2 for CT Angle Error
1236	CT Err. F2	87 Diff. Prot.		0.0 .. 5.0 °	0.0 °	CT Angle Error at I2
1237	87NL:Inrush blk	87 Diff. Prot.		NO YES	NO	Inrush blocking
1301	85 DT: SEND	85 DT Intertrip		YES NO	YES	85 DT: State of transm.the inter-trip cmd
1302	85 DT: RECEIVE	85 DT Intertrip		Alarm only Trip	Trip	85 DT: React.if intertrip cmd is receiv.
1303	85 DT: TD-BI	85 DT Intertrip		0.00 .. 30.00 sec	0.00 sec	85 DT: Delay for intertrip via bin.input
1304	85 DT:T-PROL BI	85 DT Intertrip		0.00 .. 30.00 sec	0.00 sec	85 DT: Prol. for intertrip via bin.in-put
1305	85 DT Iph rel.	85 DT Intertrip	1A	0.0 .. 25.0 A; ∞	0.0 A	85 DT minimal Phase Current to rel. trip
			5A	0.0 .. 125.0 A; ∞	0.0 A	
1306	85 DT 3I0 rel.	85 DT Intertrip	1A	0.0 .. 25.0 A; ∞	0.0 A	85 DT minimal 3I0 Current to rel. trip
			5A	0.0 .. 125.0 A; ∞	0.0 A	
2201	Direct Trip(DT)	DTT Direct Trip		ON OFF	OFF	Direct Trip (DT)
2202	Trip Time DELAY	DTT Direct Trip		0.00 .. 30.00 sec; ∞	0.00 sec	Trip Time Delay
2203	Iph rel.Trip	DTT Direct Trip	1A	0.0 .. 25.0 A; ∞	0.0 A	Minimal Phase Current to release trip
			5A	0.0 .. 125.0 A; ∞	0.0 A	
2204	3I0 rel.Trip	DTT Direct Trip	1A	0.0 .. 25.0 A; ∞	0.0 A	Minimal 3I0 Current to release trip
			5A	0.0 .. 125.0 A; ∞	0.0 A	
2301	INRUSH REST.	InRushRestraint		OFF ON	OFF	Inrush Restraint
2302	2nd HARMONIC	InRushRestraint		10 .. 45 %	15 %	2nd. harmonic in % of fundamen-tal
2303	CROSS BLOCK	InRushRestraint		NO YES	NO	Cross Block
2305	MAX INRUSH PEAK	InRushRestraint		1.1 .. 25.0 A	15.0 A	Maximum inrush-peak value
2310	CROSSB 2HM	InRushRestraint		0.00 .. 60.00 sec; ∞	0.00 sec	Time for Crossblock with 2nd harmonic
2603A	67N dir. meas.	Back-Up O/C		V0/I0 or V2/I2 with V0/I0 with V2/I2	V0/I0 or V2/I2	67N, Measurement of direction
2610	Op.Mode50(N)-B1	Back-Up O/C		ON Only Emer. prot OFF	OFF	Operating Mode 50(N)-B1
2610	Op.Mode67(N)-B1	Back-Up O/C		ON Only Emer. prot OFF	OFF	Operating Mode 67(N)-B1
2611	67(N)-B1 Dir.	Back-Up O/C		Non-Directional Forward Reverse	Non-Directional	67(N)-B1 Direction
2612	67(N)-B1 on FFM	Back-Up O/C		Non-Directional BLOCKED	BLOCKED	67(N)-B1 Direct. stage on Fuse Failure

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
2613	50-B1 PICKUP	Back-Up O/C	1A	0.10 .. 25.00 A; ∞	2.00 A	50-B1 Pickup
			5A	0.50 .. 125.00 A; ∞	10.00 A	
2613	67-B1 PICKUP	Back-Up O/C		0.10 .. 25.00 A; ∞	2.00 A	67-B1 Pickup threshold
2614	50-B1 DELAY	Back-Up O/C		0.00 .. 30.00 sec; ∞	0.30 sec	50-B1 Delay
2614	67-B1 DELAY	Back-Up O/C		0.00 .. 30.00 sec; ∞	0.30 sec	67-B1 set time delay
2615	50-B1 Inrush	Back-Up O/C		NO YES	NO	50-B1 Inrush blocking
2615	67-B1 Inrush	Back-Up O/C		NO YES	NO	67-B1 Inrush blocking
2616	50N-B1 PICKUP	Back-Up O/C	1A	0.05 .. 25.00 A; ∞	0.50 A	50N-B1 Pickup
			5A	0.25 .. 125.00 A; ∞	2.50 A	
2616	67N-B1 PICKUP	Back-Up O/C		0.05 .. 25.00 A; ∞	0.50 A	67N-B1 Pickup threshold
2617	50N-B1 DELAY	Back-Up O/C		0.00 .. 30.00 sec; ∞	2.00 sec	50N-B1 Delay
2617	67N-B1 DELAY	Back-Up O/C		0.00 .. 30.00 sec; ∞	2.00 sec	67N-B1 set time delay
2618	50(N)-B1 Pil/BI	Back-Up O/C		NO YES	YES	Instantaneous trip via Pilot Prot./BI
2618	67(N)-B1 Pil/BI	Back-Up O/C		NO YES	NO	Instantaneous trip via Pilot Prot./BI
2620	Op.Mode50(N)-B2	Back-Up O/C		ON Only Emer. prot OFF	Only Emer. prot	Operating Mode 50(N)-B2
2620	Op.Mode67(N)-B2	Back-Up O/C		ON Only Emer. prot OFF	Only Emer. prot	Operating Mode 67(N)-B2
2621	67(N)-B2 Dir.	Back-Up O/C		Non-Directional Forward Reverse	Non-Directional	67(N)-B2 Direction
2622	67(N)-B2 on FFM	Back-Up O/C		Non-Directional BLOCKED	BLOCKED	67(N)-B2 Direct. stage on Fuse Failure
2623	50-B2 PICKUP	Back-Up O/C	1A	0.10 .. 25.00 A; ∞	1.50 A	50-B2 Pickup
			5A	0.50 .. 125.00 A; ∞	7.50 A	
2623	67-B2 PICKUP	Back-Up O/C		0.05 .. 50.00 A; ∞	1.50 A	67-B2 Pickup threshold
2624	50-B2 DELAY	Back-Up O/C		0.00 .. 30.00 sec; ∞	0.50 sec	50-B2 Delay
2624	67-B2 DELAY	Back-Up O/C		0.00 .. 30.00 sec; ∞	0.50 sec	67-B2 set time delay
2625	50-B2 Inrush	Back-Up O/C		NO YES	NO	50-B2 Inrush blocking
2625	67-B2 Inrush	Back-Up O/C		NO YES	NO	67-B2 Inrush blocking
2626	50N-B2 PICKUP	Back-Up O/C	1A	0.05 .. 25.00 A; ∞	0.20 A	50N-B2 Pickup
			5A	0.25 .. 125.00 A; ∞	1.00 A	
2626	67N-B2 PICKUP	Back-Up O/C		0.05 .. 25.00 A; ∞	0.20 A	67N-B2 Pickup threshold
2627	50N-B2 DELAY	Back-Up O/C		0.00 .. 30.00 sec; ∞	2.00 sec	50N-B2 Delay
2627	67N-B2 DELAY	Back-Up O/C		0.00 .. 30.00 sec; ∞	2.00 sec	67N-B2 set time delay
2628	50(N)-B2 Pil/BI	Back-Up O/C		NO YES	NO	Instantaneous trip via Pilot Prot./BI
2628	67(N)-B2 Pil/BI	Back-Up O/C		NO YES	NO	Instantaneous trip via Pilot Prot./BI
2630	Op.Mode 51(N)-B	Back-Up O/C		ON Only Emer. prot OFF	OFF	Operating Mode 51(N)-B
2630	Op.Mode67(N)TOC	Back-Up O/C		ON Only Emer. prot OFF	OFF	Operating Mode 67(N)-TOC
2631	67(N)-TOC Dir.	Back-Up O/C		Non-Directional Forward Reverse	Non-Directional	67(N)-TOC Direction
2632	67(N)-TOCon FFM	Back-Up O/C		Non-Directional BLOCKED	BLOCKED	67(N)-TOC Direct. stage on Fuse Failure
2633	51-B PICKUP	Back-Up O/C	1A	0.10 .. 4.00 A; ∞	∞ A	51-B Pickup
			5A	0.50 .. 20.00 A; ∞	∞ A	
2633	67-TOC PICKUP	Back-Up O/C		0.10 .. 4.00 A; ∞	∞ A	67-TOC Pickup threshold

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
2634	51-B TD IEC	Back-Up O/C		0.05 .. 3.00 sec; ∞	0.50 sec	51-B Time Dial for IEC characteristic
2634	67-TOC TD IEC	Back-Up O/C		0.05 .. 3.00 sec; ∞	0.50 sec	67-TOC Time Dial for IEC characteristic
2635	51-B TD ANSI	Back-Up O/C		0.50 .. 15.00 ; ∞	5.00	51-B Time Dial for ANSI characteristic
2635	67-TOC TD ANSI	Back-Up O/C		0.50 .. 15.00 ; ∞	5.00	67-TOC Time Dial for ANSI characteristic
2636	51-B AddT-DELAY	Back-Up O/C		0.00 .. 30.00 sec	5.00 sec	51-B Additional Time Delay
2636	67-TOC AddTDel.	Back-Up O/C		0.00 .. 30.00 sec	5.00 sec	67-TOC Additional Time Delay
2637	51-B Inrush	Back-Up O/C		NO YES	NO	51-B Inrush blocking
2637	67-TOC Inrush	Back-Up O/C		NO YES	NO	67-TOC Inrush blocking
2638	51N-B PICKUP	Back-Up O/C	1A	0.05 .. 4.00 A; ∞	∞ A	51N-B Pickup
			5A	0.25 .. 20.00 A; ∞	∞ A	
2638	67N-TOC PICKUP	Back-Up O/C		0.05 .. 4.00 A; ∞	∞ A	67N-TOC Pickup threshold
2639	51N-B TD IEC	Back-Up O/C		0.05 .. 3.00 sec; ∞	0.50 sec	51N-B Time Dial for IEC characteristic
2639	67N-TOC TD IEC	Back-Up O/C		0.05 .. 3.00 sec; ∞	0.50 sec	67N-TOC Time Dial for IEC characteristic
2640	51N-B TD ANSI	Back-Up O/C		0.50 .. 15.00 ; ∞	5.00	51N-B Time Dial for ANSI characteristic
2640	67N-TOC TD ANSI	Back-Up O/C		0.50 .. 15.00 ; ∞	5.00	67N-TOC Time Dial for ANSI char.
2641	51N-B AddTdelay	Back-Up O/C		0.00 .. 30.00 sec	0.00 sec	51N-B Additional Time Delay
2641	67N-TOC AddTDel	Back-Up O/C		0.00 .. 30.00 sec	0.00 sec	67N-TOC Additional Time Delay
2642	IEC Curve	Back-Up O/C		Normal Inverse Very Inverse Extremely Inv. LongTimeInverse	Normal Inverse	IEC Curve
2642	IEC Curve	Back-Up O/C		Normal Inverse Very Inverse Extremely Inv. LongTimeInverse	Normal Inverse	IEC Curve
2643	ANSI Curve	Back-Up O/C		Inverse Short Inverse Long Inverse Moderately Inv. Very Inverse Extremely Inv. Definite Inv.	Inverse	ANSI Curve
2643	ANSI Curve	Back-Up O/C		Inverse Short Inverse Long Inverse Moderately Inv. Very Inverse Extremely Inv. Definite Inv.	Inverse	ANSI Curve
2644	51(N)-B PilotBI	Back-Up O/C		NO YES	NO	Instantaneous trip via Pilot Prot./BI
2644	67(N)TOC Pil/BI	Back-Up O/C		NO YES	NO	Instantaneous trip via Pilot Prot./BI
2650	50(N)-STUB OpMo	Back-Up O/C		ON Only Emer. prot OFF	OFF	50(N)-STUB Operating Mode
2651	50-STUB PICKUP	Back-Up O/C	1A	0.10 .. 25.00 A; ∞	1.50 A	50-STUB Pickup
			5A	0.50 .. 125.00 A; ∞	7.50 A	
2652	50-STUB DELAY	Back-Up O/C		0.00 .. 30.00 sec; ∞	0.30 sec	50-STUB Delay
2653	50-STUB Inrush	Back-Up O/C		NO YES	NO	50-STUB Inrush blocking
2654	50N-STUB PICKUP	Back-Up O/C	1A	0.05 .. 25.00 A; ∞	0.20 A	50N-STUB Pickup
			5A	0.25 .. 125.00 A; ∞	1.00 A	
2655	50N-STUB DELAY	Back-Up O/C		0.00 .. 30.00 sec; ∞	2.00 sec	50N-STUB Delay
2656	50STUB Pilot/BI	Back-Up O/C		NO YES	NO	Instantaneous trip via Pilot Prot./BI

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
2801	DMD Interval	Demand meter		15 Min., 1 Sub 15 Min., 3 Subs 15 Min.,15 Subs 30 Min., 1 Sub 60 Min., 1 Sub	60 Min., 1 Sub	Demand Calculation Intervals
2802	DMD Sync.Time	Demand meter		On The Hour 15 After Hour 30 After Hour 45 After Hour	On The Hour	Demand Synchronization Time
2811	MinMax cycRESET	Min/Max meter		NO YES	YES	Automatic Cyclic Reset Function
2812	MiMa RESET TIME	Min/Max meter		0 .. 1439 min	0 min	MinMax Reset Timer
2813	MiMa RESETCYCLE	Min/Max meter		1 .. 365 Days	7 Days	MinMax Reset Cycle Period
2814	MinMaxRES.START	Min/Max meter		1 .. 365 Days	1 Days	MinMax Start Reset Cycle in
2901	MEASURE. SUPERV	Measurem.Superv		ON OFF	ON	Measurement Supervision
2902A	BALANCE V-LIMIT	Measurem.Superv		10 .. 100 V	50 V	Voltage Threshold for Balance Monitoring
2903A	BAL. FACTOR V	Measurem.Superv		0.58 .. 0.95	0.75	Balance Factor for Voltage Monitor
2904A	BALANCE I LIMIT	Measurem.Superv	1A	0.10 .. 1.00 A	0.50 A	Current Threshold for Balance Monitoring
			5A	0.50 .. 5.00 A	2.50 A	
2905A	BAL. FACTOR I	Measurem.Superv		0.10 .. 0.95	0.50	Balance Factor for Current Monitor
2906A	Σ I THRESHOLD	Measurem.Superv	1A	0.10 .. 2.00 A	0.25 A	Summated Current Monitoring Threshold
			5A	0.50 .. 10.00 A	1.25 A	
2907A	Σ I FACTOR	Measurem.Superv		0.00 .. 0.95	0.50	Summated Current Monitoring Factor
2908A	T BAL. V LIMIT	Measurem.Superv		5 .. 100 sec	5 sec	T Balance Factor for Voltage Monitor
2909A	T BAL. I LIMIT	Measurem.Superv		5 .. 100 sec	5 sec	T Current Balance Monitor
2910	FUSE FAIL MON.	Measurem.Superv		ON OFF	ON	Fuse Failure Monitor
2911A	FFM V>(min)	Measurem.Superv		10 .. 100 V	30 V	Minimum Voltage Threshold V>
2912A	FFM I< (max)	Measurem.Superv	1A	0.10 .. 1.00 A	0.10 A	Maximum Current Threshold I<
			5A	0.50 .. 5.00 A	0.50 A	
2913A	FFM V<max (3ph)	Measurem.Superv		2 .. 100 V	5 V	Maximum Voltage Threshold V< (3phase)
2914A	FFM Idiff (3ph)	Measurem.Superv	1A	0.05 .. 1.00 A	0.10 A	Differential Current Threshold (3phase)
			5A	0.25 .. 5.00 A	0.50 A	
2915	V-Supervision	Measurem.Superv		w/ CURR.SUP w/ I> & 52a OFF	w/ CURR.SUP	Voltage Failure Supervision
2916A	T V-Supervision	Measurem.Superv		0.00 .. 30.00 sec	3.00 sec	Delay Voltage Failure Supervision
2931	BROKEN WIRE	Measurem.Superv		ON OFF Alarm only	OFF	Fast broken current-wire supervision
2933	FAST Σ i SUPERV	Measurem.Superv		ON OFF	ON	State of fast current summation supervis
2935A	ΔI min	Measurem.Superv	1A	0.05 .. 1.00 A	0.10 A	Min. current diff. for wire break det.
			5A	0.25 .. 5.00 A	0.50 A	
3401	FCT 79	79 Auto Recl.		OFF ON	ON	79 Auto-Reclose Function
3402	52? 1.TRIP	79 Auto Recl.		YES NO	NO	52-ready interrogation at 1st trip
3403	T-RECLAIM	79 Auto Recl.		0.50 .. 300.00 sec	3.00 sec	Reclaim time after successful AR cycle
3404	BLOCK MC Dur.	79 Auto Recl.		0.50 .. 300.00 sec; 0	1.00 sec	AR blocking duration after manual close
3406	EV. FLT. RECOG.	79 Auto Recl.		with PICKUP with TRIP	with TRIP	Evolving fault recognition

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
3407	EV. FLT. MODE	79 Auto Recl.		Stops 79 starts 3p AR is ignored	starts 3p AR	Evolving fault (during the dead time)
3408	T-Start MONITOR	79 Auto Recl.		0.01 .. 300.00 sec	0.50 sec	AR start-signal monitoring time
3409	CB TIME OUT	79 Auto Recl.		0.01 .. 300.00 sec	3.00 sec	Circuit Breaker (CB) Supervision Time
3410	RemoteCl. Delay	79 Auto Recl.		0.00 .. 300.00 sec; ∞	0.20 sec	Send delay for remote close command
3411A	Max. DEAD EXT.	79 Auto Recl.		0.50 .. 300.00 sec; ∞	∞ sec	Maximum dead time extension
3420	AR WITH DIFF	79 Auto Recl.		YES NO	YES	AR with differential protection ?
3423	AR w/ INT.TRIP	79 Auto Recl.		YES NO	YES	AR with intertrip ?
3424	AR w/ DTT	79 Auto Recl.		YES NO	YES	AR with DTT (direct transfer trip)
3425	AR w/ 50(N)-B	79 Auto Recl.		YES NO	YES	AR with 50(N)-B (back-up over-current)
3450	1.AR:START	79 Auto Recl.		YES NO	YES	Start of AR allowed in this cycle
3451	1.AR:ActionTime	79 Auto Recl.		0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3453	1.AR:DeadT.1Flt	79 Auto Recl.		0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults
3454	1.AR:DeadT.2Flt	79 Auto Recl.		0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults
3455	1.AR:DeadT.3Flt	79 Auto Recl.		0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults
3457	1.AR:Dead 3Trip	79 Auto Recl.		0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3458	1.AR:DeadT.EV.	79 Auto Recl.		0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3459	1.AR:52? CLOSE	79 Auto Recl.		YES NO	NO	52-ready interrogation before re-closing
3461	2.AR:START	79 Auto Recl.		YES NO	NO	AR start allowed in this cycle
3462	2.AR:ActionTime	79 Auto Recl.		0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3464	2.AR:DeadT.1Flt	79 Auto Recl.		0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults
3465	2.AR:DeadT.2Flt	79 Auto Recl.		0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults
3466	2.AR:DeadT.3Flt	79 Auto Recl.		0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults
3468	2.AR:Dead 3Trip	79 Auto Recl.		0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3469	2.AR:DeadT.EV.	79 Auto Recl.		0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3470	2.AR:52? CLOSE	79 Auto Recl.		YES NO	NO	52-ready interrogation before re-closing
3601	81 O/U FREQ. f1	81 O/U Freq.		ON: Alarm only ON: with Trip OFF	ON: Alarm only	81 Over/Under Frequency Prot. element f1
3602	81-1 PICKUP	81 O/U Freq.		45.50 .. 54.50 Hz	49.50 Hz	81-1 Pickup
3603	81-1 PICKUP	81 O/U Freq.		55.50 .. 64.50 Hz	59.50 Hz	81-1 Pickup
3604	81-1 DELAY	81 O/U Freq.		0.00 .. 600.00 sec	60.00 sec	81-1 Time Delay
3611	81 O/U FREQ. f2	81 O/U Freq.		ON: Alarm only ON: with Trip OFF	ON: Alarm only	81 Over/Under Frequency Prot. element f2
3612	81-2 PICKUP	81 O/U Freq.		45.50 .. 54.50 Hz	49.00 Hz	81-2 Pickup
3613	81-2 PICKUP	81 O/U Freq.		55.50 .. 64.50 Hz	57.00 Hz	81-2 Pickup
3614	81-2 DELAY	81 O/U Freq.		0.00 .. 600.00 sec	30.00 sec	81-2 Time Delay
3621	81 O/U FREQ. f3	81 O/U Freq.		ON: Alarm only ON: with Trip OFF	ON: Alarm only	81 Over/Under Frequency Prot. element f3
3622	81-3 PICKUP	81 O/U Freq.		45.50 .. 54.50 Hz	47.50 Hz	81-3 Pickup
3623	81-3 PICKUP	81 O/U Freq.		55.50 .. 64.50 Hz	59.50 Hz	81-3 Pickup
3624	81-3 DELAY	81 O/U Freq.		0.00 .. 600.00 sec	3.00 sec	81-3 Time delay
3631	81 O/U FREQ. f4	81 O/U Freq.		ON: Alarm only ON: with Trip OFF	ON: Alarm only	81 Over/Under Frequency Prot. element f4
3632	81-4 PICKUP	81 O/U Freq.		45.50 .. 54.50 Hz	51.00 Hz	81-4 Pickup
3633	81-4 PICKUP	81 O/U Freq.		55.50 .. 64.50 Hz	62.00 Hz	81-4 Pickup
3634	81-4 DELAY	81 O/U Freq.		0.00 .. 600.00 sec	30.00 sec	81-4 Time delay

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
3701	59-Vph-g Mode	27/59 O/U Volt.		OFF Alarm Only ON V>Alarm V>>Trip	OFF	Operating mode Vph-g overvoltage prot.
3702	59-1-Vph PICKUP	27/59 O/U Volt.		1.0 .. 170.0 V; ∞	85.0 V	59-1 Pickup Overvoltage (phase-ground)
3703	59-1-Vph DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	2.00 sec	59-1 Time Delay
3704	59-2-Vph PICKUP	27/59 O/U Volt.		1.0 .. 170.0 V; ∞	100.0 V	59-2 Pickup Overvoltage (phase-ground)
3705	59-2-Vph DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	1.00 sec	59-2 Time Delay
3709A	59-Vph RESET	27/59 O/U Volt.		0.30 .. 0.99	0.98	Reset ratio
3711	59-Vph-ph Mode	27/59 O/U Volt.		OFF Alarm Only ON V>Alarm V>>Trip	OFF	Operating mode Vph-ph overvoltage prot.
3712	59-1-Vpp PICKUP	27/59 O/U Volt.		2.0 .. 220.0 V; ∞	150.0 V	59-1 Pickup Overvoltage (phase-phase)
3713	59-1-Vpp DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	2.00 sec	59-1 Time Delay
3714	59-2-Vpp PICKUP	27/59 O/U Volt.		2.0 .. 220.0 V; ∞	175.0 V	59-2 Pickup Overvoltage (phase-phase)
3715	59-2-Vpp DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	1.00 sec	59-2 Time Delay
3719A	59-Vpp RESET	27/59 O/U Volt.		0.30 .. 0.99	0.98	Reset ratio
3721	59G-3V0 (or Vx)	27/59 O/U Volt.		OFF Alarm Only ON V>Alarm V>>Trip	OFF	Operating mode 3V0 overvoltage
3722	59G-1-3V0PICKUP	27/59 O/U Volt.		1.0 .. 220.0 V; ∞	30.0 V	59G-1 Pickup 3V0 (zero seq.)
3723	59G-1-3V0 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	2.00 sec	59G-1 Time Delay
3724	59G-2-3V0PICKUP	27/59 O/U Volt.		1.0 .. 220.0 V; ∞	50.0 V	59G-2 Pickup 3V0 (zero seq.)
3725	59G-2-3V0 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	1.00 sec	59G-2 Time Delay
3728A	59G-3Vo Stabil.	27/59 O/U Volt.		ON OFF	ON	59G: Stabilization 3Vo-Measurement
3729A	59G RESET	27/59 O/U Volt.		0.30 .. 0.99	0.95	Reset ratio
3731	59-V1 Mode	27/59 O/U Volt.		OFF Alarm Only ON V>Alarm V>>Trip	OFF	Operating mode V1 overvoltage prot.
3732	59-1-V1 PICKUP	27/59 O/U Volt.		2.0 .. 220.0 V; ∞	150.0 V	59-1 Pickup Overvoltage (pos. seq.)
3733	59-1-V1 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	2.00 sec	59-1 Time Delay
3734	59-2-V1 PICKUP	27/59 O/U Volt.		2.0 .. 220.0 V; ∞	175.0 V	59-2 Pickup Overvoltage (pos. seq.)
3735	59-2-V1 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	1.00 sec	59-2 Time Delay
3739A	59-V1 RESET	27/59 O/U Volt.		0.30 .. 0.99	0.98	Reset ratio
3741	59-V2 Mode	27/59 O/U Volt.		OFF Alarm Only ON V>Alarm V>>Trip	OFF	Operating mode V2 overvoltage prot.
3742	59-1-V2 PICKUP	27/59 O/U Volt.		2.0 .. 220.0 V; ∞	30.0 V	59-1 Pickup Overvoltage (neg. seq.)
3743	59-1-V2 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	2.00 sec	59-1 Time Delay
3744	59-2-V2 PICKUP	27/59 O/U Volt.		2.0 .. 220.0 V; ∞	50.0 V	59-2 Pickup Overvoltage (neg. seq.)
3745	59-2-V2 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	1.00 sec	59-2 Time Delay
3749A	59-V2 RESET	27/59 O/U Volt.		0.30 .. 0.99	0.98	Reset ratio
3751	27-Vph-g Mode	27/59 O/U Volt.		OFF Alarm Only ON V<Alarm V<<Trip	OFF	Operating mode Vph-g undervoltage prot.
3752	27-1-Vph PICKUP	27/59 O/U Volt.		1.0 .. 100.0 V; 0	30.0 V	27-1 Pickup Undervoltage (phase-neutral)
3753	27-1-Vph DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	2.00 sec	27-1 Time Delay
3754	27-2-Vph PICKUP	27/59 O/U Volt.		1.0 .. 100.0 V; 0	10.0 V	27-2 Pickup Undervoltage (phase-neutral)

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
3755	27-2-Vph DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	1.00 sec	27-2 Time Delay
3758	CURR.SUP 27-Vph	27/59 O/U Volt.		ON OFF	ON	Current supervision (Vph-g)
3759A	27-Vph RESET	27/59 O/U Volt.		1.01 .. 1.20	1.05	Reset ratio
3761	27-Vph-ph Mode	27/59 O/U Volt.		OFF Alarm Only ON V<Alarm V<<Trip	OFF	Operating mode Vph-ph under-voltage prot.
3762	27-1-Vpp PICKUP	27/59 O/U Volt.		1.0 .. 175.0 V; 0	50.0 V	27-1 Pickup Undervoltage (phase-phase)
3763	27-1-Vpp DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	2.00 sec	27-1 Time Delay
3764	27-2-Vpp PICKUP	27/59 O/U Volt.		1.0 .. 175.0 V; 0	17.0 V	27-2 Pickup Undervoltage (phase-phase)
3765	27-2-Vpp DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	1.00 sec	27-2 Time Delay
3768	CURR.SUP 27-Vpp	27/59 O/U Volt.		ON OFF	ON	Current supervision (Vph-ph)
3769A	27-Vph-ph RESET	27/59 O/U Volt.		1.01 .. 1.20	1.05	Reset ratio
3771	27-V1 Mode	27/59 O/U Volt.		OFF Alarm Only ON V<Alarm V<<Trip	OFF	Operating mode V1 Undervolt-age prot.
3772	27-1-V1 PICKUP	27/59 O/U Volt.		1.0 .. 100.0 V; 0	30.0 V	27-1 Pickup Undervoltage (pos. seq.)
3773	27-1-V1 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	2.00 sec	27-1 Time Delay
3774	27-2-V1 PICKUP	27/59 O/U Volt.		1.0 .. 100.0 V; 0	10.0 V	27-2 Pickup Undervoltage (pos. seq.)
3775	27-2-V1 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	1.00 sec	27-2 Time Delay
3778	CURR.SUP. 27-V1	27/59 O/U Volt.		ON OFF	ON	Current supervision (V1)
3779A	27-V1 RESET	27/59 O/U Volt.		1.01 .. 1.20	1.05	Reset ratio
3901	FCT 50BF Break.	50BF BkrFailure		ON OFF	ON	50BF Breaker Failure Protection
3902	50BF PICKUP	50BF BkrFailure	1A	0.05 .. 20.00 A	0.10 A	50BF Pickup current threshold
			5A	0.25 .. 100.00 A	0.50 A	
3905	50BF-1 Delay 3p	50BF BkrFailure		0.00 .. 30.00 sec; ∞	0.00 sec	Delay after 3pole start for local trip
3906	50BF-2 Delay	50BF BkrFailure		0.00 .. 30.00 sec; ∞	0.15 sec	Delay of 2nd element for busbar trip
3907	T3-BkrDefective	50BF BkrFailure		0.00 .. 30.00 sec; ∞	0.00 sec	Delay for start with defective bkr.
3908	Trip BkrDefect.	50BF BkrFailure		NO with Local trip with Bus trip w/Local&Bustrip	NO	Trip output selection with defec-tive bkr
3909	Chk BRK CONTACT	50BF BkrFailure		NO YES	YES	Check Breaker contacts
3912	50NBF PICKUP	50BF BkrFailure	1A	0.05 .. 20.00 A	0.10 A	50NBF Pickup neutral current threshold
			5A	0.25 .. 100.00 A	0.50 A	
3913	T2StartCriteria	50BF BkrFailure		With exp. of T1 Parallel withT1	Parallel withT1	T2 Start Criteria
3921	End Flt. elem.	50BF BkrFailure		ON OFF	OFF	End fault element
3922	EndFault Delay	50BF BkrFailure		0.00 .. 30.00 sec; ∞	2.00 sec	Trip delay of end fault element
4001	FCT 74TC	74TC TripCirc.		ON OFF	OFF	74TC TRIP Circuit Supervision
4002	No. of BI	74TC TripCirc.		1 .. 2	2	Number of Binary Inputs per trip circuit
4003	Alarm Delay	74TC TripCirc.		1 .. 30 sec	2 sec	Delay Time for alarm
4201	FCT 49	49 Th.Overload		OFF ON Alarm Only	OFF	49 Thermal overload protection
4202	49 K-FACTOR	49 Th.Overload		0.10 .. 4.00	1.10	49 K-Factor
4203	TIME CONSTANT	49 Th.Overload		1.0 .. 999.9 min	100.0 min	Time Constant
4204	49 Θ ALARM	49 Th.Overload		50 .. 100 %	90 %	49 Thermal Alarm Stage

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
4205	I ALARM	49 Th.Overload	1A	0.10 .. 4.00 A	1.00 A	Current Overload Alarm Setpoint
			5A	0.50 .. 20.00 A	5.00 A	
4206	CALC. METHOD	49 Th.Overload		Θ max Average Θ Θ from Imax	Θ max	Method of Acquiring Tempera-ture
4501	PDI FO	Prot.Interface		ON OFF	ON	Protection Data Interface fiber optic
4502	PDI FO TER	Prot.Interface		0.5 .. 20.0 %	1.0 %	PDI FO max. telegram error rate
4503	PDI FO level	Prot.Interface		-30 .. -10 dBm	-28 dBm	PDI FO min. receive level
4510	TD-DATA DISTURB	Prot.Interface		0.05 .. 2.00 sec	0.10 sec	Time delay for data disturbance alarm
4512	Td ResetRemote	Prot.Interface		0.00 .. 300.00 sec; ∞	0.00 sec	Remote signal RESET DELAY for comm.fail
4601	PDI Cu	Prot.Interface		ON OFF	ON	Protection Data Interface copper
4602	PDI Cu TER	Prot.Interface		0.5 .. 20.0 %	1.0 %	PDI Cu max. telegram error rate
4603	PDI Cu mode	Prot.Interface		01 02 03 04 05 06	01	PDI Cu operation mode
4604	PDI Cu MAX ATT	Prot.Interface		0 .. 46 dB	46 dB	PDI Cu maximum attenuation
4605	PDI Cu S/N	Prot.Interface		6 .. 30 dB	6 dB	PDI Cu min signal to noise ratio
4701	ID OF MASTER	Diff.-Topo		1 .. 65534	1	Identification number of Master
4702	ID OF SLAVE	Diff.-Topo		1 .. 65534	2	Identification number of Slave
4710	LOCAL RELAY	Diff.-Topo		Master Slave	Master	Local relay is

A.9 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 with regard to the indications is set out in the SIPROTEC 4 System Description, Order No. E50417-H1100-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
-	Test mode (Test mode)	Device, General	IntSP	On Off	*		*	LED			BO		192	21	1	Yes
-	Stop data transmission (DataStop)	Device, General	IntSP	On Off	*		*	LED			BO		192	20	1	Yes
-	Unlock data transmission via BI (UnlockDT)	Device, General	IntSP				*									
-	Reset LED (Reset LED)	Device, General	IntSP	ON	*		*	LED			BO		192	19	1	No
-	Clock Synchronization (SynchClock)	Device, General	IntSP _Ev	*	*		*	LED			BO					
-	>Back Light on (>Light on)	Device, General	SP	On Off	*				BI							
-	Hardware Test Mode (HWTestMod)	Device, General	IntSP	On Off	*		*	LED			BO					
-	Error FMS FO 1 (Error FMS1)	Device, General	OUT	On Off	*	*		LED			BO					
-	Error FMS FO 2 (Error FMS2)	Device, General	OUT	On Off	*	*		LED			BO					
-	Disturbance CFC (Distur.CFC)	Device, General	OUT	On Off	*			LED			BO					
-	Breaker OPENED (Brk OPENED)	Device, General	IntSP	*	*		*	LED			BO					
-	Feeder GROUNDED (Feeder gnd)	Device, General	IntSP	*	*		*	LED			BO					
-	Setting Group A is active (P-GrpA act)	Change Group	IntSP	On Off	*		*	LED			BO		192	23	1	Yes
-	Setting Group B is active (P-GrpB act)	Change Group	IntSP	On Off	*		*	LED			BO		192	24	1	Yes

No.	Description	Function	Type of In- for- matio n	Log Buffers: Event Log ON/OFF	Log Buffers: Trip (Fault) Log ON/OFF	Log Buffers: Ground Fault Log ON/OFF	Log Buffers: Marked in Oscill. Record	Configurable in Matrix: LED	Configurable in Matrix: Binary Input	Configurable in Matrix: Function Key	Configurable in Matrix: Relay	Configurable in Matrix: Chatter Suppression	IEC 60870-5-103: Type	IEC 60870-5-103: Information Number	IEC 60870-5-103: Data Unit	IEC 60870-5-103: General Interrogation
-	Setting Group C is active (P-GrpC act)	Change Group	IntSP	On Off	*		*	LED			BO		192	25	1	Yes
-	Setting Group D is active (P-GrpD act)	Change Group	IntSP	On Off	*		*	LED			BO		192	26	1	Yes
-	Fault Recording Start (FltRecSta)	Osc. Fault Rec.	IntSP	On Off	*		m	LED			BO					
-	Reset Minimum and Maximum counter (ResMinMax)	Min/Max meter	IntSP _Ev	ON	*											
-	CB1-TEST trip/close Phases ABC (CB1tst ABC)	Testing	-		*											
-	Controlmode REMOTE (ModeR-EMOTE)	Cntrl Authority	IntSP	On Off	*			LED			BO					
-	Control Authority (Cntrl Auth)	Cntrl Authority	IntSP	On Off	*			LED			BO		101	85	1	Yes
-	Controlmode LOCAL (ModeLO-CAL)	Cntrl Authority	IntSP	On Off	*			LED			BO		101	86	1	Yes
-	52 Breaker (52Breaker)	Control Device	CF_D 12	On Off	*						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_D 2	On Off	*						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_D 2	On Off	*						BO		240	164	20	
-	Ground Switch (GndSwit.)	Control Device	DP	On Off	*				BI			CB	240	164	1	Yes
-	Interlocking: 52 Open (52 Open)	Control Device	IntSP	*	*		*									
-	Interlocking: 52 Close (52 Close)	Control Device	IntSP	*	*		*									
-	Interlocking: Disconnect switch Open (Disc.Open)	Control Device	IntSP	*	*		*									
-	Interlocking: Disconnect switch Close (Disc.Close)	Control Device	IntSP	*	*		*									
-	Interlocking: Ground switch Open (GndSw Open)	Control Device	IntSP	*	*		*									
-	Interlocking: Ground switch Close (GndSw Cl.)	Control Device	IntSP	*	*		*									
-	Q2 Open/Close (Q2 Op/Cl)	Control Device	CF_D 2	On Off	*						BO		240	162	20	
-	Q2 Open/Close (Q2 Op/Cl)	Control Device	DP	On Off	*				BI			CB	240	162	1	Yes
-	Q9 Open/Close (Q9 Op/Cl)	Control Device	CF_D 2	On Off	*						BO		240	163	20	
-	Q9 Open/Close (Q9 Op/Cl)	Control Device	DP	On Off	*				BI			CB	240	163	1	Yes
-	Fan ON/OFF (Fan ON/OFF)	Control Device	CF_D 2	On Off	*						BO		240	175	20	
-	Fan ON/OFF (Fan ON/OFF)	Control Device	DP	On Off	*				BI			CB	240	175	1	Yes
-	>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
-	>Error Motor Voltage (>Err Mot V)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	181	1	Yes

No.	Description	Function	Type of Information	Log Buffers: Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	Configurable in Matrix: LED	Binary Input	Function Key	Relay	Chatter Suppression	IEC 60870-5-103: Type	Information Number	Data Unit	General Interrogation
-	>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 meter (Meter res)	Energy	IntSP_Ev	ON	*											
-	Error Systeminterface (SysIntErr.)	Protocol	IntSP	On Off				LED			BO					
-	Threshold Value 1 (ThreshVal1)	Thresh.-Switch	IntSP	On Off	*		*	LED	BI	FC TN	BO	CB				
1	No Function configured (Not configured)	Device, General	SP													
2	Function Not Available (Non Existent)	Device, General	OUT													
3	>Synchronize Internal Real Time Clock (>Time Synch)	Device, General	SP	*	*		*	LED	BI		BO					
4	>Trigger Waveform Capture (>Trig.Wave.Cap.)	Osc. Fault Rec.	SP	on	*		m	LED	BI		BO					
5	>Reset LED (>Reset LED)	Device, General	SP	*	*		*	LED	BI		BO					
7	>Setting Group Select Bit 0 (>Set Group Bit0)	Change Group	SP	*	*		*	LED	BI		BO					
8	>Setting Group Select Bit 1 (>Set Group Bit1)	Change Group	SP	*	*		*	LED	BI		BO					
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					
11	>User defined annunciation 1 (>Annunc. 1)	Device, General	SP	*	*	*	*	LED	BI		BO		192	27	1	Yes
12	>User defined annunciation 2 (>Annunc. 2)	Device, General	SP	*	*	*	*	LED	BI		BO		192	28	1	Yes
13	>User defined annunciation 3 (>Annunc. 3)	Device, General	SP	*	*	*	*	LED	BI		BO		192	29	1	Yes
14	>User defined annunciation 4 (>Annunc. 4)	Device, General	SP	*	*	*	*	LED	BI		BO		192	30	1	Yes
15	>Test mode (>Test mode)	Device, General	SP	On Off	*		*	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		192	18	1	Yes
55	Reset Device (Reset Device)	Device, General	OUT	*	*		*	LED			BO		192	4	1	No
56	Initial Start of Device (Initial Start)	Device, General	OUT	ON	*		*	LED			BO		192	5	1	No
60	Reset LED (Reset LED)	Device, General	OUT_Ev	ON	*		*	LED			BO					

No.	Description	Function	Type of In-for-matio n	Log Buffers: Event Log ON/OFF	Log Buffers: Trip (Fault) Log ON/OFF	Log Buffers: Ground Fault Log ON/OFF	Log Buffers: Marked in Oscill. Record	Configurable in Matrix: LED	Configurable in Matrix: Binary Input	Configurable in Matrix: Function Key	Configurable in Matrix: Relay	Configurable in Matrix: Chatter Suppression	IEC 60870-5-103: Type	IEC 60870-5-103: Information Number	IEC 60870-5-103: Data Unit	IEC 60870-5-103: General Interrogation
67	Resume (Resume)	Device, General	OUT	ON	*		*	LED			BO		135	97	1	No
68	Clock Synchronization Error (Clock SyncError)	Device, General	OUT	On Off	*		*	LED			BO					
69	Daylight Saving Time (DayLight-SavTime)	Device, General	OUT	On Off	*		*	LED			BO					
70	Setting calculation is running (Settings Calc.)	Device, General	OUT	On Off	*		*	LED			BO		192	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)	Device, General	IntSP	On Off	*		*	LED			BO					
127	79 ON/OFF (via system port) (79 ON/OFF)	79 Auto Recl.	IntSP	On Off	*		*	LED			BO					
140	Error with a summary alarm (Error Sum Alarm)	Device, General	OUT	On Off	*		*	LED			BO		192	47	1	Yes
160	Alarm Summary Event (Alarm Sum Event)	Device, General	OUT	*	*		*	LED			BO		192	46	1	Yes
161	Failure: General Current Supervi-sion (Fail I Superv.)	Measurem.Superv	OUT	*	*		*	LED			BO		192	32	1	Yes
163	Failure: Current Balance (Fail I balance)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	183	1	Yes
164	Failure: General Voltage Supervi-sion (Fail V Superv.)	Measurem.Superv	OUT	*	*		*	LED			BO		192	33	1	Yes
167	Failure: Voltage Balance (Fail V balance)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	186	1	Yes
168	Failure: Voltage absent (Fail V absent)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	187	1	Yes
169	VT Fuse Failure (alarm >10s) (VT FuseFail>10s)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	188	1	Yes
170	VT Fuse Failure (alarm instanta-neous) (VT FuseFail)	Measurem.Superv	OUT	On Off	*		*	LED			BO					
171	Failure: Phase Sequence (Fail Ph. Seq.)	Measurem.Superv	OUT	On Off	*		*	LED			BO		192	35	1	Yes
177	Failure: Battery empty (Fail Bat-tery)	Device, General	OUT	On Off	*		*	LED			BO		135	193	1	Yes
181	Error: A/D converter (Error A/D-conv.)	Device, General	OUT	On Off	*		*	LED			BO		135	178	1	Yes
182	Alarm: Real Time Clock (Alarm Clock)	Device, General	OUT													
183	Error Board 1 (Error Board 1)	Device, General	OUT	On Off	*		*	LED			BO		135	171	1	Yes
184	Error Board 2 (Error Board 2)	Device, General	OUT	On Off	*		*	LED			BO		135	172	1	Yes
185	Error Board 3 (Error Board 3)	Device, General	OUT	On Off	*		*	LED			BO		135	173	1	Yes
186	Error Board 4 (Error Board 4)	Device, General	OUT	On Off	*		*	LED			BO		135	174	1	Yes

No.	Description	Function	Type of Information	Log Buffers: Event Log ON/OFF	Log Buffers: Trip (Fault) Log ON/OFF	Log Buffers: Ground Fault Log ON/OFF	Log Buffers: Marked in Oscill. Record	Configurable in Matrix: LED	Configurable in Matrix: Binary Input	Configurable in Matrix: Function Key	Configurable in Matrix: Relay	Configurable in Matrix: Chatter Suppression	IEC 60870-5-103: Type	IEC 60870-5-103: Information Number	IEC 60870-5-103: Data Unit	IEC 60870-5-103: General Interrogation
187	Error Board 5 (Error Board 5)	Device, General	OUT	On Off	*		*	LED			BO		135	175	1	Yes
190	Error Board 0 (Error Board 0)	Device, General	OUT	On Off	*		*	LED			BO		135	210	1	Yes
191	Error: Offset (Error Offset)	Device, General	OUT	On Off	*		*	LED			BO					
193	Alarm: Analog input adjustment invalid (Alarm adjustm.)	Device, General	OUT	On Off	*		*	LED			BO		135	181	1	Yes
194	Error: Neutral CT different from MLFB (Error neutralCT)	Device, General	OUT	On Off	*		*	LED			BO		135	180	1	Yes
196	Fuse Fail Monitor is switched OFF (Fuse Fail M.OFF)	Measurem.Superv	OUT		*		*	LED			BO		135	196	1	Yes
197	Measurement Supervision is switched OFF (MeasSup OFF)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	197	1	Yes
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	FC TN	BO					
235.2111	>Function $00 instantaneous TRIP (>$00 instant.)	Flx	SP	On Off	On Off	*	*	LED	BI	FC TN	BO					
235.2112	>Function $00 Direct TRIP (>$00 Dir.TRIP)	Flx	SP	On Off	On Off	*	*	LED	BI	FC TN	BO					
235.2113	>Function $00 BLOCK TRIP Time Delay (>$00 BLK.TDly)	Flx	SP	On Off	On Off	*	*	LED	BI	FC TN	BO					
235.2114	>Function $00 BLOCK TRIP (>$00 BLK.TRIP)	Flx	SP	On Off	On Off	*	*	LED	BI	FC TN	BO					
235.2115	>Function $00 BLOCK TRIP Phase A (>$00 BL.TripA)	Flx	SP	On Off	On Off	*	*	LED	BI	FC TN	BO					
235.2116	>Function $00 BLOCK TRIP Phase B (>$00 BL.TripB)	Flx	SP	On Off	On Off	*	*	LED	BI	FC TN	BO					
235.2117	>Function $00 BLOCK TRIP Phase C (>$00 BL.TripC)	Flx	SP	On Off	On Off	*	*	LED	BI	FC TN	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					
273	Set Point Phase A dmd> (SP. I A dmd>)	Set Points(MV)	OUT	On Off	*		*	LED			BO					
274	Set Point Phase B dmd> (SP. I B dmd>)	Set Points(MV)	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
275	Set Point Phase C dmd> (SP. I C dmd>)	Set Points(MV)	OUT	On Off	*		*	LED			BO					
276	Set Point positive sequence I1dmd> (SP. I1dmd>)	Set Points(MV)	OUT	On Off	*		*	LED			BO					
277	Set Point |Pdmd|> (SP. |Pdmd|>)	Set Points(MV)	OUT	On Off	*		*	LED			BO					
278	Set Point |Qdmd|> (SP. |Qdmd|>)	Set Points(MV)	OUT	On Off	*		*	LED			BO					
279	Set Point |Sdmd|> (SP. |Sdmd|>)	Set Points(MV)	OUT	On Off	*		*	LED			BO					
285	Set Point 55 Power factor alarm (SP. PF(55)alarm)	Set Points(MV)	OUT	On Off	*		*	LED			BO					
289	Alarm: Current summation supervision (Failure Σi)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	250	1	Yes
290	Alarm: Broken current-wire detected L1 (Broken Iwire L1)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	137	1	Yes
291	Alarm: Broken current-wire detected L2 (Broken Iwire L2)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	138	1	Yes
292	Alarm: Broken current-wire detected L3 (Broken Iwire L3)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	139	1	Yes
295	Broken wire supervision is switched OFF (Broken wire OFF)	Measurem.Superv	OUT	On Off	*		*	LED			BO					
296	Current summation superv is switched OFF (Σi superv. OFF)	Measurem.Superv	OUT	On Off	*		*	LED			BO					
297	Broken current-wire at other end ØA (ext.Brk.Wire ØA)	Measurem.Superv	OUT	On Off	*		*	LED			BO					
298	Broken current-wire at other end ØB (ext.Brk.Wire ØB)	Measurem.Superv	OUT	On Off	*		*	LED			BO					
299	Broken current-wire at other end ØC (ext.Brk.Wire ØC)	Measurem.Superv	OUT	On Off	*		*	LED			BO					
301	Power System fault (Pow.Sys.Flt.)	P.System Data 2	OUT	On Off	ON		*						135	231	2	Yes
302	Fault Event (Fault Event)	P.System Data 2	OUT	*	ON		*						135	232	2	No
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
357	>Block manual close cmd. from external (>Blk Man. Close)	P.System Data 2	SP	On Off	*		*	LED	BI		BO		150	7	1	Yes
361	>Failure: Feeder VT (MCB tripped) (>FAIL:Feeder VT)	P.System Data 2	SP	On Off	*		*	LED	BI		BO		192	38	1	Yes
371	>Breaker 1 READY (for AR,CB-Test) (>Bkr1 Ready)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	71	1	Yes
378	>52 Breaker faulty (for 50BF) (>52 faulty)	P.System Data 2	SP	*	*		*	LED	BI		BO					
379	>52a Bkr. aux. contact (3pole closed) (>52a 3p Closed)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	78	1	Yes
380	>52b Bkr. aux. contact (3pole open) (>52b 3p Open)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	79	1	Yes

No.	Description	Function	Type of In-for-matio n	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
383	>Enable all AR Zones / Elements (>Enable ARzones)	P.System Data 2	SP	On Off	On Off		*	LED	BI		BO					
385	>Lockout SET (>Lockout SET)	P.System Data 2	SP	On Off	*		*	LED	BI		BO		150	35	1	Yes
386	>Lockout RESET (>Lockout RESET)	P.System Data 2	SP	On Off	*		*	LED	BI		BO		150	36	1	Yes
395	>I MIN/MAX Buffer Reset (>I MinMax Reset)	Min/Max meter	SP	ON	*		*	LED	BI		BO					
396	>I1 MIN/MAX Buffer Reset (>I1 MiMaReset)	Min/Max meter	SP	ON	*		*	LED	BI		BO					
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					
399	>V1 MIN/MAX Buffer Reset (>V1 MiMa Reset)	Min/Max meter	SP	ON	*		*	LED	BI		BO					
400	>P MIN/MAX Buffer Reset (>P MiMa Reset)	Min/Max meter	SP	ON	*		*	LED	BI		BO					
401	>S MIN/MAX Buffer Reset (>S MiMa Reset)	Min/Max meter	SP	ON	*		*	LED	BI		BO					
402	>Q MIN/MAX Buffer Reset (>Q MiMa Reset)	Min/Max meter	SP	ON	*		*	LED	BI		BO					
403	>Idmd MIN/MAX Buffer Reset (>Idmd MiMaReset)	Min/Max meter	SP	ON	*		*	LED	BI		BO					
404	>Pdmd MIN/MAX Buffer Reset (>Pdmd MiMaReset)	Min/Max meter	SP	ON	*		*	LED	BI		BO					
405	>Qdmd MIN/MAX Buffer Reset (>Qdmd MiMaReset)	Min/Max meter	SP	ON	*		*	LED	BI		BO					
406	>Sdmd MIN/MAX Buffer Reset (>Sdmd MiMaReset)	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					
408	>Power Factor MIN/MAX Buffer Reset (>PF MiMaReset)	Min/Max meter	SP	ON	*		*	LED	BI		BO					
410	>52a Bkr1 aux. 3pClosed (for AR,CB-Test) (>52a Bkr1 3p Cl)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	80	1	Yes
411	>52b Bkr1 aux. 3p Open (for AR,CB-Test) (>52b Bkr1 3p Op)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	81	1	Yes
501	Relay PICKUP (Relay PICKUP)	P.System Data 2	OUT	*	*		M	LED			BO		192	84	2	Yes
502	Relay Drop Out (Relay Drop Out)	P.System Data 2	OUT													
503	Relay PICKUP Phase A (Relay PICKUP ØA)	P.System Data 2	OUT	*	*		m	LED			BO		192	64	2	Yes
504	Relay PICKUP Phase B (Relay PICKUP ØB)	P.System Data 2	OUT	*	*		m	LED			BO		192	65	2	Yes
505	Relay PICKUP Phase C (Relay PICKUP ØC)	P.System Data 2	OUT	*	*		m	LED			BO		192	66	2	Yes
506	Relay PICKUP GROUND (Relay PICKUP G)	P.System Data 2	OUT	*	*		m	LED			BO		192	67	2	Yes
510	Relay GENERAL CLOSE command (Relay CLOSE)	P.System Data 2	OUT	*	*		*	LED			BO					
511	Relay GENERAL TRIP command (Relay TRIP)	P.System Data 2	OUT	*	OFF		M	LED			BO		192	68	2	No
530	LOCKOUT is active (LOCKOUT)	P.System Data 2	IntSP	On Off	*		*	LED			BO					
533	Primary fault current Ia (Ia =)	P.System Data 2	VI	*	On Off								150	177	4	No

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
534	Primary fault current Ib (Ib =)	P.System Data 2	VI	*	On Off								150	178	4	No
535	Primary fault current Ic (Ic =)	P.System Data 2	VI	*	On Off								150	179	4	No
536	Relay Definitive TRIP (Definitive TRIP)	P.System Data 2	OUT	ON	ON			LED			BO		150	180	2	Yes
545	Time from Pickup to drop out (PU Time)	P.System Data 2	VI													
546	Time from Pickup to TRIP (TRIP Time)	P.System Data 2	VI													
561	Manual close signal detected (Man.Clos.Detect)	P.System Data 2	OUT	ON	*		*	LED			BO		150	211	1	No
562	CB CLOSE command for manual closing (Man.Close Cmd)	P.System Data 2	OUT	*	*		*	LED			BO		150	212	1	No
563	CB alarm suppressed (CB Alarm Supp)	P.System Data 2	OUT	*	*		*	LED			BO					
590	Line closure detected (Line closure)	P.System Data 2	OUT	*	On Off		*	LED			BO					
916	Increment of active energy (Wp∆=)	Energy	-													
917	Increment of reactive energy (Wq∆=)	Energy	-													
1000	Number of breaker TRIP commands (# TRIPs=)	Statistics	VI													
1027	Accumulation of interrupted current Ph A (Σ Ia =)	Statistics	VI													
1028	Accumulation of interrupted current Ph B (Σ Ib =)	Statistics	VI													
1029	Accumulation of interrupted current Ph C (Σ Ic =)	Statistics	VI													
1030	max. fault current Phase A (Ia max. =)	Statistics	VI													
1031	max. fault current Phase B (Ib max. =)	Statistics	VI													
1032	max. fault current Phase C (Ic max. =)	Statistics	VI													
1401	>50BF: Switch on breaker fail prot. (>50BF on)	50BF BkrFailure	SP	*	*		*	LED	BI		BO					
1402	>50BF: Switch off breaker fail prot. (>50BF off)	50BF BkrFailure	SP	*	*		*	LED	BI		BO					
1403	>BLOCK 50BF (>BLOCK 50BF)	50BF BkrFailure	SP	On Off	*		*	LED	BI		BO		166	103	1	Yes
1404	>50BF use 3I0 threshold (>50BF 3I0>)	50BF BkrFailure	SP	On Off	*		*	LED	BI		BO					
1415	>50BF: External start 3pole (>50BF Start 3p)	50BF BkrFailure	SP	On Off	*		*	LED	BI		BO					
1424	>50BF: Start only delay time T2 (>50BFSTRTonlyT2)	50BF BkrFailure	SP	On Off	On Off		*	LED	BI		BO					
1432	>50BF: External release (>50BF release)	50BF BkrFailure	SP	On Off	*		*	LED	BI		BO					
1439	>50BF: External start 3p (w/o current) (>50BF STARTw/oI)	50BF BkrFailure	SP	On Off	*		*	LED	BI		BO					
1440	Breaker failure prot. ON/OFF via BI (BkrFailON/offBI)	50BF BkrFailure	IntSP	On Off	*		*	LED			BO					
1451	50BF is switched OFF (50BF OFF)	50BF BkrFailure	OUT	On Off	*		*	LED			BO		166	151	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
1452	50BF is BLOCKED (50BF BLOCK)	50BF BkrFailure	OUT	On Off	On Off		*	LED			BO		166	152	1	Yes
1453	50BF is ACTIVE (50BF ACTIVE)	50BF BkrFailure	OUT	*	*		*	LED			BO		166	153	1	Yes
1461	50BF Breaker failure protection started (50BF Start)	50BF BkrFailure	OUT	*	On Off		*	LED			BO		166	161	2	Yes
1476	50BF Local trip - ABC (50BF LocTripABC)	50BF BkrFailure	OUT	*	ON		*	LED			BO					
1493	50BF Trip in case of defective CB (50BF TripCBdef.)	50BF BkrFailure	OUT	*	ON		*	LED			BO					
1494	50BF Busbar trip (50BF BusTrip)	50BF BkrFailure	OUT	*	ON		*	LED			BO		192	85	2	No
1495	50BF Trip End fault element (50BF EndFltTrip)	50BF BkrFailure	OUT	*	ON		*	LED			BO					
1503	>BLOCK 49 Overload Protection (>BLOCK 49 O/L)	49 Th.Overload	SP	*	*		*	LED	BI		BO		167	3	1	Yes
1511	49 Overload Protection is OFF (49 O / L OFF)	49 Th.Overload	OUT	On Off	*		*	LED			BO		167	11	1	Yes
1512	49 Overload Protection is BLOCKED (49 O/L BLOCK)	49 Th.Overload	OUT	On Off	On Off		*	LED			BO		167	12	1	Yes
1513	49 Overload Protection is ACTIVE (49 O/L ACTIVE)	49 Th.Overload	OUT	On Off	*		*	LED			BO		167	13	1	Yes
1515	49 Overload Current Alarm (I alarm) (49 O/L I Alarm)	49 Th.Overload	OUT	On Off	*		*	LED			BO		167	15	1	Yes
1516	49 Overload Alarm! Near Thermal Trip (49 O/L Θ Alarm)	49 Th.Overload	OUT	On Off	*		*	LED			BO		167	16	1	Yes
1517	49 Winding Overload (49 Winding O/L)	49 Th.Overload	OUT	On Off	*		*	LED			BO		167	17	1	Yes
1521	49 Thermal Overload TRIP (49 Th O/L TRIP)	49 Th.Overload	OUT	*	ON		*	LED			BO		167	21	2	Yes
2054	Emergency mode (Emer. mode)	Device, General	OUT	On Off	On Off		*	LED			BO		192	37	1	Yes
2701	>79 ON (>79 ON)	79 Auto Recl.	SP	*	*		*	LED	BI		BO		40	1	1	Yes
2702	>79 OFF (>79 OFF)	79 Auto Recl.	SP	*	*		*	LED	BI		BO		40	2	1	Yes
2703	>BLOCK 79 (>BLOCK 79)	79 Auto Recl.	SP	On Off	*		*	LED	BI		BO		40	3	1	Yes
2711	>79 External start of internal A/R (>79 Start)	79 Auto Recl.	SP	*	ON		*	LED	BI		BO		40	11	2	Yes
2716	>79: External 3pole trip for AR start (>79 TRIP 3p)	79 Auto Recl.	SP	*	ON		*	LED	BI		BO		40	16	2	Yes
2727	>79: Remote Close signal (>79 RemoteClose)	79 Auto Recl.	SP	*	ON		*	LED	BI		BO		40	22	2	Yes
2738	>79: Block 3pole AR-cycle (>BLOCK 3pole AR)	79 Auto Recl.	SP	On Off	*		*	LED	BI		BO		40	33	1	Yes
2739	>79: Block 1phase-fault AR-cycle (>BLK 1phase AR)	79 Auto Recl.	SP	On Off	*		*	LED	BI		BO		40	34	1	Yes
2740	>79: Block 2phase-fault AR-cycle (>BLK 2phase AR)	79 Auto Recl.	SP	On Off	*		*	LED	BI		BO		40	35	1	Yes
2741	>79: Block 3phase-fault AR-cycle (>BLK 3phase AR)	79 Auto Recl.	SP	On Off	*		*	LED	BI		BO		40	36	1	Yes
2742	>79: Block 1st AR-cycle (>BLK 1.AR-cycle)	79 Auto Recl.	SP	On Off	*		*	LED	BI		BO		40	37	1	Yes
2743	>79: Block 2nd AR-cycle (>BLK 2.AR-cycle)	79 Auto Recl.	SP	On Off	*		*	LED	BI		BO		40	38	1	Yes
2746	>79: External Trip for AR start (>Trip for AR)	79 Auto Recl.	SP	*	ON		*	LED	BI		BO		40	41	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
2752	>79: External pickup 3phase for AR start (>Pickup 3ph AR)	79 Auto Recl.	SP	*	ON		*	LED	BI		BO		40	47	2	Yes
2781	79: Auto recloser is switched OFF (79 OFF)	79 Auto Recl.	OUT	On Off	*		*	LED			BO		40	81	1	Yes
2782	79: Auto recloser is switched ON (79 ON)	79 Auto Recl.	IntSP	*	*		*	LED			BO		192	16	1	Yes
2783	79: Auto recloser is blocked (79 is blocked)	79 Auto Recl.	OUT	On Off	*		*	LED			BO		40	83	1	Yes
2784	79: Auto recloser is not ready (79 not ready)	79 Auto Recl.	OUT	*	ON		*	LED			BO		192	130	1	Yes
2787	79: Circuit breaker 1 not ready (CB not ready)	79 Auto Recl.	OUT	*	*		*	LED			BO		40	87	1	Yes
2788	79: CB ready monitoring window expired (79 T-CBreadyExp)	79 Auto Recl.	OUT	*	ON		*	LED			BO		40	88	2	Yes
2796	79: Auto recloser ON/OFF via BI (79 on/off BI)	79 Auto Recl.	IntSP	*	*		*	LED			BO					
2801	79 - in progress (79 in progress)	79 Auto Recl.	OUT	*	ON		*	LED			BO		40	101	2	Yes
2809	79: Start-signal monitoring time expired (79 T-Start Exp)	79 Auto Recl.	OUT	*	ON		*	LED			BO		40	174	2	Yes
2810	79: Maximum dead time expired (79 TdeadMax Exp)	79 Auto Recl.	OUT	*	ON		*	LED			BO		40	175	2	Yes
2818	79: Evolving fault recognition (79 Evolving Flt)	79 Auto Recl.	OUT	*	ON		*	LED			BO		40	118	2	Yes
2821	79 dead time after evolving fault (79 Td. evol.Flt)	79 Auto Recl.	OUT	*	On Off		*	LED			BO		40	197	2	Yes
2840	79 dead time after 3pole trip running (79 Tdead 3pTrip)	79 Auto Recl.	OUT	*	ON		*	LED			BO		40	149	2	Yes
2843	79 dead time after 3phase fault running (79 Tdead 3pFlt)	79 Auto Recl.	OUT	*	ON		*	LED			BO		40	154	2	Yes
2844	79 1st cycle running (79 1stCyc. run.)	79 Auto Recl.	OUT	*	ON		*	LED			BO		40	155	2	Yes
2845	79 2nd cycle running (79 2ndCyc. run.)	79 Auto Recl.	OUT	*	ON		*	LED			BO		40	157	2	Yes
2851	79 - Close command (79 Close)	79 Auto Recl.	OUT	*	ON		m	LED			BO		192	128	2	No
2853	79: Close command after 3pole, 1st cycle (79 Close1.Cyc3p)	79 Auto Recl.	OUT	*	*		*	LED			BO		40	153	1	Yes
2854	79: Close command 2nd cycle (and higher) (79 Close 2.Cyc)	79 Auto Recl.	OUT	*	*		*	LED			BO		192	129	1	No
2861	79: Reclaim time is running (79 T-Recl. run.)	79 Auto Recl.	OUT	*	*		*	LED			BO		40	161	1	Yes
2862	79 - cycle successful (79 Successful)	79 Auto Recl.	OUT	*	*		*	LED			BO		40	162	1	Yes
2871	79: TRIP command 3pole (79 TRIP 3pole)	79 Auto Recl.	OUT	*	ON		*	LED			BO		40	171	2	Yes
2889	79 1st cycle zone extension release (79 1.CycZoneRel)	79 Auto Recl.	OUT	*	*		*	LED			BO		40	160	1	Yes
2890	79 2nd cycle zone extension release (79 2.CycZoneRel)	79 Auto Recl.	OUT	*	*		*	LED			BO		40	169	1	Yes
2894	79 Remote close signal send (79 Remote Close)	79 Auto Recl.	OUT	*	ON		*	LED			BO		40	129	2	Yes
2896	No. of 1st AR-cycle CLOSE commands,3pole (79 #Close1./3p=)	Statistics	VI													
2898	No. of higher AR-cycle CLOSE commands,3p (79 #Close2./3p=)	Statistics	VI													
3102	Tolerance invalid in phase A (2nd Harmonic A)	InRushRestraint	OUT		*		*	LED			BO		92	89	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
3103	Tolerance invalid in phase B (2nd Harmonic B)	InRushRestraint	OUT		*		*	LED			BO		92	90	1	Yes
3104	Tolerance invalid in phase C (2nd Harmonic C)	InRushRestraint	OUT		*		*	LED			BO		92	91	1	Yes
3190	87 Set test state of 87 (Test 87)	87 Diff. Prot.	IntSP	On Off	*		*	LED		FC TN	BO		92	106	1	Yes
3191	87 Set Commissioning state of 87 (Commiss.87)	87 Diff. Prot.	IntSP	On Off	*		*	LED		FC TN	BO		92	107	1	Yes
3192	87 Remote relay in test state (Test 87 remote)	87 Diff. Prot.	OUT	On Off	*		*	LED			BO		92	108	1	Yes
3193	87 Commissioning state is active (Comm. 87 active)	87 Diff. Prot.	OUT	On Off	*		*	LED			BO		92	109	1	Yes
3197	87 >Set test state of 87 (>Test 87 ON)	87 Diff. Prot.	SP	On Off	*		*	LED	BI		BO					
3198	87 >Reset test state of 87 (>Test 87 OFF)	87 Diff. Prot.	SP	On Off	*		*	LED	BI		BO					
3199	87 Test state of 87 ON/OFF (Test 87 ON/off)	87 Diff. Prot.	IntSP	On Off	*		*	LED			BO					
3200	87 Test state ON/OFF via BI (Test 87 ONoffBI)	87 Diff. Prot.	IntSP	On Off	*		*	LED			BO					
3217	PDI FO data mirror (PDI FO mirror)	Prot.Interface	OUT	On Off			*	LED			BO					
3218	PDI Cu data mirror (PDI Cu mirror)	Prot.Interface	OUT	On Off			*	LED			BO					
3227	>PDI FO is stopped (>PDI FO stop)	Prot.Interface	SP	On Off	*		*	LED	BI		BO					
3228	>PDI Cu is stopped (>PDI Cu stop)	Prot.Interface	SP	On Off	*		*	LED	BI		BO					
3230	PDI FO failure (PDI FO faulty)	Prot.Interface	OUT	On Off			*	LED			BO		93	136	1	Yes
3232	PDI Cu failure (PDI Cu faulty)	Prot.Interface	OUT	On Off			*	LED			BO		93	138	1	Yes
3243	PDI FO connected to relay ID (PDI FO con. to.)	Prot.Interface	VI	On Off			*									
3244	PDI Cu connected to relay ID (PDI Cu con. to.)	Prot.Interface	VI	On Off			*									
3258	PDI FO telegram error rate exceeded (PDI FO TER)	Prot.Interface	OUT	On Off			*	LED			BO					
3259	PDI Cu telegram error rate exceeded (PDI Cu TER)	Prot.Interface	OUT	On Off			*	LED			BO					
3260	87 >Commissioning state ON (>Comm. 87 ON)	87 Diff. Prot.	SP	On Off	*		*	LED	BI		BO					
3261	87 >Commissioning state OFF (>Comm. 87 OFF)	87 Diff. Prot.	SP	On Off	*		*	LED	BI		BO					
3262	87 Commissioning state ON/OFF (Comm 87 ON/OFF)	87 Diff. Prot.	IntSP	On Off	*		*	LED			BO					
3263	87 Commissioning state ON/OFF via BI (Comm 87 ONoffBI)	87 Diff. Prot.	IntSP	On Off	*		*	LED			BO					
3270	>RESET broken wire monitoring (>RESET BW)	Measurem.Superv	SP	On Off	*		*	LED	BI	FC TN	BO					
3271	Alarm: Broken current-wire detected A (Broken Iwire a)	Measurem.Superv	IntSP													
3272	Alarm: Broken current-wire detected B (Broken Iwire b)	Measurem.Superv	IntSP													
3273	Alarm: Broken current-wire detected C (Broken Iwire c)	Measurem.Superv	IntSP													

No.	Description	Function	Type of In-for-mation	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
3491	Master in Login state (Master Login)	Diff.-Topo	OUT	On Off	*		*	LED			BO		93	191	1	Yes
3492	Slave in Login state (Slave Login)	Diff.-Topo	OUT	On Off	*		*	LED			BO		93	192	1	Yes
3504	>86 DT: >Intertrip 3 pole signal input (>85 DT 3pol)	85 DT Intertrip	SP	On Off	*		*	LED	BI		BO					
3517	85 DT: General TRIP (85 DT Gen. TRIP)	85 DT Intertrip	OUT	*	On Off		m	LED			BO					
3549	>Remote Signal 1 input (>Rem. Signal 1)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3550	>Remote Signal 2 input (>Rem.Signal 2)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3551	>Remote Signal 3 input (>Rem.Signal 3)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3552	>Remote Signal 4 input (>Rem.Signal 4)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3553	>Remote Signal 5 input (>Rem.Signal 5)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3554	>Remote Signal 6 input (>Rem.Signal 6)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3555	>Remote Signal 7 input (>Rem.Signal 7)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3556	>Remote Signal 8 input (>Rem.Signal 8)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3557	>Remote Signal 9 input (>Rem.Signal 9)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3558	>Remote Signal 10 input (>Rem.Signal10)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3559	>Remote Signal 11 input (>Rem.Signal11)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3560	>Remote Signal 12 input (>Rem.Signal12)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3561	>Remote Signal 13 input (>Rem.Signal13)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3562	>Remote Signal 14 input (>Rem.Signal14)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3563	>Remote Signal 15 input (>Rem.Signal15)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3564	>Remote Signal 16 input (>Rem.Signal16)	Remote Signals	SP	On Off	*		*	LED	BI		BO					
3573	Remote signal 1 received (Rem.Sig 1 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	158	1	Yes
3574	Remote signal 2 received (Rem.Sig 2 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	159	1	Yes
3575	Remote signal 3 received (Rem.Sig 3 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	160	1	Yes
3576	Remote signal 4 received (Rem.Sig 4 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	161	1	Yes
3577	Remote signal 5 received (Rem.Sig 5 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	162	1	Yes
3578	Remote signal 6 received (Rem.Sig 6 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	163	1	Yes
3579	Remote signal 7 received (Rem.Sig 7 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	164	1	Yes
3580	Remote signal 8 received (Rem.Sig 8 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	165	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
3581	Remote signal 9 received (Rem.Sig 9 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	166	1	Yes
3582	Remote signal 10 received (Rem.Sig 10 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	167	1	Yes
3583	Remote signal 11 received (Rem.Sig 11 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	168	1	Yes
3584	Remote signal 12 received (Rem.Sig 12 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	169	1	Yes
3585	Remote signal 13 received (Rem.Sig 13 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	170	1	Yes
3586	Remote signal 14 received (Rem.Sig 14 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	171	1	Yes
3587	Remote signal 15 received (Rem.Sig 15 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	172	1	Yes
3588	Remote signal 16 received (Rem.Sig 16 Rx)	Remote Signals	OUT	On Off	*		*	LED			BO		93	173	1	Yes
4403	>BLOCK Direct Transfer Trip option (>BLOCK DTT)	DTT Direct Trip	SP	*	*		*	LED	BI		BO					
4417	>Direct Transfer Trip INPUT Phases ABC (>DTT Trip ØABC)	DTT Direct Trip	SP	On Off	*		*	LED	BI		BO					
4421	Direct Transfer Trip is switched OFF (DTT OFF)	DTT Direct Trip	OUT	On Off	*		*	LED			BO		51	21	1	Yes
4422	Direct Transfer Trip is BLOCKED (DTT BLOCK)	DTT Direct Trip	OUT	On Off	On Off		*	LED			BO		51	22	1	Yes
4435	DTT TRIP command Phases ABC (DTT TRIP ØABC)	DTT Direct Trip	OUT	*	ON		*	LED			BO		51	35	2	No
5203	>BLOCK 81O/U (>BLOCK 81O/U)	81 O/U Freq.	SP	On Off	*		*	LED	BI		BO		70	176	1	Yes
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
5215	81 Undervoltage Block (81 UnderV Blk)	81 O/U Freq.	OUT	On Off	On Off		*	LED			BO		70	238	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		*	LED			BO		70	234	2	Yes
5237	81-2 TRIP (81-2 TRIP)	81 O/U Freq.	OUT	*	ON		*	LED			BO		70	235	2	Yes
5238	81-3 TRIP (81-3 TRIP)	81 O/U Freq.	OUT	*	ON		*	LED			BO		70	236	2	Yes

No.	Description	Function	Type of Information	Log Buffers: Event Log ON/OFF	Log Buffers: Trip (Fault) Log ON/OFF	Log Buffers: Ground Fault Log ON/OFF	Log Buffers: Marked in Oscill. Record	Configurable in Matrix: LED	Configurable in Matrix: Binary Input	Configurable in Matrix: Function Key	Configurable in Matrix: Relay	Configurable in Matrix: Chatter Suppression	IEC 60870-5-103: Type	IEC 60870-5-103: Information Number	IEC 60870-5-103: Data Unit	IEC 60870-5-103: General Interrogation
5239	81-4 TRIP (81-4 TRIP)	81 O/U Freq.	OUT	*	ON		*	LED			BO		70	237	2	Yes
5240	81-1: Time Out (81-1 Time Out)	81 O/U Freq.	OUT	*	*		*	LED			BO					
5241	81-2: Time Out (81-2 Time Out)	81 O/U Freq.	OUT	*	*		*	LED			BO					
5242	81-3: Time Out (81-3 Time Out)	81 O/U Freq.	OUT	*	*		*	LED			BO					
5243	81-4: Time Out (81-4 Time Out)	81 O/U Freq.	OUT	*	*		*	LED			BO					
6854	>74TC-1 Trip circuit superv.:Trip Relay (>74TC-1 TripRel)	74TC TripCirc.	SP	On Off	*		*	LED	BI		BO					
6855	>74TC-1 Trip circuit superv.:Breaker Rel (>74TC-1 Bkr.Rel)	74TC TripCirc.	SP	On Off	*		*	LED	BI		BO					
6856	>74TC-2 Trip circuit superv.:Trip Relay (>74TC-2 TripRel)	74TC TripCirc.	SP	On Off	*		*	LED	BI		BO					
6857	>74TC-2 Trip circuit superv.:Breaker Rel (>74TC-2 Bkr.Rel)	74TC TripCirc.	SP	On Off	*		*	LED	BI		BO					
6858	>74TC-3 Trip circuit superv.:Trip Relay (>74TC-3 TripRel)	74TC TripCirc.	SP	On Off	*		*	LED	BI		BO					
6859	>74TC-3 Trip circuit superv.:Breaker Rel (>74TC-3 Bkr.Rel)	74TC TripCirc.	SP	On Off	*		*	LED	BI		BO					
6861	74TC Trip circuit supervision OFF (74TC OFF)	74TC TripCirc.	OUT	On Off	*		*	LED			BO		170	53	1	Yes
6865	74TC Failure Trip Circuit (74TC Trip cir.)	74TC TripCirc.	OUT	On Off	*		*	LED			BO		192	36	1	Yes
6866	74TC-1 blocked. Binary input is not set (74TC-1 ProgFAIL)	74TC TripCirc.	OUT	On Off	*		*	LED			BO					
6867	74TC-2 blocked. Binary input is not set (74TC-2 ProgFAIL)	74TC TripCirc.	OUT	On Off	*		*	LED			BO					
6868	74TC-3 blocked. Binary input is not set (74TC-3 ProgFAIL)	74TC TripCirc.	OUT	On Off	*		*	LED			BO					
7104	>BLOCK 50-B1 Backup OverCurrent (>BLOCK 50-B1)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO		64	4	1	Yes
7105	>BLOCK 50-B2 Backup OverCurrent (>BLOCK 50-B2)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO		64	5	1	Yes
7106	>BLOCK 51-B Backup OverCurrent (>BLOCK 51-B)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO		64	6	1	Yes
7107	>BLOCK 50N-B1 Backup OverCurrent (>BLOCK 50N-B1)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO		64	7	1	Yes
7108	>BLOCK 50N-B2 Backup OverCurrent (>BLOCK 50N-B2)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO		64	8	1	Yes
7109	>BLOCK 51N Backup OverCurrent (>BLOCK 51N)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO		64	9	1	Yes
7110	>50(N)/51(N) BackupO/C InstantaneousTrip (>5X-B InstTRIP)	Back-Up O/C	SP	On Off	On Off		*	LED	BI		BO		64	10	1	Yes
7112	>BLOCK Backup OverCurrent 67-TOC (>BLOCK 67-TOC)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO					
7114	>BLOCK Backup OverCurrent 67N-TOC (>BLOCK 67N-TOC)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO					
7115	>BLOCK Backup OverCurrent 67-B1 (>BLOCK 67-B1)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO					
7116	>BLOCK Backup OverCurrent 67N-B1 (>BLOCK 67N-B1)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO					
7117	>BLOCK Backup OverCurrent 67-B2 (>BLOCK 67-B2)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO					
7118	>BLOCK Backup OverCurrent 67N-B2 (>BLOCK 67N-B2)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO					

No.	Description	Function	Type of In-for-matio n	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
7130	>BLOCK 50-STUB (>BLOCK 50-STUB)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO		64	30	1	Yes
7132	>BLOCK 50N-STUB (>BLOCK 50N-STUB)	Back-Up O/C	SP	On Off	*		*	LED	BI		BO		64	32	1	Yes
7152	50(N)/51(N) Backup O/C is BLOCKED (5X-B BLOCK)	Back-Up O/C	OUT	On Off	On Off		*	LED			BO		64	52	1	Yes
7153	50(N)/51(N) Backup O/C is ACTIVE (5X-B ACTIVE)	Back-Up O/C	OUT	*	*		*	LED			BO		64	53	1	Yes
7154	Backup O/C stage 50(N)-B2 is sw. OFF (50(N)-B2 OFF)	Back-Up O/C	OUT	*	*		*	LED			BO					
7155	Backup O/C stage 50(N)-B1 is sw. OFF (50(N)-B1 OFF)	Back-Up O/C	OUT	*	*		*	LED			BO					
7156	Backup O/C stage 50(N)-STUB is sw. OFF (50(N)-STUB OFF)	Back-Up O/C	OUT	*	*		*	LED			BO					
7157	Backup O/C stage 51(N)-B is sw. OFF (51(N)-B OFF)	Back-Up O/C	OUT	*	*		*	LED			BO					
7161	50(N)/51(N) Backup O/C PICKED UP (5X-B PICKUP)	Back-Up O/C	OUT	*	OFF		m	LED			BO		64	61	2	Yes
7162	50(N)/51(N) Backup O/C PICKUP Phase A (5X-B Pickup ØA)	Back-Up O/C	OUT	*	ON		*	LED			BO		64	62	2	Yes
7163	50(N)/51(N) Backup O/C PICKUP Phase B (5X-B Pickup ØB)	Back-Up O/C	OUT	*	ON		*	LED			BO		64	63	2	Yes
7164	50(N)/51(N) Backup O/C PICKUP Phase C (5X-B Pickup ØC)	Back-Up O/C	OUT	*	ON		*	LED			BO		64	64	2	Yes
7165	50(N)/51(N) Backup O/C PICKUP GROUND (5X-B Pickup Gnd)	Back-Up O/C	OUT	*	ON		*	LED			BO		64	65	2	Yes
7191	50(N)-B1 Pickup (50(N)-B1 PICKUP)	Back-Up O/C	OUT	*	ON		m	LED			BO		64	91	2	Yes
7192	50(N)-B2 Pickup (50(N)-B2 PICKUP)	Back-Up O/C	OUT	*	ON		m	LED			BO		64	92	2	Yes
7193	51(N)-B Pickup (51(N)-B PICKUP)	Back-Up O/C	OUT	*	ON		m	LED			BO		64	93	2	Yes
7201	50-STUB Pickup (50-STUB PICKUP)	Back-Up O/C	OUT	*	On Off		m	LED			BO		64	101	2	Yes
7211	50(N)/51(N)-B General TRIP command (5X-B TRIP)	Back-Up O/C	OUT	*	*		*	LED			BO		64	111	2	No
7221	50(N)-B1 TRIP (50(N)-B1 TRIP)	Back-Up O/C	OUT	*	ON		*	LED			BO		64	121	2	No
7222	50(N)-B2 TRIP (50(N)-B2 TRIP)	Back-Up O/C	OUT	*	ON		*	LED			BO		64	122	2	No
7223	51(N)-B TRIP (51(N)-B TRIP)	Back-Up O/C	OUT	*	ON		*	LED			BO		64	123	2	No
7235	50-STUB TRIP (50-STUB TRIP)	Back-Up O/C	OUT	*	ON		*	LED			BO		64	135	2	No
7250	67(N)-B1 Pickup (67(N)-B1 PICKUP)	Back-Up O/C	OUT	*	on		*	LED			BO					
7251	67(N)-B2 Pickup (67(N)-B2 PICKUP)	Back-Up O/C	OUT	*	on		*	LED			BO					
7252	67(N)-TOC Pickup (67(N)-TOC PICK.)	Back-Up O/C	OUT	*	on		*	LED			BO					
7253	67(N) General TRIP command (67(N) TRIP)	Back-Up O/C	OUT	*	on		*	LED			BO					
7254	67(N)-B1 TRIP (67(N)-B1 TRIP)	Back-Up O/C	OUT	*	on		*	LED			BO					
7255	67(N)-B2 TRIP (67(N)-B2 TRIP)	Back-Up O/C	OUT	*	on		*	LED			BO					
7256	67(N)-TOC TRIP (67(N)-TOC TRIP)	Back-Up O/C	OUT	*	on		*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers: Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	Configurable in Matrix: LED	Binary Input	Function Key	Relay	Chatter Suppression	IEC 60870-5-103: Type	Information Number	Data Unit	General Interrogation
7257	67 Phase A forward (67 forward ØA)	Back-Up O/C	OUT	*	on		*	LED			BO					
7258	67 Phase B forward (67 forward ØB)	Back-Up O/C	OUT	*	on		*	LED			BO					
7259	67 Phase C forward (67 forward ØC)	Back-Up O/C	OUT	*	on		*	LED			BO					
7260	67N Gnd forward (67N forward GND)	Back-Up O/C	OUT	*	on		*	LED			BO					
7261	67 Phase A reverse (67 reverse ØA)	Back-Up O/C	OUT	*	on		*	LED			BO					
7262	67 Phase B reverse (67 reverse ØB)	Back-Up O/C	OUT	*	on		*	LED			BO					
7263	67 Phase C reverse (67 reverse ØC)	Back-Up O/C	OUT	*	on		*	LED			BO					
7264	67N Gnd forward (67N reverse GND)	Back-Up O/C	OUT	*	on		*	LED			BO					
7265	67(N) forward (67(N) forward)	Back-Up O/C	OUT	*	on		*	LED			BO					
7266	67(N) reverse (67(N) reverse)	Back-Up O/C	OUT	*	on		*	LED			BO					
7267	>67(N) BackupO/C InstantaneousTrip (>67(N) InstTRIP)	Back-Up O/C	SP	On Off	On Off		*	LED	BI		BO					
7328	CB1-TEST TRIP command ABC (CB1-TESTtripABC)	Testing	OUT	On Off	*		*	LED			BO		153	28	1	Yes
7329	CB1-TEST CLOSE command (CB1-TEST close)	Testing	OUT	On Off	*		*	LED			BO		153	29	1	Yes
7345	CB-TEST is in progress (CB-TEST running)	Testing	OUT	On Off	*		*	LED			BO		153	45	1	Yes
7346	CB-TEST canceled due to Power Sys. Fault (CB-TSTstop FLT.)	Testing	OUT_Ev	ON	*											
7347	CB-TEST canceled due to CB already OPEN (CB-TSTstop OPEN)	Testing	OUT_Ev	ON	*											
7348	CB-TEST canceled due to CB was NOT READY (CB-TSTstop NOTr)	Testing	OUT_Ev	ON	*											
7349	CB-TEST canceled due to CB stayed CLOSED (CB-TSTstop CLOS)	Testing	OUT_Ev	ON	*											
7350	CB-TEST was successful (CB-TST .OK.)	Testing	OUT_Ev	ON	*											
10201	>BLOCK 59-Vphg Overvolt. (phase-ground) (>59-Vphg BLOCK)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO					
10202	>BLOCK 59-Vphph Overvolt (phase-phase) (>59-Vphph BLOCK)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO					
10203	>BLOCK 59-3V0 Overvolt. (zero sequence) (>59-3V0 BLOCK)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO					
10204	>BLOCK 59-V1 Overvolt. (positive seq.) (>59-V1 BLOCK)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO					
10205	>BLOCK 59-V2 Overvolt. (negative seq.) (>59-V2 BLOCK)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO					
10206	>BLOCK 27-Vphg Undervolt. (phase-ground) (>27-Vphg BLOCK)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO					
10207	>BLOCK 27-Vphph Undervolt (phase-phase) (>27-Vphph BLOCK)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO					

No.	Description	Function	Type of In-for-matio n	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
10208	>BLOCK 27-V1 Undervolt (posi-tive seq.) (>27-V1 BLOCK)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO					
10215	59-Vphg Overvolt. is switched OFF (59-Vphg OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		73	15	1	Yes
10216	59-Vphg Overvolt. is BLOCKED (59-Vphg BLK)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		73	16	1	Yes
10217	59-Vphph Overvolt. is switched OFF (59-Vphph OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		73	17	1	Yes
10218	59-Vphph Overvolt. is BLOCKED (59-Vphph BLK)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		73	18	1	Yes
10219	59-3V0 Overvolt. is switched OFF (59-3V0 OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		73	19	1	Yes
10220	59-3V0 Overvolt. is BLOCKED (59-3V0 BLK)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		73	20	1	Yes
10221	59-V1 Overvolt. is switched OFF (59-V1 OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		73	21	1	Yes
10222	59-V1 Overvolt. is BLOCKED (59-V1 BLK)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		73	22	1	Yes
10223	59-V2 Overvolt. is switched OFF (59-V2 OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		73	23	1	Yes
10224	59-V2 Overvolt. is BLOCKED (59-V2 BLK)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		73	24	1	Yes
10225	27-Vphg Undervolt. is switched OFF (27-Vphg OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		73	25	1	Yes
10226	27-Vphg Undervolt. is BLOCKED (27-Vphg BLK)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		73	26	1	Yes
10227	27-Vphph Undervolt. is switched OFF (27-Vphph OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		73	27	1	Yes
10228	27-Vphph Undervolt. is BLOCKED (27-Vphph BLK)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		73	28	1	Yes
10229	27-V1 Undervolt. is switched OFF (27-V1 OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		73	29	1	Yes
10230	27-V1 Undervolt. is BLOCKED (27-V1 BLK)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		73	30	1	Yes
10231	27/59 Voltage protection is ACTIVE (27/59 ACTIVE)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		73	31	1	Yes
10240	59-1-Vphg Pickup (59-1-Vpg Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	40	2	Yes
10241	59-2-Vphg Pickup (59-2-Vpg Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	41	2	Yes
10242	59-Vphg Pickup A (59-Vpg PU A)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	42	2	Yes
10243	59-Vphg Pickup B (59-Vpg PU B)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	43	2	Yes
10244	59-Vphg Pickup C (59-Vpg PU C)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	44	2	Yes
10245	59-1-Vphg TimeOut (59-1-Vpg-TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10246	59-2-Vphg TimeOut (59-2-Vpg-TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10247	59-Vphg TRIP command (59-Vpg TRIP)	27/59 O/U Volt.	OUT	*	ON		*	LED			BO		73	47	2	Yes
10248	59-1-Vphg Pickup A (59-1-Vpg PU A)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	133	2	Yes
10249	59-1-Vphg Pickup B (59-1-Vpg PU B)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	134	2	Yes

No.	Description	Function	Type of In-for-matio n	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
10250	59-1-Vphg Pickup C (59-1-Vpg PU C)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	135	2	Yes
10251	59-2-Vphg Pickup A (59-2-Vpg PU A)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	136	2	Yes
10252	59-2-Vphg Pickup B (59-2-Vpg PU B)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	137	2	Yes
10253	59-2-Vphg Pickup C (59-2-Vpg PU C)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	138	2	Yes
10255	59-1-Vphph Pickup (59-1-Vpp Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	55	2	Yes
10256	59-2-Vphph Pickup (59-2-Vpp Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	56	2	Yes
10257	59-Vphph Pickup A-B (59-Vpp PickupAB)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	57	2	Yes
10258	59-Vphph Pickup B-C (59-Vpp PickupBC)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	58	2	Yes
10259	59-Vphph Pickup C-A (59-Vpp PickupCA)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	59	2	Yes
10260	59-1-Vphph TimeOut (59-1-Vpp-TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10261	59-2-Vphph TimeOut (59-2-Vpp-TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10262	59-Vphph TRIP command (59-Vpp TRIP)	27/59 O/U Volt.	OUT	*	ON		*	LED			BO		73	62	2	Yes
10263	59-1-Vphph Pickup A-B (59-1-Vpp PU AB)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	139	2	Yes
10264	59-1-Vphph Pickup B-C (59-1-Vpp PU BC)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	140	2	Yes
10265	59-1-Vphph Pickup C-A (59-1-Vpp PU CA)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	141	2	Yes
10266	59-2-Vphph Pickup A-B (59-2-Vpp PU AB)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	142	2	Yes
10267	59-2-Vphph Pickup B-C (59-2-Vpp PU BC)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	143	2	Yes
10268	59-2-Vphph Pickup C-A (59-2-Vpp PU CA)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	144	2	Yes
10270	59-1-3V0 Pickup (59-1-3V0 Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	70	2	Yes
10271	59-2-3V0 Pickup (59-2-3V0 Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	71	2	Yes
10272	59-1-3V0 TimeOut (59-1-3V0TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10273	59-2-3V0 TimeOut (59-2-3V0TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10274	59-3V0 TRIP command (59-3V0 TRIP)	27/59 O/U Volt.	OUT	*	ON		*	LED			BO		73	74	2	Yes
10280	59-1-V1 Pickup (59-1-V1 Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	80	2	Yes
10281	59-2-V1 Pickup (59-2-V1 Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	81	2	Yes
10282	59-1-V1 TimeOut (59-1-V1TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10283	59-2-V1 TimeOut (59-2-V1TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10284	59-V1 TRIP command (59-V1 TRIP)	27/59 O/U Volt.	OUT	*	ON		*	LED			BO		73	84	2	Yes

No.	Description	Function	Type of In-for-mation	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
10290	59-1-V2 Pickup (59-1-V2 Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	90	2	Yes
10291	59-2-V2 Pickup (59-2-V2 Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	91	2	Yes
10292	59-1-V2 TimeOut (59-1-V2TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10293	59-2-V2 TimeOut (59-2-V2TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10294	59-V2 TRIP command (59-V2 TRIP)	27/59 O/U Volt.	OUT	*	ON		*	LED			BO		73	94	2	Yes
10300	27-1-V1 Pickup (27-1-V1 Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	100	2	Yes
10301	27-2-V1 Pickup (27-2-V1 Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	101	2	Yes
10302	27-1-V1TimeOut (27-1-V1TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10303	27-2-V1TimeOut (27-2-V1TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10304	27-V1 TRIP command (27-V1 TRIP)	27/59 O/U Volt.	OUT	*	ON		*	LED			BO		73	104	2	Yes
10310	27-1-Vphg Pickup (27-1-Vpg Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	110	2	Yes
10311	27-2-Vphg Pickup (27-2-Vpg Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	111	2	Yes
10312	27-Vphg Pickup A (27-Vpg PU A)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	112	2	Yes
10313	27-Vphg Pickup B (27-Vpg PU B)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	113	2	Yes
10314	27-Vphg Pickup C (27-Vpg PU C)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	114	2	Yes
10315	27-1-Vphg TimeOut (27-1-Vpg-TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10316	27-2-Vphg TimeOut (27-2-Vpg-TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10317	27-Vphg TRIP command (27-Vpg TRIP)	27/59 O/U Volt.	OUT	*	ON		*	LED			BO		73	117	2	Yes
10318	27-1-Vphg Pickup A (27-1-Vpg PU A)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	145	2	Yes
10319	27-1-Vphg Pickup B (27-1-Vpg PU B)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	146	2	Yes
10320	27-1-Vphg Pickup C (27-1-Vpg PU C)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	147	2	Yes
10321	27-2-Vphg Pickup A (27-2-Vpg PU A)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	148	2	Yes
10322	27-2-Vphg Pickup B (27-2-Vpg PU B)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	149	2	Yes
10323	27-2-Vphg Pickup C (27-2-Vpg PU C)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	150	2	Yes
10325	27-1-Vphph Pickup (27-1-Vpp Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	125	2	Yes
10326	27-2-Vphph Pickup (27-2-Vpp Pickup)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	126	2	Yes
10327	27-Vphph Pickup A-B (27-Vpp PU AB)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	127	2	Yes
10328	27-Vphph Pickup B-C (27-Vpp PU BC)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	128	2	Yes

No.	Description	Function	Type of Information	Log Buffers: Event Log ON/OFF	Log Buffers: Trip (Fault) Log ON/OFF	Log Buffers: Ground Fault Log ON/OFF	Log Buffers: Marked in Oscill. Record	Configurable in Matrix: LED	Configurable in Matrix: Binary Input	Configurable in Matrix: Function Key	Configurable in Matrix: Relay	Configurable in Matrix: Chatter Suppression	IEC 60870-5-103: Type	IEC 60870-5-103: Information Number	IEC 60870-5-103: Data Unit	IEC 60870-5-103: General Interrogation
10329	27-Vphph Pickup C-A (27-Vpp PU CA)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		73	129	2	Yes
10330	27-1-Vphph TimeOut (27-1-Vpp-TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10331	27-2-Vphph TimeOut (27-2-Vpp-TimeOut)	27/59 O/U Volt.	OUT	*	*		*	LED			BO					
10332	27-Vphph TRIP command (27-Vpp TRIP)	27/59 O/U Volt.	OUT	*	ON		*	LED			BO		73	132	2	Yes
10333	27-1-Vphph Pickup A-B (27-1-Vpp PU AB)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	151	2	Yes
10334	27-1-Vphph Pickup B-C (27-1-Vpp PU BC)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	152	2	Yes
10335	27-1-Vphph Pickup C-A (27-1-Vpp PU CA)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	153	2	Yes
10336	27-2-Vphph Pickup A-B (27-2-Vpp PU AB)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	154	2	Yes
10337	27-2-Vphph Pickup B-C (27-2-Vpp PU BC)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	155	2	Yes
10338	27-2-Vphph Pickup C-A (27-2-Vpp PU CA)	27/59 O/U Volt.	OUT	*	*		*	LED			BO		73	156	2	Yes
17525	85 DT: Received 3pole (85 DT rec.3pole)	85 DT Intertrip	OUT	On Off	*		*	LED			BO					
17526	85 DT: Sending 3pole (85 DT sen.3pole)	85 DT Intertrip	OUT	On Off	*		*	LED			BO					
17530	67(N) Backup O/C is BLOCKED (67(N) BLOCK)	Back-Up O/C	OUT	*	ON		*	LED			BO		64	148	2	No
17531	67(N) Backup O/C is ACTIVE (67(N) ACTIVE)	Back-Up O/C	OUT	*	ON		*	LED			BO		64	149	2	No
17532	Backup O/C stage 67(N)-B2 is sw. OFF (67(N)-B2 OFF)	Back-Up O/C	OUT	*	ON		*	LED			BO					
17533	Backup O/C stage 67(N)-B1 is sw. OFF (67(N)-B1 OFF)	Back-Up O/C	OUT	*	ON		*	LED			BO					
17534	Backup O/C stage 67(N)-TOC is sw. OFF (67(N)-TOC OFF)	Back-Up O/C	OUT	*	ON		*	LED			BO					
17535	67(N) Backup O/C PICKED UP (67(N) PICKUP)	Back-Up O/C	OUT	*	on		*	LED			BO					
17536	67 Backup O/C PICKUP Phase A (67 Pickup ØA)	Back-Up O/C	OUT	*	on		*	LED			BO					
17537	67 Backup O/C PICKUP Phase B (67 Pickup ØB)	Back-Up O/C	OUT	*	on		*	LED			BO					
17538	67 Backup O/C PICKUP Phase C (67 Pickup ØC)	Back-Up O/C	OUT	*	on		*	LED			BO					
17539	67N Backup O/C PICKUP GROUND (67N Pickup Gnd)	Back-Up O/C	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													
31002	Q2 operationcounter= (Q2 OpCnt=)	Control Device	VI													
31008	Q8 operationcounter= (Q8 OpCnt=)	Control Device	VI													
31009	Q9 operationcounter= (Q9 OpCnt=)	Control Device	VI													

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
32100	>87L Protection blocking signal (>87L block)	87 Diff. Prot.	SP	On Off	*		*	LED	BI		BO					
32102	87L Protection is active (87L active)	87 Diff. Prot.	OUT	on	*		*	LED			BO					
32103	87L Fault detection A (87L Fault A)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32104	87L Fault detection B (87L Fault B)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32105	87L Fault detection C (87L Fault C)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32107	87L Protection is blocked (87L is blocked)	87 Diff. Prot.	OUT	on	*		*	LED			BO					
32108	87L Protection is switched off (87L is OFF)	87 Diff. Prot.	OUT	on	*		*	LED			BO					
32109	87L A released (87L allow A)	87 Diff. Prot.	OUT	*	*		*	LED			BO					
32110	87L B released (87L allow B)	87 Diff. Prot.	OUT	*	*		*	LED			BO					
32111	87L C released (87L allow C)	87 Diff. Prot.	OUT	*	*		*	LED			BO					
32112	87 CT primary ratio is too high (87 CTRatioAlarm)	87 Diff. Prot.	OUT	On Off	*		*	LED			BO					
32113	87L receive blocking (87L receive blk)	87 Diff. Prot.	OUT	On Off	*		*	LED			BO					
32114	87L send blocking (87L send blk)	87 Diff. Prot.	OUT	On Off	*		*	LED			BO					
32115	87L IDYN> A (87L IDYN> A)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32116	87L IDYN> B (87L IDYN> B)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32117	87L IDYN> C (87L IDYN> C)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32118	87L ISTAT> A (87L ISTAT> A)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32119	87L ISTAT> B (87L ISTAT> B)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32120	>87N L Protection blocking signal (>87N L block)	87 Diff. Prot.	SP	On Off	*		*	LED	BI		BO					
32121	>87N L: Protection is active (>87N L active)	87 Diff. Prot.	OUT	on	*		*	LED			BO					
32122	87(N)L Fault detection (87(N)L Gen.Flt.)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32124	>87N L: Fault detection of I-Diff> (>87N L I> Flt.)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32125	87(N)L General TRIP (87(N)L Gen.TRIP)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32126	87N L: Protection is blocked (87N L block)	87 Diff. Prot.	OUT	on	*		*	LED			BO					
32127	87N L: Protection is switched off (87N L OFF)	87 Diff. Prot.	OUT	on	*		*	LED			BO					
32128	87N L: detection 3V0> pickup (87N L 3V0>)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32129	87N L: detection Forward (87N L Forward)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32130	87N L: detection Reverse (87N L Reverse)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32131	87N L: detection Undef. Direction (87N L UndefDir)	87 Diff. Prot.	OUT	*	On Off		m	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
32132	87N L: receive blocking (87N L rec. blk)	87 Diff. Prot.	OUT	On Off	*		*	LED			BO					
32133	87N L: send blocking (87N L send blk)	87 Diff. Prot.	OUT	On Off	*		*	LED			BO					
32134	87N L: pickup (87N L PU)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32150	87L ISTAT> C (87L ISTAT> C)	87 Diff. Prot.	OUT	*	On Off		m	LED			BO					
32200	PDI Test Mode FO ON/OFF (PDITestFOon/OFF)	Device, General	IntSP	On Off												
32201	PDI Test Mode Cu ON/OFF (PDITestCuon/OFF)	Device, General	IntSP	On Off												
32202	PDI Test Mode (PDI Test Mode)	Device, General	OUT	On Off	*		*	LED			BO					
32203	PDI Test Mode remote (PDI Test remote)	Device, General	OUT	On Off	*		*	LED			BO					
32224	PDI FO: aging (distance damping high) (PDI FO: AGING)	Device, General	OUT	*	*		*	LED			BO					
32225	PDI Cu: aging (distance damping high) (PDI Cu: AGING)	Device, General	OUT	*	*		*	LED			BO					
32227	PDI-FO receive level to low (PDI-FO RQ LOW)	Prot.Interface	OUT	On Off			*	LED			BO					
32228	PDI-FO attenuation to high (PDI-Cu ATT HIGH)	Prot.Interface	OUT	On Off			*	LED			BO					
32229	PDI-FO signal to noise ratio to low (PDI-Cu S/N LOW)	Prot.Interface	OUT	On Off			*	LED			BO					

A.10 Group Alarms

No.	Description	Function No.	Description
140	Error Sum Alarm	- - 181	- - Error A/D-conv.
160	Alarm Sum Event	289 163 167 168 169 170 171 177 190 191 193 183 184 185 186 187	Failure Σi Fail I balance Fail V balance Fail V absent VT FuseFail>10s VT FuseFail Fail Ph. Seq. Fail Battery Error Board 0 Error Offset Alarm adjustm. Error Board 1 Error Board 2 Error Board 3 Error Board 4 Error Board 5
161	Fail I Superv.	289 163	Failure Σi Fail I balance
164	Fail V Superv.	167 168	Fail V balance Fail V absent

A.11 Measured Values

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	Information Number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
-	Control DIGSI (CntrlDIGSI)	Cntrl Authority	-	-	-	-	-	CFC	CD	DD
-	I A dmd> (I Admd>)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
-	I B dmd> (I Bdmd>)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
-	I C dmd> (I Cdmd>)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
-	I1dmd> (I1dmd>)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
-	|Pdmd|> (|Pdmd|>)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
-	|Qdmd|> (|Qdmd|>)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
-	|Sdmd|> (|Sdmd|>)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
-	|Power Factor|< (|PF|<)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
601	Ia (Ia =)	Measurement	134	129	No	9	1	CFC	CD	DD
602	Ib (Ib =)	Measurement	134	129	No	9	2	CFC	CD	DD
603	Ic (Ic =)	Measurement	134	129	No	9	3	CFC	CD	DD
610	3I0 (zero sequence) (3I0 =)	Measurement	134	129	No	9	14	CFC	CD	DD
611	3I0sen (sensitive zero sequence) (3I0sen=)	Measurement	-	-	-	-	-	CFC	CD	DD
612	Ig (grounded transformer) (Ig =)	Measurement	-	-	-	-	-	CFC	CD	DD
613	3I0par (parallel line neutral) (3I0par=)	Measurement	-	-	-	-	-	CFC	CD	DD
619	I1 (positive sequence) (I1 =)	Measurement	-	-	-	-	-	CFC	CD	DD
620	I2 (negative sequence) (I2 =)	Measurement	-	-	-	-	-	CFC	CD	DD
621	Va (Va =)	Measurement	134	129	No	9	4	CFC	CD	DD
622	Vb (Vb =)	Measurement	134	129	No	9	5	CFC	CD	DD
623	Vc (Vc =)	Measurement	134	129	No	9	6	CFC	CD	DD
624	Va-b (Va-b=)	Measurement	134	129	No	9	10	CFC	CD	DD
625	Vb-c (Vb-c=)	Measurement	134	129	No	9	11	CFC	CD	DD
626	Vc-a (Vc-a=)	Measurement	134	129	No	9	12	CFC	CD	DD
627	VN (VN =)	Measurement	-	-	-	-	-	CFC	CD	DD
631	3V0 (zero sequence) (3V0 =)	Measurement	-	-	-	-	-	CFC	CD	DD
634	V1 (positive sequence) (V1 =)	Measurement	-	-	-	-	-	CFC	CD	DD
635	V2 (negative sequence) (V2 =)	Measurement	-	-	-	-	-	CFC	CD	DD
641	P (active power) (P =)	Measurement	134	129	No	9	7	CFC	CD	DD
642	Q (reactive power) (Q =)	Measurement	134	129	No	9	8	CFC	CD	DD
643	Power Factor (PF =)	Measurement	134	129	No	9	13	CFC	CD	DD
644	Frequency (Freq=)	Measurement	134	129	No	9	9	CFC	CD	DD
645	S (apparent power) (S =)	Measurement	-	-	-	-	-	CFC	CD	DD
684	Vo (zero sequence) (Vo =)	Measurement	-	-	-	-	-	CFC	CD	DD
801	Temperat. rise for warning and trip (Θ/Θtrip =)	Measurement	-	-	-	-	-	CFC	CD	DD
802	Temperature rise for phase A (Θ/Θtrip A=)	Measurement	-	-	-	-	-	CFC	CD	DD
803	Temperature rise for phase B (Θ/Θtrip B=)	Measurement	-	-	-	-	-	CFC	CD	DD
804	Temperature rise for phase C (Θ/Θtrip C=)	Measurement	-	-	-	-	-	CFC	CD	DD
833	I1 (positive sequence) Demand (I1 dmd=)	Demand meter	-	-	-	-	-	CFC	CD	DD
834	Active Power Demand (P dmd =)	Demand meter	-	-	-	-	-	CFC	CD	DD
835	Reactive Power Demand (Q dmd =)	Demand meter	-	-	-	-	-	CFC	CD	DD
836	Apparent Power Demand (S dmd =)	Demand meter	-	-	-	-	-	CFC	CD	DD
837	I A Demand Minimum (IAdmdMin)	Min/Max meter	-	-	-	-	-	CFC	CD	DD

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	Information Number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
838	I A Demand Maximum (IAdmdMax)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
839	I B Demand Minimum (IBdmdMin)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
840	I B Demand Maximum (IBdmdMax)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
841	I C Demand Minimum (ICdmdMin)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
842	I C Demand Maximum (ICdmdMax)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
843	I1 (positive sequence) Demand Minimum (I1dmdMin)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
844	I1 (positive sequence) Demand Maximum (I1dmdMax)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
845	Active Power Demand Minimum (PdMin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
846	Active Power Demand Maximum (PdMax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
847	Reactive Power Demand Minimum (QdMin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
848	Reactive Power Demand Maximum (Qd-Max=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
849	Apparent Power Demand Minimum (SdMin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
850	Apparent Power Demand Maximum (Sd-Max=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
851	Ia Min (Ia Min=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
852	Ia Max (Ia Max=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
853	Ib Min (Ib Min=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
854	Ib Max (Ib Max=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
855	Ic Min (Ic Min=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
856	Ic Max (Ic Max=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
857	I1 (positive sequence) Minimum (I1 Min=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
858	I1 (positive sequence) Maximum (I1 Max=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
859	Va-n Min (Va-nMin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
860	Va-n Max (Va-nMax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
861	Vb-n Min (Vb-nMin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
862	Vb-n Max (Vb-nMax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
863	Vc-n Min (Vc-nMin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
864	Vc-n Max (Vc-nMax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
865	Va-b Min (Va-bMin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
867	Va-b Max (Va-bMax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
868	Vb-c Min (Vb-cMin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
869	Vb-c Max (Vb-cMax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
870	Vc-a Min (Vc-aMin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
871	Vc-a Max (Vc-aMax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
874	V1 (positive sequence) Voltage Minimum (V1 Min =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
875	V1 (positive sequence) Voltage Maximum (V1 Max =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
880	Apparent Power Minimum (Smin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
881	Apparent Power Maximum (Smax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
882	Frequency Minimum (fmin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
883	Frequency Maximum (fmax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
888	Pulsed Energy Wp (active) (Wp(puls))	Energy	133	55	No	205	-	CFC	CD	DD
889	Pulsed Energy Wq (reactive) (Wq(puls))	Energy	133	56	No	205	-	CFC	CD	DD
924	Wp Forward (Wp+=)	Energy	133	51	No	205	-	CFC	CD	DD
925	Wq Forward (Wq+=)	Energy	133	52	No	205	-	CFC	CD	DD
928	Wp Reverse (Wp-=)	Energy	133	53	No	205	-	CFC	CD	DD
929	Wq Reverse (Wq-=)	Energy	133	54	No	205	-	CFC	CD	DD

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	Information Number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
963	I A demand (Ia dmd=)	Demand meter	-	-	-	-	-	CFC	CD	DD
964	I B demand (Ib dmd=)	Demand meter	-	-	-	-	-	CFC	CD	DD
965	I C demand (Ic dmd=)	Demand meter	-	-	-	-	-	CFC	CD	DD
1040	Active Power Minimum Forward (Pmin Forw=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1041	Active Power Maximum Forward (Pmax Forw=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1042	Active Power Minimum Reverse (Pmin Rev =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1043	Active Power Maximum Reverse (Pmax Rev =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1044	Reactive Power Minimum Forward (Qmin Forw=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1045	Reactive Power Maximum Forward (Qmax Forw=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1046	Reactive Power Minimum Reverse (Qmin Rev =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1047	Reactive Power Maximum Reverse (Qmax Rev =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1048	Power Factor Minimum Forward (PFmin-Forw=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1049	Power Factor Maximum Forward (PFmax-Forw=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1050	Power Factor Minimum Reverse (PFmin Rev=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1051	Power Factor Maximum Reverse (PFmax Rev=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1052	Active Power Demand Forward (Pdmd Forw=)	Demand meter	-	-	-	-	-	CFC	CD	DD
1053	Active Power Demand Reverse (Pdmd Rev =)	Demand meter	-	-	-	-	-	CFC	CD	DD
1054	Reactive Power Demand Forward (Qdmd Forw=)	Demand meter	-	-	-	-	-	CFC	CD	DD
1055	Reactive Power Demand Reverse (Qdmd Rev =)	Demand meter	-	-	-	-	-	CFC	CD	DD
7731	PHI I AB (local) (Φ I AB=)	Measurement	-	-	-	-	-	CFC	CD	DD
7732	PHI I BC (local) (Φ I BC=)	Measurement	-	-	-	-	-	CFC	CD	DD
7733	PHI I CA (local) (Φ I CA=)	Measurement	-	-	-	-	-	CFC	CD	DD
7734	PHI V AB (local) (Φ V AB=)	Measurement	-	-	-	-	-	CFC	CD	DD
7735	PHI V BC (local) (Φ V BC=)	Measurement	-	-	-	-	-	CFC	CD	DD
7736	PHI V CA (local) (Φ V CA=)	Measurement	-	-	-	-	-	CFC	CD	DD
7737	PHI VI A (local) (Φ VI A=)	Measurement	-	-	-	-	-	CFC	CD	DD
7738	PHI VI B (local) (Φ VI B=)	Measurement	-	-	-	-	-	CFC	CD	DD
7739	PHI VI C (local) (Φ VI C=)	Measurement	-	-	-	-	-	CFC	CD	DD
7748	Diff3I0 (Differential current 3I0) (Diff3I0=)	IDiff/IRest	-	-	-	-	-	CFC	CD	DD
7751	Prot. Interf. FO: Transmission delay (PI FO TD)	Measure PDI	134	122	No	9	1	CFC	CD	DD
7752	Prot. Interf. Cu: Transmission delay (PI Cu TD)	Measure PDI	134	122	No	9	3	CFC	CD	DD
7753	Prot. Interf. FO: Availability per min. (FO A/m)	Measure PDI	-	-	-	-	-	CFC	CD	DD
7754	Prot. Interf. FO: Availability per hour (FO A/h)	Measure PDI	134	122	No	9	2	CFC	CD	DD
			134	121	No	9	1			
7755	Prot. Interf. Cu: Availability per min. (Cu A/m)	Measure PDI	-	-	-	-	-	CFC	CD	DD
7756	Prot. Interf. Cu: Availability per hour (Cu A/h)	Measure PDI	134	122	No	9	4	CFC	CD	DD
			134	121	No	9	2			

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	Information Number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
7761	Relay ID of 1st. relay (Relay ID)	Measure Master	-	-	-	-	-	CFC	CD	DD
7762	I A (% of Operational nominal current) (I A_opN=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7763	Angle I A_remote <-> I A_local (ΦI A=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7764	I B (% of Operational nominal current) (I B_opN=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7765	Angle I B_remote <-> I B_local (ΦI B=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7766	I C (% of Operational nominal current) (I C_opN=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7767	Angle I C_remote <-> I C_local (ΦI C=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7769	V A (% of Operational nominal voltage) (V A_opN=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7770	Angle V A_remote <-> V A_local (ΦV A=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7771	V B (% of Operational nominal voltage) (V B_opN=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7772	Angle V B_remote <-> V B_local (ΦV C=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7773	V C (% of Operational nominal voltage) (V C_opN=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7774	Angle V C_remote <-> V C_local (ΦV C=)	Measure Master	-	-	-	-	-	CFC	CD	DD
7781	Relay ID of 2nd. relay (Relay ID)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7782	I A (% of Operational nominal current) (I A_opN=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7783	Angle I A_remote <-> I A_local (ΦI A=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7784	I B (% of Operational nominal current) (I B_opN=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7785	Angle I B_remote <-> I B_local (ΦI B=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7786	I C (% of Operational nominal current) (I C_opN=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7787	Angle I C_remote <-> I C_local (ΦI C=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7789	V A (% of Operational nominal voltage) (V A_opN=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7790	Angle V A_remote <-> V A_local (ΦV A=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7791	V B (% of Operational nominal voltage) (V B_opN=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7792	Angle V B_rem <-> V B_local (ΦV B=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7793	V C (% of Operational nominal voltage) (V C_opN=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
7794	Angle V C_remote <-> V C_local (ΦV C=)	Measure Slave	-	-	-	-	-	CFC	CD	DD
10102	Min. Zero Sequence Voltage 3V0 (3V0min =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
10103	Max. Zero Sequence Voltage 3V0 (3V0max =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
32204	Output power of the FO-Interface = (Output-Power FO=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32205	Input power of the FO-Interface = (Input Power FO=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32206	Budget of the FO-Interface = (Budget FO =)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32208	Attenuation of the Cu-Interface = (Attenua-tionCu =)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32209	Signal-to-noise ratio Cu-Interface = (StN Ratio Cu=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32210	Send telegrams in the last second= (Send Tel.sec=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32211	Good received telegrams in the last sec= (Good Rec.sec=)	Measure PDI	-	-	-	-	-	CFC	CD	DD

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	Information Number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
32212	Bad received telegrams in the last sec= (Bad Rec.sec =)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32213	Send telegrams in the last minute= (Send Tel.min=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32214	Good received telegrams in the last min= (Good Rec.min=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32215	Bad received telegrams in the last min= (Bad Rec. min=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32216	Send telegrams in the last hour= (Send-Tel.hour=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32217	Good received telegrams in the last hour= (GoodRec.hour=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32218	Bad received telegrams in the last hour= (Bad Rec.hour=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32219	PDI Test - Send telegrams = (Test Send Tel.=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32220	PDI Test - Good received telegrams = (Test Good Rec.=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32221	PDI Test - Bad received telegrams = (Test Bad Rec.=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32222	PDI FO: temperatur = (PDI FO: TEMP =)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32223	PDI FO: BIAS current = (PDI FO: BIAS =)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32226	Rest3I0(% Operational nominal current) (Rest3I0=)	IDiff/IRest	-	-	-	-	-	CFC	CD	DD
32230	Send telegrams in the last second= (Send Tel.sec=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32231	Good received telegrams in the last sec= (Good Rec.sec=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32232	Bad received telegrams in the last sec= (Bad Rec.sec =)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32233	Send telegrams in the last minute= (Send Tel.min=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32234	Good received telegrams in the last min= (Good Rec.min=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32235	Bad received telegrams in the last min= (Bad Rec. min=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32236	Send telegrams in the last hour= (Send-Tel.hour=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32237	Good received telegrams in the last hour= (GoodRec.hour=)	Measure PDI	-	-	-	-	-	CFC	CD	DD
32238	Bad received telegrams in the last hour= (Bad Rec.hour=)	Measure PDI	-	-	-	-	-	CFC	CD	DD

■

Literature

/1/ SIPROTEC 4 System Description; E50417-H1176-C151-A1

/2/ SIPROTEC DIGSI, Start UP; E50417-G1176-C152-A2

/3/ DIGSI CFC, Manual; E50417-H1176-C098-A5

/4/ SIPROTEC SIGRA 4, Manual; E50417-H1176-C070-A1

Glossary

Battery

The buffer battery ensures that specified data areas, flags, timers and counters are retained retentively.

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).

C_xx

Command without feedback

CF_xx

Command with feedback

CFC

Continuous Function Chart. CFC is a graphics 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 blocking

A rapidly intermittent input (for example, due to a relay contact fault) is switched off after a configurable monitoring time and can 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

DIGSI V4.6 and higher allows up to 32 compatible SIPROTEC 4 devices to communicate with each other in an inter-relay communication network (IRC). The combination matrix defines which devices exchange which information.

Communication branch

A communications branch corresponds to the configuration of 1 to n users which 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 image which is displayed on devices with a large (graphic) display after pressing the control key is called 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 diagram 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 unit 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.

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.

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

External 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, → 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, 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.

Floating

→ Without electrical connection to the → ground.

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) in accordance with IEC 61850 are data packages that are transmitted cyclically and event-controlled via the Ethernet communication system. They serve for direct information exchange among the relays. This mechanism facilitates cross-communication between bay devices.

GPS

Global Positioning System. Satellites with atomic clocks on board orbit the earth twice a day in different parts 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 running time of a satellite and thus correct the transmitted GPS universal time.

Ground

The conductive ground whose electric potential can be set equal to zero in any point. In the area of ground electrodes the ground can have a potential deviating from zero. The term "Ground reference plane" is often used for this state.

Grounding

Grounding means that a conductive part is to connect via a grounding system to → ground.

Grounding

Grounding is the total of all means and measured used for grounding.

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 memorized 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 data are 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

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.

IEC61850

Worldwide communication standard for communication in substations. This standard allows devices from different manufacturers to interoperate on the station bus. Data transfer is accomplished through an Ethernet network.

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

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 among the users is also stored in this object.

IRIG-B

Time signal code of the Inter-Range Instrumentation Group

IS

Internal single-point indication → Single-point indication

IS_F

Internal indication fleeting → Fleeting indication, → Single-point indication

ISO 9001

The ISO 9000 ff range of standards defines measures used to ensure the quality of a product from the development to the manufacturing.

LFO filter

(Low Frequency Oscillation) Filter for low-frequency oscillation

Link address

The link address gives the address of a V3/V2 device.

List view

The right pane 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.

LV

Limit value

LVU

Limit value, user-defined

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 acronym of "MaschinenLesbare FabrikateBezeichnung" (machine-readable product designation). It is equivalent to the order number. The type and version of a SIPROTEC 4 device are 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 saved 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 link with the SIPROTEC 4 device is not necessary. You work with data which are stored in files.

OI_F

Output indication fleeting → Transient information

On-line

When working in online mode, there is a physical link to a SIPROTEC 4 device which can be implemented in various ways. This link can be implemented as a direct connection, as a modem connection or as a PROFIBUS FMS connection.

OUT

Output indication

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 featuring a process bus interface can communicate directly with the 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 by a number of objects which are integrated in a hierarchical structure. Physically, a project consists of a series of folders and files containing project data.

Protection devices

All devices with a protective function and no control display.

Reorganizing

Frequent addition and deletion of objects creates memory areas that can no longer be used. By cleaning up projects, you can release these memory areas. However, a cleanup also reassigns the VD addresses. As a consequence, all SIPROTEC 4 devices need to be reinitialized.

RIO file

Relay data Interchange format by Omicron.

RSxxx-interface

Serial interfaces RS232, RS422/485

SCADA Interface

Rear serial interface on the devices for connecting to a control system via IEC or PROFIBUS.

Service port

Rear serial interface on the devices for connecting DIGSI (for example, via modem).

Setting parameters

General term for all adjustments made to the device. Parameterization jobs are executed by means of DIGSI or, in some cases, directly on the device.

SI

→ Single point indication

SI_F

→ Single-point indication fleeting → Transient information, → Single-point indication

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 condition of your network graphically, visualizes alarms and indications, archives the network data, allows to intervene 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 source object. However, all variants derived from the source object have the same VD address as the source object. For this reason, they always correspond to the same real SIPROTEC 4 device as the source 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.

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.

Transient information

A transient information is a brief transient → single-point indication at which only the coming of the process signal is detected and processed immediately.

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.

TxTap

→ Transformer Tap Indication

User address

A user address comprises the name of the station, the national code, the area code and the user-specific phone number.

Users

DIGSI V4.6 and higher allows up to 32 compatible SIPROTEC 4 devices to communicate with each other in an inter-relay communication network. 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

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