SIPROTEC

Multi-Functional Protective Relay with Local Control 7SJ62/63/64

V4.6

Manual

C53000-G1140-C147-8

Disclaimer of liability

We have checked the contents of this manual against the hardware and software described. However, deviations from the description cannot be completely ruled out, so that no liability can be accepted for any errors or omissions contained in the information given.

The information given in this document is reviewed regularly and any necessary corrections will be included in subsequent editions. We appreciate any suggested improvements.

We reserve the right to make technical improvements without notice.

Document Release 04.62.01

Preface

Purpose of this Manual

This manual describes the functions, operation, installation, and commissioning of the device 7SJ62/63/64. In particular, one will find:

- Information on the Device Configuration and a description of the device functions and setting options → Chapter 2;
- Instructions for mounting and commissioning → Chapter 3;
- List of technical data → Chapter 4;
- As well as a compilation of the most significant data for experienced users in Appendix A.

For general information on operation and configuration of SIPROTEC® 4 devices, please refer to the SIPROTEC® 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 is valid for: SIPROTEC® 4 Multi-Functional Protective Relay with Local Control 7SJ62/63/64; firmware version V4.6.

Indication of Conformity

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 89/336/EEC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 73/23 EEC).

This conformity has been proved by tests performed according to Article 10 of 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 60255-6 (for Low Voltage Directive) by Siemens. AG.

This device is designed and manufactured for application in industrial environment.

The product conforms with the international standards of IEC 60255 and the German standard VDE 0435.

Further standards

IEEE Std C37.90-*

IND. CONT. EQ.
TYPE 1
69CA

IND. CONT. EQ.
TYPE 1

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.

Training Courses

Individual course offerings may be found in our Training Catalogue, or questions may be directed to our training centre in Nuremberg.

Instructions and Warnings

The warnings and notes contained in this manual serve for your own safety and for an appropriate lifetime of the device. Please observe them!
The following indicators and standard definitions are used:

DANGER

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

Warning

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

Caution

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

Note

indicates information about the device or respective part of the instruction manual which is essential to highlight.

WARNING!

When operating an electrical device, certain parts of the device inevitably have dangerous voltages.

Failure to observe these precautions can result in fatality, personal injury, or extensive material damage.

Only qualified personnel shall work on and around this equipment. It must be thoroughly familiar with all warnings and safety notices of this manual as well as with the applicable safety regulations.

The successful and safe operation of this device is dependent on proper handling, installation, operation, and maintenance by qualified personnel under observance of all warnings and hints contained in this manual. In particular the general erection and safety regulations (e.g. IEC, DIN, VDE, EN or other national and international standards) regarding the correct use of hoisting gear must be observed.

Definition

QUALIFIED PERSONNEL

For the purpose of this instruction manual and product labels, a qualified person is one who is familiar with the installation, construction and operation of the equipment and the hazards involved. In addition, he has the following qualifications:

- Is trained and authorized to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.
- Is trained in the proper care and use of protective equipment in accordance with established safety practices.
- Is trained in rendering first aid.

Typographic and Graphical Conventions

To designate terms which refer in the text to information of the device or for the device, the following fonts are used:

`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 of a monospace type style. This also applies to header bars for selection 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 Conditions`

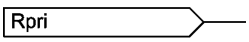
possible settings of text parameters, which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI®), are additionally written in italics. This also applies to header bars for selection menus.

`„Annunciations“`

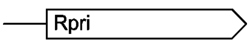
Designators for information, which may be output by the relay or required from other devices or from the switch gear, are marked in a monospace type style in quotation marks.

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

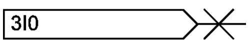
The following symbols are used in drawings:



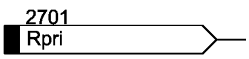
Device-internal logical input signal



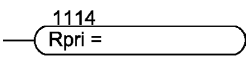
Device-internal logical output signal



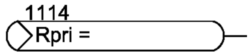
Internal input signal of an analog quantity



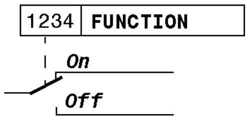
External binary input signal with number (binary input, input indication)



External binary output signal with number (device indication)

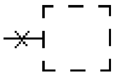


External binary output signal with number (device indication) used as input signal

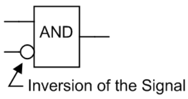


Example of a parameter switch designated **FUNCTION** with the address 1234 and the possible settings ON and OFF

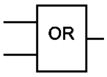
Besides these, graphical symbols are used according to IEC 60617-12 and IEC 60617-13 or symbols derived from these standards. Some of the most frequently used are listed below:



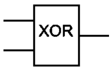
Input signal of an analog quantity



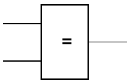
AND gate



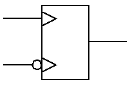
OR gate



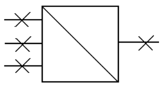
Exclusive–OR gate (antivalence): output is active, if only **one** of the inputs is active



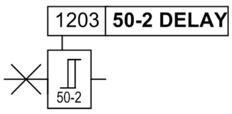
Equivalence: output is active, if **both** inputs are active or in-active at the same time



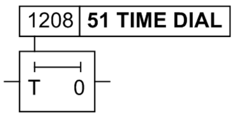
Dynamic inputs (edge–triggered) above with positive, below with negative edge



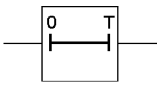
Formation of one analog output signal from a number of analog input signals



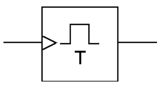
Limit stage with setting address and parameter designator (name)



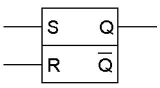
Timer (pickup delay T, example adjustable) with setting address and parameter designator (name)



Timer (dropout delay T, example non-adjustable)



Dynamic triggered pulse timer T (monoflop)



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

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Contents

Introduction 1

The device family SIPROTEC® 7SJ62/63/64 devices is introduced in this section. An overview of the devices is presented in their application, characteristics, and scope of functions.

1.1 Overall Operation

The SIPROTEC® 7SJ62/63/64 are numerical, multi-functional, protective and control devices equipped with a powerful microprocessor. All tasks are processed digitally exclusively, from acquisition of measured values up to commands to the circuit breakers. Figure 1-1 illustrates the basic structure of the devices 7SJ62/63, Figure 1-2 illustrates the basic structure of the device 7SJ64.

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 four current inputs. Depending on the model, the device is also equipped with three or four voltage inputs. Three current inputs serve for input of the phase currents. Depending on the model, the fourth 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).

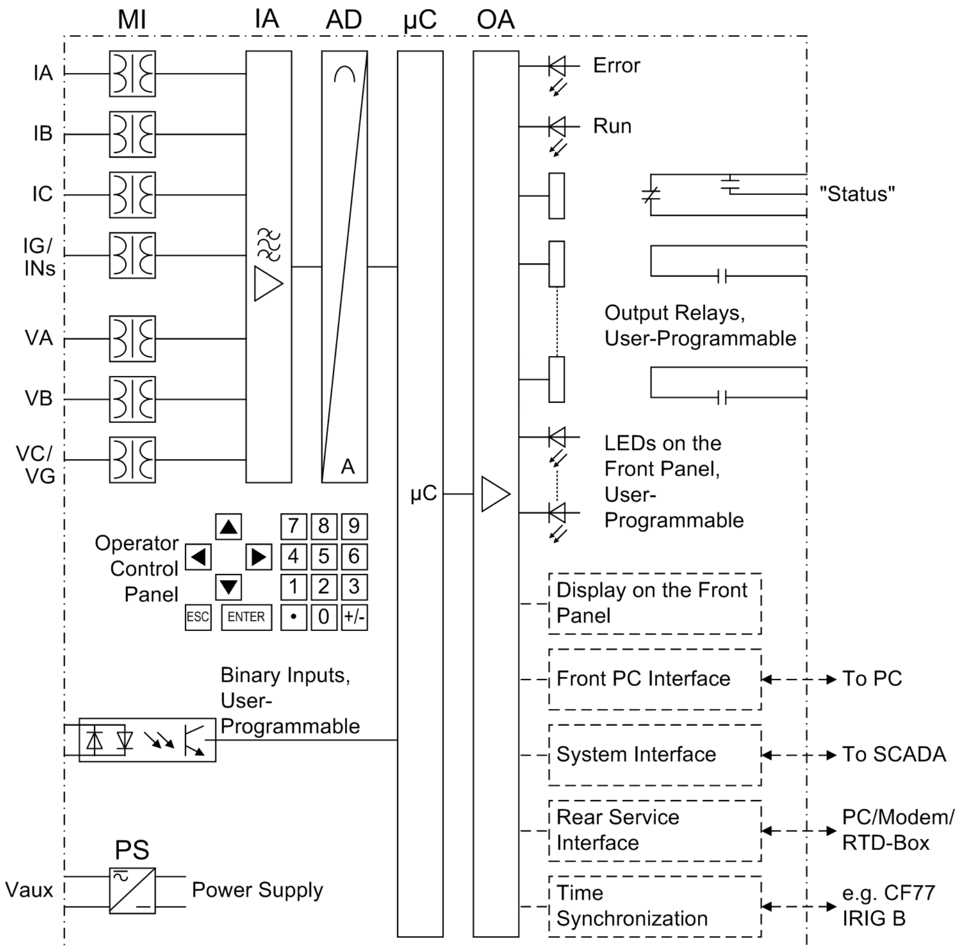


Figure 1-1 Hardware structure of the numerical multi-functional protection device 7SJ62 and 7SJ63

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

The four voltage transformers of 7SJ64 can either be applied for the input of 3 phase-to-ground voltages, one displacement voltage (V_N voltage) or a further voltage for the synchronizing function.

The analog input quantities are passed on to the input amplifiers (IA). The input amplifier IA stage provides high-resistance terminations 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) stage consists of a multiplexor, an analog-to-digital (A/D) converter and of memory components for the transmission of digital signals to the microcomputer system.

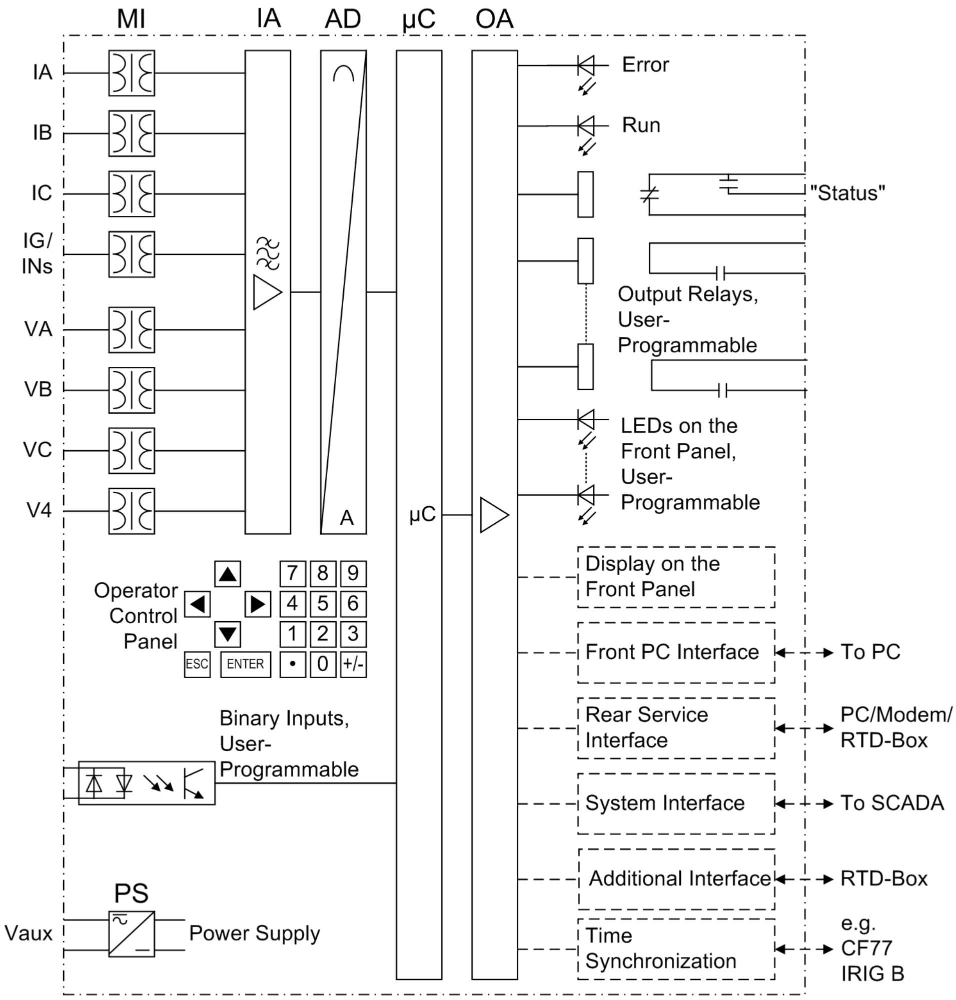


Figure 1-2 Hardware structure of the numerical multi-functional device 7SJ64

Microcomputer System

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

- Filtering and preparation of the measured quantities
- Continuous monitoring of the measured quantities

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

Binary Inputs and Outputs

The computer system obtains external information through the binary input/output modules (inputs and outputs). The computer system obtains the information from the system (e.g remote resetting) or the external equipment (e.g. blocking commands). Outputs are, in particular, commands to the switchgear units and indications for remote signalling of important events and statuses.

Front Elements

With devices with integrated or detached operator panel, information such as messages related to events, states, measured values and the functional status of the device are provided via light-emitting diodes (LEDs) and a display screen (LCD) on the front panel.

Integrated control and numeric keys in conjunction with the LCD facilitate interaction with the remote device. Via these elements all information of the device such as configuration and setting parameters, operating and fault messages, and measured values can be accessed. Setting parameters may be changed in the same way.

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

Serial Interfaces

A serial **PC interface** on the front panel is provided for local communications with the device through a personal computer using the operating program DIGSI®. This facilitates a comfortable handling of all device functions.

A separate **service interface** can be provided for remote communication with the device via a personal computer using DIGSI®. This interface is especially well suited for dedicated connection of the devices to the PC or for operation via a modem. The service interface can also be used to connect an RTD box (= resistance temperature detector) for entering external temperatures (e.g. for overload protection).

The **additional** interface (only 7SJ64) is designed exclusively for connection of a RTD-Box (= resistance temperature detector) for entering external temperatures.

All data can be transferred to a central control center or monitoring system via the serial **system** interface. This interface may be provided with various protocols and physical transmission schemes to suit the particular application.

A further interface is provided for the **time synchronization** of the internal clock via external synchronization sources.

Further communication protocols can be realized via additional interface modules.

Over the operating or service interface you can serve the device (only with 7SJ64) from a distance or locally with a standard Browser. This can take place during the initial start-up, examination and also during the operation with the devices. For this the SIPROTEC 4 standard "Web monitor" is available.

Power Supply

The before-mentioned function elements and their voltage levels are supplied with power by a power supplying unit (Vaux or PS). Voltage dips may occur if the voltage supply system (substation battery) becomes short-circuited. Usually, they are bridged by a capacitor (see also Technical Data).

1.2 Application Scope

The numerical, multi-functional SIPROTEC® 4 7SJ62/63/64 are versatile devices designed for protection, control and monitoring of busbar feeders. The devices can be used for line protection in networks that are grounded, low-resistance grounded, ungrounded, or of a compensated neutral point structure. They are suited for networks that are radial or looped, and for lines with single or multi-terminal feeds. The devices are equipped with motor protection applicable for asynchronous machines of all sizes.

The devices include the functions that are necessary for protection, monitoring of circuit breaker positions, and control of the circuit breakers in straight bus applications or breaker-and-a-half configurations; therefore, the devices can be universally employed. The devices provide excellent backup facilities of differential protective schemes of lines, transformers, generators, motors, and busbars of all voltage levels.

Protective Functions

Non-directional overcurrent protection (50, 50N, 51, 51N) is the basis of the device. There are two definite time overcurrent protective elements and one inverse time overcurrent protective element for phase and ground current. For inverse time overcurrent protective elements, several characteristics of different standards are provided. Alternatively, user-defined characteristics can be programmed.

Depending on the version of the device that is ordered, the non-directional overcurrent protection can be supplemented with directional overcurrent protection (67, 67N), breaker failure protection (50BF), and sensitive ground fault detection for high-resistance ground faults. The highly sensitive ground fault detection can be directional or non-directional.

In addition to the fault protection functions already mentioned, other protective functions are available. Some of them depend on the version of the device that is ordered. These additional functions include frequency protection (81O/U), overvoltage protection (59) and undervoltage protection (27), negative sequence protection (46) and overload protection (49) with start inhibit for motors (66/68) and motor starting protection (48), as well as automatic reclosing (79) which allows different reclosing cycles on overhead lines. The automatic reclosing system may also be connected externally. To ensure quick detection of the fault, the device is equipped with a fault locator.

A protection feature can be ordered for the detection of intermittent ground faults which detects and accumulates transient ground faults.

External detectors account for ambient temperatures or coolant temperatures (by means of an external RTD-box).

Before reclosing after three-pole tripping 7SJ64 can verify the validity of the reclosure by voltage check and/or synchronous check. The synchronization function can also be controlled externally.

Control Functions

The device provides a control function which can be accomplished for activating and deactivating switchgears via the integrated operator panel, the system interface, binary inputs, and the serial port using a personal computer with DIGSI®.

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

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

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

Messages and Measured Values; Recording of Event and Fault Data

The operating messages 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 analized subsequently.

Communication

Serial interfaces are available for the communication with operating, control and memory systems.

A 9-pole DSUB socket at the front panel is used for local communication with a personal computer. By means of the SIPROTEC® operating software DIGSI ®, all operation and evaluation tasks can be executed via this **user** interface, such as specifying and modifying configuration parameters and settings, configuring user-specific logic functions, retrieving operational messages and measured values, inquiring device conditions and measured values, issuing control commands.

Depending on the individual ordering variant, additional interfaces are located on the rear side of the device. They serve to establish an extensive communication with other digital operating, control and memory components:

The **service** interface can be operated via electrical data lines or fiber optics and also allows communication via modem. For this reason, remote operation is possible via personal computer and the DIGSI® operating software, e.g. to operate several devices via a central PC.

The **additional** port (only 7SJ64) is designed exclusively for connection of a RTD-Box (= resistance temperature detector) for entering external temperatures. It can also be operated via data lines or fibre optic cables.

The **system** interface ensures the central communication between the device and the substation controller. It can also be operated via data lines or fibre optic cables. For the data transfer Standard Protocols according IEC 60870 870-5-103 are available via the system port. The integration of the devices into the automation systems SINAUT® LSA and SICAM® can also take place with this profile.

The EN-100-module allows the devices to be integrated in 100-Mbit-Ethernet communication networks in control and automation systems using protocols according to IEC61850. Besides control system integration, this interface enables DIGSI-communication and inter-relay communication via GOOSE.

Alternatively, a field bus coupling with PROFIBUS FMS is available for SIPROTEC® 4. The PROFIBUS FMS according to DIN 19245 is an open communication standard that has particularly wide acceptance in process control and automation engineering, with especially high performance. A profile has been defined for the PROFIBUS communication that covers all of the information types required for protective and process control engineering. The integration of the devices into the power automation system SICAM® can also take place with this profile.

Besides the field-bus connection with PROFIBUS FMS, further couplings are possible with PROFIBUS DP and the protocols DNP3.0 and MODBUS. These protocols do not support all possibilities which are offered by PROFIBUS FMS.

1.3 Characteristics

General Characteristics

- Powerful 32-bit microprocessor system.
- Complete digital processing and control of measured values, from the sampling of the analog input quantities to the initiation of outputs, for example, tripping or closing circuit breakers or other switchgear devices.
- Total electrical separation between the internal processing stages of the device and the external transformer, control, and DC supply circuits of the system because of the design of the binary inputs, outputs, and the DC or AC converters.
- Complete set of functions necessary for the proper protection of lines, feeders, motors, and busbars.
- Easy device operation through an integrated operator panel or by means of a connected personal computer running DIGSI.
- Continuous calculation and display of measured and metered values on the front of the device.
- Storage of min/max measured values (slave pointer function) and storage of long-term mean values.
- Recording of event and fault data for the last eight system faults (fault in a network) with real-time information as well as instantaneous values for fault recording for a maximum time range of 5 s.
- Constant monitoring of the measurement quantities, as well as continuous self-diagnostics covering the hardware and software.
- Communication with SCADA or substation controller equipment via serial interfaces through the choice of data cable, modem, or optical fibers.
- Battery-buffered clock that can be synchronized with an IRIG-B (via satellite) or DCF77 signal, binary input signal, or system interface command.
- Statistics: Recording of the number of trip signals instigated by the device and logging of currents switched off last by the device, as well as accumulated short circuit currents of each pole of the circuit breaker.
- Operating Hours Counter: Tracking of operating hours of the equipment being protected.
- Commissioning aids such as connection check, direction determination, status indication of all binary inputs and outputs, easy check of system interface and influencing of information of the system interface during test operation

Time Overcurrent Protection 50, 51, 50N, 51N

- Two definite time overcurrent protective elements and one inverse time overcurrent protective element for phase current and ground current I_N or summation current $3I_0$;
- Two-phase operation of the overcurrent protection (I_A, I_C) possible;
- Different curves of common standards are available for 51 and 51N, or a user-defined characteristic;
- Blocking capability e.g. for reverse interlocking with any element;
- Instantaneous tripping by any overcurrent element upon switch onto fault is possible;
- Second harmonic inrush restraint.

Ground Fault Protection 50N, 51N

- Two definite time overcurrent protective elements and one inverse time overcurrent protective element for high-resistance ground faults in grounded systems;
- Different curves of common standards are available for 51 and 51N, or a user-defined characteristic;
- Second harmonic inrush restraint;
- Instantaneous tripping by any overcurrent element upon switch onto fault is possible.

Directional Time Overcurrent Protection 67, 67N

- Three directional time overcurrent elements for both phase protection and ground protection operate in parallel to the non-directional time overcurrent elements. Their pickup values and time delays can be set independently from the non-directional time overcurrent elements.
- Fault direction with cross-polarized voltages and voltage memory. Dynamically unlimited direction sensitivity;
- Fault direction is calculated phase-selectively and separately for phase faults, ground faults and summation current faults.

Dynamic Cold Load Pick-up Function 50C, 50NC, 51C, 51NC, 67C, 67NC

- Dynamic changeover of time overcurrent protection settings, e.g. when cold load conditions are anticipated;
- Detection of cold load condition via circuit breaker position or current threshold;
- Activation via automatic reclosure (AR) possible;
- Start also possible via binary input.

Single-Phase Overcurrent Protection

- Evaluation of the measured current via the sensitive or insensitive ground current transformer;
- Suitable as differential protection that includes the neutral point current on a transformer side, a generator side or a motor side or for a grounded reactor set;
- As tank leakage protection against illegal leakage currents between transformer casing and ground.

Voltage Protection 27, 59

- Two undervoltage elements 27-1 and 27-2 measuring positive sequence voltage or the smallest of the applying voltages;
- Choice of current supervision for 27-1 and 27-2;
- Two overvoltage elements 59-1 and 59-2 for separate detection of overvoltages for the largest voltage applied; in addition, detection of the negative sequence component;
- For a single-phase connection, the connected single-phase phase-to-ground or phase-to-phase voltage is evaluated;
- settable dropout ratio for all elements of the undervoltage and overvoltage protection.

Negative Sequence Protection 46

- Evaluation of negative sequence component of the currents;
- Two definite-time elements 46-1 and 46-2 and one inverse-time element 46-TOC; curves of common standards are available for 46-TOC.

Motor Starting Protection 48

- Inverse time tripping characteristic based on an evaluation of the motor starting current;
- Definite time delay for blocked rotor.

Motor Start Inhibit 66, 86

- Approximate replica of excessive rotor temperature;
- Startup is permitted only if the rotor has sufficient thermal reserves for a complete startup;
- Disabling of the start inhibit is possible if an emergency startup is required.

Frequency Protection 81 O/U

- Monitoring on undershooting (f<) and/or overshooting (f>) with 4 frequency limits and delay times that are independently adjustable;
- Insensitive to harmonics and abrupt phase angle changes;
- Adjustable undervoltage threshold.

Thermal Overload Protection 49

- Thermal profile of energy losses (overload protection has total memory capability);
- True r.m.s. calculation;
- Adjustable thermal alarm level;
- Adjustable alarm level based on current magnitude;
- Additional time constant setting for motors to accommodate the motor at standstill;
- Integration of ambient temperature or coolant temperature is possible via external temperature sensors and RTD-Box.

Monitoring Functions

- Availability of the device is greatly increased because of self-monitoring of the internal measurement circuits, power supply, hardware, and software;
- Current transformer and voltage transformer secondary circuits are monitored using summation and symmetry check techniques
- Trip circuit monitoring;
- Phase rotation check.

Ground Fault Detection 50N(s), 51N(s), 67N(s), 59N/64

- Displacement voltage is measured or calculated from the three phase voltages;
- Determination of a faulty phase on ungrounded or grounded networks;
- Two-element Ground Fault Detection: 50Ns-1 and 50Ns-2;
- High sensitivity (as low as 1 mA);
- Overcurrent element with definite time or inverse time delay;
- One user-defined and two logarithmic-inverse current/time curves are available for inverse time O/C protection;
- Direction determination with zero-sequence quantities (I_0, V_0), wattmetric ground fault direction determination;
- Any element can be set as directional or non-directional — forward sensing directional, or reverse sensing directional;
- Directional characteristic can be adjustable;
- Optionally applicable as additional ground fault protection.

Intermittent Ground Fault Protection

- Detects and accumulates intermittent ground faults;
- Tripping after configurable total time.

Automatic Reclosing 79

- Single-shot or multi-shot;
- With separate dead times for the first and all succeeding shots;
- Protective elements that initiate automatic reclosing are selectable. The choices can be different for phase faults and ground faults;
- Different programs for phase and ground faults;
- Interaction to time overcurrent protection element and ground fault elements. They can be blocked in dependence of the reclosing cycle or released instantaneously;
- Synchronous reclosing is possible (only 7SJ64) in conjunction with the integrated synchronizing feature.

Fault Location

- Initiation by trip command, external command or dropout of pickup;
- Fault distance is calculated and given in secondary ohms and miles, or kilometres.

Breaker Failure Protection 50 BF

- Checking current flow and/or evaluation of the circuit breaker auxiliary contacts;
- Initiated by the tripping of any integrated protective element that trips the circuit breaker;
- Initiation possible via a binary input from an external protective device;
- Initiation possible via the integrated control function.

Flexible Protection Functions (7SJ64 only)

- Up to 20 protection functions which can be set individually to operate in three-phase or single-phase mode;
- Any calculated or directly measured value can be evaluated on principle;
- Standard protection logic function with definite time characteristic;
- Internal and configurable pickup and dropout delay;
- Modifiable message texts.

Synchronism and Voltage Check 25 (7SJ64 only)

- Verification of the synchronous conditions before reclosing after three-pole tripping;
- Fast measuring of the voltage difference ΔV, the phase angle difference $\Delta\varphi$ and the frequency difference Δf;
- Alternatively, check of the de-energized state before reclosing;
- Switching possible for asynchronous system conditions with prediction of the synchronization time;
- Settable minimum and maximum voltage;
- Verification of the synchronous conditions or de-energized state also possible before the manual closing of the circuit breaker, with separate limit values;
- Measurement also possible via transformer without external intermediate matching transformer;
- Measuring voltages optionally phase–to–phase or phase–to–ground.

RTD-Boxes

- Detection of any ambient temperatures or coolant temperatures by means of RTD-Boxes and external temperature sensors.

Phase Rotation

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

Circuit-Breaker Maintenance

- Statistical methods to help adjust maintenance intervals for CB contacts according to their actual wear;
- Several autonomous subfunctions are imlemented (ΣI procedure, ΣI^x procedure and 2P procedure); 7SJ64 also features the I^2t procedure);
- Acquisition and conditioning of measured values for all subfunctions operates phase-selective using one procedure-specific threshold per subfunction.

User Defined Functions

- Internal and external signals can be logically combined to establish user-defined logic functions;
- All common Boolean operations are available for programming (AND, OR, NOT, Exclusive OR, etc.);
- Time delays and limit value interrogation;
- Processing of measured values, including zero suppression, adding a knee curve for a transducer input, and live-zero monitoring;
- CFC debugging via browser connection (7SJ64 only).

Breaker Control

- Circuit breakers can be opened and closed via specific process control keys (models with graphic displays only), the programmable function keys on the front panel, via the system interface (e.g. by SICAM(r) or SCADA), or via the front PC interface using a personal computer with DIGSI(r));
- Circuit breakers are monitored via the breaker auxiliary contacts;
- Plausibility monitoring of the circuit breaker position and check of interlocking conditions.

■

Functions

2

This chapter describes the various functions of the SIPROTEC 4 device 7SJ62/63/64. It shows the setting options to each function in maximum configuration and provides information on how to determine the setting values and, if required, formulas.

The following information also allows you to specify which of the available functions to use.

2.1 General

The settings associated with the various device functions can be modified using the operating or service interface in DIGSI® on a PC. Some parameters may also be changed using the controls on the front panel of the device. The detailed procedure is described in the SIPROTEC ® 4 System /1/.

2.1.1 Functional Scope

The 7SJ62/63/64 relay contains protection functions as well as many other functions. The hardware and firmware is designed for this scope of functions. Additionally, the control functions can be matched to the system requirements. Individual functions can be enabled or disabled during the configuration procedure. The interaction of functions may also be modified.

2.1.1.1 Description

Configuration of Functions

Example for the configuration of functional scope:

A protected system consists of overhead lines and underground cables. Since automatic reclosing is only needed for the overhead lines, the automatic reclosing function is not configured or "Disabled" for the relays protecting the underground cables.

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

Functions configured as ***Disabled*** are not processed by the 7SJ62/63/64. There are no messages, and corresponding settings (functions, limit values) are not queried during configuration.

Note

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

2.1.1.2 Setting Notes

Setting of the Functional Scope

Configuration settings can be entered using a PC and the software program DIGSI and transferred via the front serial port or the rear service interface. The operation via DIGSI is explained in the SIPROTEC 4 System Description.

For changing configuration parameters in the device, password no.7 is required (for parameter set). Without the password, the settings may be read, but may not be modified and transmitted to the device.

The functional scope with the available options is set in the **Functional Scope** dialog box to match plant requirements.

Special Characteristics

Most settings are self-explanatory. However, special characteristics are described below.

If the setting group change function has to be used, address 103 **Grp Chge OPTION** must be set to ***Enabled***. In service, simple and fast changeover between up to four different groups of settings is possible Only **one** setting group may be selected and used if this option is ***Disabled***.

For the relay elements associated with non-directional overcurrent protection (separately for phase and ground), various tripping characteristics may be selected at addresses 112 **Charac. Phase** and 113 **Charac. Ground**. If only the definite time characteristic is desired, then ***Definite Time*** should be selected. Additionally, depending on the relay type ordered, various inverse time characteristics, based on either IEC (***TOC IEC***) standards or ANSI (***TOC ANSI***) standards, or user-defined characteristic are available for selection. The dropout behavior of the IEC and ANSI characteristics will be specified later with settings (addresses 1210 and 1310), however, for the user-defined characteristic you determine in address 112 and 113 whether to specify only the pickup characteristic (***User Defined PU***) or the pickup and the reset time characteristic (***User def. Reset***).

The superimposed high-current element 50-2 or 50N-2 is available in all these cases. Time overcurrent protection can be disabled by setting the function to ***Disabled***.

For directional overcurrent protection, the same information that was entered for the non-directional overcurrent protection can be entered at addresses 115 **67/67-TOC** and 116 **67N/67N-TOC**.

For (sensitive) ground fault detection, address 131 **Sens. Gnd Fault** is used to specify whether this function should be enabled with definite time tripping characteristics (***Definite Time***), a ***User Defined PU*** and two logarithmic inverse characteristics or disabled by setting to ***Disabled***.

For the intermittent ground fault protection specify in address 133 **INTERM.EF** the measured quantity (***with Ignd***, ***with 3I0*** or ***with Ignd,sens.***) which is to be used by this protection function.

For negative sequence current protection, address 140 **46** is used to specify whether the tripping characteristics should be ***Definite Time***, ***TOC ANSI*** or ***TOC IEC***, or whether the function is to be ***Disabled***.

Set in address 142 **49** for the overload protection whether (***With amb. temp.***) or not (***No ambient temp***) the thermal replica of the overload protection will account for a coolant temperature or ambient temperature or whether the entire function is set to ***Disabled***.

The flexible protective functions (only 7S64) can be configured in parameter **FLEXIBLE FUNC.**. You can create max. 20 functions. This can be done by marking (setting ticks) the functions (see example in Section 2.18). If the marking (the tick) of a function is removed, all the settings and allocations previously made are lost. All the settings and locations are located in the default setting when a new marking of the function takes place. The setting of the flexible function is performed in DIGSI under „ Parameter“, „Additional Functions“ and„ Settings“. The allocation is performed, as usually, under „Parameter“ and „Allocation“.

Up to four function groups are available for the synchronizing function. They are enabled in address 016x (x = 1 ... 4). Parameters 161 **25 Function 1** to 164 **25 Function 4** indicate whether a synchronizing function is to be ***Disabled*** or ***Enabled***. The latter is determined by selecting the operating mode ***ASYN/SYNCHRON*** (closing takes place for asynchronous and synchronous conditions) or ***SYNCHROCHECK*** (corresponds to the classical synchro-check function). The function groups which are configured to be enabled via ***ASYN/SYNCHRON*** or ***SYNCHROCHECK*** are displayed when you select the synchronizing function; function groups set to ***Disabled*** are hidden.

When using the trip circuit monitoring, there is the possibility to select at address 182 **74 Trip Ct Supv** if the trip circuit monitoring should work with two (***2 Binary Inputs***) or only with one binay input (***1 Binary Input***) or if the function will be configured as ***Disabled***.

If you want to detect an ambient temperature or a coolant temperature and e.g. send the information to the overload protection, specify in address 190 **RTD-BOX INPUT** the port to which the RTD-box is connected. In 7SJ62/63/64 port C (service port) is used for this purpose, for 7SJ64 either port C (service port) or port D (additional port). The number and transmission type of the temperature detectors (RTD = Resistance Temperature Detector) can be specified in address191 **RTD CONNECTION**: ***6 RTD simplex*** or ***6 RTD HDX*** (with one RTD-box) or ***12 RTD HDX*** (with two RTD-boxes). Implementation examples are given in the Appendix (under "Connection Examples"). The settings in address 191 have to comply with those at the RTD-box (see Subsection 2.20.2, under „RTD-box Settings“).

Several options are available at address 172 **52 B.WEAR MONIT** for CB maintenance. This does in no way affect the basic functionality of summation current formation (ΣI procedure), which does not require any additional settings and sums up the tripping currents of the trips initiated by the protection function.

The **ΣI^x procedure** creates the sum of all tripping current powers and displays them as reference quantity. The **2P procedure** continuously calculates the CB's remaining lifetime.

The **I^2t procedure** is only implemented in the 7SJ64. It forms the squared tripping currrent integrals over the arcing time and displays them as reference quantity.

Section 2.23.3 provides more detailed information on CB maintenance procedures.

2.1.1.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
103	Grp Chge OPTION	Disabled Enabled	Disabled	Setting Group Change Option
104	OSC. FAULT REC.	Disabled Enabled	Disabled	Oscillographic Fault Records
112	Charac. Phase	Disabled Definite Time TOC IEC TOC ANSI User Defined PU User def. Reset	Definite Time	50/51
113	Charac. Ground	Disabled Definite Time TOC IEC TOC ANSI User Defined PU User def. Reset	Definite Time	50N/51N

Addr.	Parameter	Setting Options	Default Setting	Comments
115	67/67-TOC	Disabled Definite Time TOC IEC TOC ANSI User Defined PU User def. Reset	Definite Time	67, 67-TOC
116	67N/67N-TOC	Disabled Definite Time TOC IEC TOC ANSI User Defined PU User def. Reset	Definite Time	67N, 67N-TOC
117	Coldload Pickup	Disabled Enabled	Disabled	Cold Load Pickup
122	InrushRestraint	Disabled Enabled	Disabled	2nd Harmonic Inrush Restraint
127	50 1Ph	Disabled Enabled	Disabled	50 1Ph
131	Sens. Gnd Fault	Disabled Definite Time User Defined PU Log. inverse A Log. Inverse B	Disabled	(sensitive) Ground fault
133	INTERM.EF	Disabled with Ignd with 3I0 with Ignd,sens.	Disabled	Intermittent earth fault protection
140	46	Disabled TOC ANSI TOC IEC Definite Time	Disabled	46 Negative Sequence Protection
141	48	Disabled Enabled	Disabled	48 Startup Supervision of Motors
142	49	Disabled No ambient temp With amb. temp.	Disabled	49 Thermal Overload Protection
143	66 #of Starts	Disabled Enabled	Disabled	66 Startup Counter for Motors
150	27/59	Disabled Enabled	Disabled	27, 59 Under/Overvoltage Protection
154	81 O/U	Disabled Enabled	Disabled	81 Over/Underfrequency Protection
161	25 Function 1	Disabled ASYN/SYNCHRON SYNCHROCHECK	Disabled	25 Function group 1
162	25 Function 2	Disabled ASYN/SYNCHRON SYNCHROCHECK	Disabled	25 Function group 2
163	25 Function 3	Disabled ASYN/SYNCHRON SYNCHROCHECK	Disabled	25 Function group 3
164	25 Function 4	Disabled ASYN/SYNCHRON SYNCHROCHECK	Disabled	25 Function group 4

Addr.	Parameter	Setting Options	Default Setting	Comments
170	50BF	Disabled Enabled	Disabled	50BF Breaker Failure Protection
171	79 Auto Recl.	Disabled Enabled	Disabled	79 Auto-Reclose Function
172	52 B.WEAR MONIT	Disabled Ix-Method 2P-Method I2t-Method	Disabled	52 Breaker Wear Monitoring
180	Fault Locator	Disabled Enabled	Disabled	Fault Locator
182	74 Trip Ct Supv	Disabled 2 Binary Inputs 1 Binary Input	Disabled	74TC Trip Circuit Supervision
190	RTD-BOX INPUT	Disabled Port C	Disabled	External Temperature Input
191	RTD CONNECTION	6 RTD simplex 6 RTD HDX 12 RTD HDX	6 RTD simplex	Ext. Temperature Input Connec-tion Type
-	FLEXIBLE FUNC. 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 a power system fault occurs.

2.1.2.1 Description

Command-dependent Annunciations "No Trip – No Flag"

The indication of messages masked to local LEDs, and the maintenance of spontaneous 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 7SJ62/63/64 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. When the relay drops off, stationary conditions (fault display Target on PU / Target on TRIP; Trip / No Trip) decide whether the new fault will be stored or reset.

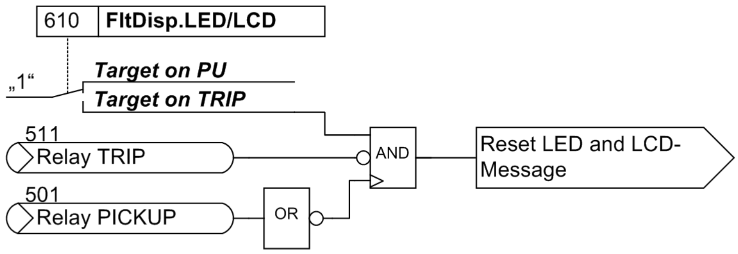


Figure 2-1 Creation of the reset command for the latched LED and LCD messages

Spontaneous Annunciations 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 Section „Fault Events“ in Chapter „Additional Functions“).

2.1.2.2 Setting Notes

Fault Messages

Pickup of a new protective function generally resets any previously set LED indications, so that only the latest fault is displayed at any time. It can be selected whether the stored LED displays and the spontaneous messages on the display appear upon renewed pickup, or only after a renewed trip signal is issued. In order to select the desired mode of display, select the submenu Device in the SETTINGS menu. The two alternatives 610 or **FltDisp.LED/LCD** („No trip – no flag“) are selected at address ***Target on PU Target on TRIP***.

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

Selection of Default Display

Devices featuring 4-line display provide a number of predefined display pages. The start page of the default display, which will open after device startup, can be selected via parameter 640 **Start image DD** The available display pages are listed in the Appendix A.5.

2.1.2.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
610	FltDisp.LED/LCD	Target on PU Target on TRIP	Target on PU	Fault Display on LED / LCD
611	Spont. FltDisp.	YES NO	NO	Spontaneous display of flt.annun-ciations
640	Start image DD	image 1 image 2 image 3 image 4 image 5 image 6	image 1	Start image Default Display

2.1.2.4 Information List

No.	Information	Type of In-formation	Comments
-	>Light on	SP	>Back Light on
-	Reset LED	IntSP	Reset LED
-	DataStop	IntSP	Stop data transmission
-	Test mode	IntSP	Test mode
-	Feeder gnd	IntSP	Feeder GROUNDED
-	Brk OPENED	IntSP	Breaker OPENED
-	HWTestMod	IntSP	Hardware Test Mode
-	SynchClock	IntSP_Ev	Clock Synchronization
-	Error FMS1	OUT	Error FMS FO 1
-	Error FMS2	OUT	Error FMS FO 2
-	Distur.CFC	OUT	Disturbance CFC
1	Not configured	SP	No Function configured
2	Non Existent	SP	Function Not Available
3	>Time Synch	SP_Ev	>Synchronize Internal Real Time Clock
5	>Reset LED	SP	>Reset LED
15	>Test mode	SP	>Test mode
16	>DataStop	SP	>Stop data transmission
51	Device OK	OUT	Device is Operational and Protecting
52	ProtActive	IntSP	At Least 1 Protection Funct. is Active
55	Reset Device	OUT	Reset Device
56	Initial Start	OUT	Initial Start of Device
67	Resume	OUT	Resume
68	Clock SyncError	OUT	Clock Synchronization Error
69	DayLightSavTime	OUT	Daylight Saving Time
70	Settings Calc.	OUT	Setting calculation is running
71	Settings Check	OUT	Settings Check
72	Level-2 change	OUT	Level-2 change
73	Local change	OUT	Local setting change
110	Event Lost	OUT_Ev	Event lost
113	Flag Lost	OUT	Flag Lost

No.	Information	Type of In-formation	Comments
125	Chatter ON	OUT	Chatter ON
140	Error Sum Alarm	OUT	Error with a summary alarm
144	Error 5V	OUT	Error 5V
145	Error 0V	OUT	Error 0V
146	Error -5V	OUT	Error -5V
147	Error PwrSupply	OUT	Error Power Supply
160	Alarm Sum Event	OUT	Alarm Summary Event
177	Fail Battery	OUT	Failure: Battery empty
178	I/O-Board error	OUT	I/O-Board Error
183	Error Board 1	OUT	Error Board 1
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
188	Error Board 6	OUT	Error Board 6
189	Error Board 7	OUT	Error Board 7
191	Error Offset	OUT	Error: Offset
192	Error1A/5Awrong	OUT	Error:1A/5Ajumper different from setting
193	Alarm NO calibr	OUT	Alarm: NO calibration data available
194	Error neutralCT	OUT	Error: Neutral CT different from MLFB
220	CT Ph wrong	OUT	Error: Range CT Ph wrong
301	Pow.Sys.Flt.	OUT	Power System fault
302	Fault Event	OUT	Fault Event
303	sens Gnd flt	OUT	sensitive Ground fault
320	Warn Mem. Data	OUT	Warn: Limit of Memory Data exceeded
321	Warn Mem. Para.	OUT	Warn: Limit of Memory Parameter exceeded
322	Warn Mem. Oper.	OUT	Warn: Limit of Memory Operation exceeded
323	Warn Mem. New	OUT	Warn: Limit of Memory New exceeded
502	Relay Drop Out	SP	Relay Drop Out
510	Relay CLOSE	SP	General CLOSE of relay

2.1.3 Power System Data 1

2.1.3.1 Description

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

2.1.3.2 Setting Notes

General

This data can be entered directly on the device featuring an integrated or detached operator panel for parameters 209 **PHASE SEQ.**, 210 **TMin TRIP CMD**, 211 **TMax CLOSE CMD** and 212 **BkrClosed I MIN**. Select the MAIN MENU by pressing the MENU key. Press the ▼ key to select **SETTINGS** and the ▶ key to navigate to the settings selection. To obtain the Power System Data display, select the **P.System Data 1** in the **SETTINGS** menu.

In DIGSI double-click on **Settings** to display the relevant selection. A dialog box will open under the option **P.System Data 1** with the tabs Power system, CTs, VTs and Breaker where you can configure the individual parameters. Thus the following Subsections are structured accordingly.

Nominal Frequency

The rated system frequency is set at address 214 **Rated Frequency**. The factory presetting in accordance with the model number must only be changed if the device will be employed for a purpose other than that which was planned when ordering.

Phase Rotation Reversal

Address 209 **PHASE SEQ.** is used to change the default phase sequence (***A B C*** for clockwise rotation), if your power system permanently has an anti-clockwise phase sequence (***A C B***). A temporary reversal of rotation is also possible using binary inputs (see Section 2.21.2).

Temperature Unit

Address 276 **TEMP. UNIT** allows you to display the temperature values either in degree Celsius or in degree Fahrenheit.

Polarity of Current Transformers

At address 201 **CT Starpoint**, the polarity of the wye-connected current transformers is specified (the following figure applies correspondingly for two current transformers). This setting determines the measuring direction of the device (forwards = line direction). Modifying this setting also results in a polarity reversal of the ground current inputs I_N or I_{NS}.

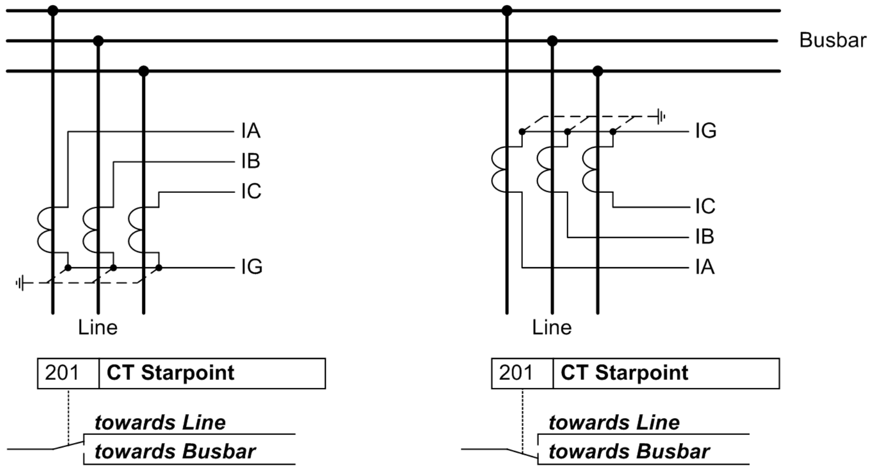


Figure 2-2 Polarity of current transformers

Voltage Connection

Address 213 specifies how the voltage transformers are connected. **VT Connect. 3ph** = ***Van, Vbn, Vcn*** means that three phase voltages in wye-connection are connected, **VT Connect. 3ph** = ***Vab, Vbc, VGnd*** signifies that two phase-to-phase voltages (V-connection) and V_N are connected. The latter setting is also selected when only two phase-to-phase voltage transformers are utilized or when only the displaced voltage (zero sequence voltage) is connected to the device.

Device 7SJ64 contains 4 voltage measuring inputs which enable further options besides the above-mentioned connection types: **VT Connect. 3ph** = ***Van,Vbn,Vcn,VGn*** is selected if the three phase voltages in wye-connection and V_N are connected to the fourth voltage input of the device. Select **VT Connect. 3ph** = ***Van,Vbn,Vcn,VSy*** in case the fourth voltage input is used for the synchronizing function even if two phase-to-phase voltages (V-connection) are available on the primary side (since the voltages are connected to the device such that the device measures phase-ground voltages under symmetrical conditions).

Note

If the synchronization function is used for the connection to two-phase-to-phase voltages in V-connection (see above), the device cannot determine a zero sequence voltage. The function „Directional Time Overcurrent Ground Protection“, „Directional Ground Fault Detection“ and „Fuse-Failure-Monitor (FFM)“ must be disabled.

Parameter 240 **VT Connect. 1ph** is set to specify that only **one** voltage transformer is connected to the devices. In this case the user defines which primary voltage is connected to which analog input. If one of the available voltages is selected, i.e. a setting unequal ***NO***, setting of address 213 is no more relevant. Only address 240 is to be set. If parameter 240 **VT Connect. 1ph** is set to ***NO*** on the other hand, parameter 213 will apply.

With 7SJ64 and single-phase voltage transformer connection the voltage connected to voltage input V_4 is always interpreted as the voltage which is to be synchronized.

Distance Unit

Address 215 **Distance Unit** corresponds to the unit of length (***km*** or ***Miles***) applicable to fault locating. If a fault locator is not included with the device, or if the fault locating function is disabled, this setting has no effect on operation of the device. Changing the length unit will not result in an automatic conversion between the systems. Such conversions must be entered at the appropriate addresses.

ATEX100

Address 235 **ATEX100** allows that the requirements for the protection of explosion-protected motors with regard to thermal profiles is fulfilled. Set this parameter to ***YES*** to save all thermal replicas of devices 7SJ62/63/64 in the event of a power supply failure. After the supply voltage is restored the thermal profiles will resume operation using the stored values. Set the parameter to ***NO*** to reset the calculated overtemperatures of all thermal profiles to zero if the power supply fails.

Two-phase Time Overcurrent Protection (Power System Data)

Two-phase time overcurrent protection is used in isolated or resonant-grounded systems where three-phase devices are desired to coact with existing two-phase protection equipment. Parameter 250 **50/51 2-ph prot** can be set to specify whether the overcurrent protection operates in two or three phases. If set to ***ON***, threshold comparison uses always the value 0A instead of the measured value for I_B, so that phase B can not initiate a pick-up. All other functions operate however in three phases.

Ground Fault Protection

With address 613 **Gnd O/Cprot. w.** define whether ground fault protection either is to operate using measured values (***Ignd (measured)***) or the quantities calculated from the three phase currents (***3I0 (calcul.)***). In the first case, the measured quantity at the fourth current input is evaluated. In the latter case, the summation current is calculated from the three phase current inputs. If the device features a sensitive ground current input (measuring range starts at 1 mA), the ground fault protection always uses the calculated quantity 3I0. In this case, parameter 613 **Gnd O/Cprot. w.** is not available.

Voltage Protection (Switchover of Characteristic Values)

With three-phase connection, the fundamental harmonic component of the largest of the three phase-to-phase voltages (***Vphph***) is supplied to the overvoltage protection elements, or the negative sequence voltage (***V2***). With three-phase connection, undervoltage protection relies either on the positive sequence voltage ***V1*** or the smallest of the phase-to-phase voltages ***Vphph***. These specifications can be configured via parameter 614 **OP. QUANTITY 59** and 615 **OP. QUANTITY 27**. If voltage transformers are connected single-phase, there is a direct comparison of measured values and thresholds, and the setting of characteristic values switchover is ignored.

Nominal Values of Current Transformers (CTs)

At addresses 204 **CT PRIMARY** and 205 **CT SECONDARY**, information is entered regarding the primary and secondary ampere ratings of the current transformers. It is important to ensure that the rated secondary current of the current transformers matches the rated current of the device, otherwise the device will incorrectly calculate primary data. At addresses 217 **Ignd-CT PRIM** and 218 **Ignd-CT SEC**, information is entered regarding the primary and secondary ampere rating of the current transformers. In case of normal connection (starpoint current connected to I_N–transformer) 217 **Ignd-CT PRIM** and 204 **CT PRIMARY** must be set to the same value.

If the device features a sensitive ground current input, address 218 **Ignd-CT SEC** is set to 1 A. In this case setting cannot be changed.

Nominal Values of Voltage Transformers (VTs)

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

Transformation Ratio of Voltage Transformers (VTs)

In address 206 **Vph / Vdelta** the adjustment factor between phase voltage and displacement voltage is communicated to the device. This information is relevant for the detection of ground faults (in grounded systems and non-grounded systems), operational measured value V_N and measured-quantity monitoring.

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

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

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

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

Trip and Close Command Duration (CB)

Address 210 **TMin TRIP CMD** is used to set the minimum time the tripping contacts will remain closed. This setting applies to all protective functions that initiate tripping.

Address 211 **TMax CLOSE CMD** is used to set the maximum time the closing contacts will remain closed. This setting applies to the integrated reclosing function This setting must be long enough to allow the circuit breaker contacts to reliably engage. An excessive duration causes no problem since the closing command is interrupted in the event another trip is initiated by a protective function.

Current Flow Monitoring (CB)

Address 212 **BkrClosed I MIN** corresponds to the threshold value of the integrated current flow monitoring system. This parameter is used by several protection functions (e.g. voltage protection with current criterion, breaker failure protection, overload protection, restart inhibit for motors and CB maintenance). If the configured current value exceeds the setting, the circuit-breaker is considered closed.

The threshold value setting applies to all three phases, and must take into consideration all used protective functions.

With regard to breaker failure protection, the threshold value must be set at a level below the minimum fault current for which breaker failure protection must operate. A setting of 10% below the minimum fault current for which breaker failure protection must operate is recommended. The pickup value should not be set too low, otherwise, the danger exists that transients in the current transformer secondary circuit could lead to extended drop out times if extremely high currents are switched off.

When using the device for motor protection, overload protection and restart inhibit, the protective relay can distinguish between a running motor and a stopped motor, as well as take into account the different motor cool-down behaviour. For this application, the set value must be lower than the minimum no-load current of the motor.

Circuit Breaker Maintenance (CBM)

Parameters 260 to 267 are assigned to CB maintenance. The parameters and the different procedures are explained in the setting notes of this function (see Section 2.23.3).

2.1.3.3 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
201	CT Starpoint		towards Line towards Busbar	towards Line	CT Starpoint
202	Vnom PRIMARY		0.10 .. 800.00 kV	12.00 kV	Rated Primary Voltage
203	Vnom SECONDARY		100 .. 225 V	100 V	Rated Secondary Voltage (L-L)
204	CT PRIMARY		10 .. 50000 A	100 A	CT Rated Primary Current
205	CT SECONDARY		1A 5A	1A	CT Rated Secondary Current
206A	Vph / Vdelta		1.00 .. 3.00	1.73	Matching ratio Phase-VT To Open-Delta-VT
209	PHASE SEQ.		A B C A C B	A B C	Phase Sequence
210A	TMin TRIP CMD		0.01 .. 32.00 sec	0.15 sec	Minimum TRIP Command Duration
211A	TMax CLOSE CMD		0.01 .. 32.00 sec	1.00 sec	Maximum Close Command Duration
212	BkrClosed I MIN	1A	0.04 .. 1.00 A	0.04 A	Closed Breaker Min. Current Threshold
		5A	0.20 .. 5.00 A	0.20 A	
213	VT Connect. 3ph		Van, Vbn, Vcn Vab, Vbc, VGnd Van,Vbn,Vcn,VGn Van,Vbn,Vcn,VSy	Van, Vbn, Vcn	VT Connection, three-phase
214	Rated Frequency		50 Hz 60 Hz	50 Hz	Rated Frequency
215	Distance Unit		km Miles	km	Distance measurement unit
217	Ignd-CT PRIM		1 .. 50000 A	60 A	Ignd-CT rated primary current
218	Ignd-CT SEC		1A 5A	1A	Ignd-CT rated secondary current
235A	ATEX100		NO YES	NO	Storage of th. Replicas w/o Power Supply
240	VT Connect. 1ph		NO Van Vbn Vcn Vab Vbc Vca	NO	VT Connection, single-phase
250A	50/51 2-ph prot		ON OFF	OFF	50, 51 Time Overcurrent with 2ph. prot.

Addr.	Parameter	C	Setting Options	Default Setting	Comments
260	Ir-52		10 .. 50000 A	125 A	Rated Normal Current (52 Breaker)
261	OP.CYCLES AT Ir		100 .. 1000000	10000	Switching Cycles at Rated Normal Current
262	Isc-52		10 .. 100000 A	25000 A	Rated Short-Circuit Breaking Current
263	OP.CYCLES Isc		1 .. 1000	50	Switch. Cycles at Rated Short-Cir. Curr.
264	Ix EXPONENT		1.0 .. 3.0	2.0	Exponent for the Ix-Method
265	Cmd.via control		(Setting options depend on configuration)	None	52 B.Wear: Open Cmd. via Control Device
266	T 52 BREAKTIME		1 .. 600 ms	80 ms	Breaktime (52 Breaker)
267	T 52 OPENING		1 .. 500 ms	65 ms	Opening Time (52 Breaker)
276	TEMP. UNIT		Celsius Fahrenheit	Celsius	Unit of temperature measurement
613A	Gnd O/Cprot. w.		Ignd (measured) 3I0 (calcul.)	Ignd (measured)	Ground Overcurrent protection with
614A	OP. QUANTITY 59		Vphph V2	Vphph	Opera. Quantity for 59 Overvolt. Prot.
615A	OP. QUANTITY 27		V1 Vphph	V1	Opera. Quantity for 27 Undervolt. Prot.

2.1.3.4 Information List

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

2.1.4 Oscillographic Fault Records

The Multi-Functional Protection with Control 7SJ62/63/64 is equipped with a fault record memory. The instantaneous values of the measured quantities

i_A, i_B, i_C, i_N or i_{NS} and v_A, v_B, v_C, v_N or $3 \cdot v_0$ and v_{SYN} (only 7SJ64)

(voltages in accordance with connection) are sampled at intervals of 1.25 ms (for 50Hz) and stored in a circulating buffer (16 samples per cycle). For a fault, the data are stored for an adjustable period of time, but not more than 5 seconds (up to 20 seconds for 7SJ64). Up to 8 fault records can be recorded in this buffer. The fault record memory is automatically updated with every new fault, so no acknowledgment for previously recorded faults is required. The fault record buffer can also be started with protection pickup, via binary input and serial port.

2.1.4.1 Description

The data can be retrieved via the serial interfaces by means of a personal computer and evaluated with the protection data processing program DIGSI and the graphic analysis software SIGRA 4. The latter graphically represents the data recorded during the system fault and also calculates additional information from the measured values. Currents and voltages can be presented as desired as primary or secondary values. Signals are additionally recorded as binary tracks (marks) e.g. "pickup", "trip".

If the device has a serial system interface, the fault recording data can be passed on to a central device via this interface. The evaluation of the data is done by applicable programs in the central device. Currents and voltages are referred to their maximum values, scaled to their rated values and prepared for graphic representation. Binary signal traces (marks) of particular events e.g. ”fault detection", ”tripping" are also represented.

In the event of transfer to a central device, the request for data transfer can be executed automatically and can be selected to take place after each fault detection by the protection, or only after a trip.

2.1.4.2 Setting Notes

Configuration

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

A fault event starts with the pickup by any protective function and ends when the last pickup of a protective function has dropped out. Usually this is also the extent of a fault recording (address 402 **WAVEFORM DATA** = ***Fault event***). If automatic reclosures are performed, the entire network fault — or with more automatic reclosures — can be recorded up to a final clearing (address 402 **WAVEFORM DATA** = ***Pow.Sys.Flt.***). This facilitates the representation of the entire system fault history, but also consumes storage capacity during the auto-reclosure dead time(s).

The actual storage time encompasses the pre-fault time **PRE. TRIG. TIME** (address 404) ahead of the reference instant, the normal recording time and the post-fault time **POST REC. TIME** (address 405) after the storage criterion has reset. The maximum length of a fault record **MAX. LENGTH** is entered in Address 403. The saving of each fault record must not exceed five seconds. A total of 8 records can be saved. However, the total length of time of all fault records in the buffer may not exceed 5 seconds.

An oscillographic record can be triggered by a change in status of a binary input, or through the operating interface via PC. Storage is then triggered dynamically. The length of the fault recording is set in address 406 **BinIn CAPT.TIME** (maximum length however is **MAX. LENGTH**, address 403). Pre-fault and post-fault times will be included. If the binary input time is set for ∞, then the length of the record equals the time that the binary input is activated (static), or the **MAX. LENGTH** setting in address 403, whichever is shorter.

2.1.4.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
401	WAVEFORMTRIGGER	Save w. Pickup Save w. TRIP Start w. TRIP	Save w. Pickup	Waveform Capture
402	WAVEFORM DATA	Fault event Pow.Sys.Flt.	Fault event	Scope of Waveform Data
403	MAX. LENGTH	0.30 .. 5.00 sec	2.00 sec	Max. length of a Waveform Capture Record
404	PRE. TRIG. TIME	0.05 .. 0.50 sec	0.25 sec	Captured Waveform Prior to Trigger
405	POST REC. TIME	0.05 .. 0.50 sec	0.10 sec	Captured Waveform after Event
406	BinIn CAPT.TIME	0.10 .. 5.00 sec; ∞	0.50 sec	Capture Time via Binary Input

2.1.4.4 Information List

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

2.1.5 Settings Groups

Four independent setting groups can be created for establishing the device's function settings.

Applications

- Setting groups enables the user to save the corresponding settings for each application so that they can be quickly called when required. All setting groups are stored in the relay. Only one setting group may be active at a given time.

2.1.5.1 Description

Changing Setting Groups

During operation the user can switch back and fourth between 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 7SJ62/63/64 devices, four independent setting groups (A to D) are available. Whereas setting values may vary, the selected functions of each setting group remain the same.

2.1.5.2 Setting Notes

General

If multiple setting groups are not required, group A is the default selection. Then, the rest of this section is not applicable.

If multiple setting groups are desired, address **Grp Chge OPTION** must be set to ***Enabled*** (address 103). For the setting of the function parameters, you configure each of the required setting groups A to D, one after the other. A maximum of 4 is possible. Please refer to the SIPROTEC® 4 System Description, to learn how to copy setting groups or reset them to their status at delivery and also what you have to do 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
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 In-formation	Comments
-	Group A	IntSP	Group A
-	Group B	IntSP	Group B
-	Group C	IntSP	Group C
-	Group D	IntSP	Group D
7	>Set Group Bit0	SP	>Setting Group Select Bit 0
8	>Set Group Bit1	SP	>Setting Group Select Bit 1

2.1.6 Power System Data 2

2.1.6.1 Description

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

Applications

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

For protection of motors the motor starting detection represents an important feature. Exceeding a configured current value serves as a criterion.

2.1.6.2 Setting Notes

Definition of Nominal Rated Values

At addresses 1101 **FullScaleVolt.** and 1102 **FullScaleCurr.**, the primary reference voltage (phase-to-phase) and reference current (phase) of the protected equipment is entered (e.g. motors). If these reference values match the primary VT and CT rating, they correspond to the settings in address 202and 204 (Subsection 2.1.3.2). They are generally used to show values referenced to full scale.

Ground Impedance Ratios (only for Fault Location)

The ground impedance ratio is only relevant for line fault location. At address 1103, resistance ratio **RG/RL Ratio** is entered, and at address 1104, the reactance ratio **XG/XL Ratio** is entered. They are calculated separately, and do not correspond to the real and imaginary components of $\underline{Z}_0/\underline{Z}_1$. Therefore, <u>no</u> complex calculations are necessary! The ratios are obtained from system data using the following formula:

$$\frac{R_G}{R_L} = \frac{1}{3} \cdot \left(\frac{R_0}{R_1} - 1\right) \qquad \frac{X_G}{X_L} = \frac{1}{3} \cdot \left(\frac{X_0}{X_1} - 1\right)$$

Where

R_0	– Zero sequence resistance of the line
X_0	– Zero sequence reactance of the line
R_1	– Positive sequence resistance of the line
X_1	– Positive sequence reactance of the line

These values may either apply to the entire line length or be based on a per unit of line length, as the quotients are independent of length.

Calculation Example:

20 kV overhead line 120 mm^2 with the following data:

R_1/s = 0.39 Ω/mile	Positive sequence resistance
X_1/s = 0.58 Ω/mile	Positive sequence reactance
R_0/s = 1.42 Ω/mile	Zero sequence resistance
X_0/s = 2.03 Ω/mile	Zero sequence reactance

For ground impedance ratios, the following result:

$$\frac{R_G}{R_L} = \frac{1}{3} \cdot \left(\frac{R_0}{R_1} - 1\right) = \frac{1}{3} \cdot \left(\frac{1.42\ \Omega/\text{mile}}{0.39\ \Omega/\text{mile}} - 1\right) = 0.89$$

$$\frac{X_G}{X_L} = \frac{1}{3} \cdot \left(\frac{X_0}{X_1} - 1\right) = \frac{1}{3} \cdot \left(\frac{2.03\ \Omega/\text{mile}}{0.55\ \Omega/\text{mile}} - 1\right) = 0.90$$

These values are set at addresses 1103 and 1104 respectively.

Reactance Setting (only for Fault Location)

The reactance setting must only be entered if using the line fault location function. The reactance setting enables the protective relay to indicate the fault location in terms of distance.

The reactance value X' is entered as a value **x'** at address 1105 in Ω per mile if set to distance unit ***Miles*** (address 215, see Section 2.1.3.2 "Distance Unit") , or at address 1106 in Ω per kilometer if set to distance unit ***km***. If the setting of address 215 is modified after entry of a reactance value at address 1105 or 1106, the reactance value must be modified and reentered accordingly.

When using the PC and DIGSI® for configuration, these values can also be entered as primary values. The following conversion to secondary values is then not relevant.

For calculation of primary values in terms of secondary values the following applies in general:

$$Z_{\text{secondary}} = \frac{\text{Current-Transformer-Ratio}}{\text{Voltage-Transformer - Ratio}} \cdot Z_{\text{primary}}$$

Likewise, the following goes for the reactance setting of a line:

$$X'_{\text{sec}} = \frac{N_{CTR}}{N_{VTR}} \cdot X'_{\text{prim}}$$

where:

N_{CTR} = Current transformer ratio
N_{VTR} = Voltage transformer ratio

with

N_{CTR}	— Current transformer ratio
N_{VTR}	— Voltage transformer ratio

Calculation Example:

In the following, the same line as used in the example for ground impedance ratios (above) and additional data on the voltage transformers will be used:

Current transformer 500 A / 5 A

Voltage transformer 20 kV / 0.1 kV

The secondary reactance value is calculated as follows:

$$X'_{sec} = \frac{N_{CTR}}{N_{VTR}} \cdot X'_{prim} = \frac{500\ A/5\ A}{20\ kV/0.1\ kV} \cdot 0.55\ \Omega/\text{mile} = 0.275\ \Omega/\text{mile}$$

Recognition of Running Condition (only for motors)

When the configured current value at Address 1107 **I MOTOR START** is exceeded, this will be interpreted as motor starting. This parameter is used by the start-up time monitoring and overload protection functions.

For this setting the following should be considered:

- A setting must be selected that is lower than the actual motor start-up current under all load and voltage conditions.
- During motor start-up the thermal profile of the overload protection is "frozen" i.e., kept at constant level. This threshold should not be set unnecessarily low since it limits the operating range of the overload protection for high currents during operation.

Inversion of Measured Power Values / Metered Values

The directional values (power, power factor, work and related min., max. and mean values), calculated in the operational measured values, are usually defined with positive direction towards the protected object. This requires that the connection polarity for the entire device was configured accordingly in the **P.System Data 1** (compare also "Polarity of Current Transformers", address 201). It is also possible to apply different settings to the “forward“ direction for the protective functions and the positive direction for the power etc., e.g. to have the active power supply (from the line to the busbar) displayed positively. To do so, set address 1108 **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 protective functions. Chapter 4 provides a detailed list of the values in question.

2.1.6.3 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
1101	FullScaleVolt.		0.10 .. 800.00 kV	12.00 kV	Measurem:FullScaleVoltage(Equipm.rating)
1102	FullScaleCurr.		10 .. 50000 A	100 A	Measurem:FullScaleCurrent(Equipm.rating)
1103	RG/RL Ratio		-0.33 .. 7.00	1.00	RG/RL - Ratio of Gnd to Line Resistance
1104	XG/XL Ratio		-0.33 .. 7.00	1.00	XG/XL - Ratio of Gnd to Line Reactance
1105	x'	1A	0.0050 .. 15.0000 Ω/mi	0.2420 Ω/mi	x' - Line Reactance per length unit
		5A	0.0010 .. 3.0000 Ω/mi	0.0484 Ω/mi	
1106	x'	1A	0.0050 .. 9.5000 Ω/km	0.1500 Ω/km	x' - Line Reactance per length unit
		5A	0.0010 .. 1.9000 Ω/km	0.0300 Ω/km	
1107	I MOTOR START	1A	0.40 .. 10.00 A	2.50 A	Motor Start Current (Block 49, Start 48)
		5A	2.00 .. 50.00 A	12.50 A	
1108	P,Q sign		not reversed reversed	not reversed	P,Q operational measured values sign

2.1.6.4 Information List

No.	Information	Type of Information	Comments
126	ProtON/OFF	IntSP	Protection ON/OFF (via system port)
356	>Manual Close	SP	>Manual close signal
501	Relay PICKUP	OUT	Relay PICKUP
511	Relay TRIP	OUT	Relay GENERAL TRIP command
533	Ia =	VI	Primary fault current Ia
534	Ib =	VI	Primary fault current Ib
535	Ic =	VI	Primary fault current Ic
561	Man.Clos.Detect	OUT	Manual close signal detected
2720	>Enable ANSI#-2	SP	>Enable 50/67-(N)-2 (override 79 blk)
4601	>52-a	SP	>52-a contact (OPEN, if bkr is open)
4602	>52-b	SP	>52-b contact (OPEN, if bkr is closed)
16019	>52 Wear start	SP	>52 Breaker Wear Start Criteria
16020	52 WearSet.fail	OUT	52 Wear blocked by Time Setting Failure
16027	52WL.blk I PErr	OUT	52 Breaker Wear Logic blk Ir-CB>=Isc-CB
16028	52WL.blk n PErr	OUT	52 Breaker W.Log.blk SwCyc.Isc>=SwCyc.Ir

2.1.7 EN100-Module

2.1.7.1 Functional Description

The **EN100-Module** enables integration of the 7SJ62/63/64 in 100-MBit communication networks in control and automation systems with the protocols according to IEC 61850 standard. This standard permits continuous 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. Besides control system integration, this interface enables DIGSI-communication and inter-relay communication via GOOSE.

2.1.7.2 Setting Notes

Interface Selection

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

2.1.7.3 Information List

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

2.2 Overcurrent Protection 50, 51, 50N, 51N

General time overcurrent protection is the main protective function of the 7SJ62/63/64 relay. Each phase current and the ground current is provided with three elements. All elements are independent of each other and can be combined in any way.

If it is desired in isolated or resonant-grounded systems that three-phase devices should work together with two-phase protection equipment, the time-overcurrent protection can be configured such that it allows two-phase operation besides three-phase mode (see Section 2.1.3.2).

High-current element 50-2 and overcurrent element 50-1 always operate with definite tripping time, the third element 51, operates always with inverse tripping time.

Applications

- The non-directional time overcurrent protection is suited for networks that are radial and supplied from a single source or open looped networks or for backup protection of differential protective schemes of all types of lines, transformers, generators, motors, and busbars.

2.2.1 General

Depending on parameter 613 **Gnd O/Cprot. w.** the overcurrent protection for the ground current can either operate with measured values I_N or with the quantities 3I0 calculated from the three phase currents. Devices featuring a sensitive ground current input, however, generally use the calculated quantity 3I0.

All overcurrent element enabled in the device may be blocked via the automatic reclosure function (depending on the cycle) or via an external signal to the binary inputs of the device. Removal of blocking during pickup will restart time delays. The Manual Close signal is an exception. If a circuit breaker is manually closed onto a fault current, it can be re-opened immediately. For overcurrent or high-set element the delay may be bypassed via a Manual Close pulse, thus resulting in high speed tripping. This pulse is extended up to at least 300 ms.

The automatic reclosure function 79 may also initiate immediate tripping for the overcurrent and high-set elements depending on the cycle.

Pickup of the 50Ns elements can be stabilized by setting the dropout times. This protection comes into use in systems where intermittent faults occur. Combined with electromechanical relays, it allows different dropout responses to be adjusted and a time grading of digital and electromechanical relays to be implemented.

Pickup and delay settings may be quickly adapted to system requirements via dynamic setting swapping (see Section 2.4).

Tripping by the 50-1, 51 elements (in phases), 50N-1 and 51N elements (in ground path) may be blocked for inrush conditions by utilizing the inrush restraint feature.

The following table gives an overview of the interconnection to other functions of 7SJ62/63/64.

Table 2-1 Interconnection to other functions

Time Overcurrent Elements	Connection to Automatic Reclosing	Manual CLOSE	Dynamic Cold Load Pickup	Inrush Restraint
50-1	•	•	•	•
50-2	•	•	•	
51	•	•	•	•
50N-1	•	•	•	•
50N-2	•	•	•	
51N	•	•	•	•

2.2.2 Definite High-Current Elements 50-2, 50N-2

Phase and ground currents are compared separately with the pickup values of the high-set elements 50-2 and 50N-2. If the respective pickup value is exceeded this is signalled. After the user-defined time delays **50-2 DELAY** or **50N-2 DELAY** have elapsed, trip signals are issued. Signals are available for each element. The dropout value is roughly equal to 95% of the pickup value for currents greater than > 0.3 I_{Nom}.

Pickup can be stabilized by setting dropout times 1215 **50 T DROP-OUT** or 1315 **50N T DROP-OUT**. This time is started and maintains the pickup condition if the current falls below the threshold. The function thus does not drop out instantaneously. The trip delay time **50-2 DELAY** or **50N-2 DELAY** continues in the meantime. After the dropout delay time has elapsed, the pickup is reported OFF and the trip delay time is reset unless the threshold 50-2 PICKUP or 50N-2 PICKUP has been violated again. If the threshold is exceeded again while the dropout delay time is still running, it will be cancelled. The trip delay time **50-2 DELAY** or **50N-2 DELAY** continues in the meantime. If the threshold is still exceeded after the time has elapsed, a trip will be initiated immediately. If the threshold violation then no longer exists, there will be no response. If the threshold is violated again after the trip command delay time has elapsed and while the dropout delay time is still running, a trip will be initiated at once.

These elements can be blocked by the automatic reclosure feature (AR).

The following figures show the logic diagrams for the high-current elements 50-2 and 50N-2.

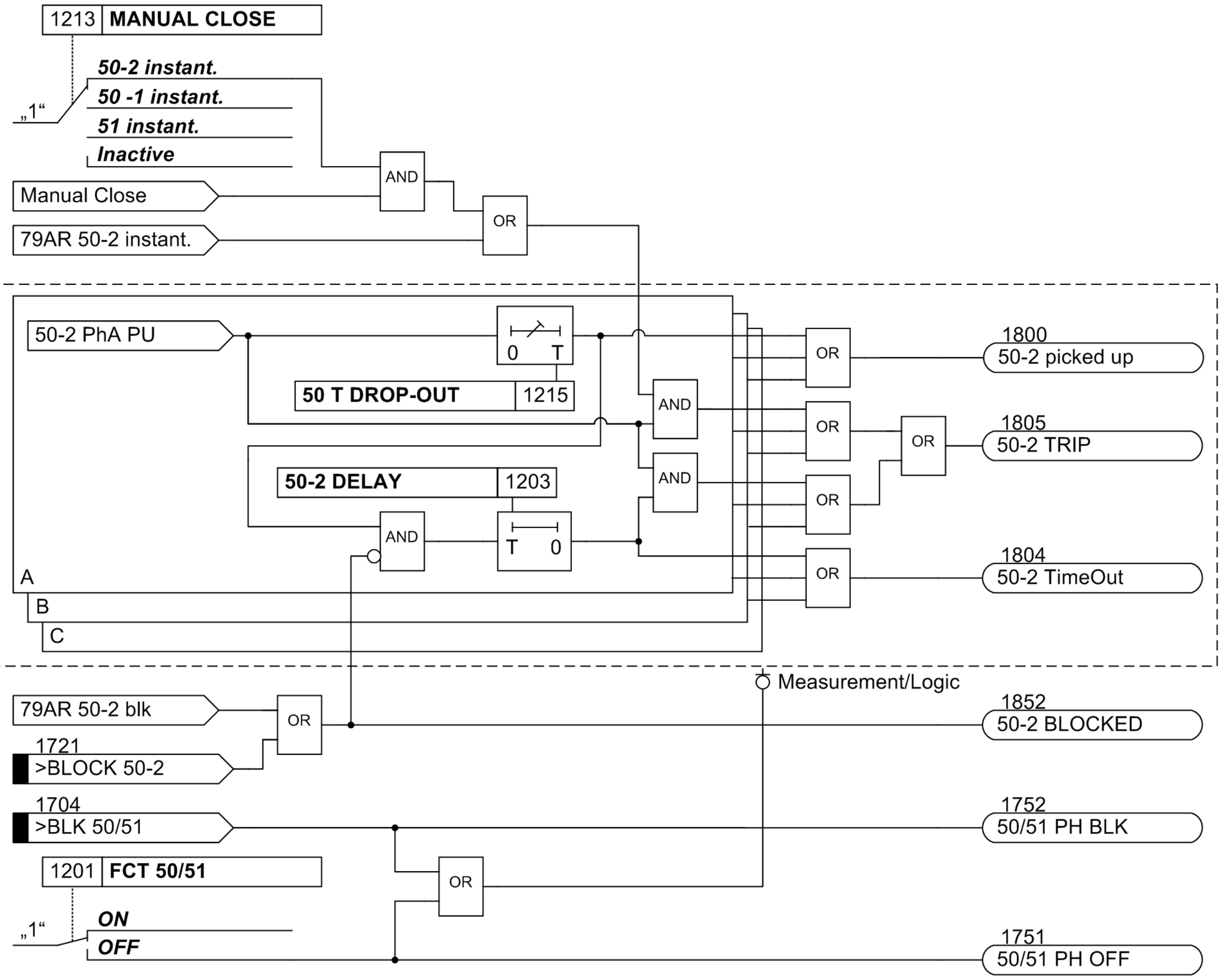


Figure 2-3 Logic diagram of the 50-2 high-current element for phases

If parameter **MANUAL CLOSE** is set to ***50-2 instant.*** and manual close detection applies, the trip is initiated as soon as the pickup conditions arrive, even if the element is blocked via binary input. The same applies to 79AR 50-2 instantaneous.

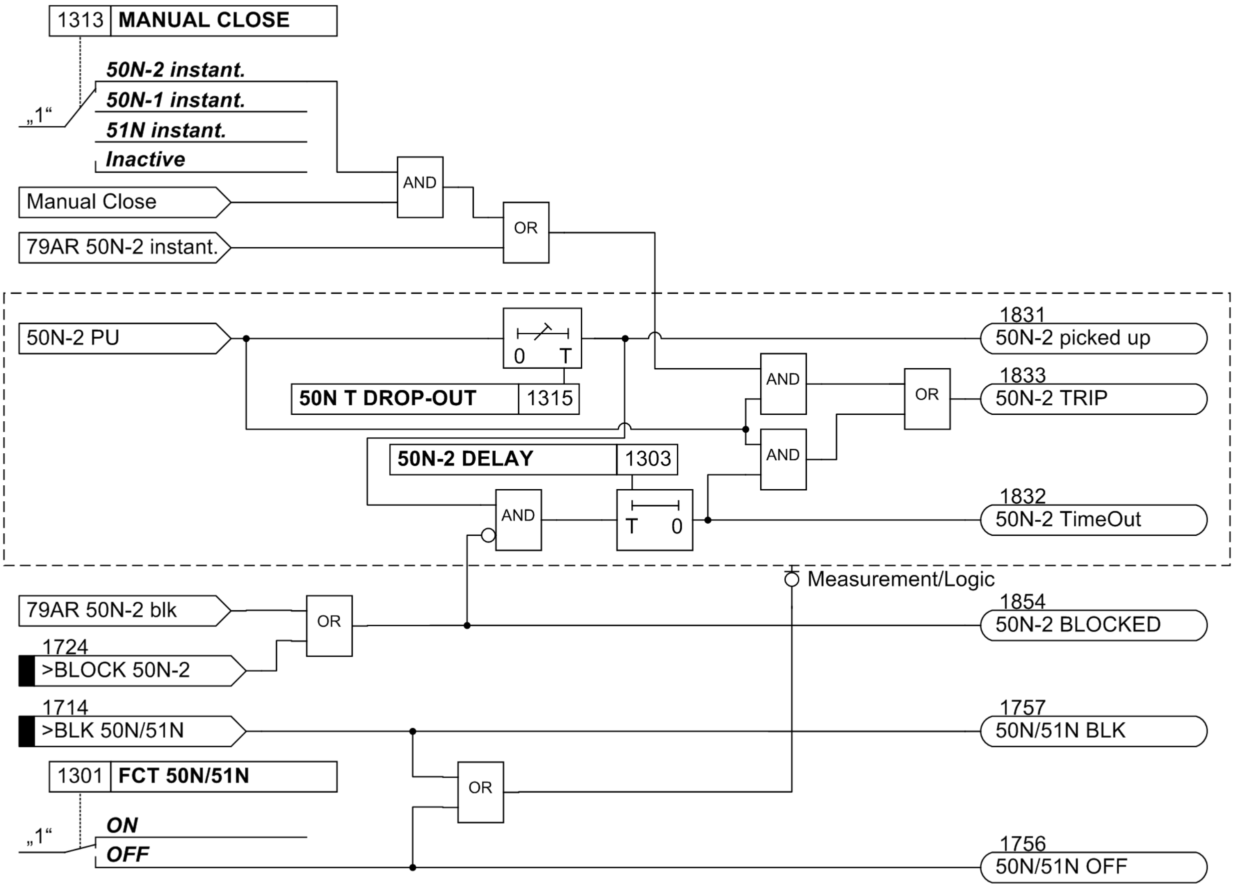


Figure 2-4 Logic diagram of the 50N-2 high-current element for ground

If parameter **MANUAL CLOSE** is set to ***50N-2 instant.*** and manual close detection applies, the trip is initiated as soon as the pickup conditions arrive, even if the element is blocked via binary input. The same applies to 79AR 50N-2 instantaneous.

2.2.3 Definite Overcurrent Elements 50-1, 50N-1

Each phase and ground current is compared separately with the setting values of the 50-1 and 50N-1 relay elements and is signalled separately when exceeded. If the inrush restraint feature (see below) is applied, either the normal pickup signals or the corresponding inrush signals are output as long as inrush current is detected. After user-configured time delays **50-1 DELAY** and **50N-1 DELAY** have elapsed, a trip signal is issued if no inrush current is detected or inrush restraint is disabled. If the inrush restraint feature is enabled, and an inrush condition exists, no tripping takes place, but a message is recorded and displayed indicating when the overcurrent element time delay elapses. Tripping signals and signals on the expiration of time delay are available separately for each element. The dropout value is roughly equal to 95% of the pickup value for currents greater than > 0.3 I_{Nom}.

Pickups can be stabilized by setting dropout times 1215 **50 T DROP-OUT** or 1315 **50N T DROP-OUT**. This time is started and maintains the pickup condition if the current falls below the threshold. The function thus does not drop out instantaneously. The trip delay time **50-1 DELAY** or **50N-1 DELAY** continues in the meantime. After the dropout delay time has elapsed, the pickup is reported OFF and the trip delay time is reset unless the threshold 50-1 PICKUP or 50N-1 PICKUP has been violated again. If the threshold is violated again while the dropout delay time is still running, it will be cancelled. The trip delay time **50-1 DELAY** or **50N-1 DELAY** continues in the meantime. If the threshold is still exceeded after the time has elapsed, a trip will be initiated immediately. If the threshold violation then no longer exists, there will be no response. If the threshold is violated again after the trip command delay time has elapsed and while the dropout delay time is still running, a trip will be initiated at once.

Pickup stabilization of the overcurrent elements 50-1 or 50N-1 by means of settable dropout time is deactivated if an inrush pickup is present since an inrush does not represent an intermittent fault.

These elements can be blocked by the automatic reclosure feature (AR).

The following figures show the logic diagrams for the current elements 50-1 and 50N-1.

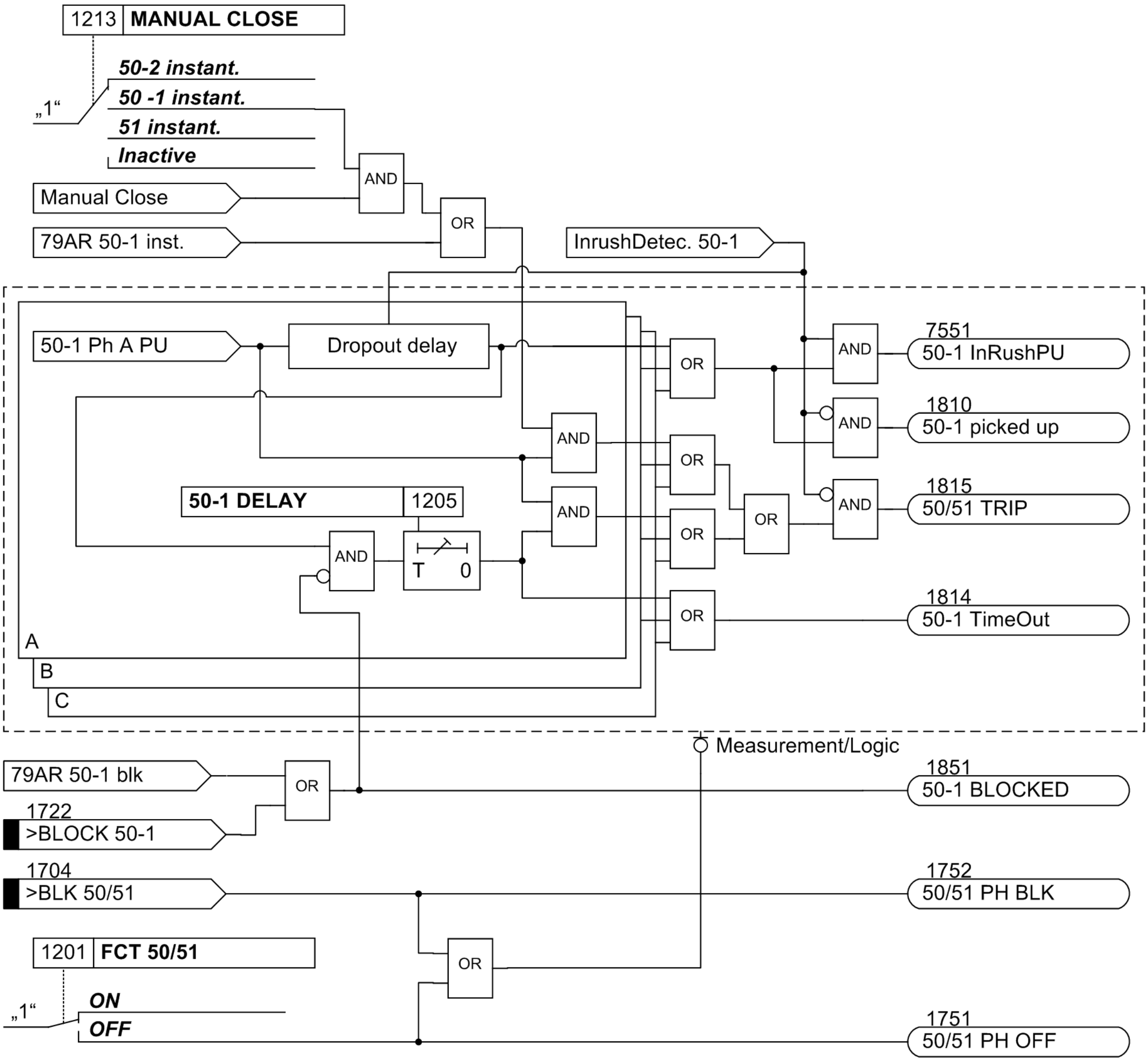


Figure 2-5 Logic diagram of the 50-1 current element for phases

The dropout delay only operates if no inrush was detected. An incoming inrush will reset a running dropout delay time.

If parameter **MANUAL CLOSE** is set to ***50 -1 instant.*** and manual close detection applies, the trip is initiated as soon as the pickup conditions arrive, even if the element is blocked via binary input. The same applies to 79AR 50-1 instantaneous.

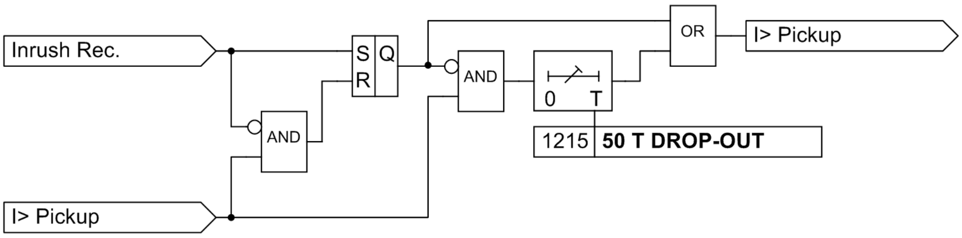


Figure 2-6 Logic of the dropout delay for 50-1 phase current element

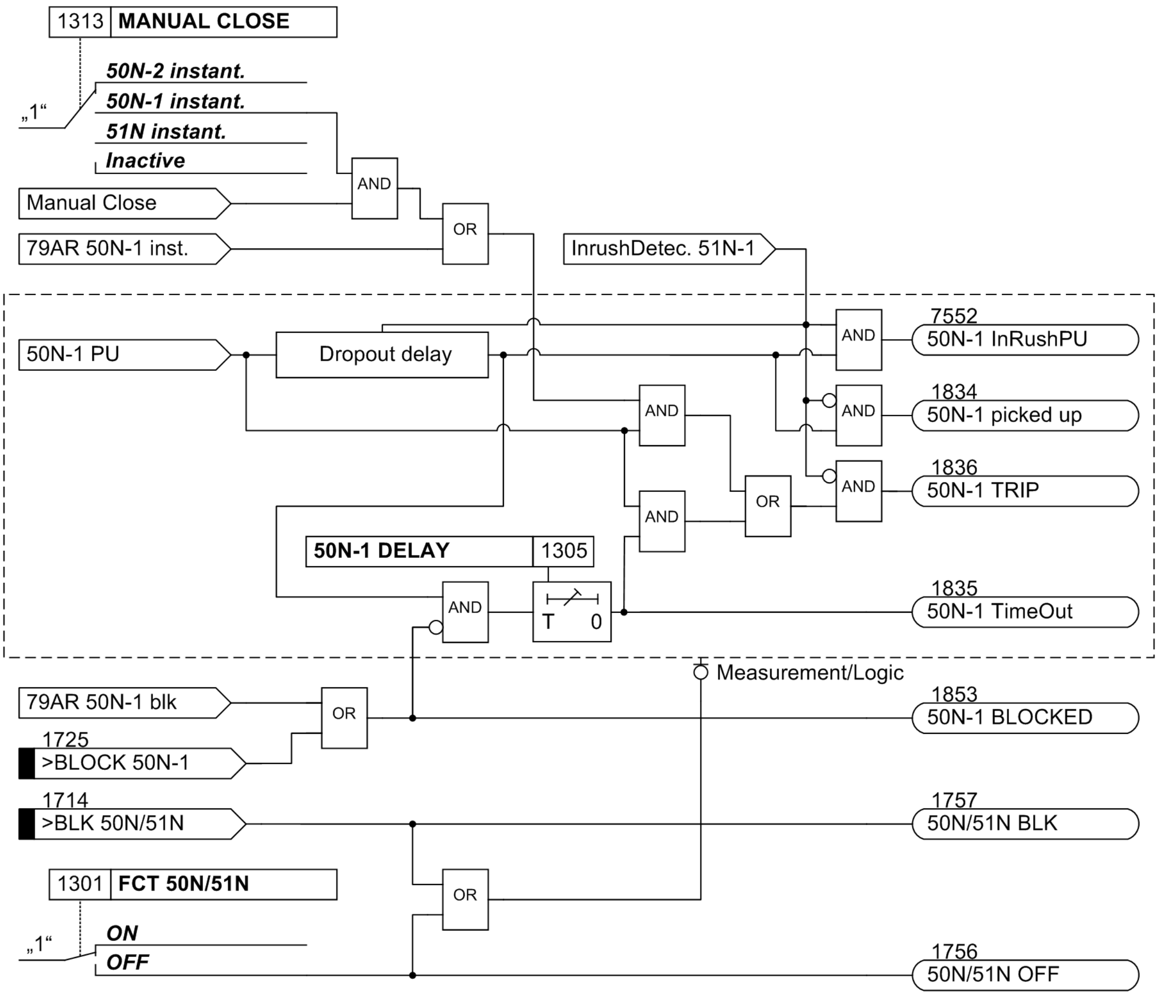


Figure 2-7 Logic diagram of the 50N-1 current element for ground

If parameter **MANUAL CLOSE** is set to ***50N-1 instant.*** and manual close detection applies, the trip is initiated as soon as the pickup conditions arrive, even if the element is blocked via binary input. The same applies to 79AR 50N-1 instantaneous.

The pickup values of each element 50-1, 50-2 for the phase currents and 50N-1, 50N-2 for the ground current and the valid delay times for each element can be set individually.

The dropout delay only operates if no inrush was detected. An arriving inrush will reset an already running dropout delay time.

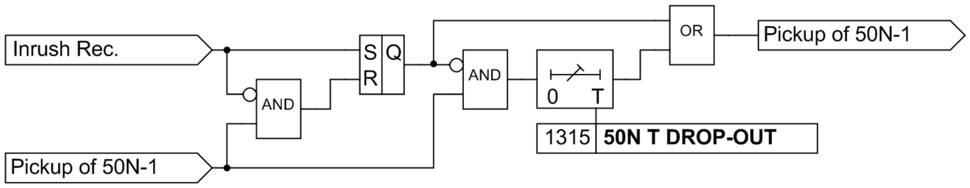


Figure 2-8 Logic of the dropout delay for 50N-1 ground current element

2.2.4 Inverse Time Overcurrent Elements 51, 51N

Inverse time elements are dependent on the variant ordered. They operate with an inverse time characteristic either according to the IEC- or the ANSI-standard or with a user-defined characteristic. The characteristics and associated formulas are given in the Technical Data. If inverse time characteristics have been configured, definite time elements 50-2 and 50-1 are also enabled (see Sections "Definite Time High-Set Elements 50-2, 50N-2" and "Definite Time Overcurrent Elements 50-1, 50N-1").

Pickup Behaviour

Each phase and ground current is separately compared with the pickup values of the inverse time overcurrent protection element 51 and 51N. If a current exceeds 1.1 times the setting value, the corresponding element picks up and is signalled individually. If the inrush restraint feature is applied, either the normal pickup signals or the corresponding inrush signals are output as long as inrush current is detected. Pickup of a relay element is based on the rms value of the fundamental harmonic. When the 51 element picks up, the time delay of the trip signal is calculated using an integrated measurement process. The calculated time delay is dependent on the actual fault current flowing and the selected tripping characteristics. Once the time delay elapses, a trip signal is issued assuming that no inrush current is detected or inrush restraint is disabled. If the inrush restraint feature is enabled and an inrush condition exists, no tripping takes place, but a message is recorded and displayed indicating when the overcurrent element time delay elapses.

These elements can be blocked by the automatic reclosure feature (79).

For ground current element 51N the characteristic may be selected independently of the characteristic used for phase currents.

Pickup values of elements 51 (phases) and 51N (ground current) and the associated time multipliers may be individually set.

The following two figures show the logic diagrams for the 51 and 51N protection.

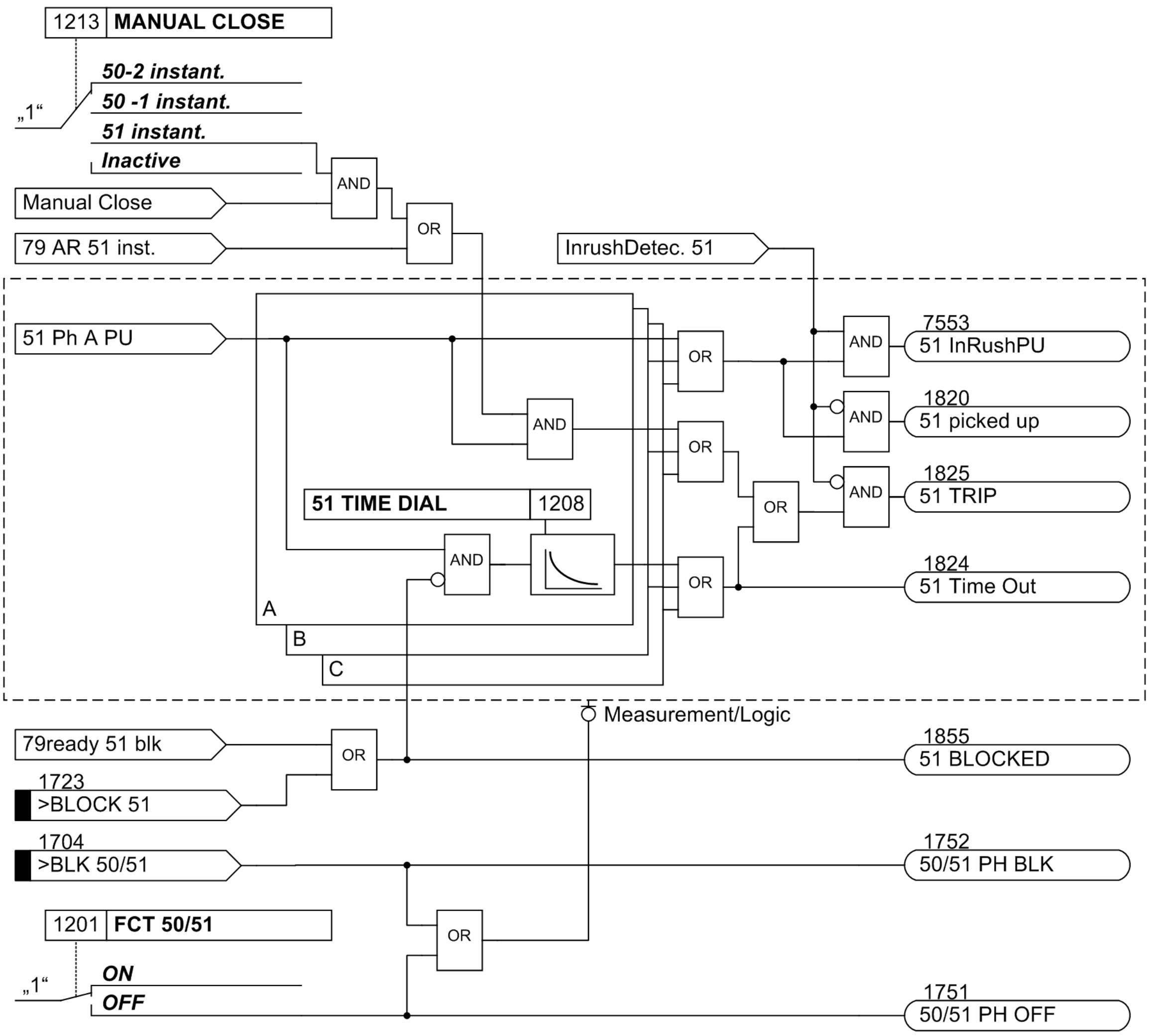


Figure 2-9 Logic diagram of the 51 current element for phases

If parameter **MANUAL CLOSE** is set to ***51 instant.*** and manual close detection applies, the trip is initiated as soon as the pickup conditions arrives, even if the element is blocked via binary input. The same applies to 79AR 51 instantaneous.

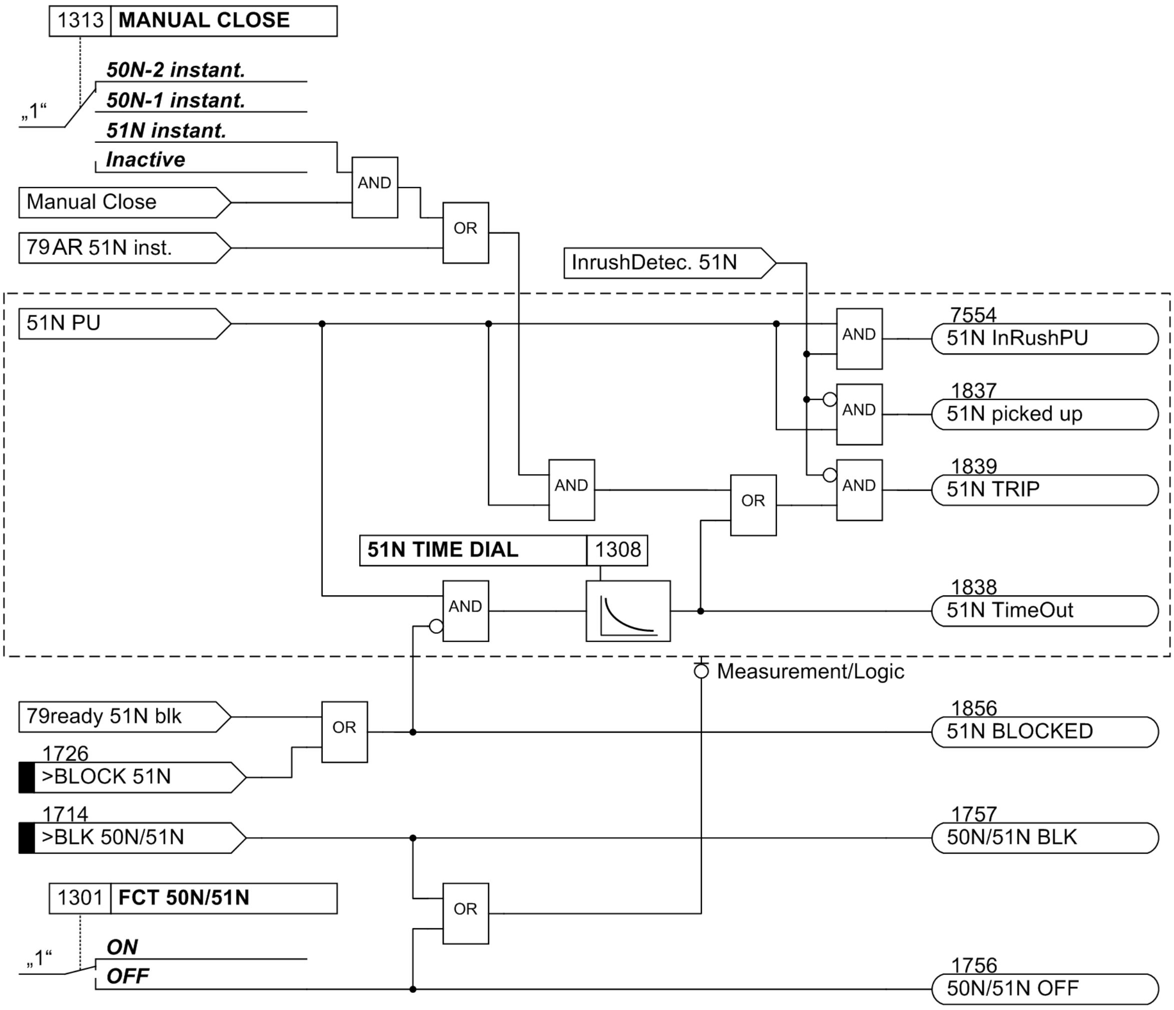


Figure 2-10 Logic diagram of the 51N current element for ground

If parameter **MANUAL CLOSE** is set to ***51N instant.*** and manual close detection applies, the trip is initiated as soon as the pickup conditions arrive, even if the element is blocked via binary input. The same applies to 79AR 51N instantaneous.

Dropout Behaviour

When using an ANSI or IEC curve select whether the dropout of an element is to occur instantaneously after the threshold has been undershot or whether dropout is to be performed by means of the disk emulation. "Instantaneously" means that pickup drops out when the pickup value of approx. 95 % is undershot. For a new pickup the time counter starts at zero.

The disk emulation evokes a dropout process (time counter is decrementing) which begins after de-energization. This process corresponds to the reset of a Ferraris-disk (explaining its denomination "disk emulation"). In case several faults occur in succession the "history" is taken into consideration due to the inertia of the Ferraris-disk and the time response is adapted. Reset begins as soon as 90% of the setting value is undershot, in accordance to the dropout curve of the selected characteristic. In the range between the dropout value (95% of the pickup value) and 90% of the setting value, the incrementing and the decrementing processes are in idle state.

Disk emulation offers advantages when the overcurrent relay elements must be coordinated with conventional electromechanical overcurrent relays located toward the source.

User Defined Curves

When user defined characteristics are utilized, the tripping curve may be defined point by point. Up to 20 pairs of values (current, time) may be entered. The device then approximates the characteristic, using linear interpolation.

The dropout curve may be user-defined as well. See dropout for ANSI and IEC curves in the function description. If no user-defined dropout curve is required, the element drops out as soon as the respective current falls below approx. 95% of the set pickup value. When a new pickup is evoked, the timer starts again at zero.

2.2.5 Dynamic Cold Load Pickup Function

It may be necessary to dynamically increase the pickup values if, during starting, certain elements of the system show an increased power consumption after a long period of zero voltage (e.g. air-conditioning systems, heating installations, motors). Thus, a general raise of pickup thresholds can be avoided taking such starting conditions into consideration.

This dynamic pickup value changeover is common to all overcurrent elements and is described in Section 2.4. The alternative pickup values can be set individually for each element of the time overcurrent protection.

2.2.6 Inrush Restraint

When the multi-functional protective relay with local control 7SJ62/63/64 is installed, for instance, to protect a power transformer, large magnetizing inrush currents will flow when the transformer is energized. These inrush currents may be several times the nominal transformer current, and, depending on the transformer size and design, may last from several milliseconds to several seconds.

Although pickup of the relay elements is based only on the fundamental harmonic component of the measured currents, false device pickup due to inrush is still a potential problem since, depending on the transformer size and design, the inrush current also comprises a large component of the fundamental.

The 7SJ62/63/64 features an integrated inrush restraint function. It prevents the "normal" pickup of the 50-1 or 51 elements (not 50-2) in the phases and the ground path of the non-directional and directional time-overcurrent protection. The same is true for the alternative pickup thresholds of the dynamic cold load pickup function. After detection of inrush currents above a pickup value special inrush signals are generated. These signals also initiate fault annunciations and start the associated trip delay time. If inrush conditions are still present after the tripping time delay has elapsed, a corresponding message („`....Timeout.`“) is output, but the overcurrent tripping is blocked (see also logic diagrams of time overcurrent elements, Figures 2-5 to 2-10).

Inrush current contains a relatively large second harmonic component (twice the nominal frequency) which is nearly absent during a fault current. The inrush restraint is based on the evaluation of the 2nd harmonic present in the inrush current. For frequency analysis, digital filters are used to conduct a Fourier analysis of all three phase currents and the ground current.

Inrush current is recognized, if the following conditions are fulfilled at the same time:

- the harmonic content is larger than the setting value 2202 **2nd HARMONIC**;
- the currents do not exceed an upper limit value 2205 **I Max**;
- an exceeding of a threshold value via an inrush restraint of the blocked element takes place.

In this case an inrush in the affected phase is recognized (annunciations 1840 to 1842 and 7558 „InRush Gnd Det“, see figure 2-11) and its blocking being carried out.

Since quantitative analysis of the harmonic components cannot be completed until a full AC cycle has been measured, pickup will generally be blocked by then. Therefore, assuming the inrush restraint feature is enabled, a pickup message will be delayed by a full AC cycle if no closing process is present. On the other hand, trip delay times of the time overcurrent protection feature are started immediately even with the inrush restraint being enabled. Time delays continue running with inrush currents present. If inrush blocking drops out after the time delay has elapsed, tripping will occur immediately. Therefore, utilization of the inrush restraint feature will not result in any additional tripping delays. If a relay element drops out during inrush blocking, the associated time delay will reset.

Cross Blocking

Since inrush restraint operates individually for each phase, protection is ideal when a transformer is energized onto a single-phase fault and inrush currents are detected on a different healthy phase. However, the protection feature can be configured to ensure that not only this phase element, but also the remaining elements (including ground) are blocked (the so-called **CROSS BLOCK** function, address 2203), if the permissible harmonic component of the current is exceeded for only one phase.

Please take into consideration that inrush currents flowing in the ground path will not cross-block tripping by the phase elements.

Cross blocking is reset if there is no more inrush in any phase. Furthermore, the cross blocking function may also be limited to a particular time interval (address 2204 **CROSS BLK TIMER**). After expiry of this time interval, the cross-blocking function will be disabled, even if inrush current is still present.

The inrush restraint has an upper limit: Above this (via adjustable parameter 2205 **I Max**) current blocking is suppressed since a high-current fault is assumed in this case.

The following figure shows the inrush restraint influence on the time overcurrent elements including cross-blocking.

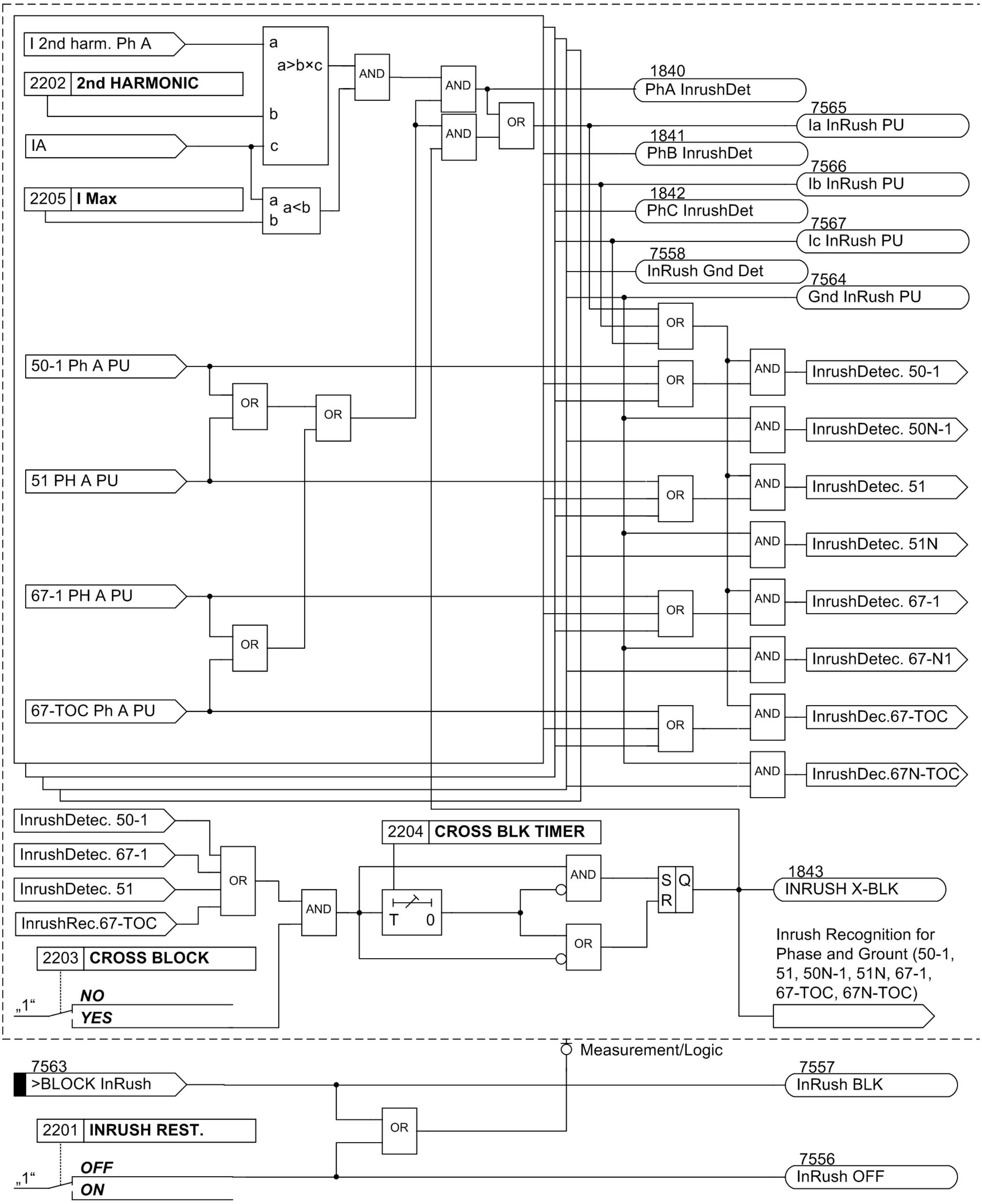


Figure 2-11 Logic diagram for inrush restraint

2.2.7 Pickup Logic and Tripping Logic

The pickup annunciations of the individual phases (or ground) and the individual elements are combined with each other such that the phase information and the element that have picked up are issued.

Table 2-2 Pickup annunciations of the time overcurrent protection

Internal Annunciation	Figure	Output Annunciation	FNo.
50-2 Ph A PU (Phase A, pickup) 50-1 Ph A PU 51 Ph A PU	2-3 2-5 2-9	„50/51 Ph A PU“	1762
50-2 Ph B PU 50-1 Ph B PU 51 Ph B PU	2-3 2-5 2-9	„50/51 Ph B PU“	1763
50-2 Ph C PU 50-1 Ph C PU 51 Ph C PU	2-3 2-5 2-9	„50/51 Ph C PU“	1764
50N-2 PU 50N-1 PU 51N PU	2-4 2-7 2-10	„50N/51NPickedup“	1765
50-2 Ph A PU 50-2 Ph B PU 50-2 Ph C PU 50N-2 PU	2-3 2-3 2-3 2-4	„50-2 picked up“	1800
50-1 Ph A PU 50-1 Ph B PU 50-1 Ph C PU 50N-1 PU	2-5 2-5 2-5 2-4	„50-1 picked up“	1810
51 Ph A PU 51 Ph B PU 51 Ph C PU 51N PU	2-9 2-9 2-9 2-10	„51 picked up“	1820
(All pickups)		„50(N)/51(N) PU“	1761

Also for the tripping signals the element is indicated which has initiated the tripping.

2.2.8 Two-Phase Time Overcurrent Protection (non-directional only)

Two-phase time overcurrent protection is used in isolated or resonant-grounded systems where interaction with existing two-phase protection equipment is required. Since an isolated or resonant-grounded system can still be operated with a ground fault in one phase, this protection function detects double ground faults with high ground fault currents. Only in the latter case, should a faulted feeder be shut down. Measuring in two phases is sufficient to this end. Only phases A and C are monitored in order to ensure selectivity of the protection in the network system.

If 250 **50/51 2-ph prot** (settable in **P.System Data 1**) is set to ***ON***, I_B is not used for threshold comparison. If the fault is a simple ground fault in B, the element will not pick up. Only after pickup on A or C a double ground fault is assumed, causing the element to pick up and trip after the delay time has elapsed.

Note

With inrush recognition activated and inrush only on B, no crossblocking will take place in the other phases. On the other hand, if inrush with crossblocking is activated on A or C, B will also be blocked.

2.2.9 Busbar Protection by Use of Reverse Interlocking

Application Example

Each of the overcurrent elements can be blocked via binary inputs of the relay. A setting parameter determines whether the binary input operates in the normally open (i.e. actuated when energized) or the normally closed (i.e. actuated when de-energized) mode. This allows fast busbar protection to be applied in star systems or open ring systems by utilizing "reverse interlocking". This principle is often used, for example, in distribution systems, auxiliary systems of power plants, and the like, where a station supply transformer supplied from the transmission grid serves internal loads of the generation station via a medium voltage bus with multiple feeders (Figure 2-12).

The reverse interlocking principle is based on the following: time overcurrent protection of the busbar feeder trips with a short time delay 50-2 DELAY independent of the grading times of the feeders, unless the pickup of the next load-side time overcurrent protection element blocks the bus protection (Figure 2-12). Always the protection element nearest to the fault will trip with the short time delay since this element cannot be blocked by a protection element located behind the fault. Time elements 50-1 DELAY or 51 TIME DIAL are still effective as backup element. Pickup signals output by the load-side protective relay are used as input message „>BLOCK 50-2“ via a binary input at the feeder-side protective relay.

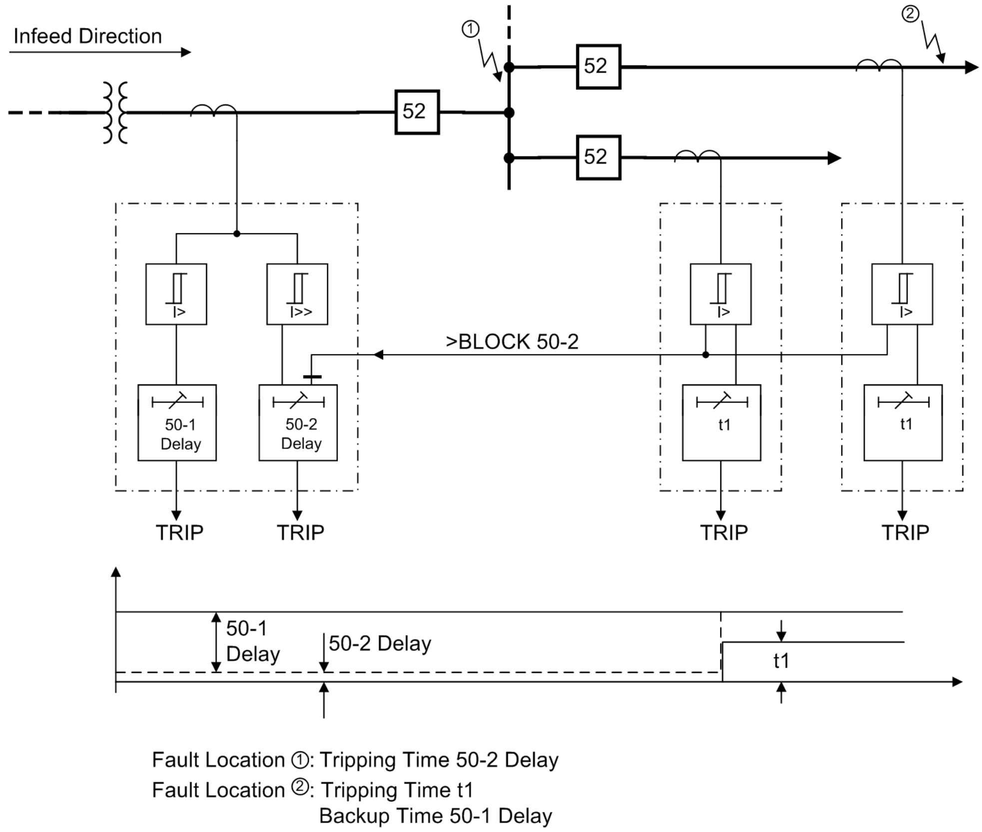


Figure 2-12 Reverse interlocking protection scheme

2.2.10 Setting Notes

General

When selecting the time overcurrent protection in DIGSI a dialog box appears with several tabs, such as General, 50, 51, 50N, 51N and InrushRestraint for setting individual parameters. Depending on the functional scope specified during configuration of the protective functions in addresses 112 **Charac. Phase** and 113 **Charac. Ground** the number of tabs can vary. If address **FCT 50/51** was set to ***Definite Time***, or **Charac. Ground** to = ***Definite Time***, then only the settings for the definite time elements are available. The selection of ***TOC IEC*** or ***TOC ANSI*** makes available additional inverse characteristics. The superimposed high-set elements 50-2 and 50N-2 are available in all these cases. Parameter 250 **50/51 2-ph prot** can also be set to activate two-phase overcurrent protection.

At address 1201 **FCT 50/51** the phase time-overcurrent protection and at address 1301 **FCT 50N/51N** the ground time-overcurrent protection may be switched ***ON*** or ***OFF***.

Pickup values, time delays, and characteristics for ground protection are set separately from the pickup values, time delays and characteristic curves associated with phase protection. Because of this, relay coordination for ground faults is independent of relay coordination for phase faults, and more sensitive settings can often be applied to directional ground protection.

50-2 Element

The pickup value of the relay element 50-2 is set at address 1202, the assigned time delay 50-2 DELAY at address 1203. This stage is often used for current grading in view of impedances such as transformers, motors or generators. It is specified such that it picks up for faults up to this impedance.

Example: Transformer used to distribution bus supply with the following data:

Rated Power of the Transformer	S_{NomT} = 16 MVA
Transformer Impedance	ZTX = 10 %
Primary Nominal Voltage	V_{Nom1} = 110 kV
Secondary Nominal Voltage	V_{Nom2} = 20 kV
Vector Groups	Dy 5
Starpoint	Grounded
Fault power on 110 kV–side	1 GVA

Based on the data above, the following fault currents are calculated:

3-Phase High Side Fault Current	at 110 kV = 5250 A
3-Phase Low Side Fault Current	at 20 kV = 3928 A
Current flowing on the High Side	at 110 kV = 714 A

The nominal current of the transformer is:

$I_{NomT, 110}$ = 84 A (High side)	$I_{NomT, 20}$ = 462 A (Low side)
Current Transformer (High Side)	100 A / 1 A
Current Transformer (Low Side)	500 A / 1 A

Due to the following definition

$$\text{50-2 Pickup} > \frac{1}{Z_{TX}} \times \frac{I_{Base-110kV}}{\text{CTR-HS}}$$

the following setting applies to the protection device: The 50-2 relay element must be set higher than the maximum fault current, which is detected during a low side fault on the high side. To reduce fault probability as much as possible even when fault power varies, the following setting is selected in primary values: $I>>/I_{Nom}$ = 10, i.e. $I>>$ = 1000 A.

Increased inrush currents, if the fundamental component exceeds the setting value, are rendered harmless by delay times (address 1203 **50-2 DELAY**).

For motor protection, the 50-2 relay element must be set smaller than the smallest phase-to-phase fault current and larger than the largest motor starting current. Since the maximum appearing startup current is usually below 1.6 x the rated startup current (even with unfavorable conditions), the following setting is adequate for fault current stage 50-2:

1.6 x $I_{Startup}$ < 50-2 Pickup <$I_{\varphi\varphi-Min}$

The potential increase in starting current caused by overvoltage conditions is already accounted for by the 1.6 factor. The 50-2 element may be set with no delay (**50-2 DELAY** = 0.00 s) since, unlike with e.g. the transformer, no saturation of the shunt reactance occurs in a motor.

The principle of the "reverse interlocking" utilizes the multi-element function of the time overcurrent protection: element 50–2 is used as accelerated busbar protection with a short safety delay **50-2 DELAY** (e.g. 100 ms). For faults on the outgoing feeders the element 50-2 is blocked. Both elements 50-1 or 51 serve as backup protection. The pickup values of both elements (**50-1 PICKUP** or **51 PICKUP** and **50-2 PICKUP**) are set equal. Delay time **50-1 DELAY** or **51 TIME DIAL** is set such that it overgrades the delay for the outgoing feeders.

The selected time is an additional time delay and does not include the operating time (measuring time, dropout time). The delay can be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 50-2 element is not required at all, then the pickup threshold **50-2 PICKUP** should be set to ∞. This setting prevents tripping and the generation of a pickup message.

50N-2 Element

The pickup and delay of element 50N-2 are set at addresses 1302 and 1303. The same considerations apply for these settings as they did for phase currents discussed earlier.

The selected time is only an additional time delay and does not include the operating time (measuring time, dropout time). The delay can be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 50N-2 element is not required at all, the pickup threshold 50N-2 PICKUP should be set to ∞. This setting prevents tripping and the generation of a pickup message.

50-1 Element

For setting the 50-1 relay element it is the maximum anticipated load current that must be considered. Pickup due to overload should never occur, since the device, in this mode, operates as fault protection with correspondingly short tripping times and not as overload protection. For this reason, a setting equal to 20% is recommended for line protection, and a setting equal to 40% of the expected peak load is recommended for transformers and motors.

The settable time delay (address 1205 **50-1 DELAY**) results from the grading coordination chart defined for the network.

The selected time is an additional time delay and does not include the operating time (measuring time, dropout time). The delay can be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 50-1 element is not required at all, then the pickup threshold 50-1 PICKUP should be set to ∞. This setting prevents tripping and the generation of a pickup message.

50N-1 Element

The pickup value of the 50N-1 relay element should be set below the minimum anticipated ground fault current.

If the relay is used to protect transformers or motors with large inrush currents, the inrush restraint feature of 7SJ62/63/64 may be used for the 50N–1 relay element. It can be enabled or disabled for both the phase current and the ground current in address 2201 **INRUSH REST.**. The characteristic values of the inrush restraint are listed in Subsection "Inrush Restraint".

The delay is set at address 1305 **50N-1 DELAY** and should be based on system coordination requirements. For ground currents in a grounded system a separate coordination chart with short time delays is often used.

The selected time is an additional time delay and does not include the operating time (measuring time, dropout time). The delay can be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 50N-1 element is not required at all, the pickup threshold 50N-1 PICKUP should be set to ∞. This setting prevents tripping and the generation of a pickup message.

Pickup Stabilization (Definite Time)

The dropout times 1215 **50 T DROP-OUT** or 1315 **50N T DROP-OUT** can be set to implement a uniform dropout behaviour when using electromechanical relays. This is necessary for a time grading. The dropout time of the electromechanical relay must be known to this end. Subtract the dropout time of the 7SJ relay (see Technical Data) from this value and enter the result in the parameters.

51 Element with IEC or ANSI Characteristics

Having set address 112 **Charac. Phase** = ***TOC IEC*** or ***TOC ANSI*** when configuring the protective functions (Section 2.1.1.2), the parameters for the inverse characteristic will also be available.

If address 112 **Charac. Phase** = ***TOC IEC***, you can specify the desired IEC–characteristic (***Normal Inverse***, ***Very Inverse***, ***Extremely Inv.*** or ***Long Inverse***) in address 1211 **51 IEC CURVE**. If address 112 **Charac. Phase** = ***TOC ANSI***, you can specify the desired ANSI–characteristic (***Very Inverse***, ***Inverse***, ***Short Inverse***, ***Long Inverse***, ***Moderately Inv.***, ***Extremely Inv.*** or ***Definite Inv.***) in address 1212 **51 ANSI CURVE**.

If the inverse time trip characteristic is selected, it must be noted that a safety factor of about 1.1 has already been included between the pickup value and the setting value. This means that a pickup will only occur if a current of about 1.1 times the setting value is present. If ***Disk Emulation*** was selected at address 1210 **51 Drop-out**, reset will occur in accordance with the reset curve as described before.

The current value is set at address 1207 **51 PICKUP**. The setting is mainly determined by the maximum operating current. Pickup due to overload should never occur, since the device, in this mode, operates as fault protection with correspondingly short tripping times and not as overload protection.

The corresponding element time multiplication factor for an IEC characteristic is set at address 1208 **51 TIME DIAL** and in address 1209 **51 TIME DIAL** for an ANSI characteristic. It must be coordinated with the time grading of the network.

The time multiplier can also be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 51 element is not required at all, address 112 **Charac. Phase** should be set to ***Definite Time*** during protective function configuration (see Section 2.1.1.2).

51N Element with IEC or ANSI Characteristics

Having set address 113 **Charac. Ground** = ***TOC IEC*** when configuring the protective functions (Section 2.1.1), the parameters for the inverse characteristics will also be available. Specify in address 1311 **51N IEC CURVE** the desired IEC characteristic (***Normal Inverse***, ***Very Inverse***, ***Extremely Inv.*** or ***Long Inverse***). If address 113 **Charac. Ground** = ***TOC ANSI***, you can specify the desired ANSI–characteristic (***Very Inverse***, ***Inverse***, ***Short Inverse***, ***Long Inverse***, ***Moderately Inv.***, ***Extremely Inv.*** or ***Definite Inv.***) in address 1312 **51N ANSI CURVE**.

If the inverse time trip characteristic is selected, it must be noted that a safety factor of about 1.1 has already been included between the pickup value and the setting value. This means that a pickup will only occur if a current of about 1.1 times the setting value is present. If ***Disk Emulation*** was selected at address 1310 **51 Drop-out**, reset will occur in accordance with the reset curve as described before.

The current value is set at address 1307 **51N PICKUP**. The most relevant for this setting is the minimum appearing ground fault current.

The corresponding element time multiplication factor for an IEC characteristic is set at address 1308 **51N TIME DIAL** and in address 1309 **51N TIME DIAL** for an ANSI characteristic. This has to be coordinated with the grading coordination chart of the network. For ground and grounded currents with grounded network, you can often set up a separate grading coordination chart with shorter delay times.

The time multiplier can also be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 51N-TOC element is not required at all, address 113 **Charac. Ground** should be set to ***Definite Time*** during protective function configuration (see Section 2.1.1).

User Defined Characteristics (Phases and ground)

Having set address 112 **Charac. Phase** or 113 = **Charac. Ground** = ***User Defined PU*** or ***User def. Reset*** when configuring the protective functions (Section 2.1.1.2), the user specified curves will also be available. A maximum of 20 value pairs (current and time) may be entered at address 1230 **51/51N** or 1330 **50N/51N** in this case. This option allows point-by-point entry of any desired curve. If during configuration of address 112 was set to ***User def. Reset*** or 113 was set to ***User def. Reset***, additional value pairs (current and reset time) may be entered in address 1231 **MofPU Res T/Tp** or 1331 **MofPU Res T/TEp** to represent the reset curve.

Since current values are rounded in a specific pattern before they are processed in the device (see Table 2-3), we recommend to use exactly the same preferred current values you can find in this table.

The current and time value pairs are entered as multiples of addresses 1207 **51 PICKUP** and 1208 **51 TIME DIAL** for the phase currents and 1307 and 1308 for the ground system. Therefore, it is recommended that these addresses are initially set to 1.00 for simplicity. Once the curve is entered, the settings at addresses 1207 or 1307 and/or 1208 or 1308 may be modified later on if necessary.

The default setting of current values is ∞. They are, therefore, not enabled — and no pickup or tripping of these protective functions will occur.

The following must be observed:

- The value pairs should be entered in increasing sequence. Fewer than 20 pairs is also sufficient. In most cases, about 10 pairs is sufficient to define the characteristic accurately. A value pair which will not be used has to be made invalid by entering "∞© for the threshold! The user must ensure the value pairs produce a clear and constant characteristic.

  The current values entered should be those from the following table, along with the matching times. Deviating values MofPU (multiples of PU-values) are rounded. This, however, will not be indicated.

  Current flows less than the smallest current value entered will not lead to an extension of the tripping time. The pickup curve (see Figure 2-13, right side) is parallel to the current axis, up to the smallest current value point.

  Current flows greater than the highest current value entered will not lead to a reduction of the tripping time. The pickup characteristic (see Figure 2-13, right side) is parallel to the current axis, beginning with the greatest curve value point.

Table 2-3 Preferential values of standardized currents for user-defined tripping curves

MofPU = 1 to 1.94		MofPU = 2 to 4.75		MofPU = 5 to 7.75		MofPU = 8 to 20	
1.00	1.50	2.00	3.50	5.00	6.50	8.00	15.00
1.06	1.56	2.25	3.75	5.25	6.75	9.00	16.00
1.13	1.63	2.50	4.00	5.50	7.00	10.00	17.00
1.19	1.69	2.75	4.25	5.75	7.25	11.00	18.00
1.25	1.75	3.00	4.50	6.00	7.50	12.00	19.00
1.31	1.81	3.25	4.75	6.25	7.75	13.00	20.00
1.38	1.88					14.00	
1.44	1.94						

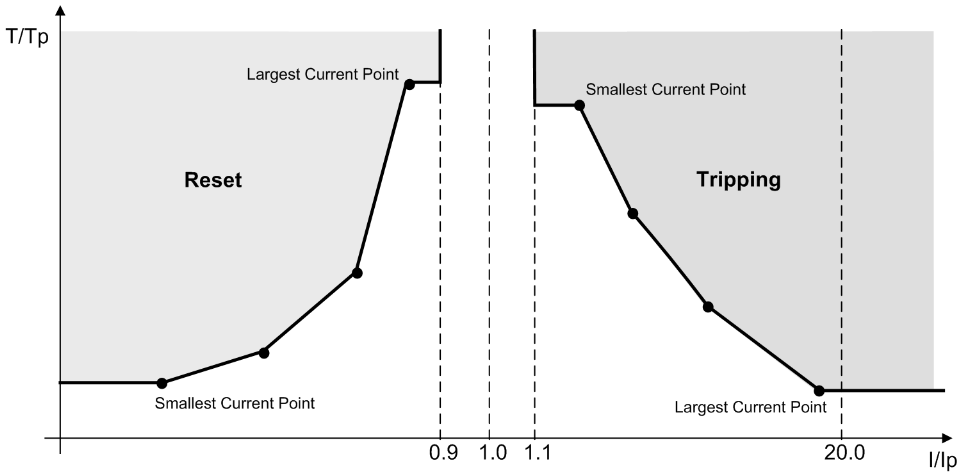


Figure 2-13 Using a user-defined curve

The value pairs are entered at address 1231 **MofPU Res T/Tp** or 1331 **MofPU Res T/TEp** to recreate the reset curve. The following must be observed:

- The current values entered should be those from the following Table 2-4, along with the matching times. Deviating values of MofPU are rounded. This, however, will not be indicated.

  Current flows greater than the highest current value entered will not lead to a prolongation of the reset time. The reset curve (see Figure 2-13, left side) is parallel to the current axis, beginning with the greatest curve value point.

  Current flows which are less than the smallest current value entered will not lead to a reduction of the reset time. The reset curve (see Figure 2-13, left side) is parallel to the current axis, beginning with the smallest curve value point.

Table 2-4 Preferential values of standardized currents for user-defined reset curves

MofPU = 1 to 0.86		MofPU = 0.84 to 0.67		MofPU = 0.66 to 0.38		MofPU = 0.34 to 0.00	
1.00	0.93	0.84	0.75	0.66	0.53	0.34	0.16
0.99	0.92	0.83	0.73	0.64	0.50	0.31	0.13
0.98	0.91	0.81	0.72	0.63	0.47	0.28	0.09
0.97	0.90	0.80	0.70	0.61	0.44	0.25	0.06
0.96	0.89	0.78	0.69	0.59	0.41	0.22	0.03
0.95	0.88	0.77	0.67	0.56	0.38	0.19	0.00
0.94	0.86						

When using DIGSI to modify settings, a dialog box is available to enter up to 20 value pairs for a characteristic curve (see figure 2-14).

In order to represent the characteristic graphically, the user should click on "characteristic". The previously entered characteristic will appear as shown in Figure 2-14.

The characteristic curve shown in the graph can be modified later on. Placing the mouse cursor over a point on the characteristic, the cursor changes to the shape of a hand. Press and hold the left mouse button and drag the data item to the desired position. Releasing the mouse button will automatically update the value in the value table.

The respective upper limits for the value setting range are indicated by dotted lines in the right-hand and upper area of the system of coordinates. If the position of a data point lies outside these limits, the associated value will be set to infinity.

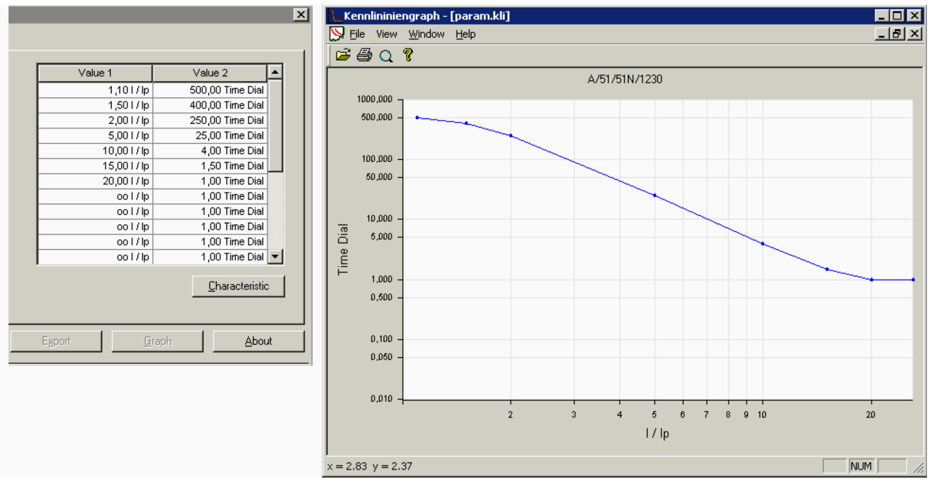


Figure 2-14 Inputting and visualizing a user-defined trip curve with DIGSI® – Example

Inrush Restraint

When applying the protection device to transformers where high inrush currents are to be expected, the 7SJ62/63/64 can make use of an inrush restraint function for the overcurrent elements 50–1, 51, 50N–1 and 51N as well as the non-directional overcurrent elements.

Inrush restraint is only effective and accessible if address 122 **InrushRestraint** was set to ***Enabled*** during configuration. If the function is not required ***Disabled*** is to be set. In address 2201 **INRUSH REST.** the function is switched ***ON*** or ***OFF*** jointly for the overcurrent elements 50–1,51, 50N-1 and 51N.

The inrush restraint is based on the evaluation of the 2nd harmonic present in the inrush current. Upon delivery from the factory, a ratio I_{2f}/I_f of 15 % is set. Under normal circumstances, this setting will not need to be changed. The setting value is identical for all phases and ground. However, the component required for restraint may be adjusted to system conditions in address 2202 **2nd HARMONIC**. To provide more restraint in exceptional cases, where energizing conditions are particularly unfavourable, a smaller value can be set in the address before-mentioned, e.g. 12 %.

The effective duration of the cross-blocking 2203 **CROSS BLK TIMER** can be set to a value between 0 s (harmonic restraint active for each phase individually) and a maximum of 180 s (harmonic restraint of a phase also blocks the other phases for the specified duration).

If the current exceeds the value set in address 2205 **`I Max`**, no further restraint will take place for the 2nd harmonic.
The lower operating limit of the restraining function amounts to 0.25 times the secondary nominal current of the fundamental harmonic (250 mA with 1 A sec. nominal current). The blocking is thus not enabled for lower currents. This also applies to the ground current and, if necessary, should be taken into consideration during setting of the pickup threshold of the ground stage.

Manual Close Mode (Phases, ground)

When a circuit breaker is closed onto a faulted line section, a high speed trip by the circuit breaker is usually desired. For overcurrent or high-set elements the delay may be bypassed via a Manual Close pulse, thus resulting in instantaneous tripping. This pulse is prolonged by at least 300 ms. To enable the device to react properly on occurrence of a fault in the phase elements after manual close, address 1213 **`MANUAL CLOSE`** has to be set accordingly. Accordingly, address 1313 **`MANUAL CLOSE`** is considered for the ground path address. Thus, the user determines for both elements, the phase and the ground element, what pickup value is active with what delay when the circuit breaker is closed manually.

External Control Switch

If the manual closing signal is not from a 7SJ62/63/64 relay, that is, neither sent via the built-in operator interface nor via a series interface, but, rather, directly from a control acknowledgment switch, this signal must be passed to a 7SJ62/63/64 binary input, and configured accordingly („`>Manual Close`“), so that the element selected for **`MANUAL CLOSE`** will be effective. Its alternative ***`Inactive`*** means that the element operates as configured even with manual close.

Internal Control Function

The manual closing information must be allocated via CFC (interlocking task-level) using the CMD_Information block, if the internal control function is used (see Figure 2-15).

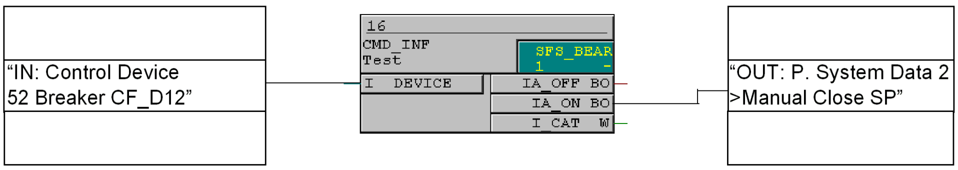


Figure 2-15 Example for manual close feature using the internal control function

Note

For an interaction between the automatic reclosure (AR) and the control function, an extended CFC logic is necessary. See margin heading „CLOSE command: Directly or via control“ in the Setting Notes of the AR function (Section 2.14.6).

Interaction with Automatic Reclosure Function (Phases)

When reclosing occurs, it is desirable to have high speed protection against faults with 50-2. If the fault still exists after the first reclosure, elements 50-1 or 51 will be initiated with graded tripping times, that is, the 50-2 elements will be blocked. At address 1214 **`50-2 active`**, it can be specified whether (***`with 79 active`***) or not (***`Always`***) the 50-2 elements should be supervised by the status of an internal or external automatic reclosing device. Address ***`with 79 active`*** determines that the 50-2 elements will not operate unless automatic reclosing is not blocked. If not desired, then setting ***`Always`*** is selected having the effect that the 50-2 elements will always operate, as configured.

The integrated automatic reclosing function of 7SJ62/63/64 also provides the option to individually determine for each time overcurrent element whether tripping or blocking is to be carried out instantaneously, unaffected by the AR with time delay (see Section 2.14).

Interaction with Automatic Reclosing Function (ground)

When reclosing is expected, it is desirable to have high speed protection against faults with 50N-2. If the fault still exists after the first reclosure, elements 50N-1 or 51N must operate with graded tripping times, that is, the 50N-2 elements will be blocked. At address 1314 **50N-2 active**, it can be specified whether (***with 79 active***) or not (***Always***) the 50N-2 elements should be supervised by the status of an internal or external automatic reclosing device. Address ***with 79 active*** determines that the 50N-2 elements will only operate when automatic reclosing is not blocked. If not desired, then setting ***Always*** is selected having the effect that the 50N-2 elements will always operate, as configured.

The integrated automatic reclosing function of 7SJ62/63/64 also provides the option to individually determine for each time overcurrent element whether tripping or blocking is to be carried out instantaneously, unaffected by the AR with time delay (see Section 2.14).

2.2.11 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	FCT 50/51		ON OFF	ON	50, 51 Phase Time Overcurrent
1202	50-2 PICKUP	1A	0.10 .. 35.00 A; ∞	2.00 A	50-2 Pickup
		5A	0.50 .. 175.00 A; ∞	10.00 A	
1203	50-2 DELAY		0.00 .. 60.00 sec; ∞	0.00 sec	50-2 Time Delay
1204	50-1 PICKUP	1A	0.10 .. 35.00 A; ∞	1.00 A	50-1 Pickup
		5A	0.50 .. 175.00 A; ∞	5.00 A	
1205	50-1 DELAY		0.00 .. 60.00 sec; ∞	0.50 sec	50-1 Time Delay
1207	51 PICKUP	1A	0.10 .. 4.00 A	1.00 A	51 Pickup
		5A	0.50 .. 20.00 A	5.00 A	
1208	51 TIME DIAL		0.05 .. 3.20 sec; ∞	0.50 sec	51 Time Dial
1209	51 TIME DIAL		0.50 .. 15.00 ; ∞	5.00	51 Time Dial
1210	51 Drop-out		Instantaneous Disk Emulation	Disk Emulation	Drop-out characteristic
1211	51 IEC CURVE		Normal Inverse Very Inverse Extremely Inv. Long Inverse	Normal Inverse	IEC Curve

Addr.	Parameter	C	Setting Options	Default Setting	Comments
1212	51 ANSI CURVE		Very Inverse Inverse Short Inverse Long Inverse Moderately Inv. Extremely Inv. Definite Inv.	Very Inverse	ANSI Curve
1213A	MANUAL CLOSE		50-2 instant. 50 -1 instant. 51 instant. Inactive	50-2 instant.	Manual Close Mode
1214A	50-2 active		Always with 79 active	Always	50-2 active
1215A	50 T DROP-OUT		0.00 .. 60.00 sec	0.00 sec	50 Drop-Out Time Delay
1230	51/51N		1.00 .. 20.00 I/Ip; ∞ 0.01 .. 999.00 TD		51/51N
1231	MofPU Res T/Tp		0.05 .. 0.95 I/Ip; ∞ 0.01 .. 999.00 TD		Multiple of Pickup <-> T/Tp
1301	FCT 50N/51N		ON OFF	ON	50N, 51N Ground Time Overcurrent
1302	50N-2 PICKUP	1A	0.05 .. 35.00 A; ∞	0.50 A	50N-2 Pickup
		5A	0.25 .. 175.00 A; ∞	2.50 A	
1303	50N-2 DELAY		0.00 .. 60.00 sec; ∞	0.10 sec	50N-2 Time Delay
1304	50N-1 PICKUP	1A	0.05 .. 35.00 A; ∞	0.20 A	50N-1 Pickup
		5A	0.25 .. 175.00 A; ∞	1.00 A	
1305	50N-1 DELAY		0.00 .. 60.00 sec; ∞	0.50 sec	50N-1 Time Delay
1307	51N PICKUP	1A	0.05 .. 4.00 A	0.20 A	51N Pickup
		5A	0.25 .. 20.00 A	1.00 A	
1308	51N TIME DIAL		0.05 .. 3.20 sec; ∞	0.20 sec	51N Time Dial
1309	51N TIME DIAL		0.50 .. 15.00 ; ∞	5.00	51N Time Dial
1310	51N Drop-out		Instantaneous Disk Emulation	Disk Emulation	Drop-Out Characteristic
1311	51N IEC CURVE		Normal Inverse Very Inverse Extremely Inv. Long Inverse	Normal Inverse	IEC Curve
1312	51N ANSI CURVE		Very Inverse Inverse Short Inverse Long Inverse Moderately Inv. Extremely Inv. Definite Inv.	Very Inverse	ANSI Curve
1313A	MANUAL CLOSE		50N-2 instant. 50N-1 instant. 51N instant. Inactive	50N-2 instant.	Manual Close Mode

Addr.	Parameter	C	Setting Options	Default Setting	Comments
1314A	50N-2 active		Always With 79 Active	Always	50N-2 active
1315A	50N T DROP-OUT		0.00 .. 60.00 sec	0.00 sec	50N Drop-Out Time Delay
1330	50N/51N		1.00 .. 20.00 I/Ip; ∞ 0.01 .. 999.00 TD		50N/51N
1331	MofPU Res T/TEp		0.05 .. 0.95 I/Ip; ∞ 0.01 .. 999.00 TD		Multiple of Pickup <-> T/TEp
2201	INRUSH REST.		OFF ON	OFF	Inrush Restraint
2202	2nd HARMONIC		10 .. 45 %	15 %	2nd. harmonic in % of fundamental
2203	CROSS BLOCK		NO YES	NO	Cross Block
2204	CROSS BLK TIMER		0.00 .. 180.00 sec	0.00 sec	Cross Block Time
2205	I Max	1A	0.30 .. 25.00 A	7.50 A	Maximum Current for Inrush Restraint
		5A	1.50 .. 125.00 A	37.50 A	

2.2.12 Information List

No.	Information	Type of Information	Comments
1704	>BLK 50/51	SP	>BLOCK 50/51
1714	>BLK 50N/51N	SP	>BLOCK 50N/51N
1721	>BLOCK 50-2	SP	>BLOCK 50-2
1722	>BLOCK 50-1	SP	>BLOCK 50-1
1723	>BLOCK 51	SP	>BLOCK 51
1724	>BLOCK 50N-2	SP	>BLOCK 50N-2
1725	>BLOCK 50N-1	SP	>BLOCK 50N-1
1726	>BLOCK 51N	SP	>BLOCK 51N
1751	50/51 PH OFF	OUT	50/51 O/C switched OFF
1752	50/51 PH BLK	OUT	50/51 O/C is BLOCKED
1753	50/51 PH ACT	OUT	50/51 O/C is ACTIVE
1756	50N/51N OFF	OUT	50N/51N is OFF
1757	50N/51N BLK	OUT	50N/51N is BLOCKED
1758	50N/51N ACT	OUT	50N/51N is ACTIVE
1761	50(N)/51(N) PU	OUT	50(N)/51(N) O/C PICKUP
1762	50/51 Ph A PU	OUT	50/51 Phase A picked up
1763	50/51 Ph B PU	OUT	50/51 Phase B picked up
1764	50/51 Ph C PU	OUT	50/51 Phase C picked up
1765	50N/51NPickedup	OUT	50N/51N picked up
1791	50(N)/51(N)TRIP	OUT	50(N)/51(N) TRIP
1800	50-2 picked up	OUT	50-2 picked up
1804	50-2 TimeOut	OUT	50-2 Time Out
1805	50-2 TRIP	OUT	50-2 TRIP

No.	Information	Type of Information	Comments
1810	50-1 picked up	OUT	50-1 picked up
1814	50-1 TimeOut	OUT	50-1 Time Out
1815	50-1 TRIP	OUT	50-1 TRIP
1820	51 picked up	OUT	51 picked up
1824	51 Time Out	OUT	51 Time Out
1825	51 TRIP	OUT	51 TRIP
1831	50N-2 picked up	OUT	50N-2 picked up
1832	50N-2 TimeOut	OUT	50N-2 Time Out
1833	50N-2 TRIP	OUT	50N-2 TRIP
1834	50N-1 picked up	OUT	50N-1 picked up
1835	50N-1 TimeOut	OUT	50N-1 Time Out
1836	50N-1 TRIP	OUT	50N-1 TRIP
1837	51N picked up	OUT	51N picked up
1838	51N TimeOut	OUT	51N Time Out
1839	51N TRIP	OUT	51N TRIP
1840	PhA InrushDet	OUT	Phase A inrush detection
1841	PhB InrushDet	OUT	Phase B inrush detection
1842	PhC InrushDet	OUT	Phase C inrush detection
1843	INRUSH X-BLK	OUT	Cross blk: PhX blocked PhY
1851	50-1 BLOCKED	OUT	50-1 BLOCKED
1852	50-2 BLOCKED	OUT	50-2 BLOCKED
1853	50N-1 BLOCKED	OUT	50N-1 BLOCKED
1854	50N-2 BLOCKED	OUT	50N-2 BLOCKED
1855	51 BLOCKED	OUT	51 BLOCKED
1856	51N BLOCKED	OUT	51N BLOCKED
1866	51 Disk Pickup	OUT	51 Disk emulation Pickup
1867	51N Disk Pickup	OUT	51N Disk emulation picked up
7551	50-1 InRushPU	OUT	50-1 InRush picked up
7552	50N-1 InRushPU	OUT	50N-1 InRush picked up
7553	51 InRushPU	OUT	51 InRush picked up
7554	51N InRushPU	OUT	51N InRush picked up
7556	InRush OFF	OUT	InRush OFF
7557	InRush BLK	OUT	InRush BLOCKED
7558	InRush Gnd Det	OUT	InRush Ground detected
7559	67-1 InRushPU	OUT	67-1 InRush picked up
7560	67N-1 InRushPU	OUT	67N-1 InRush picked up
7561	67-TOC InRushPU	OUT	67-TOC InRush picked up
7562	67N-TOCInRushPU	OUT	67N-TOC InRush picked up
7563	>BLOCK InRush	SP	>BLOCK InRush
7564	Gnd InRush PU	OUT	Ground InRush picked up
7565	Ia InRush PU	OUT	Phase A InRush picked up
7566	Ib InRush PU	OUT	Phase B InRush picked up
7567	Ic InRush PU	OUT	Phase C InRush picked up

2.3 Directional Overcurrent Protection 67, 67N

With directional time overcurrent protection the phase currents and the ground current are provided with three elements. All elements may be configured independently from each other and combined according to the user's requirements.

High-current elements 67-2 and overcurrent element 67-1 always operate with definite tripping time, the third element 67-TOC, operates with inverse tripping time.

Applications

- The directional overcurrent protection allows the application of multifunctional protection devices 7SJ62/63/64 to systems where coordination protection depends on knowing both the magnitude of the fault current and the direction of energy flow to the fault location.
- The time overcurrent protection (non-directional) described in Section 2.2 may operate as overlapping backup protection or may be disabled. Additionally, individual elements (e.g. 67-2 and/or 67N-2) may be interconnected with the directional overcurrent protection.
- For parallel lines or transformers supplied from a single source only directional overcurrent protection allows selective fault detection.
- For line sections supplied from two sources or in ring-operated lines the time overcurrent protection has to be supplemented by the directional criterion.

2.3.1 General

For parallel lines or transformers supplied from a single source (Figure 2-16), the second feeder (II) is opened on occurrence of a fault in the first feeder (I) if tripping of the breaker in the parallel feeder is not prevented by a directional measuring element (at B). Therefore, where indicated with an arrow (Figure 2-16) directional overcurrent protection is applied. Be careful that the "Forward" direction of the protective element is in the direction of the line (or object to be protected). This is not necessarily identical with the direction of the normal load flow, as shown in Figure 2-16.

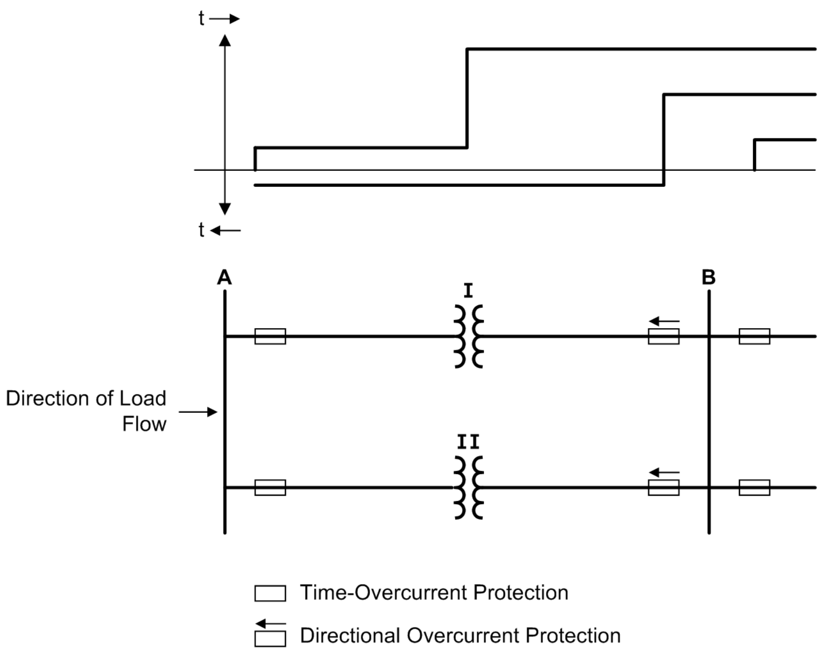


Figure 2-16 Overcurrent protection for parallel transformers

For line sections supplied from two sources or in ring-operated lines the time overcurrent protection has to be supplemented by the directional criterion. Figure 2-17 shows a ring system where both energy sources are merged to one single source.

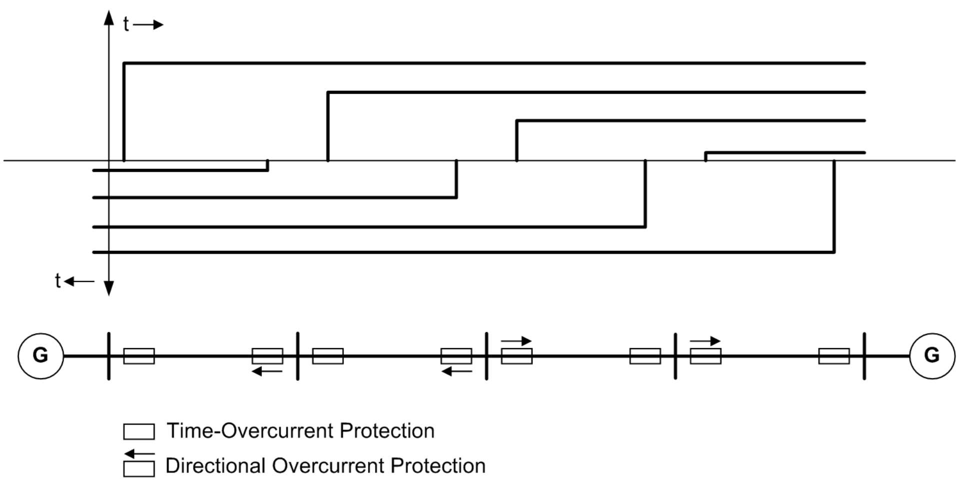


Figure 2-17 Transmission lines with sources at each end

Depending on the setting of parameter 613 **Gnd O/Cprot. w.**, the ground current element can operate either with measured values I_N or with the values 3I0 calculated from the three phase currents. Devices featuring a sensitive ground current input, however, use the calculated quantity 3I0.

For each element the time can be blocked via binary input or automatic reclosure (cycle-dependent), thus suppressing the trip command. Removal of blocking during pickup will restart time delays. The Manual Close signal is an exception. If a circuit breaker is manually closed onto a fault, it can be re-opened immediately. For overcurrent elements or high-set elements the delay may be bypassed via a Manual Close pulse, thus resulting in high-speed tripping.

Furthermore, immediate tripping may be initiated in conjunction with the automatic reclosure function (cycle-dependent).

Pickup stabilization for the 67/67N elements of the directional time overcurrent protection can be accomplished by means of settable dropout times. This protection comes into use in systems where intermittent faults occur. Combined with electromechanical relays, it allows different dropout responses to be adjusted and a time grading of digital and electromechanical relays to be implemented.

Pickup and delay settings may be quickly adjusted to system requirements via dynamic setting swapping (see Section 2.4).

Utilizing the inrush restraint feature tripping may be blocked by the 67-1, 67-TOC, 67N-1, and 67N-TOC elements in phases and ground path when inrush current is detected.

The following table gives an overview of the interconnection to other functions of 7SJ62/63/64.

Table 2-5 Interconnection to other functions

Directional Time Overcurrent Protection Elements	Connection to Automatic Reclosing	Manual CLOSE	Dynamic Cold Load Pickup	Inrush Restraint
67-1	•	•	•	•
67-2	•	•	•	
67-TOC	•	•	•	•
67N-1	•	•	•	•
67N-2	•	•	•	
67N-TOC	•	•	•	•

2.3.2 Definite Time, Directional High-set Elements 67-2, 67N-2

Phase and ground current are compared separately with the pickup values **67-2 PICKUP** and **67N-2 PICKUP** of the respective relay elements. Currents above the setting values are signalled separately when fault direction is equal to the direction configured. After the user-defined time delays **67-2 DELAY**, **67N-2 DELAY** have elapsed, trip signals are issued. Signals are available for each element. The dropout threshold is roughly equal to 95% of the pickup value for currents greater than > 0.3 I_{Nom}.

Pickup can be stabilized by setting dropout times 1518 **67 T DROP-OUT** or 1618 **67N T DROP-OUT**. This time is started if the current falls below the threshold and maintains the pickup condition. The function thus does not drop out instantaneously. The trip delay time **67-2 DELAY** or **67N-2 DELAY** continues in the meantime. After the dropout delay time has elapsed, the pickup is reported OFF and the trip delay time is reset unless the threshold **67-2 PICKUP** or **67N-2 PICKUP** has been violated again. If the threshold is exceeded again while the dropout delay time is still running, it will be cancelled. The trip delay time **67-2 DELAY** or **67N-2 DELAY** continues in the meantime. If the threshold is still exceeded after the time has elapsed, a trip will be initiated immediately. If the threshold violation then no longer exists, there will be no response. If the threshold is exceeded again after the trip command delay time has elapsed and while the dropout delay time is still running, a trip will be initiated at once.

These elements can be blocked by the automatic reclosure feature (AR).

The following figure shows by way of example the logic diagram for the high-set element 67-2.

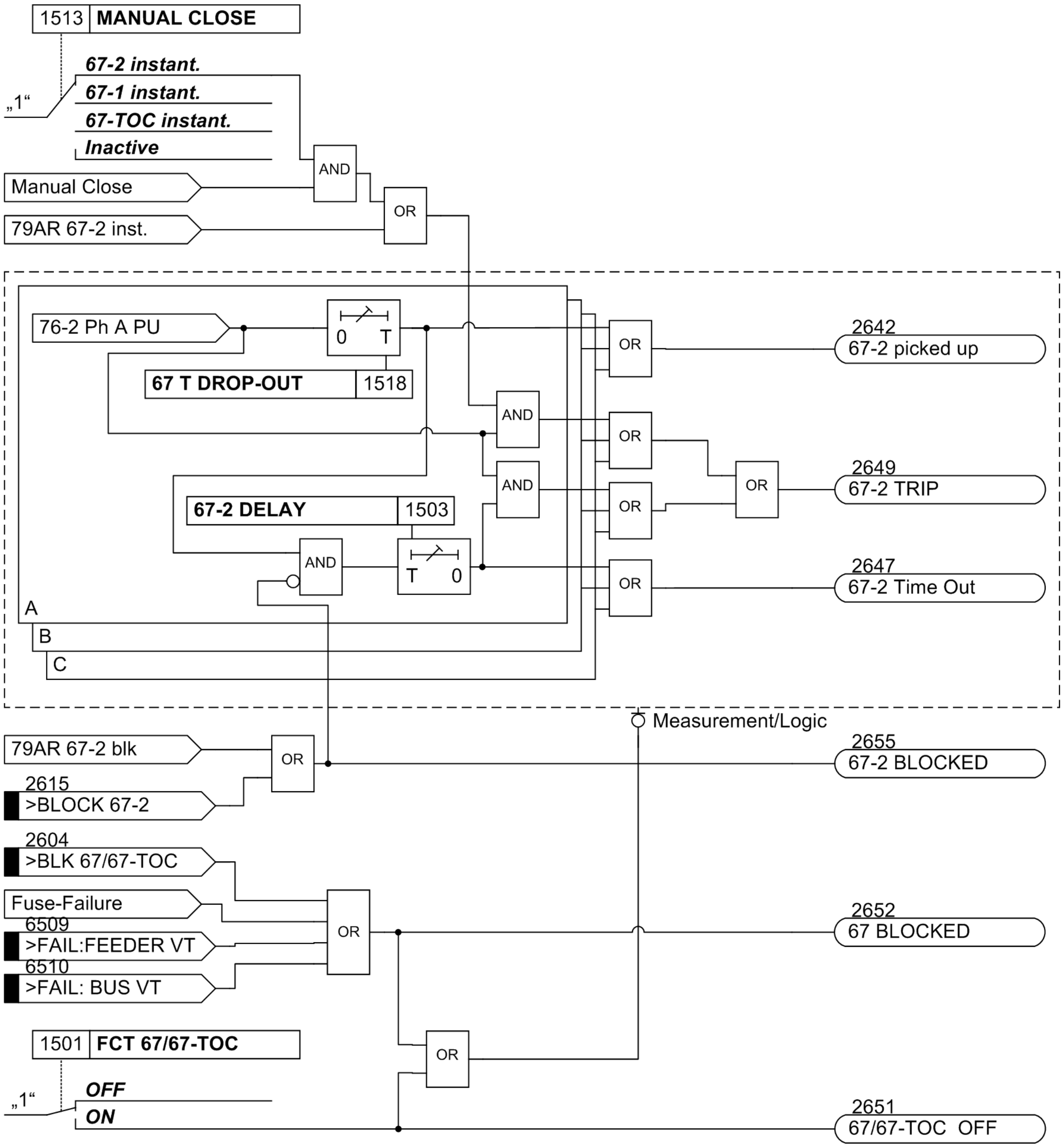


Figure 2-18 Logic diagram of the directional high-current element 67-2 for phases

If parameter **MANUAL CLOSE** is set to ***67-2 instant.*** and manual close detection applies, the pickup is tripped instantaneously, also if the element is blocked via binary input. The same applies to 79 AR 67-2 instantaneous.

2.3.3 Definite Time, Directional Overcurrent Elements 67-1, 67N-1

Phase and ground current are compared separately with the setting values **67-1 PICKUP** and **67N-1 PICKUP** of the respective relay elements. Currents above the setting values are signalled separately when fault direction is equal to the direction configured. If the inrush restraint feature is applied, either the normal pickup signals or the corresponding inrush signals are output as long as inrush current is detected. When, after pickup without inrush recognition, the relevant delay times **67-1 DELAY**, **67N-1 DELAY** have expired, a tripping command is issued. If the inrush restraint feature is enabled, and an inrush condition exists, no tripping takes place, but a message is recorded and displayed indicating when the overcurrent element time delay elapses. Tripping signals and signals on the expiration of time delay are available separately for each element. The dropout value is roughly equal to 95% of the pickup value for currents greater than > 0.3 I_{Nom}.

In addition, pickups can be stabilized by setting dropout times 1518 **67 T DROP-OUT** or 1618 **67N T DROP-OUT**. This time is started if the current falls below the threshold and maintains the pickup condition. The function thus does not drop out instantaneously. The trip delay time **67-1 DELAY** or **67N-1 DELAY** continues in the meantime. After the dropout delay time has elapsed, the pickup is reported OFF and the trip delay time is reset unless the threshold **67-1 PICKUP** or **67N-1 PICKUP** has been violated again. If the threshold is violated again while the dropout delay time is still running, it will be cancelled. The trip delay time **67-1 DELAY** or **67N-1 DELAY** continues in the meantime. If the threshold is still exceeded after the time has elapsed, a trip will be initiated immediately. If the threshold violation then no longer exists, there will be no response. If the threshold is violated again after the trip command delay time has elapsed and while the dropout delay time is still running, a trip will be initiated at once.

Pickup stabilization of the overcurrent elements 67-1 or 67N-1 by means of settable dropout times is deactivated in the event of an inrush pickup, since an inrush is no intermittent fault.

These elements can be blocked by the automatic reclosure feature (AR).

The following figure shows by way of an example the logic diagram for the directional overcurrent element 67-1.

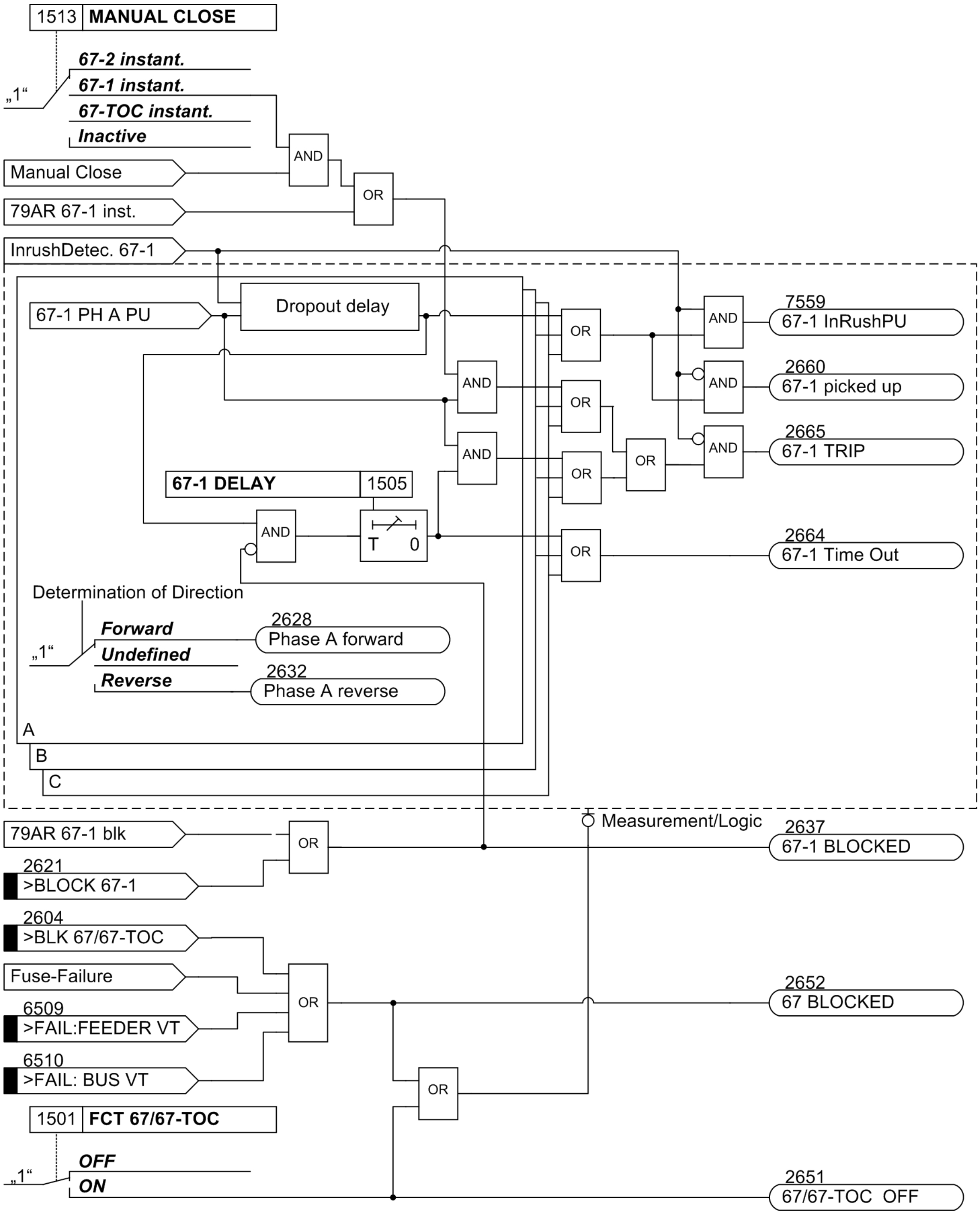


Figure 2-19 Logic diagram for the directional overcurrent element 67-1 for phases

The dropout delay only operates if no inrush was detected. An arriving inrush will reset an already running dropout delay time.

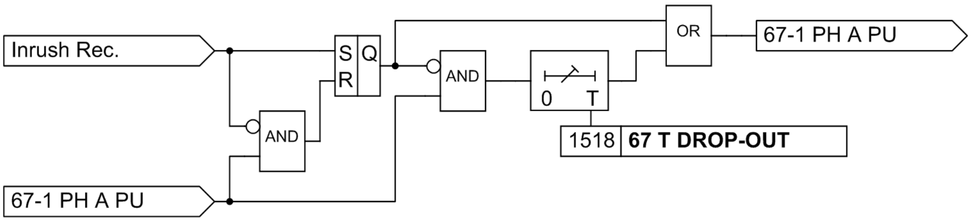


Figure 2-20 Logic of the dropout delay for 67-1

2.3.4 Inverse Time, Directional Overcurrent Protection Elements 67-TOC, 67N-TOC.

Inverse time elements are dependent on the variant ordered. They operate either according to the IEC- or the ANSI-standard or to a user-defined characteristic. The curves and associated formulas are identical with those of the non-directional time overcurrent protection and are given in the Technical Specifications. When the inverse time curves are configured, the definite time relay elements (67-2, 67-1) are available.

Pickup Behaviour

Each phase and ground current is separately compared with the pickup values **67-TOC PICKUP** and **67N-TOC PICKUP** of the respective relay elements. When a current value exceeds the corresponding setting value by a factor of 1.1, the corresponding phase picks up and a message is signalled phase-selectively assuming that the fault direction is equal to the direction configured. If the inrush restraint feature is applied, either the normal pickup signals or the corresponding inrush signals are output as long as inrush current is detected. Pickup of a relay element is based on the rms value of the fundamental harmonic. When the 67-TOC and 67N-TOC elements pick up, the time delay of the trip signal is calculated using an integrating measurement scheme. The calculated time delay is dependent on the actual fault current flowing and the selected tripping curve. Once the time delay elapses, a trip signal is issued assuming that no inrush current is detected or inrush restraint is disabled. If the inrush restraint feature is enabled and an inrush condition exists, no tripping takes place, but a message is recorded and displayed indicating when the overcurrent element time delay elapses.

For ground current element 67N-TOC the characteristic may be selected independently of the characteristic used for phase currents.

Pickup values of elements 67-TOC and 67N-TOC and the associated time multipliers may be individually set.

Dropout Behaviour

When using an IEC or ANSI curve select whether the dropout of an element is to occur instantaneously after the threshold has been undershot or whether dropout is to be performed by means of the disk emulation. "Instantaneously" means that pickup drops out when the pickup value of approx. 95 % of the set pickup value is undershot. For a new pickup the time counter starts at zero.

The disk emulation evokes a dropout process (time counter is decrementing) which begins after de-energization. This process corresponds to the reset of a Ferraris-disk (explaining its denomination "disk emulation"). In case several faults occur in succession the "history" is taken into consideration due to the inertia of the Ferraris-disk and the time response is adapted. Reset begins as soon as 90% of the setting value is undershot, in accordance to the dropout curve of the selected characteristic. In the range between the dropout value (95% of the pickup value) and 90% of the setting value, the incrementing and the decrementing processes are in idle state.

Disk emulation offers advantages when the overcurrent relay elements must be coordinated with conventional electromechanical overcurrent relays located toward the source.

User-defined Curves

When user-defined characteristic are utilized, the tripping curve may be defined point by point. Up to 20 value pairs (current, time) may be entered. The device then approximates the characteristic, using linear interpolation.

The dropout curve may be user-defined as well. This is advantageous when the overcurrent protection must be coordinated with conventional electromechanical overcurrent relays located toward the source. If no user-specified dropout curve is required, the element pickup drops out as soon as the measured signal is less than approx. 95% of the pickup setting. When a new pickup is evoked, the timer starts at zero again.

The following figure shows by way of an example the logic diagram for the 67-TOC relay element of the directional inverse time overcurrent protection of the phase currents.

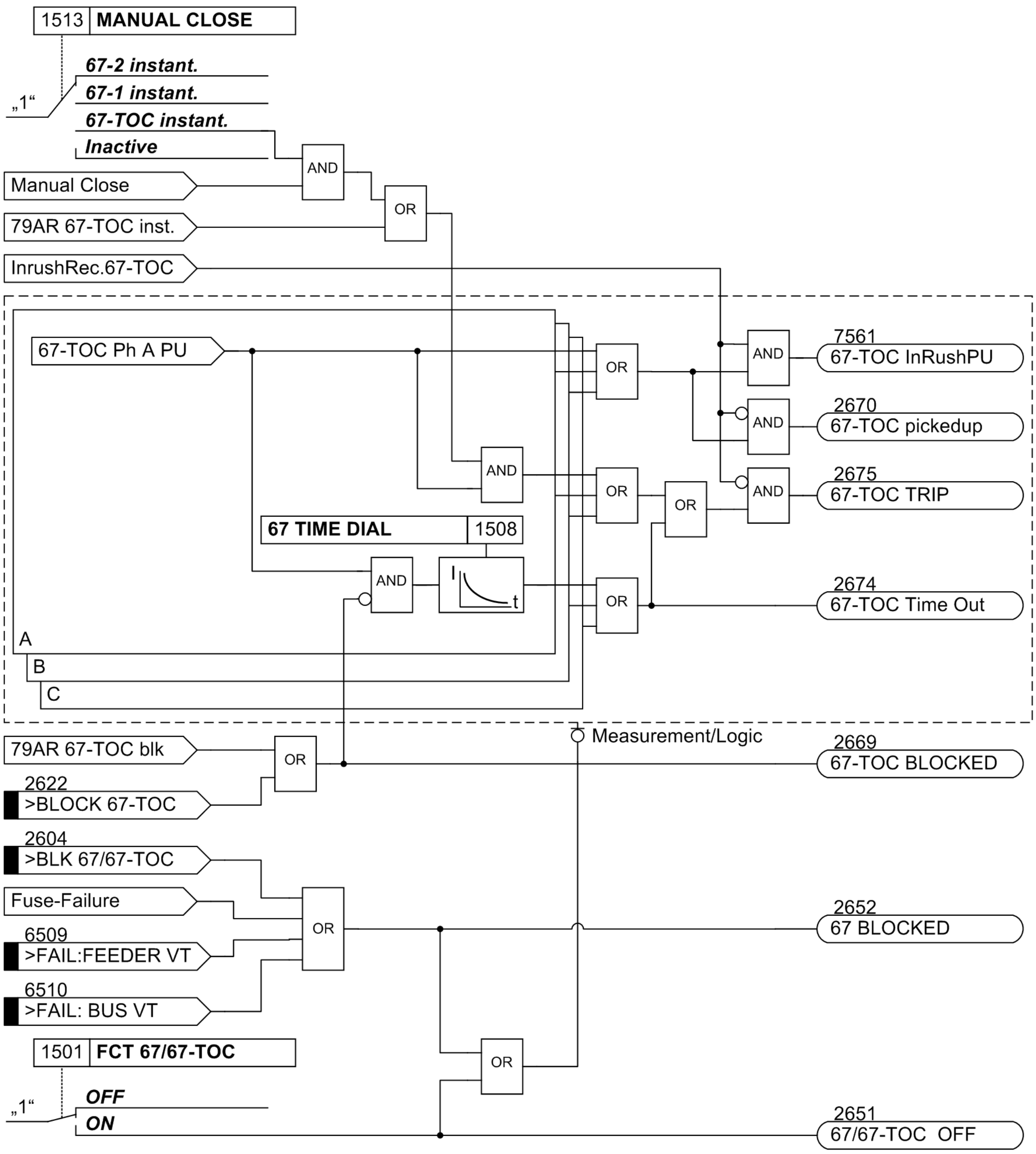


Figure 2-21 Logic diagram for the directional overcurrent protection: 67-TOC relay element

2.3.5 Interaction with the Fuse Failure Monitor (FFM)

Spurious tripping can be caused by failure of a measuring voltage due to short-circuit, broken wire in the voltage transformer's secondary system or pickup of the voltage transformer fuse. Failure of the measuring voltage in one or two poles can be detected, and the directional time overcurrent elements (Dir Phase and Dir Ground) can be blocked (see logic diagrams). Undervoltage protection, sensitive ground fault detection and synchronization are equally blocked in this case.

2.3.6 Dynamic Cold Load Pickup Function

It may be necessary to dynamically increase the pickup values of the directional time overcurrent protection if, at starting, certain elements of the system show an increased power consumption after a long period of zero voltage (e.g. air-conditioning systems, heating installations, motors). Thus, a general raise of pickup thresholds can be avoided taking into consideration such starting conditions.

This dynamic pickup value changeover is common to all overcurrent elements and is described in Section 2.4. The alternative pickup values can be set individually for each element of the directional and non-directional time overcurrent protection.

2.3.7 Inrush Restraint

The 7SJ62/63/64 features an integrated inrush restraint function. It prevents the "normal" pickup of all directional and non-directional overcurrent relay elements in the phases and ground path, but not the high-set elements. The same is true for the alternative pickup thresholds of the dynamic cold load pickup function. After detection of inrush currents above a pickup value special inrush signals are generated. These signals also initiate fault annunciations and start the associated trip delay time. If inrush conditions are still present after the tripping time delay has elapsed, a corresponding message ("....TimeOut ") is output, but the overcurrent tripping is blocked (for further information see "Inrush Restraint" in Section 2.2).

2.3.8 Determination of Direction

Determination of fault direction is performed independently for each of the four directional elements (three phases, ground or summation current 3I0).

Basically, the direction determination is performed by determining the phase angle between the fault current and a reference voltage.

Method of Directional Measurement

For the directional phase elements the short-circuit current of the affected phase and as reference voltage the unfaulted phase-to-phase voltage are used. The unfaulted voltage also allows an unambiguous direction determination if the fault voltage has collapsed severely (close-up fault). With phase-to-ground voltages connection, the phase-to-phase voltages are calculated. With connection to two phase-to-phase voltages and V_N, the third phase-to-phase voltage is also calculated.

With three-pole faults, stored voltage values are used to clearly determine the direction if the measurement voltages are not sufficient. After the expiration of the storage time period (2 cycles), the detected direction is saved, as long as no sufficient measuring voltage is available. When closing onto a fault, if no stored voltage values exist in the buffer, the relay element will trip. In all other cases the voltage magnitude will be sufficient for determining the direction.

Two methods are available to determine the direction for the directional ground fault element.

Direction Determination with Zero-Sequence System or Ground Quantities

For the directional ground fault elements, direction can be determined by comparing the zero sequence system quantities. In the current path, the I_N current is valid, when the transformer neutral current is connected to the device. Otherwise the device calculates the ground current from the sum of the three phase currents. In the voltage path, the displacement voltage V_N is used as reference voltage, if it is connected. Otherwise the device calculates as reference voltage the zero-sequence voltage $3 \cdot V_0$ from the sum of the three phase voltages. If the magnitude of V_N or $3 \cdot V_0$ is not sufficient to determine direction, the direction is undefined. Then the directional ground elements will not initiate a trip signal. If the current I_0 cannot be determined, e.g. because only two current transformers are utilized or the current transformers are connected in an open delta configuration, then the directional ground elements will not be able to function. The latter is only permitted in ungrounded systems.

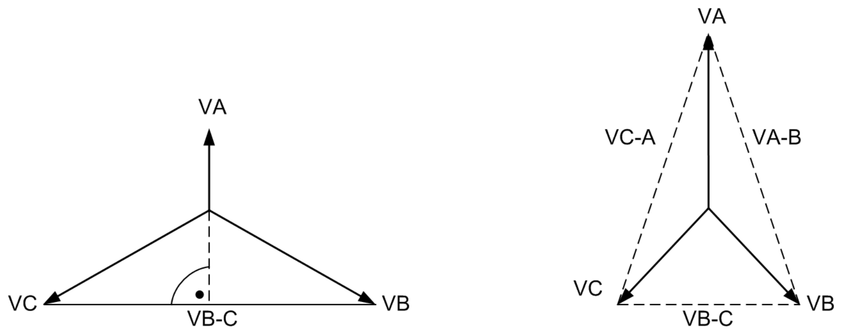
Direction Determination with Negative Sequence System

Here, the negative sequence current and as reference voltage the negative sequence voltage are used for the direction determination. This is advantageous if the zero sequence is influenced via a parallel line or if the zero voltage becomes very small due to unfavorable zero impedances. The negative sequence system is calculated from the individual voltages and currents. As with the use of the zero sequence values, a direction determination is carried out if the values necessary for the direction determination have exceeded a minimum threshold. Otherwise the direction is undetermined.

Cross-Polarized Reference Voltages for Direction Determination

A 2-pole short circuit is detected by two directional phase elements, i.e. the directional phase elements associated with the faulted phases. A single-pole fault (ground fault) is detected by the directional ground element, and may be detected by the directional phase elements associated with the faulted phases if the magnitude of the fault current is sufficient to pickup the directional element. For the directional ground fault elements, naturally, pre-described connection requirements must be fulfilled.

For a phase-to-ground fault, the voltage (reference voltage) used by the directional phase element of the faulted phase is 90° out of phase with the phase-to-ground voltage of the faulted phase at the relay location (see Figure 2-22). With phase-to-phase faults, the angle between the unfaulted voltages (reference voltages) and the fault voltages can be between 90° (remote fault) and 60° (close-up fault) depending on the degree of collapse of the fault voltages.



a) Phase to Ground Fault (A-G)   b) Phase to Phase Fault (B-C)

Figure 2-22 Cross-polarized voltages for direction determination

The following table shows the assignment of measured values for the determination of fault direction for various types of pickups.

Table 2-6 Measured values for the determination of fault direction

PICKUP	Directional Element							
	A		B		C		N	
	Current	**Voltage**	**Current**	**Voltage**	**Current**	**Voltage**	**Current**	**Voltage**
A	I_A	$V_B - V_C$	—	—	—	—	—	—
B	—	—	I_B	$V_C - V_A$	—	—	—	—
C	—	—	—	—	I_C	$V_A - V_B$	—	—
N	—	—	—	—	—	—	I_N	V_N 1)
A, N	I_A	$V_B - V_C$	—	—	—	—	I_N	V_N 1)
B, N	—	—	I_B	$V_C - V_A$	—	—	I_N	V_N 1)
C, N	—	—	—	—	I_C	$V_A - V_B$	I_N	V_N 1)
A, B	I_A	$V_B - V_C$	I_B	$V_C - V_A$	—	—	—	—
B, C	—	—	I_B	$V_C - V_A$	I_C	$V_A - V_B$	—	—
A, C	I_A	$V_B - V_C$	—	—	I_C	$V_A - V_B$	—	—
A, B, N	I_A	$V_B - V_C$	I_B	$V_C - V_A$	—	—	I_N	V_N 1)
B, C, N	—	—	I_B	$V_C - V_A$	I_C	$V_A - V_B$	I_N	V_N
A, C, N	I_A	$V_B - V_C$	—	—	I_C	$V_A - V_B$	I_N	V_N 1)
A, B, C	I_A	$V_B - V_C$	I_B	$V_C - V_A$	I_C	$V_A - V_B$	—	—
A, B, C, N	I_A	$V_B - V_C$	I_B	$V_C - V_A$	I_C	$V_A - V_B$	I_N	V_N 1)

1) or $3 \cdot V_0$ = |VA + VB + VC|, depending on type of connection for the voltages

Direction Determination of Directional Phase Elements

As already mentioned, the direction determination is performed by determining the phase angle between the fault current and the reference voltage. In order to satisfy different network conditions and applications, the reference voltage can be rotated through an adjustable angle. In this way, the vector of the rotated reference voltage can be closely adjusted to the vector of the fault current in order to provide the best possible result for the direction determination. Figure 2-23 clearly shows the relationship for the directional phase elements based on a single-pole ground fault in Phase A. The fault current I_{scA} follows the fault voltage by the fault angle φ_{sc}. The reference voltage, in this case V_{BC} for the directional phase element A, is rotated through the setting value 1519 **ROTATION ANGLE**, positive counter-clockwise. In this case, a rotation of +45°.

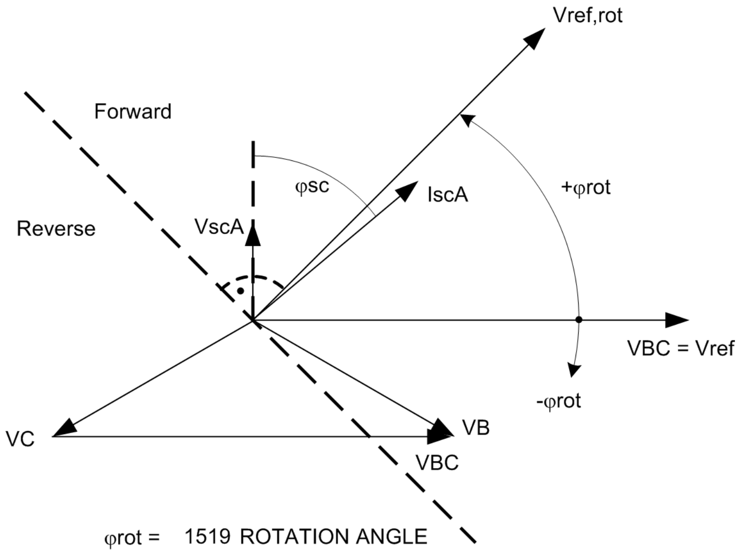


Figure 2-23 Rotation of the reference voltage, directional phase element

The rotated reference voltage defines the forward and backward area, see Figure 2-24. The forward area is a range of ±86° around the rotated reference voltage $V_{ref, rot}$. If the vector of the fault current is in this area, the device detects forward direction. In the mirrored area, the device detects backward direction. In the intermediate area, the direction result is undefined.

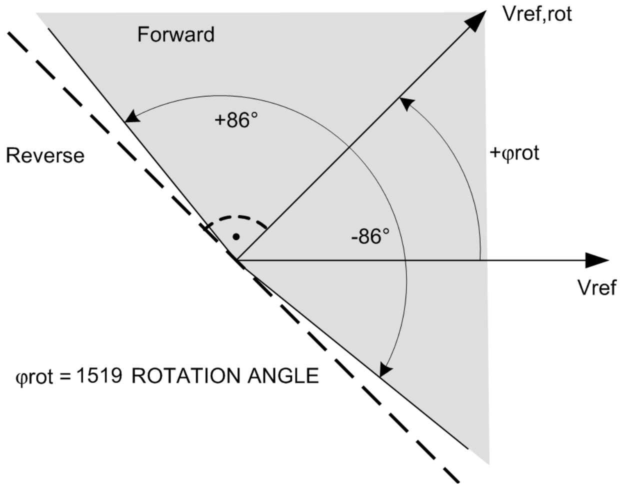


Figure 2-24 Forward characteristic of the directional function, directional phase element

Direction Determination of Directional Ground Element with Ground Values

Figure 2-25 shows the treatment of the reference voltage for the directional ground element, also based on a single-pole ground fault in Phase A. Contrary to the directional phase elements, which work with the unfaulted voltage as reference voltage, the fault voltage itself is the reference voltage for the directional ground element. Depending on the connection of the voltage transformer, this is the voltage $3V_0$ (as shown in

Figure 2-25) or V_N. The fault current $-3I_0$ is in phase oposition to the fault current I_{scA} and follows the fault voltage $3V_0$ by the fault angle φ_{sc}. The reference voltage is rotated through the setting value 1619 **ROTATION ANGLE**. In this case, a rotation of -45°.

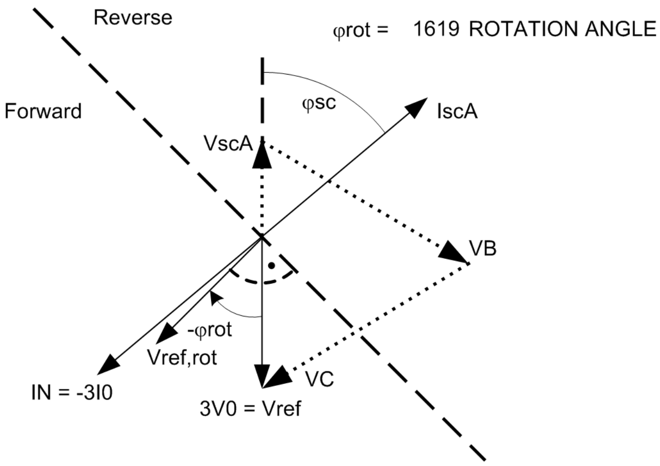


Figure 2-25 Rotation of the reference voltage, directional ground element with zero sequence values

The forward area is also a range of ±86° around the rotated reference voltage $V_{ref, rot}$. If the vector of the fault current $-3I_0$ (or I_N) is in this area, the device detects forward direction.

Direction Determination of Directional Ground Element with Negative Sequence Values

Figure 2-26 shows the treatment of the reference voltage for the directional ground element using the negative sequence values based on a single-pole ground fault in Phase A. As reference voltage, the negative sequence system voltage is used, as current for the direction determination, the negative sequence system current, in which the fault current is displayed. The fault current $-3I_2$ is in phase oposition to the fault current I_{scA} and follows the voltage $3V_2$ by the fault angle φ_{sc}. The reference voltage is rotated through the setting value 1619 **ROTATION ANGLE**. In this case, a rotation of -45°.

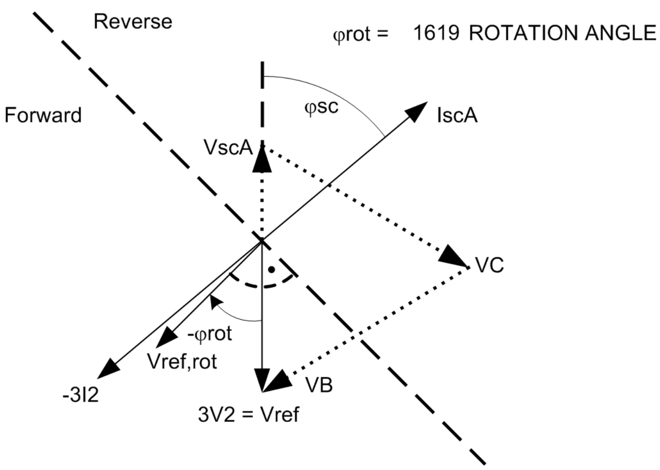


Figure 2-26 Rotation of the reference voltage, directional ground element with negative sequence values

The forward area is a range of ±86° around the rotated reference voltage $V_{ref, rot}$. If the vector of the negative sequence system current $-3I_2$ is in this area, the device detects forward direction.

2.3.9 Reverse Interlocking for Double End Fed Lines

Application Example

The directionality feature of the directional overcurrent protection enables the user to perform reverse interlocking also on double end fed lines using relay element 67-1. It is designed to selectively isolate a faulty line section (e.g. sections of rings) in high speed, i.e. no long graded times will slow down the process. This scheme is feasible when the distance between protective relays is not too great and when pilot wires are available for signal transfer via an auxiliary voltage loop.

For each line, a separate data transfer path is required to facilitate signal transmission in each direction. When implemented in a closed-circuit connection, disturbances in the communication line are detected and signalled with time delay. The local system requires a local interlocking bus wire similar to the one described in Subsection "Reverse Interlocking Bus Protection" for the directional overcurrent protection (Section 2.2).

During a line fault, the device that detects faults in forward (line) direction using the directional relay element 67-1 will block one of the non-directional overcurrent elements (50-1, 50-TOC) of devices in the reverse direction (at the same busbar) since they should not trip (Figure 2-27). In addition, a message is generated regarding the fault direction. "Forward" messages are issued when the current threshold of the directional relay element 67-1 is exceeded and directional determination is done. Subsequently, "forward" messages are transmitted to the device located in reverse direction.

During a busbar fault, the device that detects faults in reverse (busbar) direction using the directional relay element 67-1 will block one of the non-directional overcurrent elements (50-1, 50-TOC) of devices at the opposite end of the same feeder. In addition, a "Reverse" message is generated and transmitted via the auxiliary voltage loop to the relay located at the opposite end of the line.

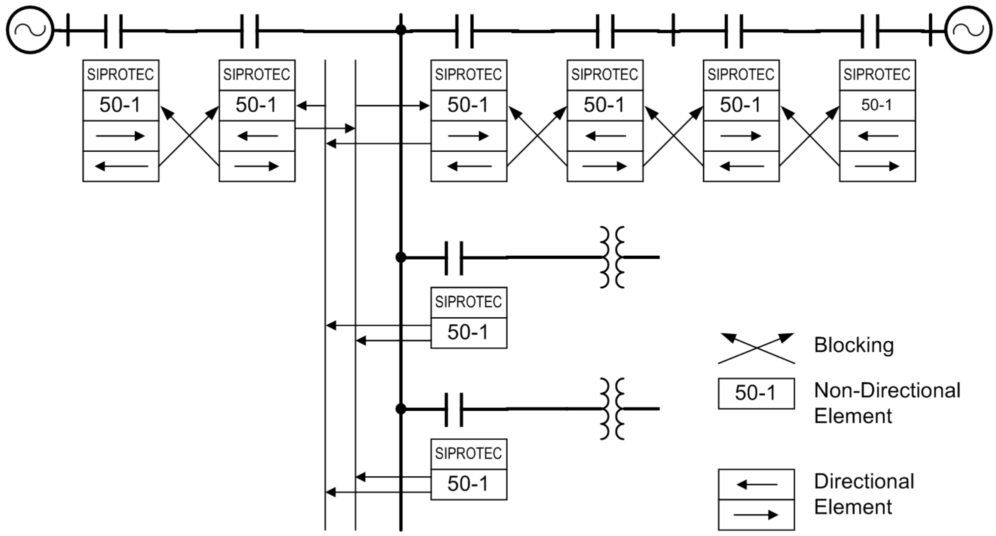


Figure 2-27 Reverse interlocking using directional elements

The directional overcurrent element providing normal time grading operates as selective backup protection.

The following figure shows the logic diagram for the generation of fault direction signals.

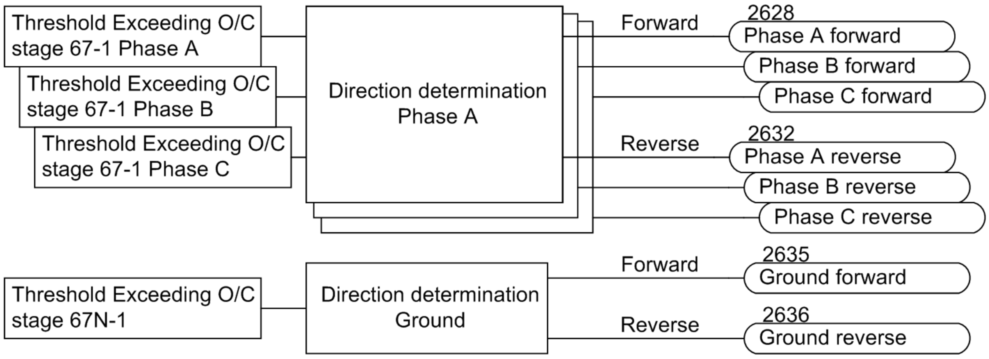


Figure 2-28 Logic diagram for the generation of fault direction signals.

2.3.10 Setting Notes

General

When selecting the directional time overcurrent protection in DIGSI, a dialog box appears with several tabs for setting the associated parameters. Depending on the functional scope specified during configuration of the protective functions in addresses 115 **67/67-TOC** and 116 **67N/67N-TOC**, the number of tabs can vary.

If **67/67-TOC** or **67N/67N-TOC** = ***Definite Time*** is selected, then only the settings for the definite time elements are available. If ***TOC IEC*** or ***TOC ANSI*** is selected, the inverse characteristics are also available. The superimposed directional elements 67-2 and 67-1 or 67N-2 and 67N-1 apply in all these cases.

At address 1501 **FCT 67/67-TOC**, directional phase overcurrent protection may be switched ***ON*** or ***OFF***.

Pickup values, time delays, and characteristic are set separately for phase protection and ground protection. Because of this, relay coordination for ground faults is independent of relay coordination for phase faults, and more sensitive settings can often be applied to directional ground protection. Thus, at address 1601 **FCT 67N/67N-TOC**, directional ground time overcurrent protection may be switched ***ON*** or ***OFF*** independent of the directional phase time overcurrent protection.

Depending on the parameter 613 **Gnd O/Cprot. w.**, the device can either operate using measured values IN or the quantities 3I0 calculated from the three phase currents. Devices featuring a sensitive ground current input generally use the calculated quantity 3I0.

The direction determination of the function is affected by parameter 201 **CT Starpoint** (see chapter 2.1.3).

Direction Characteristic

The direction characteristic, i.e. the position of the ranges „forward“ and „backward“ is set for the phase directional elements under address 1519 **ROTATION ANGLE** and for the ground directional element under address 1619 **ROTATION ANGLE**. The short-circuit angle is generally inductive in a range of 30° to 60°. I.e., usually the default settings of +45° for the phase directional elements and -45° for the ground directional element can be maintained for the adjustment of the reference voltage, as they guarantee a safe direction result.

Nevertheless, the following contains some setting examples for special applications (Table 2-7). The following must be observed: With the phase directional elements, the reference voltage (fault-free voltage) for phase-ground-faults is vertical on the short-circuit voltage. For this reason, the resulting setting of the angle of rotation is (see also Section 2.3.8):

Angle of rotation of ref. volt. $= 90 - \varphi_{sc}$ phase directional element (phase-ground fault)

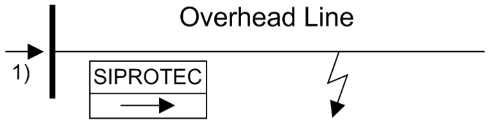
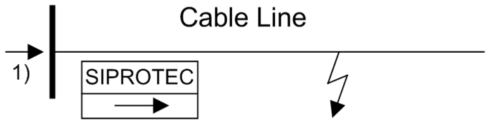
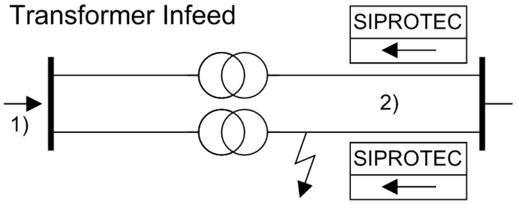
With the ground directional element, the reference voltage is the short-circuit voltage itself. The resulting setting of the angle of rotation is then:

Angle of rotation of ref. volt. $= -\varphi_{sc}$ ground directional element (phase-ground fault)

It should also be noted for phase directional elements that with phase-to-phase faults, the reference voltage is rotated between 0° (remote fault) and 30° (close-up fault) depending on the collapse of the faulty voltage. This can be taken into account with a mean value of 15°:

Angle of rotation of ref. volt. $= 90 - \varphi_{sc} - 15°$ phase directional element (phase-to-phase fault).

Table 2-7 Setting example

Application	φ_{sc} typical	Phase directional element setting 1519 ROTATION ANGLE	Ground directional element setting 1619 ROTATION ANGLE
Overhead Line 	60°	Range 30°...0° → 15°	–60°
Cable Line 	30°	Range 60°...30° → 45°	–30°
Transformer Infeed 	30°	Range 60°...30° → 45°	–30°

1) Power flow direction
2) With the assumption that these are cable lines

Before Version V4.60, the direction characteristic could only be set in three discrete positions. In the following, the settings are specified which correspond to the old parameters 1515 and 1615.

Up to V4.60	As of V4.60	
Addr. 1515 / 1615	Phase directional elements Addr. 1519	Ground directional element Addr. 1619
Inductive (135°)[1]	45°[1]	–45°[1]
Resistive (90°)	90°	0°
Capacitive (45°)	135°	45°

1) Default Setting

Directional Orientation

The directional orientation can be changed for the phase directional elements under address 1516 **67 Direction** and for the ground directional element under address 1616 **67N Direction**. Directional overcurrent protection normally operates in the direction of the protected object (line, transformer). If the protection device is properly connected in accordance with one of the circuit diagrams in Appendix A.3, this is the „forward“ direction.

Quantity Selection for the Direction Determination for the Ground Directional Element

Parameter 1617 **67N POLARIZAT.** can be set to specify whether direction determination is accomplished from the zero sequence quantities, the ground quantities (***with VN and IN***) or the negative sequence quantities (***with V2 and I2***) in the ground directional element. The first option is the preferential setting; the latter should be selected if there is the risk of the zero sequence voltage becoming extremely small due to unfavorable zero sequence impedance or a parallel line influencing the zero sequence system.

67-2 Directional High-set Element (Phases)

The pickup and delay of element 67-2 are set at addresses 1502 and 1503. For setting, the same considerations apply as did for the non-directional time overcurrent protection in Section 2.2.10.

The selected time is only an additional time delay and does not include the operating time (measuring time, dropout time). The delay can be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 67-2 element is not required at all, the pickup value **67-2 PICKUP** should be set to ∞. For this setting, there is neither a pickup signal generated nor a trip.

67N-2 Directional High-set Element (Ground)

The pickup and delay of element 67N-2 are set at addresses 1602 and 1603. The same considerations apply for these settings as did for phase currents discussed earlier.

The selected time is only an additional time delay and does not include the operating time (measuring time, dropout time). The delay can be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 67N-2 element is not required at all, then the pickup value **67N-2 PICKUP** should be set to ∞. This setting prevents from tripping and the generation of a pickup message.

67-1 Directional Overcurrent Element (Phases)

The pickup value of the 67-1 relay element 1504 **67-1 PICKUP** should be set above the maximum anticipated load current. Pickup due to overload should never occur, since the device in this operating mode operates as short circuit protection with correspondingly short tripping times and not as overload protection. For this reason, lines are set to approx. 20% above the maximum expected (over)load and transformers and motors to approx. 40%.

If the relay is used to protect transformers or motors with large inrush currents, the inrush restraint feature of 7SJ62/63/64 may be used for the 67-1 relay element (for more information see margin heading "Inrush Restraint").

The delay for directional elements (address 1505 **67-1 DELAY**) is usually set shorter than the delay for non-directional elements (address 1205) since the non-directional elements overlap the directional elements as backup protection. It should be based on the system coordination requirements for directional tripping.

For parallel transformers supplied from a single source (see "Usecases"), the delay of elements **67-1 DELAY** located on the load side of the transformers may be set to 0 without provoking negative impacts on selectivity.

The selected time is only an additional time delay and does not include the operating time (measuring time, dropout time). The delay can be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 67-1 element is not required at all, the pickup value **67-1 PICKUP** should be set to ∞. This setting prevents from tripping and the generation of a pickup message.

67N-1 Directional Relay Element (ground)

The pickup value of the 67N-1 relay element should be set below the minimum anticipated ground fault current.

If the relay is used to protect transformers or motors with large inrush currents, the inrush restraint feature of 7SJ62/63/64 may be used for the 67N-1 relay element (for more information see margin heading "Inrush Restraint").

The delay is set at address 1605 **67N-1 DELAY** and should be based on system coordination requirements for directional tripping. For ground currents in a grounded system a separate coordination chart with short time delays is often used.

The selected time is only an additional time delay and does not include the operating time (measuring time, dropout time). The delay can be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 67N-1 element is not required at all, the pickup value **67N-1 PICKUP** should be set to ∞. This setting prevents from tripping and the generation of a pickup message.

Pickup Stabilization (67/67N Directional)

Pickup of the direction 67/67N elements can be stabilized by setting dropout times 1518 **67 T DROP-OUT** or 1618 **67N T DROP-OUT**.

67-TOC Directional Element with IEC or ANSI Curves (Phases)

Having set address 115 **67/67-TOC** = ***TOC IEC*** or ***TOC ANSI*** when configuring the protective functions (Section 2.1.1), the parameters for the inverse characteristics will also be available.

If the relay is used to protect transformers or motors with large inrush currents, the inrush restraint feature of 7SJ62/63/64 may be used for the 67-TOC relay element (for more information see margin heading "Inrush Restraint").

If the inverse time trip characteristic is selected, it must be noted that a safety factor of about 1.1 has already been included between the pickup value and the setting value. This means that a pickup will only occur if a current of about 1.1 times the setting value is present.

The current value is set in address 1507 **67-TOC PICKUP**. The setting is mainly determined by the maximum operating current. Pickup due to overload should never occur, since the device in this operating mode operates as fault protection with correspondingly short tripping times and not as overload protection.

The corresponding element time multiplication factor for an IEC characteristic is set at address 1508 **67 TIME DIAL** and in address 1509 **67 TIME DIAL** for an ANSI characteristic. It must be coordinated with the time grading of the network.

The time multiplier can also be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 67-TOC element is not required at all, address 115 **67/67-TOC** should be set to ***Definite Time*** during protective function configuration (see Section 2.1.1).

If address 115 **67/67-TOC** = ***TOC IEC***, you can specify the desired IEC–characteristic (***Normal Inverse***, ***Very Inverse***, ***Extremely Inv.*** or ***Long Inverse***) in address 1511 **67- IEC CURVE**. If address 115 **67/67-TOC** = ***TOC ANSI*** you can specify the desired ANSI–characteristic (***Very Inverse***, ***Inverse***, ***Short Inverse***, ***Long Inverse***, ***Moderately Inv.***, ***Extremely Inv.*** or ***Definite Inv.***) in address 1512 **67- ANSI CURVE**.

67N-TOC Directional Element with IEC or ANSI Curves (ground)

Having set address 116 **67N/67N-TOC** = ***TOC IEC*** when configuring the protective functions (Section 2.1.1), the parameters for the inverse characteristics will also be available. Specify in address 1611 **67N-TOC IEC** the desired IEC characteristic (***Normal Inverse***, ***Very Inverse***, ***Extremely Inv.*** or ***Long Inverse***). If address 116 **67N/67N-TOC** = ***TOC ANSI***, you can specify the desired ANSI–characteristic (***Very Inverse***, ***Inverse***, ***Short Inverse***, ***Long Inverse***, ***Moderately Inv.***, ***Extremely Inv.*** or ***Definite Inv.***) in address 1612 **67N-TOC ANSI**.

If the relay is used to protect transformers or motors with large inrush currents, the inrush restraint feature of 7SJ62/63/64 may be used for the 67N-TOC relay element (for more information see margin heading "Inrush Restraint").

If the inverse time trip characteristic is selected, it must be noted that a safety factor of about 1.1 has already been included between the pickup value and the setting value **67N-TOC PICKUP**. This means that a pickup will only occur if a current of about 1.1 times the setting value is present. If ***Disk Emulation*** was selected at address 1610 **67N-TOC DropOut**, reset will occur in accordance with the reset curve as for the existing non-directional time overcurrent protection described in Section 2.2.

The current value is set at address 1607 **67N-TOC PICKUP**. The minimum appearing ground fault current is most relevant for this setting.

The corresponding element time multiplication factor for an IEC characteristic is set at address 1608 **67N-TOC T-DIAL** and in address 1609 **67N-TOC T-DIAL** for an ANSI characteristic. This has to be coordinated with the system grading coordination chart for directional tripping. For ground currents with grounded network, you can mostly set up a separate grading coordination chart with shorter delay times.

The time multiplier can also be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the 67N-TOC element is not required at all, address 116 **67N/67N-TOC** should be set to ***Definite Time*** during protective function configuration (see Section 2.1.1).

User-defined characteristic (Inverse Time Phases and ground)

If address 115 or 116 were set to ***User Defined PU*** or ***User def. Reset*** during configuration of the user-defined characteristic option, a maximum of 20 value pairs (current and time) may be entered at address 1530 **67** or 1630 **M.of PU TD**. This option allows point-by-point entry of any desired curve.

If address 115 or 116 were set to ***User def. Reset*** during configuration, additional value pairs (current and reset time) may be entered in address 1531 **MofPU Res T/Tp** or 1631 **I/IEp Rf T/TEp** to represent the reset curve.

Entry of the value pair (current and time) is a multiple of the settings of the values of the addresses 1507 **67-TOC PICKUP** or 1607 **67N-TOC PICKUP** and 1508 **67 TIME DIAL** or 1608. **67N-TOC T-DIAL**. Therefore, it is recommended that parameter values are initially set to 1.00 for simplicity. Once the curve is entered, the settings at addresses 1507 and 1607 or/and 1508 and 1608 may be modified later on if necessary.

The default setting of current values is ∞. They are, therefore, not enabled — and no pickup or tripping of these protective functions will occur.

The following must be observed:

- The value pairs should be entered in increasing sequence. If desired, fewer than 20 pairs may be entered. In most cases, about 10 pairs is sufficient to define the characteristic accurately. A value pair which will not be used has to be made invalid entering „∞“ for the threshold! The user must ensure the value pairs produce a clear and constant characteristic.

  The current values entered should be those from the following Table, along with the matching times. Deviating values I/I_p are rounded. This, however, will not be indicated.

  Current flows less than the smallest current value entered will not lead to an extension of the tripping time. The pickup curve (see Figure 2-13, right side) goes parallel to the current axis, up to the smallest current point.

  Current flows greater than the highest current value entered will not lead to a reduction of the tripping time. The pickup characteristic (see Figure 2-13, right side) goes parallel to the current axis, beginning with the greatest current point.

Table 2-8 Preferential values of standardized currents for user-defined tripping curves

I/Ip = 1 to 1.94		I/Ip = 2 to 4.75		I/Ip = 5 to 7.75		I/Ip = 8 to 20	
1.00	1.50	2.00	3.50	5.00	6.50	8.00	15.00
1.06	1.56	2.25	3.75	5.25	6.75	9.00	16.00
1.13	1.63	2.50	4.00	5.50	7.00	10.00	17.00
1.19	1.69	2.75	4.25	5.75	7.25	11.00	18.00
1.25	1.75	3.00	4.50	6.00	7.50	12.00	19.00
1.31	1.81	3.25	4.75	6.25	7.75	13.00	20.00
1.38	1.88					14.00	
1.44	1.94						

The value pairs are entered at address 1531 **MofPU Res T/Tp** to recreate the reset curve. The following must be observed:

- The current values entered should be those from Table 2-8, along with the matching times. Deviating values I/Ip are rounded. This, however, will not be indicated.

  Current flows greater than the highest current value entered will not lead to a prolongation of the reset time. The reset curve (see Figure 2-13, left side) is parallel to the current axis, beginning with the largest current point.

  Current flows which are less than the smallest current value entered will not lead to a reduction of the reset time. The reset curve (see Figure 2-13, left side) is parallel to the current axis, beginning with the smallest current point.

Table 2-9 Preferential values of standardized currents for user-defined reset curves

I/Ip = 1 to 0.86		I/Ip = 0.84 to 0.67		I/Ip = 0.66 to 0.38		I/Ip = 0.34 to 0.00	
1.00	0.93	0.84	0.75	0.66	0.53	0.34	0.16
0.99	0.92	0.83	0.73	0.64	0.50	0.31	0.13
0.98	0.91	0.81	0.72	0.63	0.47	0.28	0.09
0.97	0.90	0.80	0.70	0.61	0.44	0.25	0.06
0.96	0.89	0.78	0.69	0.59	0.41	0.22	0.03
0.95	0.88	0.77	0.67	0.56	0.38	0.19	0.00
0.94	0.86						

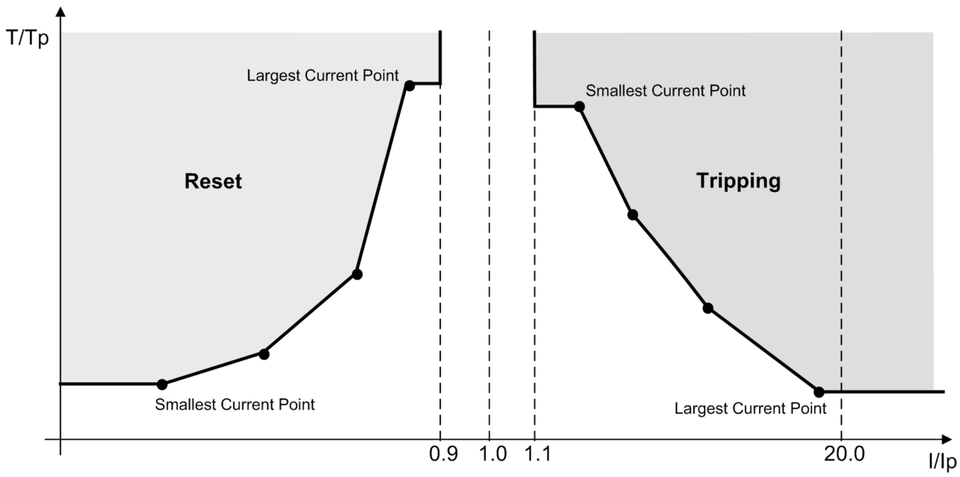


Figure 2-29 Using a user-defined curve

Inrush Restraint

When applying the protection device to transformers where high inrush currents are to be expected, the 7SJ62/63/64 can make use of an inrush restraint function for the directional overcurrent elements `67-1`, `67-TOC`, `67N-1` and `67N-TOC` as well as the non-directional overcurrent elements. The inrush restraint option is enabled or disabled in 2201 **`INRUSH REST.`** (in the settings option **non-directional** time overcurrent protection). The characteristic values of the inrush restraint are already listed in the section discussing the non-directional time overcurrent (Section 2.2.10).

Manual Close Mode (Phases, ground)

When a circuit breaker is closed onto a faulted line, a high speed trip by the circuit breaker is often desired. For overcurrent or high-set element the delay may be bypassed via a Manual Close pulse, thus resulting in instantaneous tripping. This pulse is prolonged by at least 300 ms. To enable the device to react properly on occurrence of a fault in the phase elements after manual close, address 1513 **`MANUAL CLOSE`** has to be set accordingly. Accordingly, address 1613 **`MANUAL CLOSE`** is considered for the ground path address. Thus, the user determines for both elements, the phase and the ground element, what pickup value is active with what delay when the circuit breaker is closed manually.

External Control Switch

If the manual closing signal is not from a 7SJ62/63/64 relay, that is, neither sent via the built-in operator interface nor via a series interface, but, rather, directly from a control acknowledgment switch, this signal must be passed to a 7SJ62/63/64 binary input, and configured accordingly („`>Manual Close`“), so that the element selected for **`MANUAL CLOSE`** will be effective. ***`Inactive`*** means that the element operates as configured even with manual close.

Internal Control Function

The manual closing information must be allocated via CFC (interlocking task-level) using the CMD_Information block, if the internal control function is used.

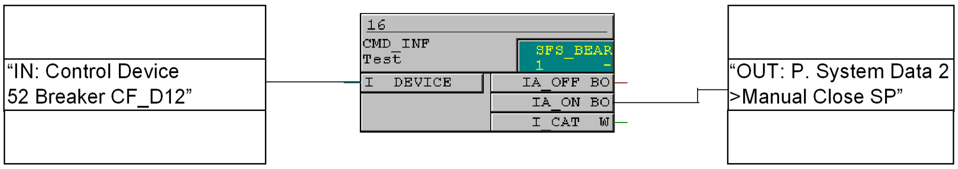


Figure 2-30 Example for manual close feature using the internal control function

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Note

For an interaction between the automatic reclosure (AR) and the control function, an extended CFC logic is necessary. See margin heading „CLOSE command: Directly or via control“ in the Setting Notes of the AR function (Section 2.14.6).

Interaction with Automatic Reclosure Function (Phases)

When reclosing occurs, it is desirable to have high speed protection against faults with 67-2. If the fault still exists after the first reclosure, elements 67-1 or 67-TOC will be initiated with graded tripping times, i.e., the 67-2 elements will be blocked. At address 1514 **67 active**, it can be specified whether (***with 79 active***) or not (***Always***) the 67-2 elements should be supervised by the status of an internal or external automatic reclosing device. Address ***with 79 active*** determines that the 67-2 elements will not operate unless automatic reclosing is not blocked. If not desired, then setting ***Always*** is selected having the effect that the 67-2 elements will always operate, as configured.

The integrated automatic reclosing function of 7SJ62/63/64 also provides the option to individually determine for each time overcurrent element whether instantaneous tripping, i.e. normal time delayed tripping unaffected by the automatic reclosing, or blocking shall take place (see Section 2.14).

Interaction with Automatic Reclosing Function (ground)

When reclosing occurs, it is desirable to have high speed protection against faults with 67N-2. If the fault still exists after the first reclosure, elements 67N-1 or 67N-TOC will be initiated with graded tripping times, i.e. the 67N-2 elements will be blocked. At address 1614 **67N active**, it can be specified whether (***with 79 active***) or not (***Always***) the 67N-2 elements should be supervised by the status of an internal or external automatic reclosing device. Address ***with 79 active*** determines that the 67N-2 elements will not operate unless automatic reclosing is not blocked. If not desired, then setting ***Always*** is selected having the effect that the 67N-2 elements will always operate, as configured.

The integrated automatic reclosing function of 7SJ62/63/64 also provides the option to individually determine for each time overcurrent element whether instantaneous tripping, i.e. normal time delayed tripping unaffected by the automatic reclosing, or blocking shall take place (see Section 2.14).

2.3.11 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
1501	FCT 67/67-TOC		OFF ON	OFF	67, 67-TOC Phase Time Overcurrent
1502	67-2 PICKUP	1A	0.10 .. 35.00 A; ∞	2.00 A	67-2 Pickup
		5A	0.50 .. 175.00 A; ∞	10.00 A	
1503	67-2 DELAY		0.00 .. 60.00 sec; ∞	0.10 sec	67-2 Time Delay
1504	67-1 PICKUP	1A	0.10 .. 35.00 A; ∞	1.00 A	67-1 Pickup
		5A	0.50 .. 175.00 A; ∞	5.00 A	
1505	67-1 DELAY		0.00 .. 60.00 sec; ∞	0.50 sec	67-1Time Delay
1507	67-TOC PICKUP	1A	0.10 .. 4.00 A	1.00 A	67-TOC Pickup
		5A	0.50 .. 20.00 A	5.00 A	
1508	67 TIME DIAL		0.05 .. 3.20 sec; ∞	0.50 sec	67-TOC Time Dial
1509	67 TIME DIAL		0.50 .. 15.00 ; ∞	5.00	67-TOC Time Dial
1510	67-TOC Drop-out		Instantaneous Disk Emulation	Disk Emulation	Drop-Out Characteristic
1511	67- IEC CURVE		Normal Inverse Very Inverse Extremely Inv. Long Inverse	Normal Inverse	IEC Curve
1512	67- ANSI CURVE		Very Inverse Inverse Short Inverse Long Inverse Moderately Inv. Extremely Inv. Definite Inv.	Very Inverse	ANSI Curve
1513A	MANUAL CLOSE		67-2 instant. 67-1 instant. 67-TOC instant. Inactive	67-2 instant.	Manual Close Mode
1514A	67 active		with 79 active always	always	67 active
1516	67 Direction		Forward Reverse	Forward	Phase Direction
1518A	67 T DROP-OUT		0.00 .. 60.00 sec	0.00 sec	67 Drop-Out Time Delay
1519A	ROTATION ANGLE		-180 .. 180 °	45 °	Rotation Angle of Reference Voltage
1530	67		1.00 .. 20.00 I/Ip; ∞ 0.01 .. 999.00 TD		67

Addr.	Parameter	C	Setting Options	Default Setting	Comments
1531	MofPU Res T/Tp		0.05 .. 0.95 I/Ip; ∞ 0.01 .. 999.00 TD		Multiple of Pickup <-> T/Tp
1601	FCT 67N/67N-TOC		OFF ON	OFF	67N, 67N-TOC Ground Time Overcurrent
1602	67N-2 PICKUP	1A	0.05 .. 35.00 A; ∞	0.50 A	67N-2 Pickup
		5A	0.25 .. 175.00 A; ∞	2.50 A	
1603	67N-2 DELAY		0.00 .. 60.00 sec; ∞	0.10 sec	67N-2 Time Delay
1604	67N-1 PICKUP	1A	0.05 .. 35.00 A; ∞	0.20 A	67N-1 Pickup
		5A	0.25 .. 175.00 A; ∞	1.00 A	
1605	67N-1 DELAY		0.00 .. 60.00 sec; ∞	0.50 sec	67N-1 Time Delay
1607	67N-TOC PICKUP	1A	0.05 .. 4.00 A	0.20 A	67N-TOC Pickup
		5A	0.25 .. 20.00 A	1.00 A	
1608	67N-TOC T-DIAL		0.05 .. 3.20 sec; ∞	0.20 sec	67N-TOC Time Dial
1609	67N-TOC T-DIAL		0.50 .. 15.00 ; ∞	5.00	67N-TOC Time Dial
1610	67N-TOC DropOut		Instantaneous Disk Emulation	Disk Emulation	Drop-Out Characteristic
1611	67N-TOC IEC		Normal Inverse Very Inverse Extremely Inv. Long Inverse	Normal Inverse	IEC Curve
1612	67N-TOC ANSI		Very Inverse Inverse Short Inverse Long Inverse Moderately Inv. Extremely Inv. Definite Inv.	Very Inverse	ANSI Curve
1613A	MANUAL CLOSE		67N-2 instant. 67N-1 instant. 67N-TOC instant Inactive	67N-2 instant.	Manual Close Mode
1614A	67N active		always with 79 active	always	67N active
1616	67N Direction		Forward Reverse	Forward	Ground Direction
1617	67N POLARIZAT.		with VN and IN with V2 and I2	with VN and IN	Ground Polarization
1618A	67N T DROP-OUT		0.00 .. 60.00 sec	0.00 sec	67N Drop-Out Time Delay
1619A	ROTATION ANGLE		-180 .. 180 °	-45 °	Rotation Angle of Reference Voltage
1630	M.of PU TD		1.00 .. 20.00 I/Ip; ∞ 0.01 .. 999.00 TD		Multiples of PU Time-Dial
1631	I/IEp Rf T/TEp		0.05 .. 0.95 I/Ip; ∞ 0.01 .. 999.00 TD		67N TOC

2.3.12 Information List

No.	Information	Type of In-formation	Comments
2604	>BLK 67/67-TOC	SP	>BLOCK 67/67-TOC
2614	>BLK 67N/67NTOC	SP	>BLOCK 67N/67N-TOC
2615	>BLOCK 67-2	SP	>BLOCK 67-2
2616	>BLOCK 67N-2	SP	>BLOCK 67N-2
2621	>BLOCK 67-1	SP	>BLOCK 67-1
2622	>BLOCK 67-TOC	SP	>BLOCK 67-TOC
2623	>BLOCK 67N-1	SP	>BLOCK 67N-1
2624	>BLOCK 67N-TOC	SP	>BLOCK 67N-TOC
2628	Phase A forward	OUT	Phase A forward
2629	Phase B forward	OUT	Phase B forward
2630	Phase C forward	OUT	Phase C forward
2632	Phase A reverse	OUT	Phase A reverse
2633	Phase B reverse	OUT	Phase B reverse
2634	Phase C reverse	OUT	Phase C reverse
2635	Ground forward	OUT	Ground forward
2636	Ground reverse	OUT	Ground reverse
2637	67-1 BLOCKED	OUT	67-1 is BLOCKED
2642	67-2 picked up	OUT	67-2 picked up
2646	67N-2 picked up	OUT	67N-2 picked up
2647	67-2 Time Out	OUT	67-2 Time Out
2648	67N-2 Time Out	OUT	67N-2 Time Out
2649	67-2 TRIP	OUT	67-2 TRIP
2651	67/67-TOC OFF	OUT	67/67-TOC switched OFF
2652	67 BLOCKED	OUT	67/67-TOC is BLOCKED
2653	67 ACTIVE	OUT	67/67-TOC is ACTIVE
2655	67-2 BLOCKED	OUT	67-2 is BLOCKED
2656	67N OFF	OUT	67N/67N-TOC switched OFF
2657	67N BLOCKED	OUT	67N/67N-TOC is BLOCKED
2658	67N ACTIVE	OUT	67N/67N-TOC is ACTIVE
2659	67N-1 BLOCKED	OUT	67N-1 is BLOCKED
2660	67-1 picked up	OUT	67-1 picked up
2664	67-1 Time Out	OUT	67-1 Time Out
2665	67-1 TRIP	OUT	67-1 TRIP
2668	67N-2 BLOCKED	OUT	67N-2 is BLOCKED
2669	67-TOC BLOCKED	OUT	67-TOC is BLOCKED
2670	67-TOC pickedup	OUT	67-TOC picked up
2674	67-TOC Time Out	OUT	67-TOC Time Out
2675	67-TOC TRIP	OUT	67-TOC TRIP
2676	67-TOC DiskPU	OUT	67-TOC disk emulation is ACTIVE
2677	67N-TOC BLOCKED	OUT	67N-TOC is BLOCKED
2679	67N-2 TRIP	OUT	67N-2 TRIP
2681	67N-1 picked up	OUT	67N-1 picked up
2682	67N-1 Time Out	OUT	67N-1 Time Out
2683	67N-1 TRIP	OUT	67N-1 TRIP

No.	Information	Type of Information	Comments
2684	67N-TOCPickedup	OUT	67N-TOC picked up
2685	67N-TOC TimeOut	OUT	67N-TOC Time Out
2686	67N-TOC TRIP	OUT	67N-TOC TRIP
2687	67N-TOC Disk PU	OUT	67N-TOC disk emulation is ACTIVE
2691	67/67N pickedup	OUT	67/67N picked up
2692	67 A picked up	OUT	67/67-TOC Phase A picked up
2693	67 B picked up	OUT	67/67-TOC Phase B picked up
2694	67 C picked up	OUT	67/67-TOC Phase C picked up
2695	67N picked up	OUT	67N/67N-TOC picked up
2696	67/67N TRIP	OUT	67/67N TRIP

2.4 Dynamic Cold Load Pickup

With the cold load pickup function, pickup and delay settings of directional and non-directional time overcurrent protection can be changed over dynamically.

Applications

- It may be necessary to dynamically increase the pickup values if, during starting and for a short time thereafter, certain elements of the system have an increased power consumption after a long period of zero voltage (e.g. air-conditioning systems, heating installations, motors). Thus a raise of pickup thresholds can be avoided by taking into consideration such starting conditions.
- As a further option the pickup thresholds may be modified by an automatic reclosure function in accordance with its ready or not ready state.

Prerequisites

Note:

Dynamic cold load pickup is not be confused with the changeover option of the 4 setting groups (A to D). It is an additional feature.

It is possible to change pickup thresholds and delay times.

2.4.1 Description

Effect

There are two methods by which the device can determine if the protected equipment is de-energized:

- Via binary inputs, the device is informed of the position of the circuit breaker (address 1702 **Start Condition** = ***Breaker Contact***).
- As a criterion a set current threshold is undershot (address 1702 **Start Condition** = ***No Current***).

If the device determines that the protected equipment is de-energized via one of the above methods, a time, **CB Open Time**, is started and after its expiration the increased thresholds take effect.

In addition, switching between parameters can be triggered by two further events:

- by signal "79M Auto Reclosing ready" of the internal automatic reclosure function (address 1702 **Start Condition** = ***79 ready***). Thus the protection thresholds and the tripping times can be changed if automatic reclosure is ready for reclosing (see also Section 2.14).
- Irrespective of the setting of parameter 1702 **Start Condition** the release of cold load pickup may always be selected via the binary input „>ACTIVATE CLP“.

Figure 2-32 shows the logic diagram for dynamic cold load pickup function.

When the auxiliary contact or current criterion detects that the system is de-energized, i.e. the circuit breaker is open, the CB open time **CB Open Time** is started. As soon as it times out, the greater thresholds are enabled. When the protected equipment is re-energized (the device receives this information via the binary inputs or when threshold **BkrClosed I MIN** is exceeded), a second time delay referred to as the **Active Time** is initiated. Once it elapses, the pickup values of the relay elements return to their normal settings. The time may be reduced when current values after startup, i.e. after the circuit breaker is closed, fall below all normal pickup values for a set time, **Stop Time**. The starting condition of the fast reset time is made up of an OR-combination of the configured dropout conditions of all non-directional time overcurrent elements. When **Stop Time** is set to ∞ or when binary input „>BLK CLP stpTim“ is active, no comparison is made with the "normal" thresholds. The function is inactive and the fast reset time, if applied, is reset.

If overcurrent elements are picked up while time **Active Time** is running, the fault generally prevails until pickup drops out, using the dynamic settings. Only then the parameters are set back to "normal".

When the dynamic setting values are activated via the binary input „>ACTIVATE CLP“ or the signal "79M Auto Reclosing ready" and this causes drops out, the "normal" settings are restored immediately, even if a pick up is the result.

When binary input „>BLOCK CLP“ is enabled, all triggered timers will be reset and, as a consequence, all "normal" settings will be immediately restored. If blocking occurs during an on-going fault with dynamic cold load pick-up functions enabled, the timers of all non-directional overcurrent relay elements will be stopped, and may then be restarted based on their normal duration.

During power up of the protective relay with an open circuit breaker, the time delay **CB Open Time** is started, and is processed using the "normal" settings. Therefore, when the circuit breaker is closed, the "normal" settings are effective.

Figure 2-31 illustrates the timing sequence. Figure 2-32 shows the logic diagram of the dynamic cold load pickup feature.

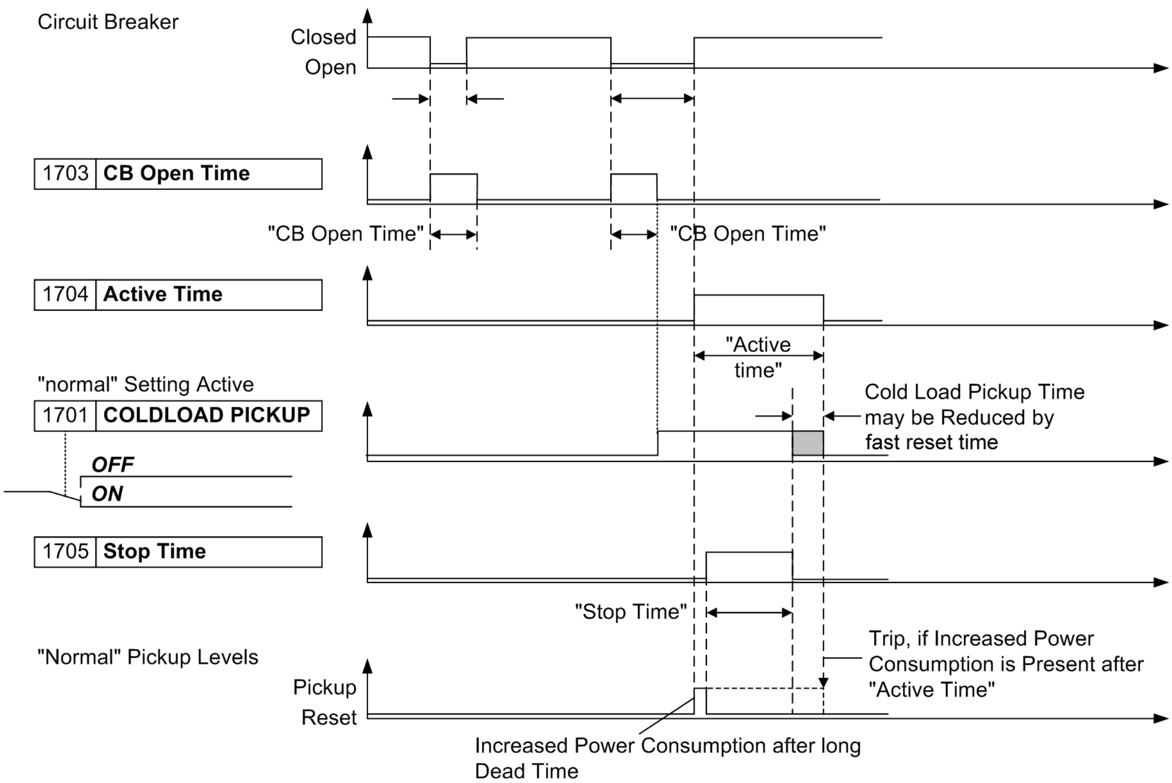


Figure 2-31 Timing charts of the dynamic cold load pickup function

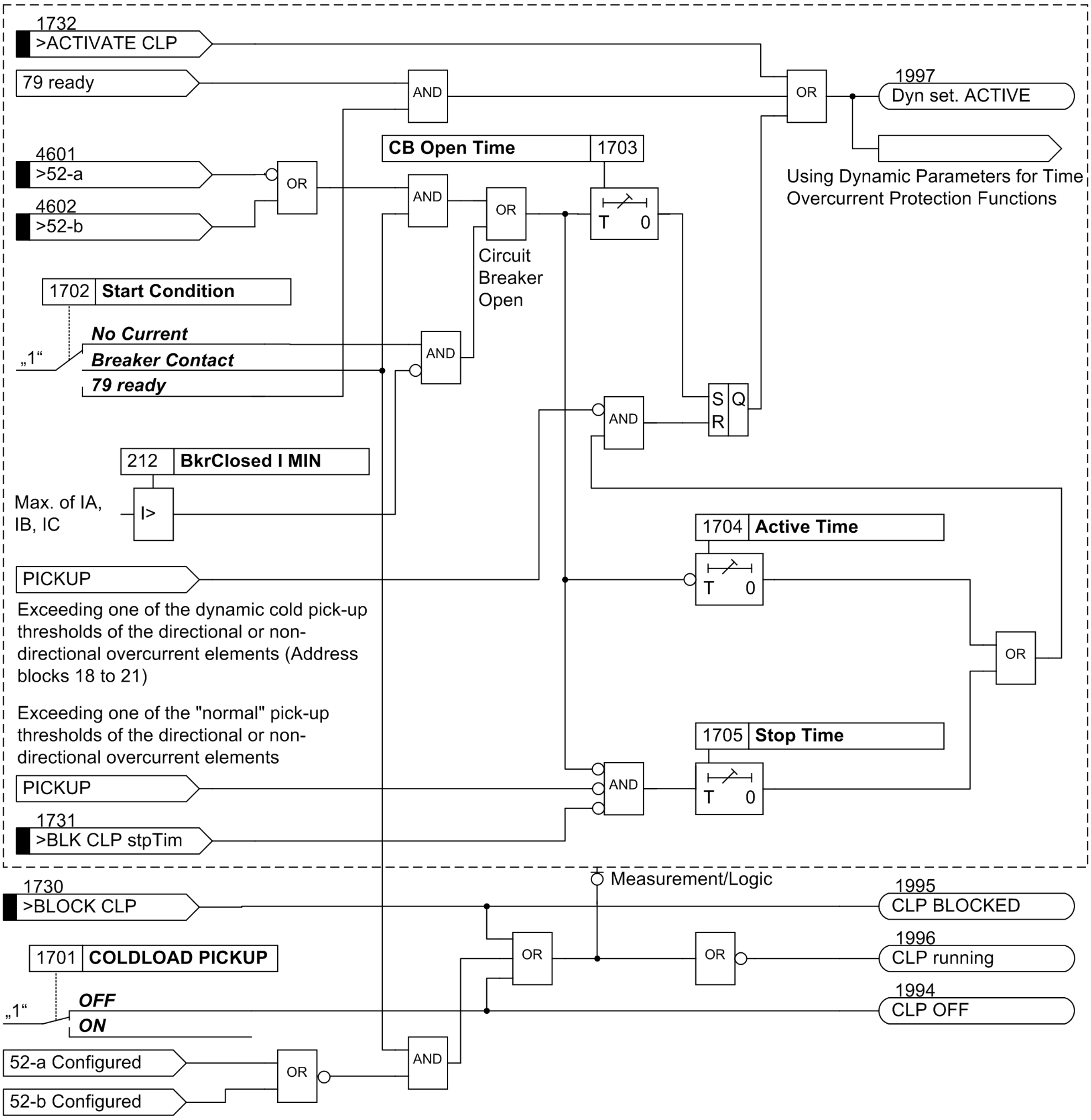


Figure 2-32 Logic diagram of the dynamic cold load pickup function (50c, 50Nc, 51c, 51Nc, 67c, 67Nc)

2.4.2 Setting Notes

General

The dynamic cold load pickup function can only be enabled if address 117 **Coldload Pickup** was set to ***Enabled*** during configuration of the protective functions. If not required, this function should be set to ***Disabled***. The function can be turned ***ON*** or ***OFF*** under address 1701 **Coldload Pickup**.

Depending on the condition that should initiate the cold load pickup function address 1702 **Start Condition** is set to either ***No Current***, ***Breaker Contact*** or to ***79 ready***. Naturally, the option ***Breaker Contact*** can only be selected if the device receives information regarding the switching state of the circuit breaker via at least one binary input. The option ***79 ready*** modifies dynamically the pickup thresholds of the directional and non-directional time overcurrent protection when the automatic reclosing feature is ready. To initiate the cold load pickup the automatic reclosing function provides the internal signal "79M Auto Reclosing ready". It is always active when autoreclosure is available, activated, unblocked and ready for a further cycle (see also margin heading "Controlling Directional/Non-Directional Overcurrent Protection Elements via Cold Load Pickup" in Section 2.14.6).

Time Delays

There are no specific procedures on how to set the time delays at addresses 1703 **CB Open Time**, 1704 **Active Time** and 1705 **Stop Time**. These time delays must be based on the specific loading characteristics of the equipment being protected, and should be set to allow for brief overloads associated with dynamic cold load conditions.

Non-Directional 50/51 Elements (Phases)

The dynamic pickup values and time delays associated with non-directional time overcurrent protection are set at address block 18 (**50C.../51C...**) for phase currents:

The dynamic pickup and delay settings for the 50N-2 element are set at addresses 1801 **50c-2 PICKUP** and 1802 **50c-2 DELAY** respectively; the dynamic pickup and delay settings for the 50N-1 element are set at addresses 1803 **50c-1 PICKUP** and 1804 **50c-1 DELAY** respectively; and the pickup, time multiplier (for IEC curves or user-defined curves), and time dial (for ANSI curves) settings for the 51N element are set at addresses 1805 **51c PICKUP**, 1806 **51c TIME DIAL**, and 1807 **51c TIME DIAL**, respectively.

Non-Directional 50N/51N Elements (ground)

The dynamic pickup values and time delays associated with non-directional time overcurrent ground protection are set at address block 19 (**50NC.../51NC...**):

The dynamic pickup and delay settings for the 50N-2 element are set at addresses 1901 **50Nc-2 PICKUP** and 1902 **50Nc-2 DELAY** respectively; the dynamic pickup and delay settings for the 50N-1 element are set at addresses 1903 **50Nc-1 PICKUP** and 1904 **50Nc-1 DELAY** respectively; and the pickup, time multiplier (for IEC curves or user-defined curves), and time dial (for ANSI curves) settings for the 51N element are set at addresses 1905 **51Nc PICKUP**, 1906 **51Nc T-DIAL**, and 1907 **51Nc T-DIAL**, respectively.

Directional 67/67–TOC Elements (Phases)

The dynamic pickup values and time delays associated with directional overcurrent phase protection are set at address block 20 (**g67C...**):

The dynamic pickup and delay settings for the 67-2 element are set at addresses 2001 **67c-2 PICKUP** and 2002 **67c-2 DELAY** respectively; the dynamic pickup and delay settings for the 67-1 element are set at addresses 2003 **67c-1 PICKUP** and 2004 **67c-1 DELAY** respectively; and the pickup, time multiplier (for IEC curves or user-defined curves), and time dial (for ANSI curves) settings for the 67-TOC element are set at addresses 2005 **67c-TOC PICKUP**, 2006 **67c-TOC T-DIAL** , and 2007 **67c-TOC T-DIAL** respectively.

Directional 67/67N Elements (ground)

The dynamic pickup values and time delays associated with directional overcurrent ground protection are set at address block 21 (**gU/AMZ E dynP.**):

The dynamic pickup and delay settings for the 67N-2 element are set at addresses 2101 **67Nc-2 PICKUP** and 2102 **67Nc-2 DELAY** respectively; the dynamic pickup and delay settings for the 67N-1 element are set at addresses 2103 **67Nc-1 PICKUP** and 2104 **67Nc-1 DELAY** respectively; and the pickup, time multiplier (for IEC curves or user-defined curves), and time dial (for ANSI curves) settings for the 67N-TOC element are set at addresses 2105 **67Nc-TOC PICKUP**, 2106 **67Nc-TOC T-DIAL**, 2107 **67Nc-TOC T-DIAL**, respectively.

2.4.3 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
1701	COLDLOAD PICKUP		OFF ON	OFF	Cold-Load-Pickup Function
1702	Start Condition		No Current Breaker Contact 79 ready	No Current	Start Condition
1703	CB Open Time		0 .. 21600 sec	3600 sec	Circuit Breaker OPEN Time
1704	Active Time		1 .. 21600 sec	3600 sec	Active Time
1705	Stop Time		1 .. 600 sec; ∞	600 sec	Stop Time
1801	50c-2 PICKUP	1A	0.10 .. 35.00 A; ∞	10.00 A	50c-2 Pickup
		5A	0.50 .. 175.00 A; ∞	50.00 A	
1802	50c-2 DELAY		0.00 .. 60.00 sec; ∞	0.00 sec	50c-2 Time Delay
1803	50c-1 PICKUP	1A	0.10 .. 35.00 A; ∞	2.00 A	50c-1 Pickup
		5A	0.50 .. 175.00 A; ∞	10.00 A	
1804	50c-1 DELAY		0.00 .. 60.00 sec; ∞	0.30 sec	50c-1 Time Delay
1805	51c PICKUP	1A	0.10 .. 4.00 A	1.50 A	51c Pickup
		5A	0.50 .. 20.00 A	7.50 A	
1806	51c TIME DIAL		0.05 .. 3.20 sec; ∞	0.50 sec	51c Time dial
1807	51c TIME DIAL		0.50 .. 15.00 ; ∞	5.00	51c Time dial
1901	50Nc-2 PICKUP	1A	0.05 .. 35.00 A; ∞	7.00 A	50Nc-2 Pickup
		5A	0.25 .. 175.00 A; ∞	35.00 A	
1902	50Nc-2 DELAY		0.00 .. 60.00 sec; ∞	0.00 sec	50Nc-2 Time Delay
1903	50Nc-1 PICKUP	1A	0.05 .. 35.00 A; ∞	1.50 A	50Nc-1 Pickup
		5A	0.25 .. 175.00 A; ∞	7.50 A	
1904	50Nc-1 DELAY		0.00 .. 60.00 sec; ∞	0.30 sec	50Nc-1 Time Delay

Addr.	Parameter	C	Setting Options	Default Setting	Comments
1905	51Nc PICKUP	1A	0.05 .. 4.00 A	1.00 A	51Nc Pickup
		5A	0.25 .. 20.00 A	5.00 A	
1906	51Nc T-DIAL		0.05 .. 3.20 sec; ∞	0.50 sec	51Nc Time Dial
1907	51Nc T-DIAL		0.50 .. 15.00 ; ∞	5.00	51Nc Time Dial
2001	67c-2 PICKUP	1A	0.10 .. 35.00 A; ∞	10.00 A	67c-2 Pickup
		5A	0.50 .. 175.00 A; ∞	50.00 A	
2002	67c-2 DELAY		0.00 .. 60.00 sec; ∞	0.00 sec	67c-2 Time Delay
2003	67c-1 PICKUP	1A	0.10 .. 35.00 A; ∞	2.00 A	67c-1 Pickup
		5A	0.50 .. 175.00 A; ∞	10.00 A	
2004	67c-1 DELAY		0.00 .. 60.00 sec; ∞	0.30 sec	67c-1 Time Delay
2005	67c-TOC PICKUP	1A	0.10 .. 4.00 A	1.50 A	67c Pickup
		5A	0.50 .. 20.00 A	7.50 A	
2006	67c-TOC T-DIAL		0.05 .. 3.20 sec; ∞	0.50 sec	67c Time Dial
2007	67c-TOC T-DIAL		0.50 .. 15.00 ; ∞	5.00	67c Time Dial
2101	67Nc-2 PICKUP	1A	0.05 .. 35.00 A; ∞	7.00 A	67Nc-2 Pickup
		5A	0.25 .. 175.00 A; ∞	35.00 A	
2102	67Nc-2 DELAY		0.00 .. 60.00 sec; ∞	0.00 sec	67Nc-2 Time Delay
2103	67Nc-1 PICKUP	1A	0.05 .. 35.00 A; ∞	1.50 A	67Nc-1 Pickup
		5A	0.25 .. 175.00 A; ∞	7.50 A	
2104	67Nc-1 DELAY		0.00 .. 60.00 sec; ∞	0.30 sec	67Nc-1 Time Delay
2105	67Nc-TOC PICKUP	1A	0.05 .. 4.00 A	1.00 A	67Nc-TOC Pickup
		5A	0.25 .. 20.00 A	5.00 A	
2106	67Nc-TOC T-DIAL		0.05 .. 3.20 sec; ∞	0.50 sec	67Nc-TOC Time Dial
2107	67Nc-TOC T-DIAL		0.50 .. 15.00 ; ∞	5.00	67Nc-TOC Time Dial

2.4.4 Information List

No.	Information	Type of Information	Comments
1730	>BLOCK CLP	SP	>BLOCK Cold-Load-Pickup
1731	>BLK CLP stpTim	SP	>BLOCK Cold-Load-Pickup stop timer
1732	>ACTIVATE CLP	SP	>ACTIVATE Cold-Load-Pickup
1994	CLP OFF	OUT	Cold-Load-Pickup switched OFF
1995	CLP BLOCKED	OUT	Cold-Load-Pickup is BLOCKED
1996	CLP running	OUT	Cold-Load-Pickup is RUNNING
1997	Dyn set. ACTIVE	OUT	Dynamic settings are ACTIVE

2.5 Single-Phase Overcurrent Protection

The single-phase overcurrent protection evaluates the current that is measured by the sensitive I_{NS}- or the normal I_N input. Which transformer is used depends on the device version and the order number.

Applications

- Plain ground fault protection at a power transformer;
- Sensitive tank leakage protection.

2.5.1 Functional Description

The single-phase time overcurrent function yields the tripping characteristic depicted in Figure 2-33. Numerical algorithms filter the current to be detected. A particular narrow-band filter is used due to the possible high sensitivity. The current pickup thresholds and tripping times can be set. The detected current is compared to the pickup value **50 1Ph-1 PICKUP** or **50 1Ph-2 PICKUP** and reported if this is violated. The trip command is generated after the associated delay time **50 1Ph-1 DELAY** or **50 1Ph-2 DELAY** has elapsed. The two elements together form a two-stage protection. The dropout value is roughly equal to 95% of the pickup value for currents $I > 0.3 \cdot I_{Nom}$.

The current filter is bypassed if currents are extremely high to achieve a short tripping time. This will always happen automatically when the instantaneous current value exceeds the setting value of the **50 1Ph-2 PICKUP** element by at least factor $2 \cdot \sqrt{2}$.

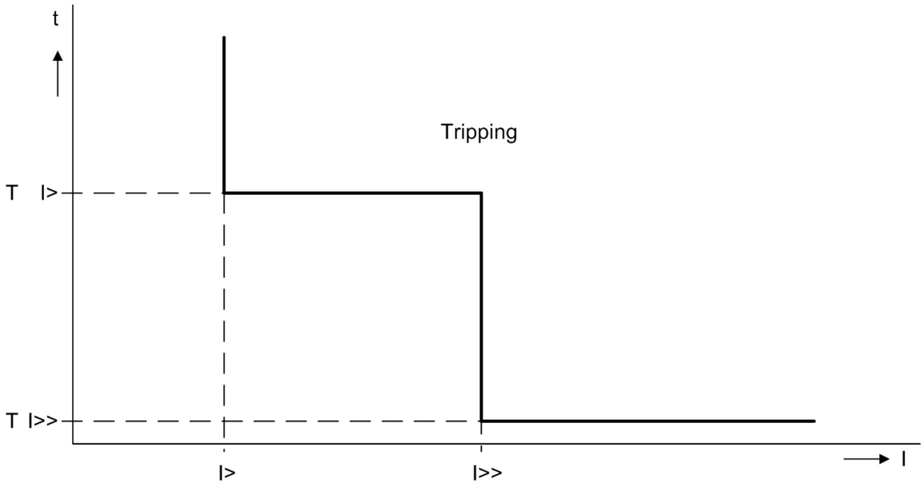


Figure 2-33 Two-stage characteristic of the single-phase time-overcurrent protection

The following figure shows the logic diagram for the single-phase overcurrent protection.

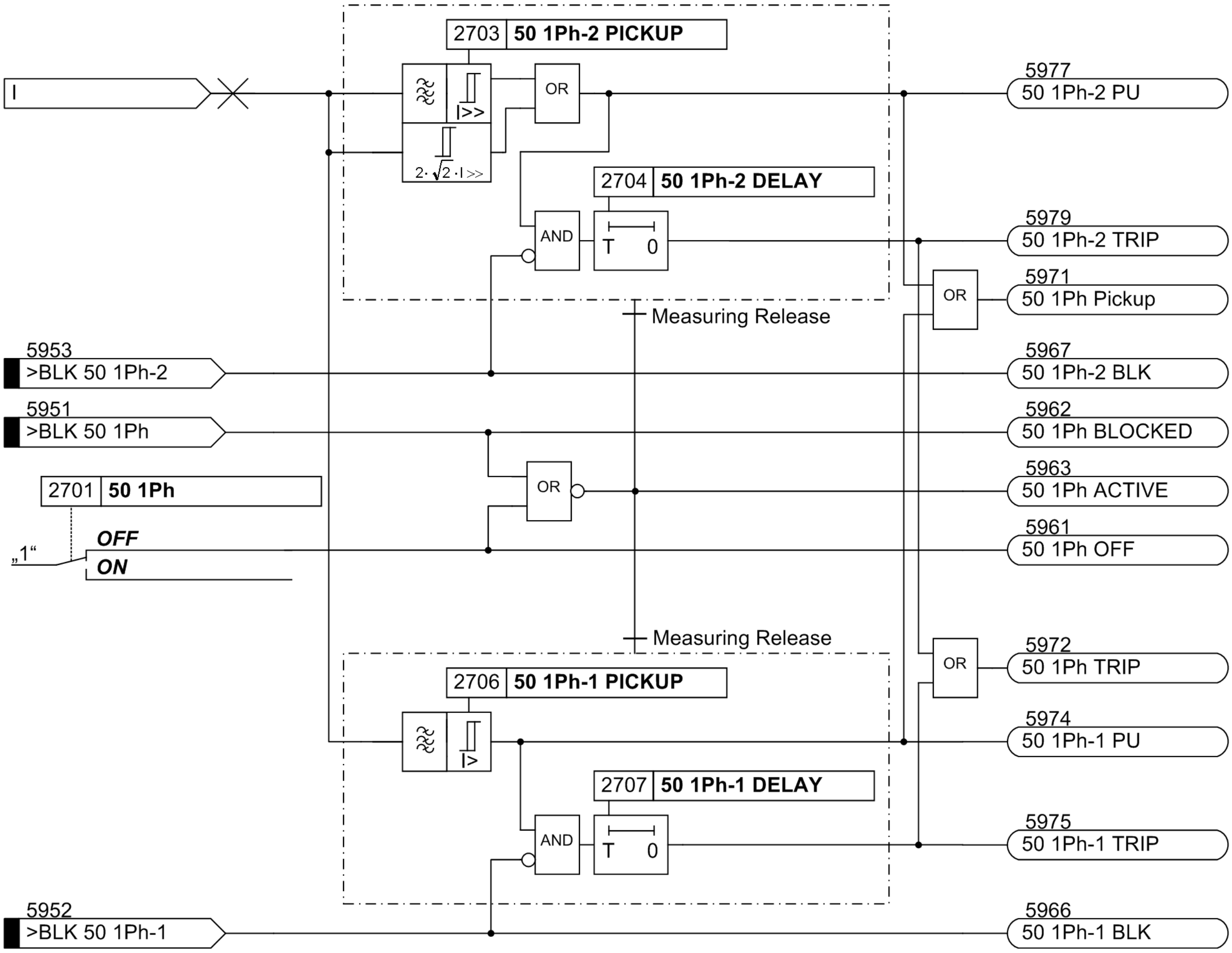


Figure 2-34 Logic diagram of the single-phase time-overcurrent protection

2.5.2 High-impedance Ground Fault Unit Protection

Application Examples

In the high-impedance procedure, all CT's operate at the limits of the protected zone parallel on a common, relatively high-resistive resistor R whose voltage is measured.

The CTs must be of the same design and feature at least a separate core for high-impedance protection. In particular, they must have the same transformer ratios and approximately identical knee-point voltage.

With 7SJ62/63/64, the high-impedance principle is particularly well suited for detecting ground faults in grounded networks at transformers, generators, motors and shunt reactors.

Figure 2-35 shows an application example for a grounded transformer winding or a grounded motor/generator. The right-hand example depicts an ungrounded transformer winding or an ungrounded motor/generator where the grounding of the system is assumed somewhere else.

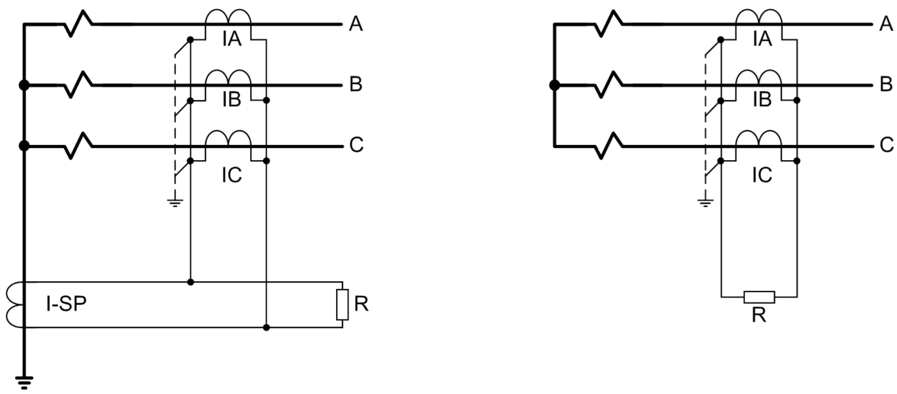


Figure 2-35 Ground fault protection according to the high-impedance principle

Function of the High-Impedance Principle

The high-impedance principle is explained on the basis of a grounded transformer winding.

No zero sequence current will flow during normal operation, i.e. the starpoint current is $I_{SP} = 0$ and the phase currents are $3\,\underline{I}_0 = \underline{I}_A + \underline{I}_B + \underline{I}_C = 0$.

With an external ground fault (Figure 2-36, left side), whose fault current is supplied via the grounded starpoint, the same current flows through the transformer starpoint and the phases. The corresponding secondary currents (all current transformers have the same transformation ratio) compensate each other; they are connected in series. Across resistor R only a small voltage is generated. It originates from the inner resistance of the transformers and the connecting cables of the transformers. Even if any current transformer experiences a partial saturation, it will become low-resistive for the period of saturation and creates a low-resistive shunt to the high-resistive resistor R. Thus, the high resistance of the resistor also has a restraining effect (the so-called resistance restraint).

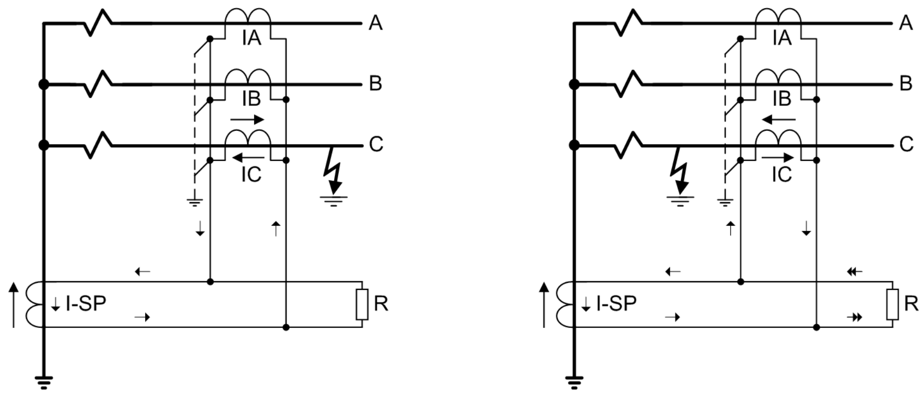


Figure 2-36 Principle of ground fault protection according to the high-impedance principle

When a ground fault occurs in the protected zone (Figure 2-36 right), there is always a starpoint current I_{SP}. The grounding conditions in the rest of the network determine how strong a zero sequence current from the system is. A secondary current which is equal to the total fault current tries to pass through the resistor R. Since the latter is high-resistive, a high voltage emerges immediately. Therefore, the current transformers get saturated. The RMS voltage across the resistor approximately corresponds to the knee-point voltage of the current transformers.

Resistance R is dimensioned such that, even with the very lowest ground fault current to be detected, it generates a secondary voltage which is equal to the half knee-point voltage of current transformers (see also notes on dimensioning in Section 2.5.4).

High-impedance Protection with 7SJ62/63/64

With 7SJ62/63/64 the sensitive measuring input I_{NS} or alternatively the insensitive measuring input I_N is used for high-impedance protection. As this is a current input, the protection detects current through the resistor instead of the voltage across the resistor R.

Figure 2-37 shows the connections diagram. The protection relay is connected in series to resistor R and measures its current.

Varistor B limits the voltage when internal faults occur. High voltage peaks emerging with transformer saturation are cut by the varistor. At the same time, voltage is smoothed without reduction of the mean value.

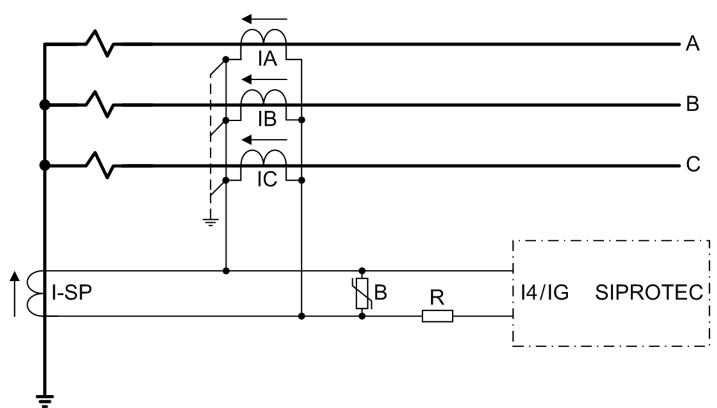


Figure 2-37 Connection diagram of the ground fault differential protection according to the high-impedance principle

For protection against overvoltages it is also important that the device is directly connected to the grounded side of the current transformers so that the high voltage at the resistor can be kept away from the device.

For generators, motors and shunt reactors high-impedance protection can be used analogously. All current transformers at the overvoltage side, the undervoltage side and the current transformer at the starpoint have to be connected in parallel when using auto-transformers.

In principle, this scheme can be applied to every protected object. When applied as busbar protection, for example, the device is connected to the parallel connection of all feeder current transformers via the resistor.

2.5.3 Tank Leakage Protection

Application Example

The tank leakage protection has the task to detect ground leakage — even high-resistive — between a phase and the frame of a power transformer. The tank must be isolated from ground. A conductor links the tank to ground, and the current through this conductor is fed to a current input of the relay. When a tank leakage occurs, a fault current (tank leakage current) will flow through the grounding conductor to ground. This tank leakage current is detected by the single-phase overcurrent protection as an overcurrent; an instantaneous or delayed trip command is issued in order to disconnect all sides of the transformer

A high-sensitivity single-phase current input is normally used for tank leakage protection.

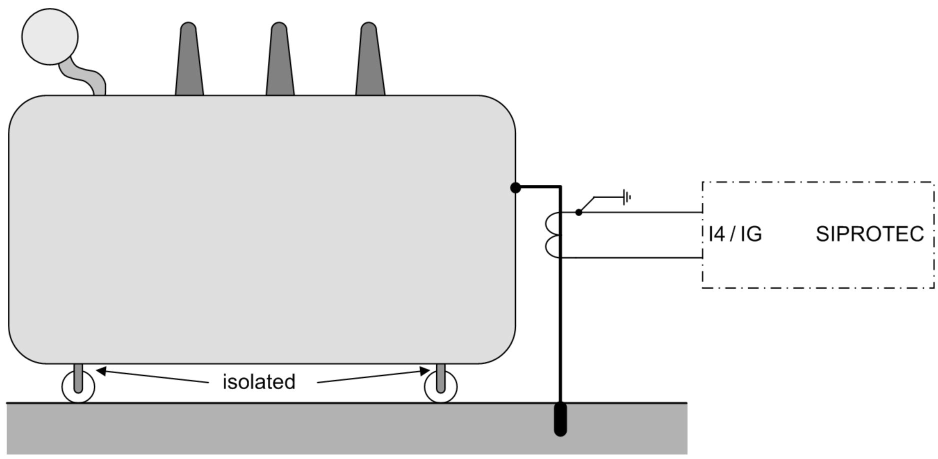


Figure 2-38 Principle of tank-leakage protection

2.5.4 Setting Notes

General

Single-phase time overcurrent protection can be set ***ON*** or ***OFF*** at address 2701 **50 1Ph**.

The settings are based on the particular application. The setting ranges depend on whether the current measuring input is a sensitive or a normal input transformer (see also „Ordering Information“ in Appendix A.1).

In case of a normal input transformer, set the pickup value for **50 1Ph-2 PICKUP** in address 2702, the pickup value for **50 1Ph-1 PICKUP** in address 2705. If only one element is required, set the one not required to ∞.

In case of a sensitive input transformer, set the pickup value for **50 1Ph-2 PICKUP** in address 2703, the pickup value for **50 1Ph-1 PICKUP** in address 2706. If only one element is required, set the one not required to ∞.

If you need a trip time delay for the 50-2 element, set it in address 2704 **50 1Ph-2 DELAY**, for the 50-1 element in address 2707 **50 1Ph-1 DELAY**. With setting 0 s no delay takes place.

The selected times are additional time delays and do not include the operating time (measuring time, etc.) of the elements. The delay can also be set to ∞; the corresponding element will then not trip after pickup, but the pickup is reported.

Special notes are given in the following for the use as high-impedance unit protection and tank leakage protection.

Use as High-impedance Protection

The use as high-impedance protection requires that starpoint current detection is possible in the system in addition to phase current detection (see example in figure 2-37). Furthermore, a sensitive input transformer must be available at device input I_N/I_{NS}. In this case, only the pickup value for single-phase overcurrent protection is set at the 7SJ62/63/64 device for the current at input I_N/I_{NS}.

The entire function of high-impedance protection is, however, dependent on the interaction of current transformer characteristics, external resistor R and voltage across R. The following section gives information on this topic.

Current Transformer Data for High-impedance Protection

All current transformers must have an identical transformation ratio and nearly equal knee-point voltage. This is usually the case if they are of equal design and identical rated data. The knee-point voltage can be approximately calculated from the rated data of a CT as follows:

$$V_{KPV} = \left(R_I - \frac{P_{Nom}}{I_{Nom}{}^2}\right) \cdot n \cdot I_{Nom}$$

V_{KPV} Knee-point voltage

R_I Internal burden of the CT

P_{Nom} Rated power of the CT

I_{Nom} Secondary nominal current of CT

ALF Rated accuracy limit factor of the CT

The rated current, rated power and accuracy limit factor are normally stated on the rating plate of the current transformer, e.g.

Current transformer 800/5; 5P10; 30 VA

That means

I_{Nom}	= 5 A (from 800/**5**)
ALF	= 10 (from 5P**10**)
P_{Nom}	= **30** VA

The internal burden is often stated in the test report of the current transformer. If not, it can be derived from a DC measurement on the secondary winding.

Calculation Example:

CT 800/5; 5P10; 30 VA with R_i = 0.3 Ω

$$V_{KPV} = \left(R_I - \frac{P_{Nom}}{I_{Nom}^2}\right) \cdot n \cdot I_{Nom} - \left(0.3\ \Omega + \frac{30\ VA}{(5\ A)^2}\right) \cdot 10 \cdot 5\ A = 75\ V$$

or

CT 800/1; 5P10; 30 VA with R_i = 5 Ω

$$V_{KPV} = \left(R_I - \frac{P_{Nom}}{I_{Nom}^2}\right) \cdot n \cdot I_{Nom} - \left(5\ \Omega + \frac{30\ VA}{(1\ A)^2}\right) \cdot 10 \cdot 1\ A = 350\ V$$

Besides the CT data, the resistance of the longest connection lead between the CTs and the 7SJ62/63/64 device must be known.

Stability with High-impedance Protection

The stability condition is based on the following simplified assumption: If there is an external fault, **one** of the current transformers gets totally saturated. The other ones will continue transmitting their (partial) currents. In theory, this is the most unfavorable case. Since, in practice, it is also the saturated transformer which supplies current, an automatic safety margin is guaranteed.

Figure 2-39 shows a simplified equivalent circuit. CT1 and CT2 are assumed as ideal transformers with their inner resistances R $_{i1}$ and R $_{i2}$. R_a are the resistances of the connecting cables between current transformers and resistor R. They are multiplied by 2 as they have a forward and a return line. R_{a2} is the resistance of the longest connecting cable.

CT1 transmits current I_1. CT2 shall be saturated. Because of saturation the transformer represents a low-resistance shunt which is illustrated by a dashed short-circuit line.

R >> ($2R_{a2}$ + R_{i2}) is a further prerequisite.

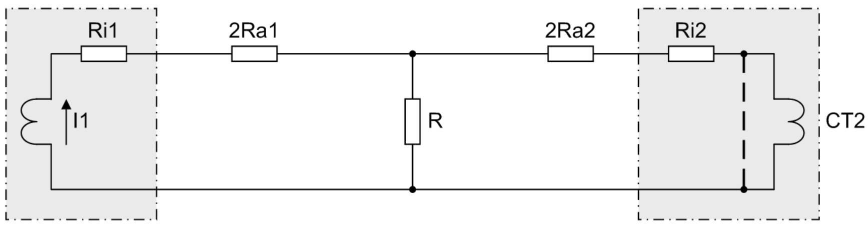


Figure 2-39 Simplified equivalent circuit of a circulating current system for high-impedance protection

The voltage across R is then

$V_R = I_1 \cdot (2R_{a2} + R_{i2})$

It is assumed that the pickup value of the 7SJ62/63/64 corresponds to half the knee-point voltage of the current transformers. In the balanced case results

$V_R = V_{KPV} / 2$

This results in a stability limit I_{SL} , i.e. the maximum through-fault current below which the scheme remains stable:

$$I_{SL} = \frac{V_{KPV}/2}{2 \cdot R_{a2} + R_{i2}}$$

Calculation Example:

For the 5-A CT as above with V_{KPV} = 75 V and R_i = 0.3 Ω

longest CT connection lead 22 m (24.06 yd) with 4 mm² cross-section; this corresponds to R_a = 0.1 Ω

$$I_{SL} = \frac{V_{KPV}/2}{2 \cdot R_{a2} + R_{i2}} = \frac{37.5\ \text{V}}{2 \cdot 0.1\ \Omega + 0.3\ \Omega} = 75\ \text{A}$$

that is 15 × rated current or 12 kA primary.

For 1-A CT as above with V_{KPV} = 350 V and R_i = 5 Ω

longest CT connection lead 107 m (117.02 yd) with 2.5 mm² cross-section, results in R_a = 0.75 Ω

$$I_{SL} = \frac{V_{KPV}/2}{2 \cdot R_{a2} + R_{i2}} = \frac{175\ \text{V}}{2 \cdot 0.75\ \Omega + 5\ \Omega} = 27\ \text{A}$$

that is 27 × rated current or 21.6 kA primary.

Sensitivity with High-impedance Protection

The voltage present at the CT set is forwarded to the protective relay across a series resistor R as proportional current for evaluation. The following considerations are relevant for dimensioning the resistor:

As already mentioned, it is desired that the high-impedance protection should pick up at half the knee-point voltage of the CT's. The resistor R can calculated on this basis.

Since the device measures the current flowing through the resistor, resistor and measuring input of the device must be connected in series. Since, furthermore, the resistance shall be high-resistance (condition: R >> $2R_{a2} + R_{i2}$, as above mentioned), the inherent resistance of the measuring input can be neglected. The resistance is then calculated from the pickup current I_{pu} and the half knee-point voltage:

$$R = \frac{V_{KPV}/2}{I_{pu}}$$

Calculation Example:

For 5-A CT as above

desired pickup value I_{pu} = 0.1 A (equivalent to 16 A primary)

$$R = \frac{V_{KPV}/2}{I_{pu}} = \frac{75\ V/2}{0.1\ A} = 375\ \Omega$$

For 1-A CT as above

desired pickup value I_{pu} = 0.05 A (equivalent to 40 A primary)

$$R = \frac{V_{KPV}/2}{I_{pu}} = \frac{350\ V/2}{0.05\ A} = 3500\ \Omega$$

The required short-term power of the resistor is derived from the knee-point voltage and the resistance:

$$P_R = \frac{V_{KPV}^2}{R} = \frac{(75\ V)^2}{375\ \Omega} = 15\ W \qquad \text{for the 5 A CT example}$$

$$P_R = \frac{V_{KPV}^2}{R} = \frac{(350\ V)^2}{3500\ \Omega} = 35\ W \qquad \text{for the 1 A CT example}$$

As this power only appears during ground faults for a short period of time, the rated power can be smaller by approx. factor 5.

Please bear in mind that when choosing a higher pickup value I_{pu}, the resistance must be decreased and, in doing so, power loss will increase significantly.

The varistor B (see following figure) must be dimensioned such that it remains high-resistive until reaching knee-point voltage, e.g.

approx. 100 V for 5 A CT,

approx. 500 V for 1 A CT.

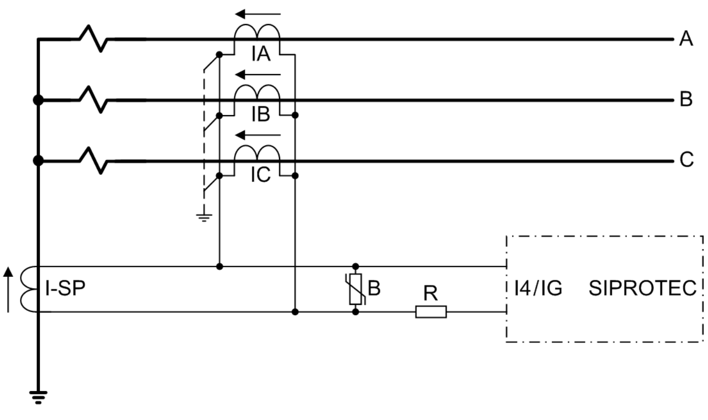


Figure 2-40 Connection diagram of the ground fault differential protection according to the high-impedance principle

Even with an unfavorable external circuit, the maximum voltage peaks should not exceed 2 kV for safety reasons.

If performance makes it necessary to switch several varistors in parallel, preference should by given to types with a flat characteristic to avoid asymmetrical loading. We therefore recommend the following types from METRSIL:

600A/S1/S256 (k = 450, β = 0.25)

600A/S1/S1088 (k = 900, β = 0.25)

The pickup value (0.1 A or 0.05 A in the example) is set in address 2706 **50 1Ph-1 PICKUP** in the device. The 50-2 element is not required (address 2703 **50 1Ph-2 PICKUP** = ∞).

The trip command of the element can be delayed in address 2707 **50 1Ph-1 DELAY**. This delay is normally set to 0.

If a higher number of CT's is connected in parallel, e.g. as busbar protection with several feeders, the magnetizing currents of the transformers connected in parallel cannot be neglected any more. In this case, the magnetizing currents at the half knee-point voltage (corresponds to the setting value) have to be summed up. These magnetizing currents reduce the current through the resistor R. Therefore the actual pickup value will be correspondingly higher.

Use as Tank Leakage Protection

The use as tank leakage protection requires that a sensitive input transformer is available at the device input I_N/I_{NS}. In this case, only the pickup value for single phase overcurrent protection is set at the 7SJ62/63/64 device for the current at input I_N/I_{NS}.

The tank leakage protection is a sensitive overcurrent protection which detects the leakage current between the isolated transformer tank and ground. Its sensitivity is set in address 2706 **50 1Ph-1 PICKUP**. The 50-2 element is not required (address 2703 **50 1Ph-2 PICKUP** = ∞).

The trip command of the element can be delayed in address 2707 **50 1Ph-1 DELAY**. It is normally set to ***0***.

Note

In the following Setting overview addresses 2703 and 2706 are valid for a highly sensitive current measuring input independently of the nominal current.

2.5.5 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
2701	50 1Ph		OFF ON	OFF	50 1Ph
2702	50 1Ph-2 PICKUP	1A	0.05 .. 35.00 A; ∞	0.50 A	50 1Ph-2 Pickup
		5A	0.25 .. 175.00 A; ∞	2.50 A	
2703	50 1Ph-2 PICKUP		0.003 .. 1.500 A; ∞	0.300 A	50 1Ph-2 Pickup
2704	50 1Ph-2 DELAY		0.00 .. 60.00 sec; ∞	0.10 sec	50 1Ph-2 Time Delay
2705	50 1Ph-1 PICKUP	1A	0.05 .. 35.00 A; ∞	0.20 A	50 1Ph-1 Pickup
		5A	0.25 .. 175.00 A; ∞	1.00 A	
2706	50 1Ph-1 PICKUP		0.003 .. 1.500 A; ∞	0.100 A	50 1Ph-1 Pickup
2707	50 1Ph-1 DELAY		0.00 .. 60.00 sec; ∞	0.50 sec	50 1Ph-1 Time Delay

2.5.6 Information List

No.	Information	Type of Information	Comments
5951	>BLK 50 1Ph	SP	>BLOCK 50 1Ph
5952	>BLK 50 1Ph-1	SP	>BLOCK 50 1Ph-1
5953	>BLK 50 1Ph-2	SP	>BLOCK 50 1Ph-2
5961	50 1Ph OFF	OUT	50 1Ph is OFF
5962	50 1Ph BLOCKED	OUT	50 1Ph is BLOCKED
5963	50 1Ph ACTIVE	OUT	50 1Ph is ACTIVE
5966	50 1Ph-1 BLK	OUT	50 1Ph-1 is BLOCKED
5967	50 1Ph-2 BLK	OUT	50 1Ph-2 is BLOCKED
5971	50 1Ph Pickup	OUT	50 1Ph picked up
5972	50 1Ph TRIP	OUT	50 1Ph TRIP
5974	50 1Ph-1 PU	OUT	50 1Ph-1 picked up
5975	50 1Ph-1 TRIP	OUT	50 1Ph-1 TRIP
5977	50 1Ph-2 PU	OUT	50 1Ph-2 picked up
5979	50 1Ph-2 TRIP	OUT	50 1Ph-2 TRIP
5980	50 1Ph I:	VI	50 1Ph: I at pick up

2.6 Voltage Protection 27, 59

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

Applications

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

2.6.1 Measurement Principle

Connection

The voltages supplied to the device may correspond to the three phase-to-ground voltages V_{AN}, V_{BN}, V_{CN} or two phase-to-phase voltages (V_{AB}, V_{BC}) and the displacement voltage (V_N) or, in case of a single-phase connection, any phase-to-ground voltage or phase-to-phase voltage. Relay 7SJ64 provides the option to detect three phase-ground voltages and the ground voltage in addition. With multiple-phase connection the connection mode was specified during the configuration in address 213 **VT Connect. 3ph**.

If there is only **one** voltage transformer, the device has to be informed of this fact during configuration via address 240 **VT Connect. 1ph** (see also section 2.24).

With **three-phase connection**, the overvoltage protection requires the phase-to-phase voltages and, if necessary, calculated from the phase-to-ground voltages. In case of phase-to-phase connection, two voltages are measured and the third one is calculated. Depending on the configured parameter setting (address 614 **OP. QUANTITY 59**), the evaluation uses either the largest of the phase-to-phase voltages ***Vphph*** or the negative sequence component ***V2*** of the voltages.

With **three-phase connection**, undervoltage protection relies either on the positive sequence component ***V1*** or the smallest of the phase-to-phase voltages ***Vphph***. This is configured by setting the parameter value in address 615 **OP. QUANTITY 27**.

The choice between phase–ground and phase–phase voltage allows voltage asymmetries (e.g. caused by a ground fault) to be taken into account (phase–ground) or to be unconsidered (phase–phase).

With **single-phase connection** a phase-ground or phase-phase voltage is connected and evaluated (see also Section 2.24) dependent on the type of connection.

Current Supervision

The primary voltage transformers are arranged, depending on the system, either on the supply side or the load side of the associated circuit breaker. These different arrangements lead to different behavior of the voltage protection function when a fault occurs. When a tripping command is issued and a circuit breaker is opened, full voltage remains on the supply side while the load side voltage becomes zero. When voltage supply is absent, undervoltage protection, for instance, will remain picked up. If pickup condition must reset, the current can be used as an additional criterion for pickup of undervoltage protection (current supervision CS). Undervoltage pickup can only be maintained when the undervoltage criterion is satisfied and a settable minimum current level (**BkrClosed I MIN**) is exceeded. Here, the largest of the three phase currents is used. When the current decreases below the minimum current setting after the circuit breaker has opened, undervoltage protection will drop out.

Note

Note: If parameter **CURRENT SUPERV.** is set to disabled in address 5120, the device picks up when the undervoltage protection is enabled and no measured voltage is present and the undervoltage protection function is in pickup. Apply measuring voltage or block the voltage protection to continue with configuration. Moreover, you have the option of setting a flag via device operation for blocking the voltage protection. This initiates the reset of the pickup and device configuration can be resumed.

Preparation of Measured Data

Using a Fourier analysis, the fundamental harmonic component of the three phase-to-phase voltages is filtered out and forwarded for further processing. Depending on configuration, either the positive sequence component ***V1*** of the voltages is supplied to the undervoltage protection elements (multiplied by $\sqrt{3}$ because the treshold values are set as phase-to-phase quantities) or the actual phase-to-phase voltage ***Vphph***. The largest of the three phase–phase voltages i***Vphph*** is evaluated accordingly for overvoltage protection or the negative sequence voltage ***V2*** is calculated, whereas in that case the thresholds should be set as phase-to-ground voltages.

2.6.2 Overvoltage Protection 59

Application

The overvoltage protection has the task of protecting the transmission lines and electrical machines against inadmissible overvoltage conditions that may cause insulation damage.

Abnormally high voltages often occur, e.g. on low loaded, long distance transmission lines, in islanded systems when generator voltage regulation fails, or after full load shutdown of a generator from the system.

Function

With three-phase connection, the fundamental component of the largest of the three phase-to-phase voltages is supplied to the overvoltage protection elements or, optionally, the negative sequence voltage.

If only one voltage transformer is connected, the function is provided with the phase-to-ground or phase-phase fundamental component voltage in accordance with the connection type.

The overvoltage protection has two elements. In case of a high overvoltage, tripping switchoff is performed with a short-time delay, whereas in case of less severe overvoltages, the switchoff is performed with a longer time delay. When one of the adjustable settings is exceeded, the 59 element picks up, and trips after an adjustable time delay elapses. The time delay is not dependent on the magnitude of the overvoltage.

The dropout ratio for the two overvoltage elements (= $V_{dropout\ value}/V_{pickup\ value}$) can be set.

The following figure shows the logic diagram of the overvoltage protection for phase–phase voltages.

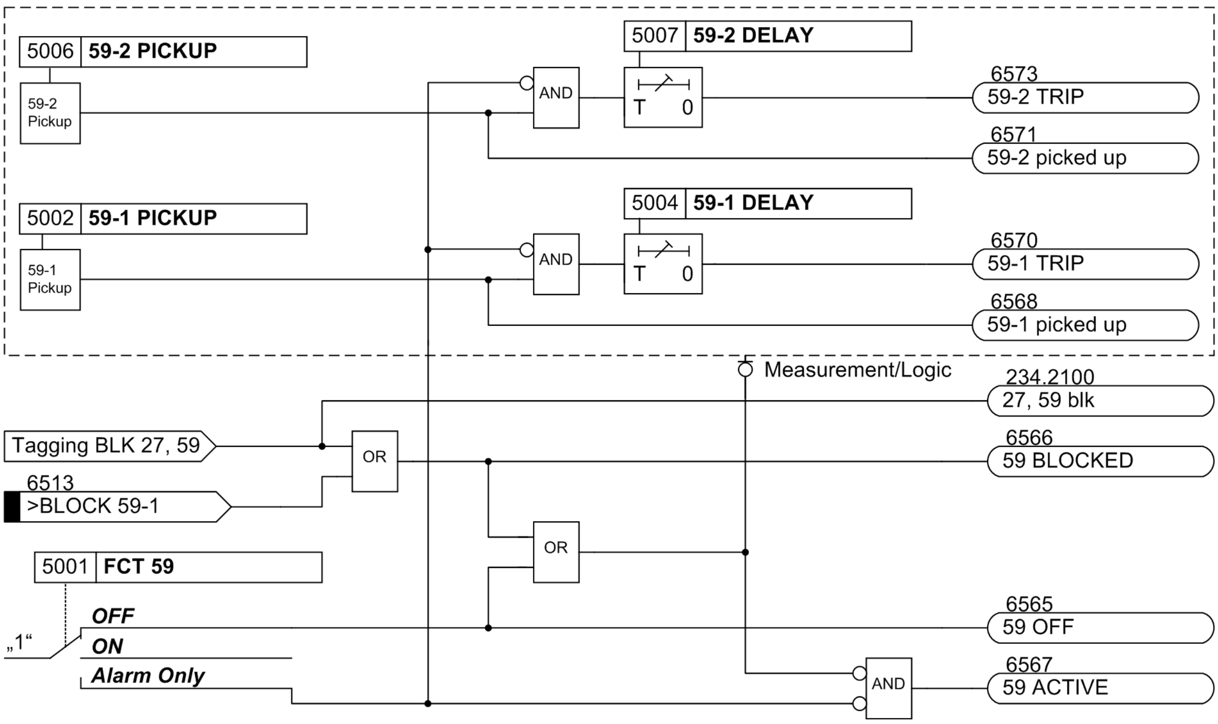


Figure 2-41 Logic diagram of the overvoltage protection

2.6.3 Undervoltage Protection 27

Application

The undervoltage protection function detects voltage collapses on transmission lines and electrical machines and prevents the persistance of inadmissible operating states and a possible loss of stability.

Function

With three-phase connection, undervoltage protection uses the positive sequence fundamental component or, optionally, also the actual phase-to-phase voltages. The latter case applies the smallest of the phase-to-phase voltages.

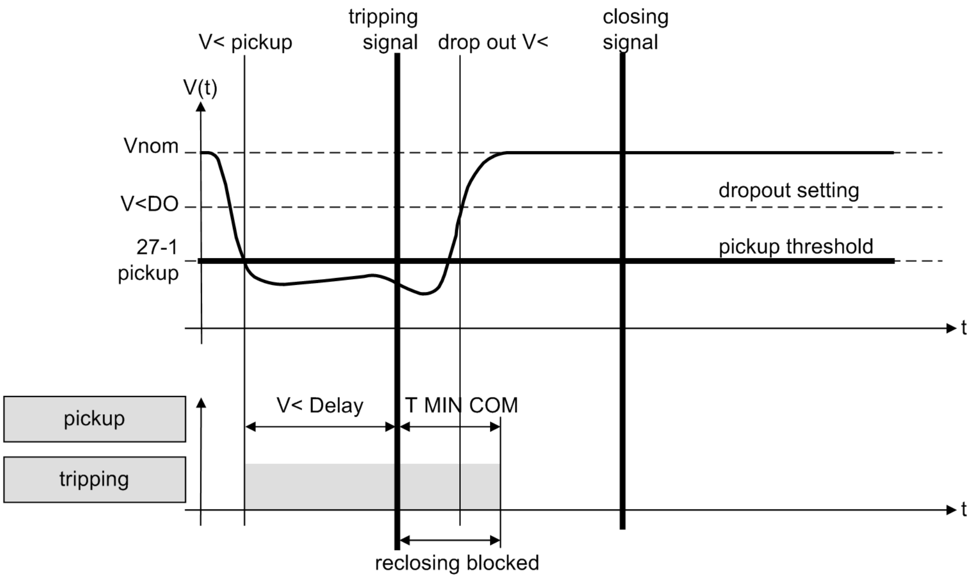
If only one voltage transformer is connected, the function is provided with the phase-to-ground or phase-phase fundamental component voltage in accordance with the type of connection.

Undervoltage protection consists of two definite time elements (**27-1 PICKUP** and **27-2 PICKUP**). Therefore, tripping can be time-graded depending on how severe voltage collapses are. Voltage thresholds and time delays can be set individually for both elements. The voltage limit values are configured as phase-to-phase quantities. Thus, either the positive sequence system value ***V1*** $\cdot \sqrt{3}$ or, optionally, the smallest of the phase-to-phase voltages is evaluated.

The dropout ratio for the two undervoltage elements (= $V_{dropout\ value}/V_{pickup\ value}$) can be set.

The undervoltage protection works in an additional frequency range. This ensures that the protective function is preserved even when it is applied, e.g. as motor protection in context with decelerating motors. However, the r.m.s. value of the positive-sequence voltage component is considered too small when severe frequency deviations exist. This function therefore exhibits an overfunction. If applications are anticipated in which the frequency range of $f_{Nom} \pm 10\%$, will be exceeded, the current criterion will not return a correct result and must be switched off.

Figure 2-42 shows a typical voltage profile during a fault for source side connection of the voltage transformers. Because full voltage is present after the circuit breaker is opened the current supervision CS described above is not necessary in this case. After the voltage drops below the pickup setting, tripping is initiated after time delay **27-1 DELAY**. As long as the voltage remains below the drop out setting, reclosing is blocked. Only after the fault has been cleared, i.e. when the voltage increases above the drop out level, the element drops out and allows reclosing of the circuit breaker.



T MIN COM = minimum command time

Figure 2-42 Typical fault profile for source side connection of the voltage transformer (without current supervision)

Figure 2-43 shows a fault profile for a load side connection of the voltage transformers. When the circuit breaker is open, the voltage disappears (the voltage remains below the pickup setting), and current supervision is used to ensure that pickup drops out after the circuit breaker has opened (**BkrClosed I MIN**).

After the voltage drops below the pickup setting, tripping is initiated after time delay **27-1 DELAY**. When the circuit breaker opens voltage decreases to zero and undervoltage pickup is maintained. The current value also decreases to zero so that current supervision is reset as soon as the release threshold (**BkrClosed I MIN**) is exceeded. Thanks to the AND-combination of voltage and current criteria pickup of the protective function is also reset. As a consequence, energization is admitted a new when the minimum command time elapsed.

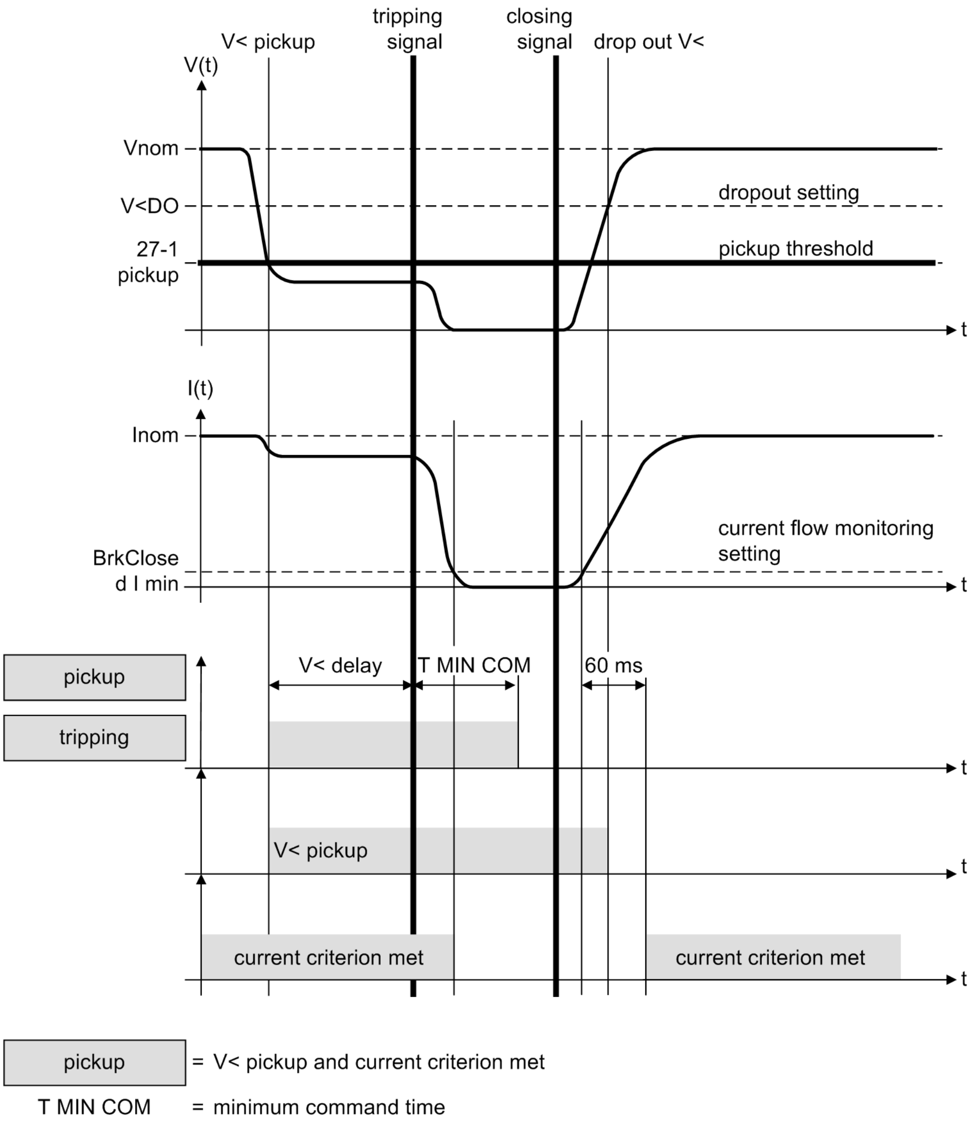


Figure 2-43 Typical fault profile for load side connection of the voltage transformers (with current supervision)

Following closing of the circuit breaker, current supervision **BkrClosed I MIN** is delayed for a short period of time. If voltage criterion drops out during this time period (about 60 ms), the protection function will not pick up. Thereby no fault record is generated when closing the CB in a healthy system. It is important to understand, however, that if a low voltage condition exists on the load after the circuit breaker is closed (unlike Figure 2-43), the desired pickup of the element will be delayed by 60 ms.

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

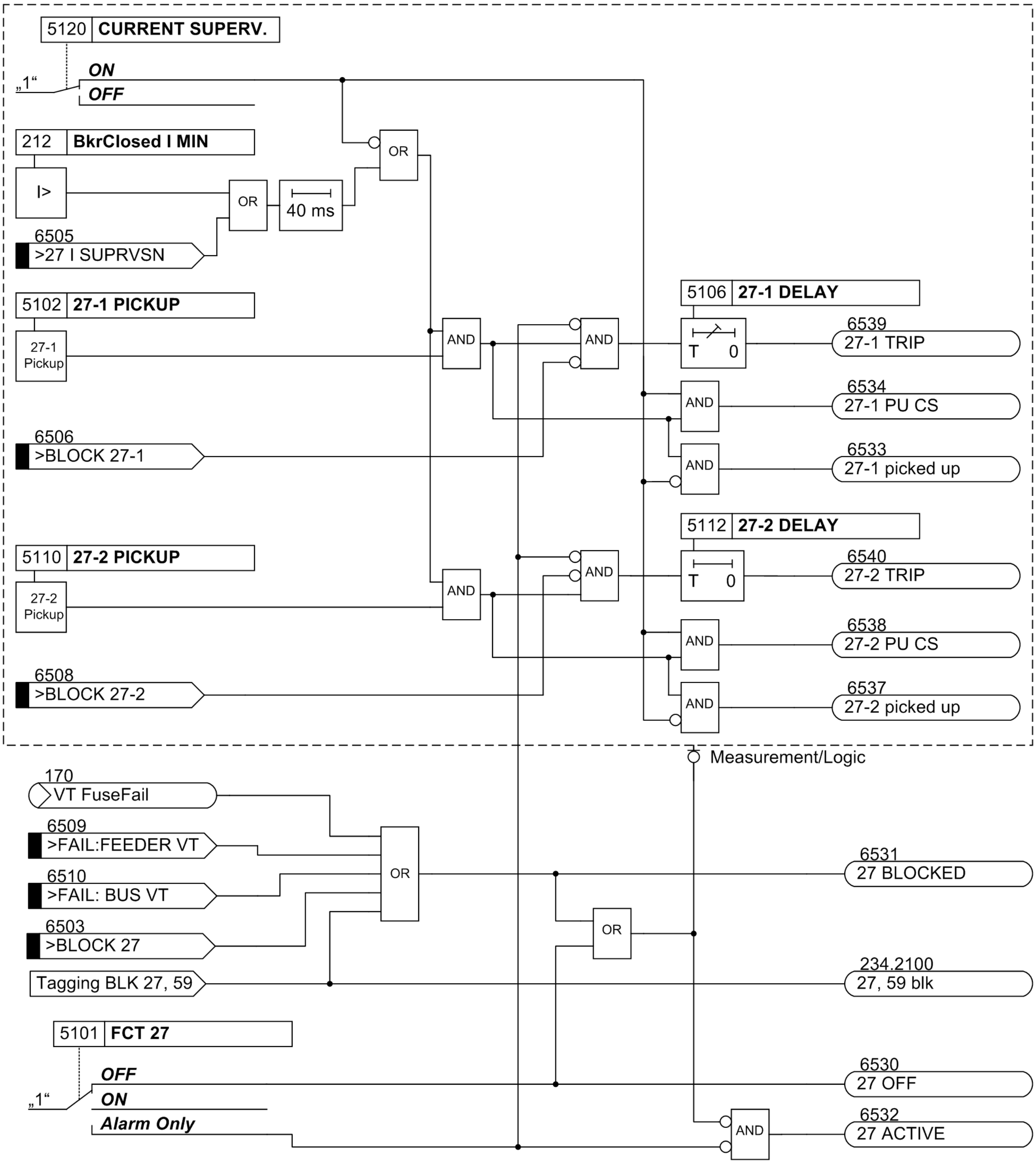


Figure 2-44 Logic diagram of the undervoltage protection

2.6.4 Setting Notes

General

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

The setting values refer to phase-phase voltages with three-phase voltage transformer connection and also with connection of only one phase-phase voltage if the evaluation quantity for overvoltage protection was configured to phase-phase voltage at address 614 **OP. QUANTITY 59**. They must be set as phase-to-ground voltages if this parameter is configured to negative-sequence voltage ***V2***.

In case of a single-phase connection of a phase-to-ground voltage, the threshold values must be set as phase-to-ground voltages. The setting ranges depend on the type of voltage transformer connection utilized (specified at address 213 **VT Connect. 3ph**, three phase-to-ground voltages or two phase-to-phase voltages). For voltage transformers connected in a ground-wye configuration, higher setting values may be used because the voltage inputs are subjected only to phase-to-ground voltage levels.

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

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

With the protection functions activated (***ON***), tripping, the opening of a fault and fault recording are initiated when the thresholds are exceeded and the set time delays have expired.

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

Overvoltage Protection with Phase Voltages

The largest of the voltages applied is evaluated for the phase-to-phase or phase-to-ground overvoltage protection. With three-phase connection as well as with single-phase connection of a phase-to-phase voltage the threshold is set as a phase-to-phase quantity. With single phase-to-ground connection the threshold is set as phase–to–ground voltage.

Overvoltage protection includes two elements. The pickup value of the lower threshold is set at address 5002 or 5003, **59-1 PICKUP** (depending on if the phase-to-ground or the phase-to-phase voltages are connected), while time delay is set at address 5004, **59-1 DELAY** (a longer time delay). The pickup value of the upper element is set at address 5005 or 5006, **59-2 PICKUP**, while the time delay is set at address 5007,**59-2 DELAY** (a short time delay). There are no clear cut procedures on how to set the pickup values. However, since the overvoltage function is primarily intended to prevent insulation damage on equipment and users, the setting value 5002 or 5003 **59-1 PICKUP** should be set between 110% and 115% of nominal voltage, and setting value 5005 or 5006 **59-2 PICKUP** should be set to about 130% of nominal voltage. Addresses 5002 and 5005 can be accessed if phase-to-ground voltages are connected to 7SJ62/63/64, whereas addresses 5003 and 5006 can be accessed if phase-to-phase voltages are connected. The time delays of the overvoltage elements are entered at addresses 5004 **59-1 DELAY** and 5007 **59-2 DELAY** and should be selected to allow the brief voltage spikes that are generated during switching operations and to enable clearance of stationary overvoltages in time.

Overvoltage Protection - Negative Sequence System V2

The three-phase voltage transformer connection for the overvoltage protection can be configured by means of parameter 614 **OP. QUANTITY 59**. Either the largest of the phase-to-phase voltages (***Vphph***) or the negative system voltage (***V2***) are evaluated as measured quantities. The negative system detects negative sequence reactance and can be used for the stabilization of the time overcurrent protection. With backup protection of transformers or generators, the fault currents lie, in some cases, only slightly over the load currents. To obtain a pickup threshold of the definite time overcurrent protection which should be as sensitive as possible, it is necessary to stabilize the definite time overcurrent protection by the voltage protection.

Overvoltage protection includes two elements. Thus, with configuration of the negative system, a longer time delay (address 5004, **59-1 DELAY**) may be assigned to the lower element (address 5015, **59-1 PICKUP V2**) and a shorter time delay (address 5007, **59-2 DELAY**) may be assigned to the upper element (address 5016, **59-2 PICKUP V2**). There are no clear cut procedures on how to set the pickup values **59-1 PICKUP V2** or **59-2 PICKUP V2**, as they depend on the respective station configuration. Since the negative sequence voltage V2 corresponds to a phase-ground voltage, their threshold value must be set as such.

The parameter 5002 **59-1 PICKUP** and 5005 **59-2 PICKUP** or 5003 **59-1 PICKUP** and 5006 **59-2 PICKUP** are deleted during configuration of the negative sequence voltage and the setting values are activated under the addresses 5015 **59-1 PICKUP V2** or 5016 **59-2 PICKUP V2**. Be aware that the parameter device 614 **OP. QUANTITY 59** is ignored with single-pole voltage transformer connection and the activation of the threshold value for the phase-to-phase voltages takes place. The time delays of the overvoltage elements are entered at addresses 5004 **59-1 DELAY** and 5007 **59-2 DELAY** and should be selected to allow the brief voltage spikes that are generated during switching operations and to enable clearance of stationary overvoltages in time.

Dropout Threshold of the Overvoltage Protection

The dropout thresholds of the **59-1** element and the **59-2** element can be set via the dropout ratio r = $V_{dropout}/V_{pickup}$ (5117 **59–1 DOUT RATIO** or 5118 **59–2 DOUT RATIO**). In this, the following marginal condition always holds for r:

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

r · (configured pickup threshold) ≤ 260 V with connection of phase-to-ground voltages.

The minimum hysteresis is 0.6 V.

Undervoltage Protection - Positive Sequence System V1

The positive sequence component (***V1***) is evaluated for the undervoltage protection. Especially in case of stability problems, their acquisition is advantageous because the positive sequence system is relevant for the limit of the stable energy transmission. Concerning the pickup values, there are not clear cut procedures on how to set them. However, because the undervoltage protection function is primarily intended to protect induction machines from voltage dips and to prevent stability problems, the pickup values will usually be between 60% and 85% of the nominal voltage. Please note that with frequency deviations of > 5 Hz of the calculated r. m. s value of the voltage will be too small and the device will perform unwanted operations.

With a three-phase connection and a single-phase connection of a phase-to-phase voltage the thresholds are set as phase-phase quantities. Since the positive sequence component of the voltages corresponds to a phase-ground voltage, their threshold value has to be multiplied with $\sqrt{3}$. With a single-phase phase-to-ground connection the threshold is set as phase-ground voltage.

The time delay settings should be set that tripping results when voltage dips occur, which could lead to unstable operating conditions. On the other hand, the time delay should be long enough to avoid tripping due to momentary voltage dips.

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

Undervoltage Protection with Phase Voltages

The smallest of the phase-to-phase voltages ***Vphph*** can also be configured as measured quantity for the undervoltage protection with three-phase connection by means of parameter 615 **OP. QUANTITY 27** instead of the positive sequence component (***V1***). The threshold values have to be set as phase-phase quantities.

The time delay settings should be set that tripping results when voltage dips occur which could lead to unstable operating conditions. On the other hand, the time delay should be long enough to permissable short voltage dips.

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

Dropout Threshold of the Undervoltage Protection

The dropout thresholds of the **27-1** element and the **27-2** element can be set via the dropout ratio r = $V_{dropout}/V_{pickup}$ (5113 **27–1 DOUT RATIO** or 5114 **27–2 DOUT RATIO**). In this, the following marginal condition always holds for r:

r · (configured pickup threshold) ≤ 120 V with connection of phase-to-phase voltages or

r · (configured pickup threshold) ≤ 210 V with connection of phase-to-ground voltages.

The minimum hysteresis is 0.6 V.

Note

If a setting is selected such that the dropout threshold (= pickup threshold · dropout ratio) results in a greater value than 120 V / 210 V, it will be limited automatically. No error message occurs.

Current Criterion for Undervoltage Protection

The 27-2 and 27-1 elements can be supervised by the current flow monitoring setting. If the **CURRENT SUPERV.** is switched ON at address 5120 (factory setting), the release condition of the current criterion must be fulfilled in addition to the corresponding undervoltage condition, which means that a configured minimum current (**BkrClosed I MIN**, address 212) must be present to make sure that this protective function can pick up. Therefore, it is possible to achieve that pickup of undervoltage protection drops out when the line is disconnected from voltage supply. Furthermore, this feature prevents an immediate general pickup of the device when the device is powered-up without measurement voltage being present.

Note

If parameter **CURRENT SUPERV.** is set to disabled in address 5120, the device picks up without measurement voltage and the undervoltage protection function in pickup. Further configuration can be performed by pickup of measurement voltage or blocking voltage protection. The latter can be initiated via device operation in DIGSI® and via communication from the control centre by means of a tagging command for blocking voltage protection. This causes the dropout of the pickup and parameterization can be resumed.

Please note that pickup threshold **BkrClosed I MIN** is used in other protective functions as well, including breaker failure protection, overload protection, and start inhibit for motors.

2.6.5 Settings

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

Addr.	Parameter	Setting Options	Default Setting	Comments
5001	FCT 59	OFF ON Alarm Only	OFF	59 Overvoltage Protection
5002	59-1 PICKUP	40 .. 260 V	110 V	59-1 Pickup
5003	59-1 PICKUP	40 .. 150 V	110 V	59-1 Pickup
5004	59-1 DELAY	0.00 .. 100.00 sec; ∞	0.50 sec	59-1 Time Delay
5005	59-2 PICKUP	40 .. 260 V	120 V	59-2 Pickup
5006	59-2 PICKUP	40 .. 150 V	120 V	59-2 Pickup
5007	59-2 DELAY	0.00 .. 100.00 sec; ∞	0.50 sec	59-2 Time Delay
5015	59-1 PICKUP V2	2 .. 150 V	30 V	59-1 Pickup V2
5016	59-2 PICKUP V2	2 .. 150 V	50 V	59-2 Pickup V2
5017A	59-1 DOUT RATIO	0.90 .. 0.99	0.95	59-1 Dropout Ratio
5018A	59-2 DOUT RATIO	0.90 .. 0.99	0.95	59-2 Dropout Ratio
5101	FCT 27	OFF ON Alarm Only	OFF	27 Undervoltage Protection
5102	27-1 PICKUP	10 .. 210 V	75 V	27-1 Pickup
5103	27-1 PICKUP	10 .. 120 V	75 V	27-1 Pickup
5106	27-1 DELAY	0.00 .. 100.00 sec; ∞	1.50 sec	27-1 Time Delay
5110	27-2 PICKUP	10 .. 210 V	70 V	27-2 Pickup
5111	27-2 PICKUP	10 .. 120 V	70 V	27-2 Pickup
5112	27-2 DELAY	0.00 .. 100.00 sec; ∞	0.50 sec	27-2 Time Delay

Addr.	Parameter	Setting Options	Default Setting	Comments
5113A	27-1 DOUT RATIO	1.01 .. 3.00	1.20	27-1 Dropout Ratio
5114A	27-2 DOUT RATIO	1.01 .. 3.00	1.20	27-2 Dropout Ratio
5120A	CURRENT SUPERV.	OFF ON	ON	Current Supervision

2.6.6 Information List

No.	Information	Type of Information	Comments
234.2100	27, 59 blk	IntSP	27, 59 blocked via operation
6503	>BLOCK 27	SP	>BLOCK 27 undervoltage protection
6505	>27 I SUPRVSN	SP	>27-Switch current supervision ON
6506	>BLOCK 27-1	SP	>BLOCK 27-1 Undervoltage protection
6508	>BLOCK 27-2	SP	>BLOCK 27-2 Undervoltage protection
6513	>BLOCK 59-1	SP	>BLOCK 59-1 overvoltage protection
6530	27 OFF	OUT	27 Undervoltage protection switched OFF
6531	27 BLOCKED	OUT	27 Undervoltage protection is BLOCKED
6532	27 ACTIVE	OUT	27 Undervoltage protection is ACTIVE
6533	27-1 picked up	OUT	27-1 Undervoltage picked up
6534	27-1 PU CS	OUT	27-1 Undervoltage PICKUP w/curr. superv
6537	27-2 picked up	OUT	27-2 Undervoltage picked up
6538	27-2 PU CS	OUT	27-2 Undervoltage PICKUP w/curr. superv
6539	27-1 TRIP	OUT	27-1 Undervoltage TRIP
6540	27-2 TRIP	OUT	27-2 Undervoltage TRIP
6565	59 OFF	OUT	59-Overvoltage protection switched OFF
6566	59 BLOCKED	OUT	59-Overvoltage protection is BLOCKED
6567	59 ACTIVE	OUT	59-Overvoltage protection is ACTIVE
6568	59-1 picked up	OUT	59 picked up
6570	59-1 TRIP	OUT	59 TRIP
6571	59-2 picked up	OUT	59-2 Overvoltage V>> picked up
6573	59-2 TRIP	OUT	59-2 Overvoltage V>> TRIP

2.7 Negative Sequence Protection 46

Negative sequence protection detects unbalanced loads on the system.

Applications

- The application of negative sequence protection to motors has a special significance. Unbalanced loads create counter-rotating fields in three-phase induction motors, which act on the rotor at double frequency. Eddy currents are induced on the rotor surface, which causes local overheating in rotor end zones and the slot wedges. This especially goes for motors which are tripped via vacuum contactors with fuses connected in series. With single phasing due to operation of a fuse, the motor only generates small and pulsing torques such that it soon is thermally strained assuming that the torque required by the machine remains unchanged. In addition, the unbalanced supply voltage introduces the risk of thermal overload. Due to the small negative sequence reactance even small voltage asymmetries lead to large negative sequence currents.
- In addition, this protection function may be used to detect interruptions, faults, and polarity problems with current transformers.
- It is also useful in detecting 1 pole and 2 pole faults with fault current lower than the maximum load current.

Prerequisites

In order to prevent pickup chattering, the negative sequence protection becomes only active when one phase current becomes larger than 0.1 x I_{Nom} and all phase currents are smaller than 4 x I_{Nom}.

2.7.1 Definite Time element 46-1, 46-2

The definite time characteristic consists of two elements. As soon as the first settable threshold **46-1 PICKUP** is reached, a pickup message is output and time element **46-1 DELAY** is started. When the second element **46-2 PICKUP** is started, another message is output and time element **46-2 DELAY** is initiated. Once either time delay elapses, a trip signal is initiated.

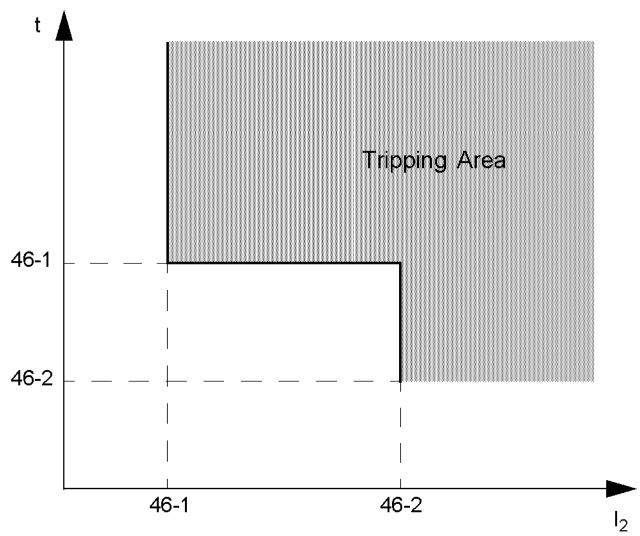


Figure 2-45 Definite time characteristic for negative sequence protection

Settable Dropout Times

Pickup stabilization for the definite-time tripping characteristic 46-1, 46-2 can be accomplished by means of settable dropout times. This facility is used in power systems with intermittent faults. Used together with electromechanical relays, it allows different dropout profiles to be adapted and time grading of digital and electromechanical components.

2.7.2 Inverse Time element 46-TOC

The inverse time element is dependent on the ordered device version. It operates with IEC or ANSI characteristic tripping curves. The characteristics and associated formulas are given in the Technical Data. When programming the inverse time characteristic 46-TOC, also definite time elements **46-2 PICKUP** and **46-1 PICKUP** are available (see previous section).

Pickup and Tripping

The negative sequence current I2 is compared with setting value **46-TOC PICKUP**. When negative sequence current exceeds 1.1 times the setting value, a pickup annunciation is generated. The tripping time is calculated from the negative sequence current according to the characteristic selected. After expiration of the time period a tripping command is output. The characteristic curve is illustrated in the following Figure.

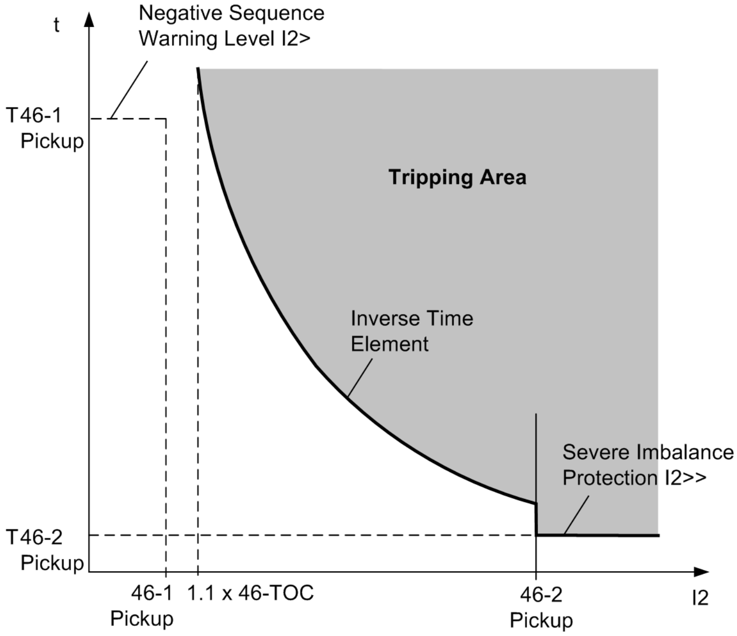


Figure 2-46 Inverse time characteristic for negative sequence protection

Drop Out for IEC Curves

The element drops out when the negative sequence current decreases to approx. 95% of the pickup setting. The time delay resets immediately in anticipation of another pickup.

Drop Out for ANSI Curves

When using an ANSI curve, select if dropout after pickup is instantaneous or with disk emulation. "Instantaneous" means that pickup drops out when the pickup value of approx. 95 % is undershot. For a new pickup the time delay starts at zero.

The disk emulation evokes a dropout process (timer counter is decremented) which begins after de-energization. This process corresponds to the reset rotation of a Ferraris-disk (explaining its denomination "disk emulation"). In case several faults occur successively the "history" is taken into consideration due to the inertia of the Ferraris-disk and the timing response is correspondingly adapted. This ensures a proper simulation of the temperature rise of the protected object even for extremely fluctuating unbalanced load values. Reset begins as soon as 90 % of the setting value is undershot, in correspondence with the dropout curve of the selected characteristic. In the range between the dropout value (95 % of the pickup value) and 90 % of the setting value, the incrementing and the decrementing processes are in idle state.

Disk emulation offers advantages when the behaviour of the negative sequence protection must be coordinated with other relays in the system based on electromagnetic measuring principles.

Logic

The following figure shows the logic diagram for the negative sequence protection function. The protection may be blocked via a binary input. This resets pickup and time stages and clears measured values.

When the negative sequence protection operating range is left (i.e. all phase currents below 0.1 x I_{Nom} or at least one phase current is greater than 4 x I_{Nom}), all pickups issued by the negative sequence protection function are reset.

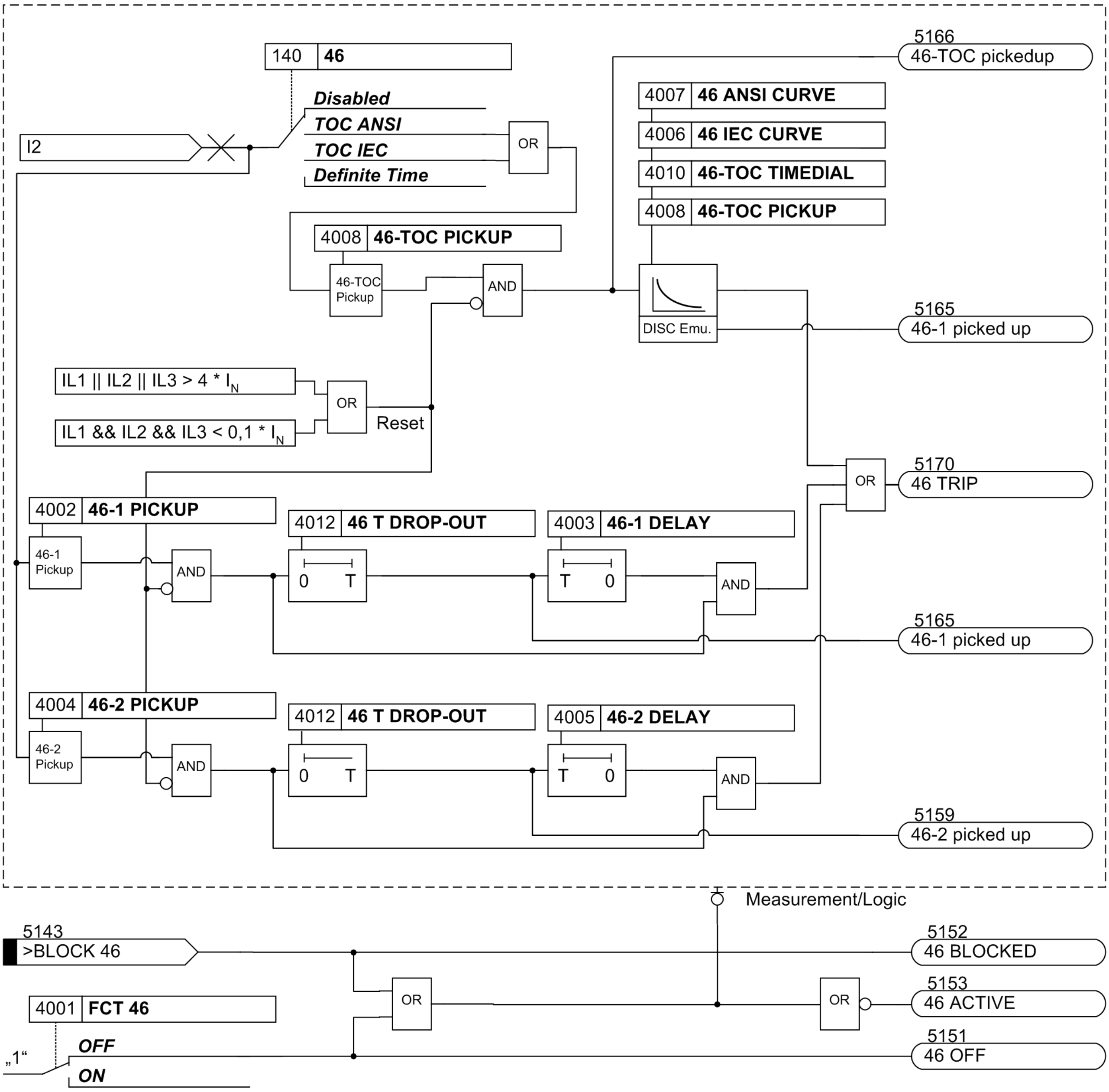


Figure 2-47 Logic diagram of the unbalanced load protection

Pickup of the definite time elements can be stabilized by setting the dropout time 4012 **46 T DROP-OUT**. This time is started if the current falls below the threshold and maintains the pickup condition. The function thus does not drop out instantaneously. The trip delay time continues in the meantime. After the dropout delay time has elapsed, the pickup is reported OFF and the trip delay time is reset unless the threshold has been violated again. If the threshold is violated again while the dropout delay time is still running, it will be cancelled. The trip delay time continues however. If the threshold is still exceeded after the time has elapsed, a trip will be initiated immediately. If the threshold violation then no longer exists, there will be no response. If the threshold is violated again after the trip command delay time has elapsed and while the dropout delay time is still running, a trip will be initiated at once.

The settable dropout times do not affect the trip times of the inverse time elements since they depend dynamically on the measured current value. Disk emulation is applied here to coordinate the dropout behavior with the electromechanical relays.

2.7.3 Setting Notes

General

Negative sequence protection **46** is configured at address 140, (see Section 2.1.1.2). If only the definite time elements are desired, address **46** should be set to ***Definite Time***. Selecting **46** = ***TOC IEC*** or = ***TOC ANSI*** in address 140 will additionally make all the parameters relevant for inverse characteristics available. If the function is not required ***Disabled*** is set.

The function can be turned ***ON*** or ***OFF*** in address 4001 **FCT 46**.

The default pickup settings and delay settings are generally sufficient for most applications. If data is available from the manufacturer regarding the permissable continous load imbalance and the permissable level of load imbalance per unit of time, then this data should preferably be used. It is important to relate the manufacturer's data to the primary values of the machine, for example, the maximum permissible continuous inverse current related to the nominal machine current. For the settings on the protective relay, this information is converted to the secondary inverse current. The following applies

$$\text{Pickup Setting} \qquad I_2 = \left(\frac{I_{2\,perm\,prim}}{I_{Nom\,Motor}}\right) \cdot I_{Nom\,Motor} \cdot \frac{I_{CT\,sec}}{I_{CT\,prim}}$$

with

$I_{2\ perm\ prim}$	Permissible Thermal Inverse Current of the Motor
$I_{Nom\ Motor}$	Nominal Motor Current
$I_{CT\ sec}$	Secondary Nominal Current of the Current Transformer
$I_{CT\ prim}$	Primary Nominal Current of the Current Transformer

Definite Time Elements

The unbalanced load protection function is composed of two elements. Therefore, the upper element (address 4004 **46-2 PICKUP**) can be set to a short time delay 4005 **46-2 DELAY**) and the lower element (address 4002 **46-1 PICKUP**) can be set to a somewhat longer time delay (address 4003 **46-1 DELAY**). This allows the lower element to act e.g. as an alarm while the upper element will cut the inverse characteristic as soon as high inverse currents are present. If **46-2 PICKUP** is set to about 60 %, tripping is always performed with the thermal characteristic. On the other hand, with more than 60% of unbalanced load, a two-phase fault can be assumed. The delay time **46-2 DELAY** must be coordinated with the system grading of phase-to-phase faults. If power supply with current I is provided via just two phases, the following applies to the inverse current:

$$I_2 = \frac{1}{\sqrt{3}} \cdot I = 0.58 \cdot I$$

Examples:

Motor with the following data:

Nominal current	$I_{Nom\ Motor}$ = 545 A
Continuously permissible negative sequence current	$I_{2\ dd\ prim}$ /$I_{Nom\ Motor}$ = 0.11 continuous
Briefly permissible negative sequence current	$I_{2\ long\text{-}term\ prim}$ /$I_{Nom\ Motor}$= 0.55 for T max = 1 s
Current Transformer	CT = 600 A / 1 A
Setting value	I_2> = 0.11 · 545 A · (1/600 A) = 0.10 A
Setting value	I_2> = 0.55 · 545 A · (1/600 A) = 0.50 A

When protecting feeder or cable systems, unbalanced load protection may serve to identify low magnitude unsymmetrical faults below the pickup values of the directional and non-directional overcurrent elements.

Here, the following must be observed:

$$I_2 = \frac{1}{\sqrt{3}} \cdot I = 0.58 \cdot I$$

A phase-to-ground fault with current I corresponds to the following negative sequence current:

$$I_2 = \frac{1}{3} \cdot I = 0.33 \cdot I$$

On the other hand, with more than 60% of unbalanced load, a phase-to-phase fault can be assumed. The delay time **46-2 DELAY** must be coordinated with the system grading of phase-to-phase faults.

For a power transformer, unbalanced load protection may be used as sensitive protection for low magnitude phase-to-ground and phase-to-phase faults. In particular, this application is well suited for delta-wye transformers where low side phase-to-ground faults do not generate high side zero sequence currents (e.g. vector group Dy).

Since transformers transform symmetrical currents according to the transformation ratio "CTR", the relationship between negative sequence currents and total fault current for phase-to-phase faults and phase-to-ground faults are valid for the transformer as long as the turns ratio "CTR" is taken into consideration.

Consider a transformer with the following data:

Base Transformer Rating	S_{NomT} = 16 MVA	
Primary Nominal Voltage	V_{Nom} = 110 kV	
Secondary Nominal Voltage	V_{Nom} = 20 kV	(TR_V = 110/20)
Vector Groups	Dy5	
High Side CT	100 A / 1 A	(CT_I = 100)

The following fault currents may be detected at the low side:

If **46-1 PICKUP** on the high side of the device is set to = 0.1 A, then a fault current of $I = 3 \cdot TR_V \cdot TR_I \cdot$ **46-1 PICKUP** = 3 · 110/20 · 100 · 0.1 A = 165 A for single-phase faults and $\sqrt{3} \cdot TR_V \cdot TR_I \cdot$**46-1 PICKUP** = 95 A can be detected for two-phase faults at the low side. This corresponds to 36 % and 20 % of the transformer nominal current respectively. It is important to note that load current is not taken into account in this simplified example.

As it cannot be recognized reliably on which side the thus detected fault is located, the delay time **46-1 DELAY** must be coordinated with other downstream relays in the system.

Pickup Stabilization (Definite Time)

Pickup of the definite time elements can be stabilized by means of a configurable dropout time. This dropout time is set in 4012 **46 T DROP-OUT**.

IEC Curves (Inverse Time Tripping Curve)

The thermal behavior of a machine can be closely replicated due to negative sequence by means of an inverse time tripping curve. In address 4006 **46 IEC CURVE**, select out of three IEC curves provided by the device the curve which is most similar to the thermal unbalanced load curve provided by the manufacturer. The tripping curves of the protective relay, and the formulas on which they are based, are given in the Technical Data.

It must be noted that a safety factor of about 1.1 has already been included between the pickup value and the setting value when an inverse time characteristic is selected. This means that a pickup will only occur if an unbalanced load of about 1.1 times the setting value **46-TOC PICKUP** is present (address 4008). The dropout is performed as soon as the value falls below 95% of the pickup value.

The associated time multiplier is entered at address 4010, **46-TOC TIMEDIAL**.

The time multiplier can also be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the inverse time element is not required at all, address 140 **46** should be set to ***Definite Time*** during the configuration of protective functions (Section 2.1.1.2).

ANSI Curves (Inverse Time Tripping Curve)

Behavior of a machine due to negative sequence current can be closely replicated by means of an inverse time tripping curve. In address 4007 the **46 ANSI CURVE**, select out of four ANSI curves provided by the device the curve which is most similar to the thermal unbalanced load curve provided by the manufacturer. The tripping curves of the protective relay, and the formulas on which they are based, are given in the Technical Data.

It must be noted that a safety factor of about 1.1 has already been included between the pickup value and the setting value when an inverse time characteristic is selected. This means that a pickup will only occur if an unbalanced load of about 1.1 times the setting value is present. If ***Disk Emulation*** was selected at address 4011 **46-TOC RESET**, reset will occur in accordance with the reset curve as described in the Functional Description.

The unbalanced load value is set at address 4008 **46-TOC PICKUP**. The corresponding time multiplier is accessible via address 4009 **46-TOC TIMEDIAL**.

The time multiplier can also be set to ∞. After pickup the element will then not trip. Pickup, however, will be signaled. If the inverse time element is not required at all, address 140 **46** should be set to ***Definite Time*** during the configuration of protective functions (Section 2.1.1.2).

2.7.4 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
4001	FCT 46		OFF ON	OFF	46 Negative Sequence Protection
4002	46-1 PICKUP	1A	0.10 .. 3.00 A	0.10 A	46-1 Pickup
		5A	0.50 .. 15.00 A	0.50 A	
4003	46-1 DELAY		0.00 .. 60.00 sec; ∞	1.50 sec	46-1 Time Delay
4004	46-2 PICKUP	1A	0.10 .. 3.00 A	0.50 A	46-2 Pickup
		5A	0.50 .. 15.00 A	2.50 A	
4005	46-2 DELAY		0.00 .. 60.00 sec; ∞	1.50 sec	46-2 Time Delay
4006	46 IEC CURVE		Normal Inverse Very Inverse Extremely Inv.	Extremely Inv.	IEC Curve
4007	46 ANSI CURVE		Extremely Inv. Inverse Moderately Inv. Very Inverse	Extremely Inv.	ANSI Curve
4008	46-TOC PICKUP	1A	0.10 .. 2.00 A	0.90 A	46-TOC Pickup
		5A	0.50 .. 10.00 A	4.50 A	
4009	46-TOC TIMEDIAL		0.50 .. 15.00 ; ∞	5.00	46-TOC Time Dial
4010	46-TOC TIMEDIAL		0.05 .. 3.20 sec; ∞	0.50 sec	46-TOC Time Dial
4011	46-TOC RESET		Instantaneous Disk Emulation	Instantaneous	46-TOC Drop Out
4012A	46 T DROP-OUT		0.00 .. 60.00 sec	0.00 sec	46 Drop-Out Time Delay

2.7.5 Information List

No.	Information	Type of Information	Comments
5143	>BLOCK 46	SP	>BLOCK 46
5151	46 OFF	OUT	46 switched OFF
5152	46 BLOCKED	OUT	46 is BLOCKED
5153	46 ACTIVE	OUT	46 is ACTIVE
5159	46-2 picked up	OUT	46-2 picked up
5165	46-1 picked up	OUT	46-1 picked up
5166	46-TOC pickedup	OUT	46-TOC picked up
5170	46 TRIP	OUT	46 TRIP
5171	46 Dsk pickedup	OUT	46 Disk emulation picked up

2.8 Motor Protection (Motor Starting Protection 48, Motor Restart Inhibit 66)

For protection of motors the devices 7SJ62/63/64 are provided with a motor starting time monitoring feature and a restart inhibit. The first feature mentioned supplements the overload protection (see Section 2.10) by protecting the motor from frequent starting or extended starting durations. The restart inhibit described prevents from a restart of the motor, when starting might exceed the permissible time the rotor can suffer heating.

2.8.1 Motor Starting Protection 48

By application of devices 7SJ62/63/64 to motors, the motor starting time monitoring protects the motor from too long starting attempts and supplements the overload protection (see Section 2.10)

2.8.1.1 Description

General

In particular, rotor-critical high-voltage motors can quickly be heated above their thermal limits when multiple starting attempts occur in a short period of time. If the durations of these starting attempts are lengthened e.g. by excessive voltage dips during motor starting, by excessive load torques, or by blocked rotor conditions, a tripping signal will be initiated by the device.

Motor starting is detected when a settable current threshold **I MOTOR START** is exceeded. Calculation of the tripping time is then initiated.

The protection function consists of one definite time and one inverse time tripping element.

Inverse Time Overcurrent Element

The inverse time overcurrent element is designed to operate only when the rotor is not blocked. With decreased starting current resulting from voltage dips when starting the motor, prolonged starting times are evaluated correctly and tripping with appropriate time delay. The tripping time is calculated based on the following equation:

$$t_{TRIP} = \left(\frac{I_{STARTUP}}{I}\right)^2 \cdot t_{STARTUPmax} \qquad \text{where } I > I_{MOT\ START}$$

with

t_{TRIP}	– Actual tripping time for flowing current I
$t_{STARTUPmax}$	– Tripping time for nominal start-up current I_A (address 4103, **STARTUP TIME**)
I	– Current actually flowing (measurement value)
$I_{STARTUP}$	– Nominal starting current of the motor (address 4102, **STARTUP CURRENT**)
$I_{MOTOR\ START}$	– Pickup value for recognition of motor starting (address 1107**I MOTOR START**),

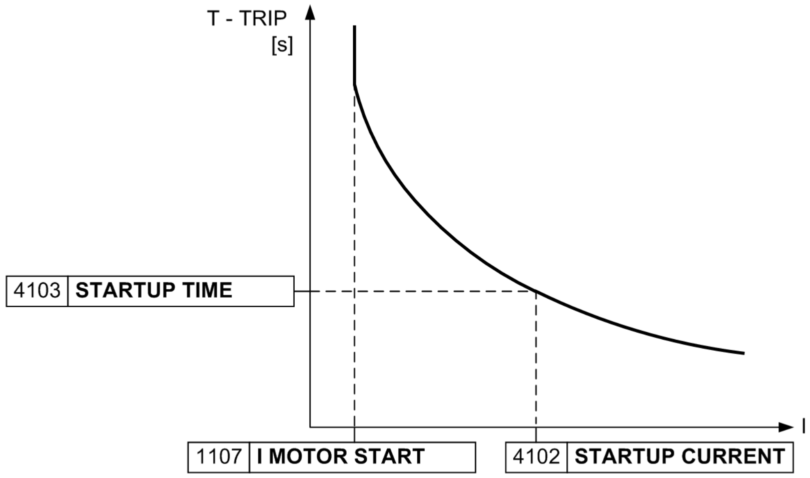


Figure 2-48 Inverse time tripping curve for motor starting current

Therefore, if the startup current I actually measured is smaller (or larger) than the nominal startup current $I_{STARTUP}$ (parameter **STARTUP CURRENT**) entered at address 4102, the actual tripping time t_{Trip} is lengthened (or shortened) accordingly (see Figure 2-48).

Definite Time Overcurrent Tripping Characteristic (Locked Rotor Time)

Tripping must be executed when the actual motor starting time exceeds the maximum allowable locked rotor time if the rotor is locked. The device can be informed about the locked rotor condition via the binary input („>Rotor locked“), e.g. from an external rpm-monitor. The motor startup condition is assumed when the current in any phase exceeds the current threshold I MOTOR START. At this instant, the timer LOCK ROTOR TIME is started. It should be noted that this timer starts every time the motor is started. This is therefore a normal operating condition that is neither indicated in the fault log nor causes the creation of a fault record. Only when the locked rotor time has elapsed, is the trip command issued.

The locked rotor delay time (**LOCK ROTOR TIME**) is linked with the binary input „>Rotor locked“ over an AND gate. If the binary input is picked up after the set locked rotor time has expired, immediate tripping will take place regardless of whether the locked rotor condition occurred before, during or after the timeout.

Logic

Motor starting protection may be switched on or off. In addition, motor starting protection may be blocked via a binary input which will reset timers and pickup annunciations. The following figure illustrates the logic of motor starting protection. A pickup does not create messages in the trip log buffer. Fault recording is not started until a trip command has been issued. When the function drops out, all timers are reset. The annunciations disappear and a trip log is terminated should it have been created.

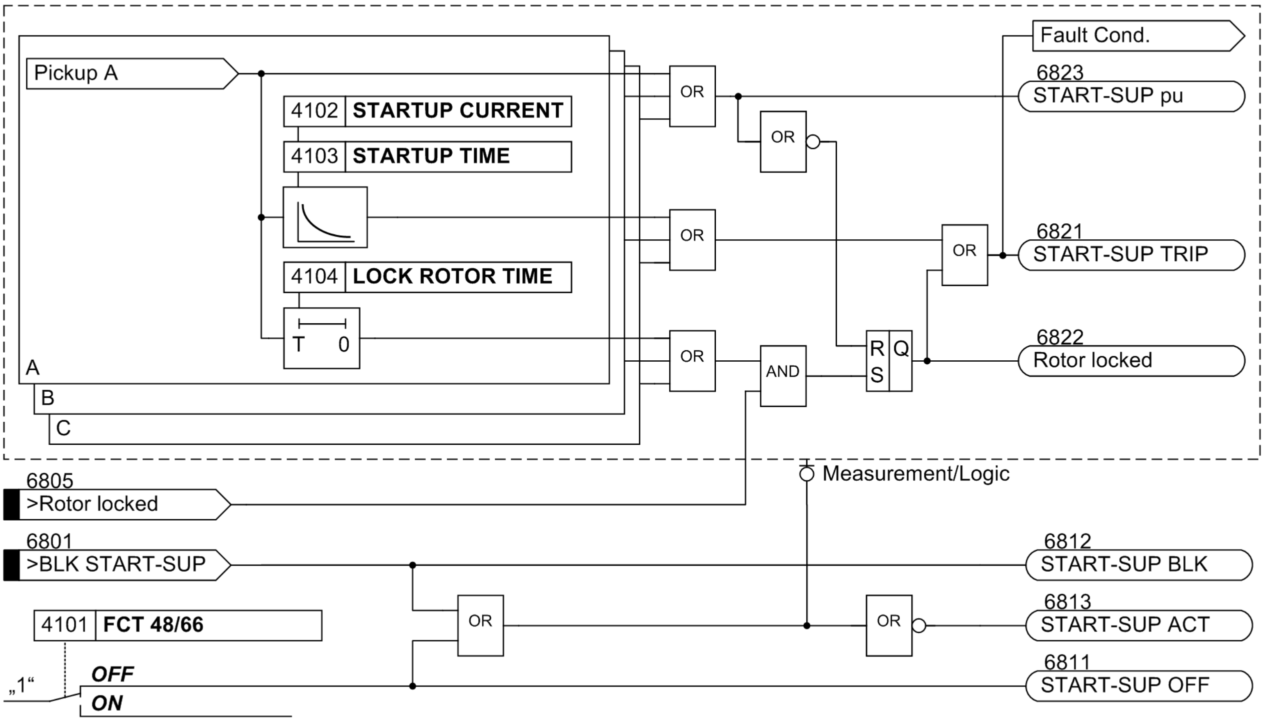


Figure 2-49 Logic diagram of the Motor Starting Time Supervision

2.8.1.2 Setting Notes

General

Motor starting protection is only effective and accessible if address 141 **48** = ***Enabled*** is set. If the function is not required ***Disabled*** is set. The function can be turned ***ON*** or ***OFF*** under address 4101 **48**.

Startup Parameter

The device is informed of the startup current values under normal conditions at address 4102 **STARTUP CURRENT**, the startup time at address 4103 **STARTUP TIME**. At all times this enables timely tripping if the value I^2t calculated in the protection device is exceeded.

If the startup time is longer than the permissible blocked rotor time, an external rpm-counter can initiate the definite-time tripping element via binary input („>Rotor locked“). A locked rotor leads to a loss of ventilation and therefore to a reduced thermal load capacity of the machine. For this reason the motor starting time monitor must issue a tripping command before reaching the thermal tripping characteristic valid for normal operation.

A current above the threshold **I MOTOR START** (address 1107) is interpreted as a motor startup. Consequently, this value must be selected such that under all load and voltage conditions during motor startup the actual startup current safely exceeds the setting, but stays below the setting in case of permissible, momentary overload.

Example: Motor with the following data:

Rated Voltage	V_{Nom} = 6600 V
Nominal Current	I_{Nom} = 126 A
Startup Current (primary)	$I_{STARTUP}$ = 624 A
Long-Term Current Rating	I_{max} = 135 A
Startup Duration	$T_{STARTUP}$ = 8.5 s
Current Transformers	$I_{Nom\ CTprim}/I_{Nom\ CTsec}$ = 200 A / 1 A

The setting for address **STARTUP CURRENT** ($I_{STARTUP}$) as a secondary value is calculated as follows:

$$I_{STARTUP\ sec} = \frac{I_{STARTUP}}{I_{Nom\,CT\ prim}} \cdot I_{Nom\,CT\ sec} = \frac{624\ A}{200\ A} \cdot I_{Nom\,CT\ sec} = 3.12\ A$$

For reduced voltage, the startup current is also reduced almost linearly. At 80 % nominal voltage, the startup current in this example is reduced to 0.8 · $I_{STARTUP}$ = 2.5.

The setting for detection of a motor startup must lie above the maximum load current and below the minimum start-up current. If no other influencing factors are present (peak loads), the value for motor startup **I MOTOR START** set at address 1107 may be an average value:

Based on the Long-Term Current Rating:

$$\frac{135\text{ A}}{200\text{ A}} \cdot I_{\text{Nom CT sec}} = 0.68\text{ A}$$

$$I_{\text{STARTUP sec}} = \frac{2.5\text{ A} + 0.68\text{ A}}{2} \approx 1.6\text{ A}$$

For ratios deviating from nominal conditions, the motor tripping time changes:

$$T_{\text{TRIP}} = \left(\frac{I_{\text{STARTUP}}}{I}\right)^2 \cdot T_{\text{STARTUP}}$$

At 80% of nominal voltage (which corresponds to 80% of nominal starting current), the tripping time is:

$$T_{\text{TRIP}} = \left(\frac{624\text{ A}}{0.8 \cdot 624\text{ A}}\right)^2 \cdot 8.5\text{ s} = 13.3\text{ s}$$

After the delay time 4104 **LOCK ROTOR TIME** has elapsed, the locked rotor binary input becomes effective and initiates a tripping signal. If the locked rotor time is set just long enough that during normal startup the binary input „>Rotor locked“ (FNo. 6805) is reliably reset during the delay time **LOCK ROTOR TIME**, faster tripping will be available during motor starting under locked rotor conditions.

Note

Overload protection characteristic curves are also effective during motor starting conditions. However, thermal profile during motor starting is constant. The setting at address **I MOTOR START** (1107) limits the operating range of the overload protection with regard to larger currents.

2.8.2 Motor Restart Inhibit 66

The restart inhibit prevents restarting of the motor when this restart may cause the permissible thermal limits of the rotor to be exceeded.

2.8.2.1 Description

General

The rotor temperature of a motor generally remains well below its maximum admissible temperature during normal operation and also under increased load conditions. However, high startup currents required during motor startup increase the risk of the rotor being thermally damaged rather the stator, due to the short thermal constant of the rotor. To avoid that multiple starting attempts provoke tripping, a restart of the motor must be inhibited, if it is apparent that the thermal limit of the rotor will be exceeded during this startup attempt. Therefore, the 7SJ62/63/64 relays feature the motor start inhibit which outputs a blocking command until a new motor startup is permitted for the deactivated motor (restarting limit). The blocking signal must be configured to a binary output relay of the device whose contact is inserted in the motor starting circuit.

Determining the Rotor Overtemperature

Since the rotor current cannot be measured directly, the stator current must be used to generate a thermal profile of the rotor. The r.m.s. values of the currents are utilized for this. The rotor overtemperature Θ_R is calculated using the largest of these three currents. Therefore, it is assumed that the thermal limit values for the rotor winding are based on the manufacturer's data regarding the nominal starting current, maximum permissible starting time, and the number of starts permitted from cold (n_{cold}) and warm (n_{warm}) conditions. From this data, the device performs the necessary calculations to establish the thermal profile of rotor and issues a blocking signal until the thermal profile of rotor decreases below the restarting limit at which point starting is permitted anew.

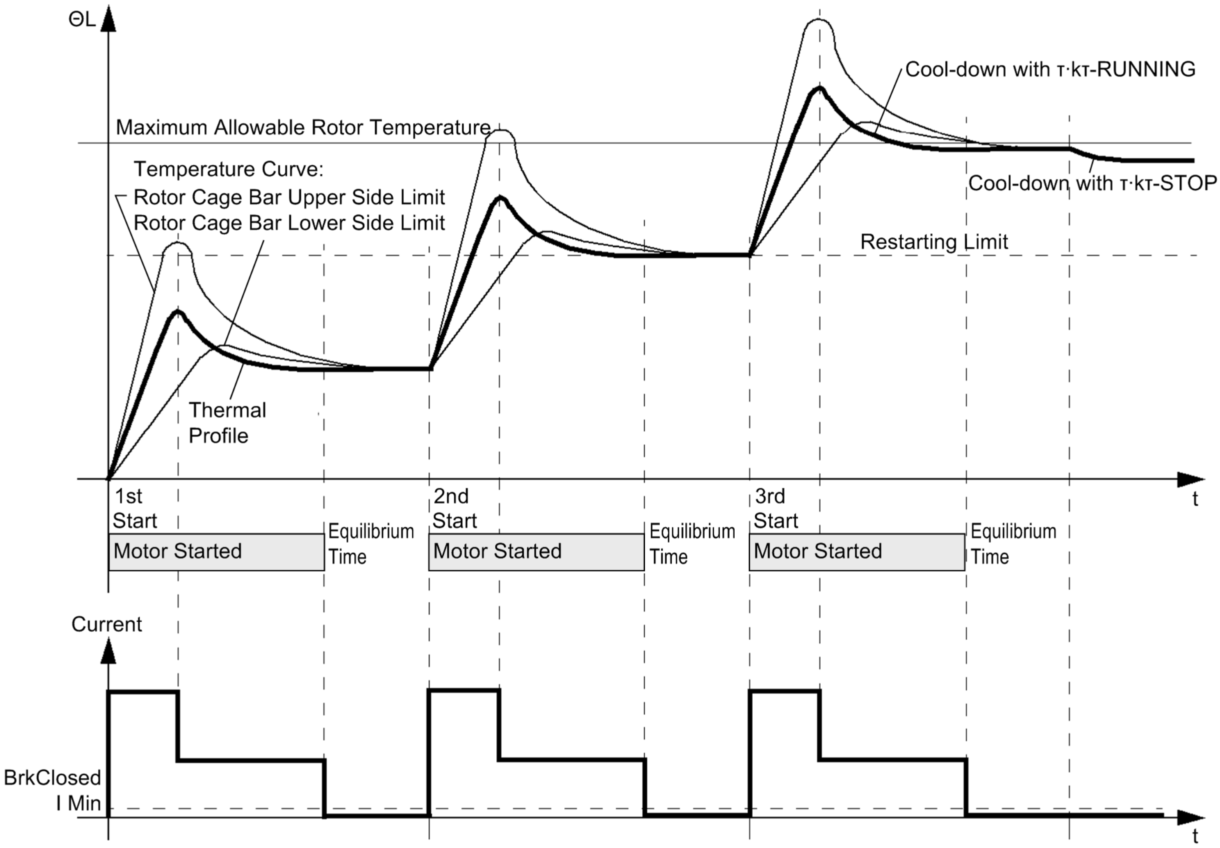


Figure 2-50 Temperature curve at the rotor and the thermal profile during repeated start-up attempts

Although the heat distribution on the rotor bars may severely differ during motor starting, the different maximum temperatures in the rotor are not pertinant for motor restart inhibit (see Figure 2-50). It is much more important to establish a thermal profile, after a complete motor start, that is appropriate for the protection of the motor's thermal condition. Figure 2-50 shows, as an example, the heating processes during repeated motor starts (three starts from cold operating condition), as well as the thermal profile in the protection relay.

Restarting Limit

If the rotor temperature has exceeded the restart threshold, the motor cannot be restarted. The blocking signal is not lifted unless the rotor temperature has fallen below the restarting limit, that is, when exactly one start becomes possible without exceeding the excessive rotor temperature limit. Based on the specified motor parameters the device calculates the normalized restarting limit $\Theta_{Restart}$:

$$\Theta_{Restart} = \left(\frac{I_{Start}}{I_B \cdot k_R}\right)^2 \cdot \left(1 - e^{-\frac{(n_{cold} - 1) \cdot T_m}{\tau_R}}\right)$$

Where:

$\Theta_{Restart}$	=	Temperature threshold below which restarting is possible
k_R	=	k-factor for the rotor, calculated internally
I_{Start}	=	Startup current
I_B	=	Basic current
T_m	=	Maximum starting time
τ_R	=	Thermal time constant of the rotor, calculated internally
n_{cold}	=	Permitted starts with cold motor

The restarting limit $\Theta_{Restart}$ is displayed as operational measured value in the "thermal measured values".

Restart Time

The motor manufacturer allows a maximum allowable cold (n_{cold}) and warm (n_{warm}) starting attempts. Afterwards the device must be allowed to cool off! A certain time must elapse - restarting time $t_{Restart}$ - to ensure that the rotor has cooled off.

Equilibrium Time

This thermal behavior is provided for in the protection as follows: Each time the motor is shutdown, the timer starts (address 4304 **T Equal**). It takes into account the different thermal conditions of the motor parts at the moment of shutdown. During the equilibrium time, the thermal profile of the rotor is not updated. It is maintained constant to replicate the equilization process in the rotor. Then the thermal model with the corresponding time constant (rotor time constant x extension factor) cools down. During the equilibrium time the motor cannot be restarted. As soon as the temperature sinks below the restarting threshold, the next restart attempt can be made.

Minimum Inhibit Time

Regardless of thermal profiles, some motor manufacturers require a minimum inhibit time after the maximum number of permissible starting attempts has been exceeded.

The total duration of the inhibit signal depends on which of the times $T_{Min\ Inhibit}$ or $T_{Restart}$ is longer.

Total Time $T_{Reclose}$

The total waiting time $T_{Reclose}$, before the motor can be restarted, therefore is composed of the equilibrium time and the time $T_{Restart}$ calculated from the thermal profile, and the value that is needed to drop below the limit for restarting. If the calculated temperature rise of the rotor is above the restarting limit when the motor is shut down, the minimum inhibit time will be started together with the equilibrium time.

Thus the total inhibit time $T_{Reclose}$ can become equal to the minimum inhibit time if it is longer than the sum of the two first mentioned times:

$T_{Reclose} = T_{Equal} + T_{Restart}$	for $T_{Min\ Inhibit} < T_{Equal} + T_{Restart}$
$T_{Reclose} = T_{Min\ Inhibit}$	for $T_{Min\ Inhibit} \geq T_{Equal} + T_{Restart}$, if the calculated excessive temperature > restarting limit

The operational measured value $T_{Reclose}$ (visible in the thermal measured values) is the remaining time until the next restart is permissible. When the rotor excessive temperature is below the restarting limit and thus the next restarting attempt is permitted, the operational measured value for the waiting time has reached zero.

Extension of Cool Down Time Constants

In order to properly account for the reduced heat exchange when a self-ventilated motor is stopped, the cooling time constants can be increased relative to the time constants for a running machine with the factor **Kτ at STOP** (address 4308). The criterion for the motor stop is the undershooting of a set current threshold **BkrClosed I MIN**. This understands that the motor idle current is greater than this threshold. The pickup threshold **BkrClosed I MIN** affects also the thermal overload protection function (see Section 2.10).

While the motor is running, the heating of the thermal profile is modeled with the time constant τ_R calculated from the motor ratings, and the cool down calculated with the time constant τ_R x **Kτ at RUNNING** (address 4309). In this way, the protection caters to the requirements in case of a slow cool down (slow temperature equilibrium).

For calculation of the restarting time $T_{Restart}$ the following applies:

$$T_{RESTART} = k_{\tau at\ STOP} \cdot \tau_R \cdot I_{Nom} \left[\frac{\Theta_{pre} \cdot n_{cold}}{n_{cold} - 1}\right] \qquad \text{at Stop}$$

$$T_{RESTART} = k_{\tau at\ RUNNING} \cdot \tau_R \cdot I_{Nom} \left[\frac{\Theta_{pre} \cdot n_{cold}}{n_{cold} - 1}\right] \qquad \text{at Running}$$

with

$k_{\tau\ at\ STOP}$	– extension factor for the time constant = **Kτ at STOP**, address 4308
$k_{\tau\ at\ RUNNING}$	– extension factor for the time constant = **Kτ at RUNNING**, address 4309
Θ_{pre}	– thermal replica at the instant the motor is switched off (depends on operational condition)
τ_R	– rotor time constant, calculated internally

Behavior in Case of Power Supply Failure

Depending on the setting in address 235 **ATEX100** of Power System Data 1 (see Section 2.1.3.2) the value of the thermal replica is either reset to zero (**ATEX100** = ***NO***) if the power supply voltage fails, or cyclically buffered in a non-volatile memory (**ATEX100** = ***YES***) so that it is maintained in the event of auxiliary supply voltage failure. In the latter case, the thermal replica uses the stored value for calculation and matches it to the operating conditions. The first option is the default setting (see "Additional Information on the Protection of Explosion-Protected Motors of Protection Type Increased Safety "e", C53000-B1174-C157"/5/). For further details, see /5/.

EmergencyStart

If, for emergency reasons, motor starting that will exceed the maximum allowable rotor temperature must take place, the motor start blocking signal can be terminated via a binary input („>66 emer.start“), thus allowing a new starting attempt. The thermal rotor profile however continues to function and the maximum allowable rotor temperature will be exceeded. No motor shutdown will be initiated by motor start blocking, but the calculated excessive temperature of the rotor can be observed for risk assessment.

Blocking

If the motor restart inhibit function is blocked via binary input „>BLOCK 66“ or switched off, the thermal replica of the rotor overtemperature, the equilibrium time **T Equal** and the minimum inhibit time **T MIN. INHIBIT** are reset. Thus any blocking signal that is present or upcoming is disregarded.

Via another binary input („>66 RM th.repl.“) the thermal replica can be reset independently. This may be useful for testing and commissioning, and after a power supply voltage failure.

Logic

There is no pickup annunciation for the restart inhibit and no trip log is produced. The following figure shows the logic diagram for the restart inhibit.

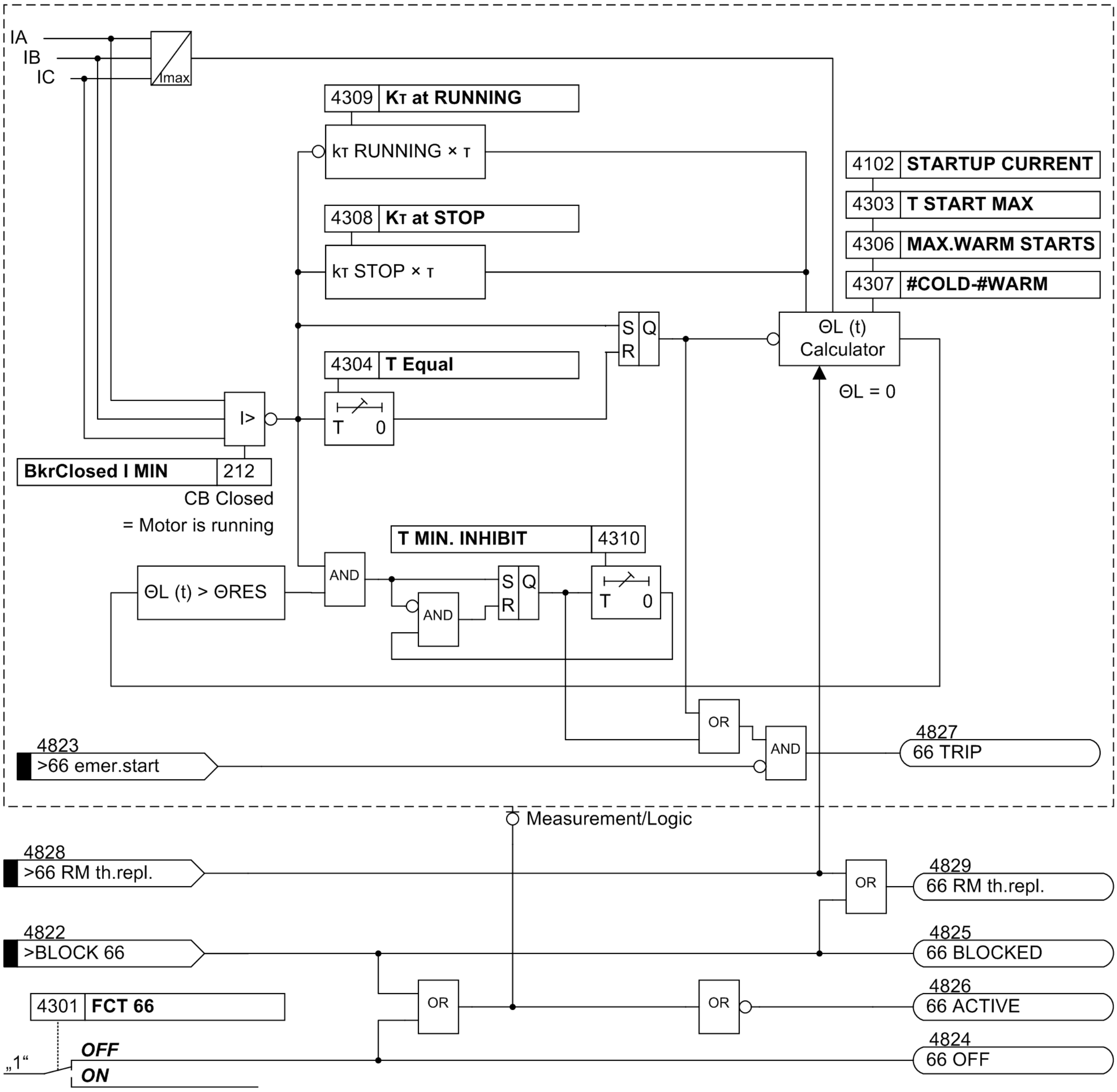


Figure 2-51 Logic diagram of the Restart Inhibit

2.8.2.2 Setting Notes

General

Restart inhibit is only effective and accessible if address 143 **48** is set to ***Enabled***. If not required, this function is set to ***Disabled***. The function can be turned ***ON*** or ***OFF*** under address 4301 **FCT 66**..

Note

When function settings of the restart inhibit are changed, the thermal profile of this function is reset.

The restart inhibit acts on the starting process of a motor that is shut down. A motor is considered shut down if its current consumption falls below the settable threshold 212 **BkrClosed I MIN**. Therefore, this threshold must set lower than the motor idle current.

Characteristic Values

Many of the variables needed to calculate the rotor temperature are supplied by the motor manufacturer. Among these variables are the starting current $I_{STARTUP}$, the nominal motor current $I_{MOT. NOM}$, the maximum allowable starting time **T START MAX** (address 4303), the number of allowable starts from cold conditions (n_{cold}), and the number of allowable starts from warm conditions (n_{warm}).

The starting current is entered at address 4302 **IStart/IMOTnom** , expressed as a multiple of nominal motor current. In contrast, the nominal motor current is entered as a secondary value, directly in amperes, at address 4305 **I MOTOR NOMINAL**. The number of warm starts allowed is entered at address 4306 (**MAX.WARM STARTS**) and the difference (**#COLD-#WARM**) between the number of allowable cold and warm starts is entered at address 4307.

For motors without separate ventilation, the reduced cooling at motor stop can be accounted for by entering the factor **Kτ at STOP** at address 4308. As soon as the current no longer exceeds the setting value entered at address 212 **BkrClosed I MIN**, motor standstill is detected and the time constant is increased by the extension factor configured.

If no difference between the time constants is to be used (e.g. externally-ventilated motors), then the extension factor **Kτ at STOP** should be set to 1.

The cooling with the motor running is influenced by the extension factor 4309 **Kτ at RUNNING**. This factor considers that motor running under load and a stopped motor do not cool down at the same speed. It becomes effective as soon as the current exceeds the value set at address 212 **BkrClosed I MIN**. With **Kτ at RUNNING** = 1 the heating and the cooling time constant are the same at operating conditions ($I >$ **BkrClosed I MIN**).

Example: Motor with the following data:

Nominal Voltage	V_{Nom} = 6600 V
Nominal current	I_{Nom} = 126 A
Startup current	$I_{STARTUP}$ = 624 A
Startup Duration	$T_{STARTUP}$ = 8.5 s
Allowable Starts with Cold Motor	n_{cold} = 3
Allowable Starts with Warm Motor	n_{warm} = 2
Current Transformer	200 A / 1 A

The following settings are derived from these data:

$$I_{STARTUP}/I_{MOTnom} = \frac{624\ \text{A}}{126\ \text{A}} = 4.95$$

$$I_{MOTnom} = \frac{126\ \text{A}}{200\ \text{A}} = 0.62 \cdot I_{NomCTsec}$$

The following settings are made:

IStart/IMOTnom = ***4.9***

I MOTOR NOMINAL = ***0.6 A***

T START MAX = ***8.5 s***

MAX.WARM STARTS = ***2***

#COLD-#WARM = ***1***

For the rotor temperature equilibrium time (address 4304), a setting of. **T Equal** = ***1 min*** has proven to be a good value. The value for the minimum inhibit time **T MIN. INHIBIT** depends on the requirements set by the motor manufacturer, or by the system conditions. It must in any case be higher than 4304 **T Equal**. In this example, a value was chosen that reflects the thermal profile (**T MIN. INHIBIT** = ***6.0 min***).

The motor manufacturer's, or the requirements also determine also the extension factor for the time constant during cool-down, especially with the motor stopped. Where no other specifications are made, the following settings are recommended: **Kτ at STOP** = ***5*** and **Kτ at RUNNING** = ***2***.

For a proper functioning, it is also important that the CT values and the current threshold for distinction between stopped and running motor (address 212 **BkrClosed I MIN**, recommended setting ≈ 0.1 $I_{MOT.NOM}$) have been set correctly. An overview of parameters and their default settings is generally given in the setting tables.

Temperature Behaviour during Changing Operating States

For a better understanding of the above considerations several possible operating ranges in two different operating areas will be discussed in the following paragraph. Settings indicated above are to be used prevaling 3 cold and 2 warm startup attempts have resulted in the restart limit reaching 66.7%.

A. Below the thermal restarting limit:

1. A normal startup brings the machine into a temperature range below the thermal restarting limit and the machine is stopped. The stop launches the equilibrium time 4304 **T Equal** and generates the message „66 TRIP“. The equilibrium time expires and the message „66 TRIP“ is cleared. During the time **T Equal** the thermal model remains "frozen" (see Figure 2-52, to the left).
2. A normal startup brings the machine into a temperature range below the thermal restarting limit, the machine is stopped and is started by an emergency startup without waiting for expiry of the equilibrium time. The equilibrium time is reset and the thermal profile is released and „66 TRIP“ is reported to be cleared (see Figure 2-52, to the right).

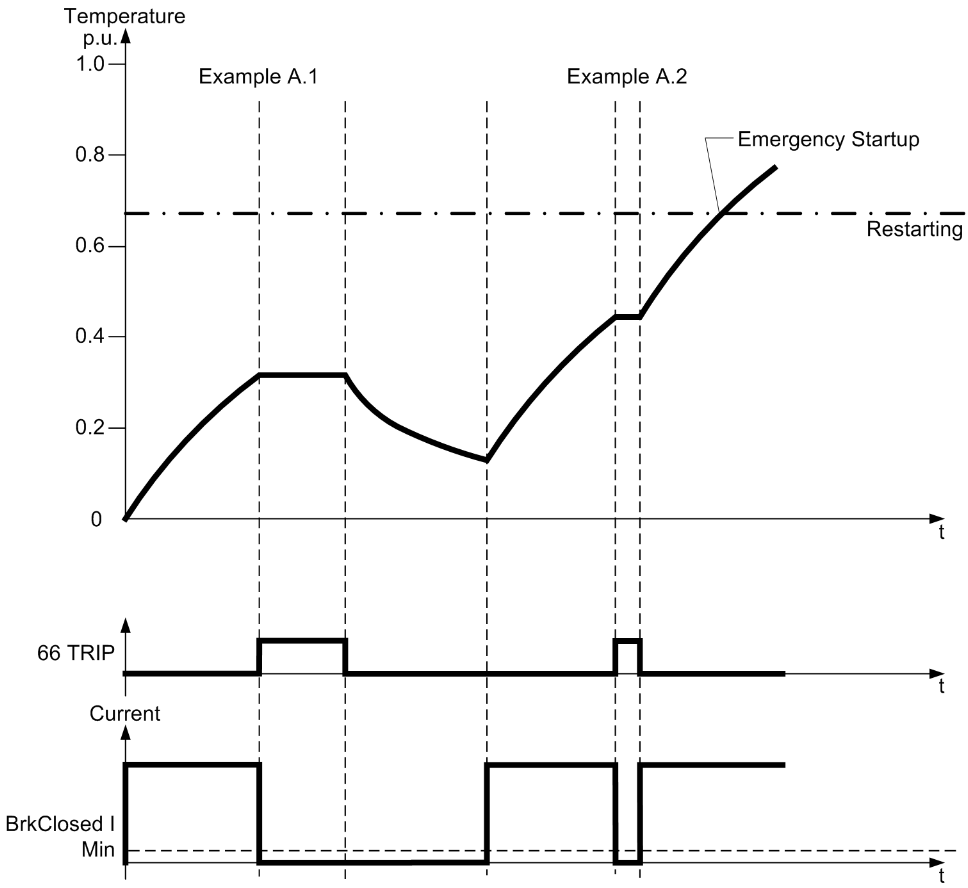


Figure 2-52 Startups according to examples A.1 and A.2

B. Above the thermal restarting limit:

1. A startup brings the machine from load operation into a temperature range far above the thermal restarting limit and the machine is stopped. The minimum inhibit time and the equilibrium time are started and „66 TRIP“ is reported. The temperature cool-down below the restarting limit takes longer than 4310 **T MIN. INHIBIT** and 4304 **T Equal**, so that the time passing until the temperature falls below the temperature limit is the decisive factor for clearing the message „66 TRIP“. The thermal profile remains "frozen" while the time expires (see Figure 2-53, to the left).
2. A startup brings the machine from load operation into a temperature range just above the thermal restarting limit and the machine is stopped. The minimum inhibit time and the equilibrium time are started and „66 TRIP“ is reported. Although the temperature soon falls below the restarting limit, the blocking „66 TRIP“ is preserved until the equilibrium time and the minimum inhibit time have expired (see Figure 2-53, to the right).

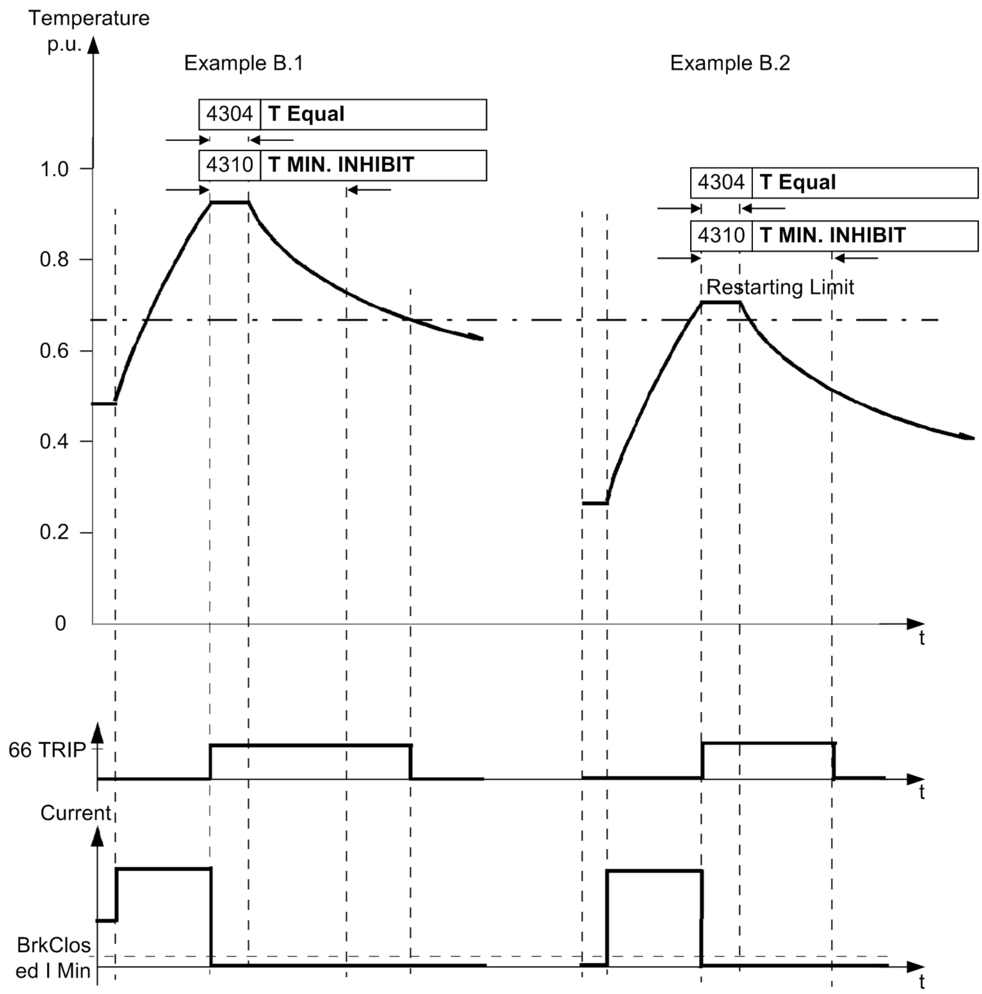


Figure 2-53 Starting up according to examples B.1 and B.2

2.8.3 Motor (Motor Starting Protection 48, Motor Restart Inhibit 66)

Functions Motor Starting Protection and Restart Inhibit for Motors associated with motor protection are described in the previous two sections and contain information concerning configuration.

2.8.3.1 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
4101	FCT 48/66		OFF ON	OFF	48 / 66 Motor (Startup Monitor/Counter)
4102	STARTUP CURRENT	1A	0.50 .. 16.00 A	5.00 A	Startup Current
		5A	2.50 .. 80.00 A	25.00 A	
4103	STARTUP TIME		1.0 .. 180.0 sec	10.0 sec	Startup Time
4104	LOCK ROTOR TIME		0.5 .. 120.0 sec; ∞	2.0 sec	Permissible Locked Rotor Time
4301	FCT 66		OFF ON	OFF	66 Startup Counter for Motors
4302	IStart/IMOTnom		1.10 .. 10.00	4.90	I Start / I Motor nominal
4303	T START MAX		3 .. 320 sec	10 sec	Maximum Permissible Starting Time
4304	T Equal		0.0 .. 320.0 min	1.0 min	Temperature Equalizaton Time
4305	I MOTOR NOMINAL	1A	0.20 .. 1.20 A	1.00 A	Rated Motor Current
		5A	1.00 .. 6.00 A	5.00 A	
4306	MAX.WARM STARTS		1 .. 4	2	Maximum Number of Warm Starts
4307	#COLD-#WARM		1 .. 2	1	Number of Cold Starts - Warm Starts
4308	Kτ at STOP		0.2 .. 100.0	5.0	Extension of Time Constant at Stop
4309	Kτ at RUNNING		0.2 .. 100.0	2.0	Extension of Time Constant at Running
4310	T MIN. INHIBIT		0.2 .. 120.0 min	6.0 min	Minimum Restart Inhibit Time

2.8.3.2 Information List

No.	Information	Type of Information	Comments
4822	>BLOCK 66	SP	>BLOCK Motor Startup counter
4823	>66 emer.start	SP	>Emergency start
4824	66 OFF	OUT	66 Motor start protection OFF
4825	66 BLOCKED	OUT	66 Motor start protection BLOCKED
4826	66 ACTIVE	OUT	66 Motor start protection ACTIVE
4827	66 TRIP	OUT	66 Motor start protection TRIP
4828	>66 RM th.repl.	SP	>66 Reset thermal memory
4829	66 RM th.repl.	OUT	66 Reset thermal memory
6801	>BLK START-SUP	SP	>BLOCK Startup Supervision
6805	>Rotor locked	SP	>Rotor locked
6811	START-SUP OFF	OUT	Startup supervision OFF
6812	START-SUP BLK	OUT	Startup supervision is BLOCKED
6813	START-SUP ACT	OUT	Startup supervision is ACTIVE
6821	START-SUP TRIP	OUT	Startup supervision TRIP
6822	Rotor locked	OUT	Rotor locked
6823	START-SUP pu	OUT	Startup supervision Pickup

2.9 Frequency Protection 81 O/U

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

Applications

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

2.9.1 Description

Detection of Frequency

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

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

Underfrequency and Overfrequency Protection

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

The parameter setting decides for what purpose the particular element will be used:

- Set the pickup threshold lower than nominal frequency if the element is to be used for underfrequency protection.
- Set the pickup threshold lower than nominal frequency if the element is to be used for overfrequency protection.
- If the threshold is set equal to the nominal frequency, the element is inactive.

Operating Ranges

The frequency can be determined if for three-phase voltage transformer connections the positive frequency component of the voltages or for single-phase voltage transformer connections the corresponding voltage is present and of sufficient magnitude. If the measured voltage drops below a settable value **Vmin**, the frequency protection is blocked since a precise frequency value can no longer be calculated from the signal under these conditions.

Time Delays / Logic

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

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

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

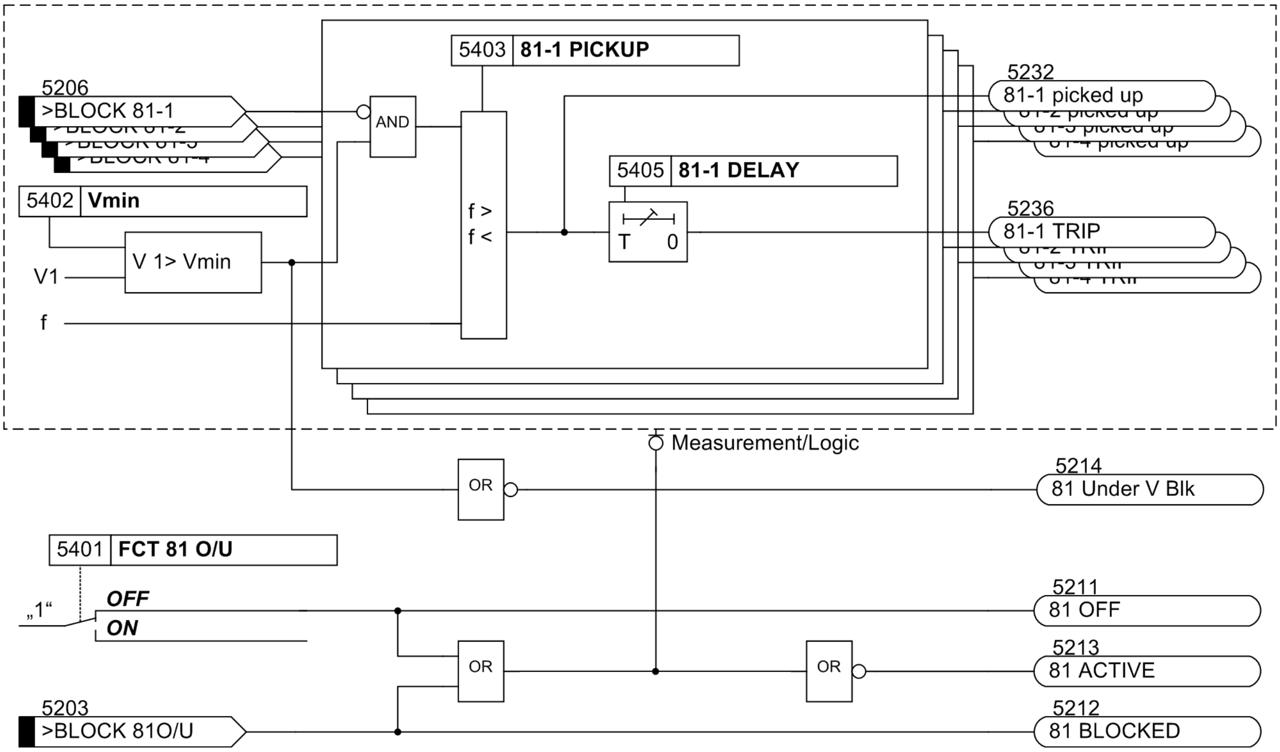


Figure 2-54 Logic diagram of the frequency protection

2.9.2 Setting Notes

General

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

Minimum Voltage

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

On all three-phase connections and single-phase connections of a phase-to-phase voltage, the threshold must be set as a phase-to-phase value. With a single-phase phase-to-ground connection the threshold is set as a phase-to-ground voltage.

Pickup Values

The nominal system frequency is programmed in Power System Data 1, and the pickup settings for each of the frequency elements **81-1 PICKUP** to **81-4 PICKUP** determines whether the function will be used for overfrequency or underfrequency protection. Set the pickup threshold lower than nominal frequency if the element is to be used for underfrequency protection. Set the pickup threshold higher than nominal frequency if the element is to be used for overfrequency protection.

Note

If the threshold is set equal to the nominal frequency, the element is inactive.

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 a graded load shedding is required that takes into account the importance of the consumers or consumer groups.

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

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

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

Time Delays

The time delays (definite time) **81-1 DELAY** to **81-4 DELAY** entered at addresses 5405, 5408, 5411 and 5414 allow the device to prioritize or sort corrective actions based on the degree to which the actual system frequency departs (upward or downward) from the nominal system frequency, e.g. for load shedding equipment. The set times are additional time delays not including the operating times (measuring time, drop-out time) of the protective function.

2.9.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
5401	FCT 81 O/U	OFF ON	OFF	81 Over/Under Frequency Protection
5402	Vmin	10 .. 150 V	65 V	Minimum required voltage for operation
5403	81-1 PICKUP	45.50 .. 54.50 Hz	49.50 Hz	81-1 Pickup
5404	81-1 PICKUP	55.50 .. 64.50 Hz	59.50 Hz	81-1 Pickup
5405	81-1 DELAY	0.00 .. 100.00 sec; ∞	60.00 sec	81-1 Time Delay
5406	81-2 PICKUP	45.50 .. 54.50 Hz	49.00 Hz	81-2 Pickup
5407	81-2 PICKUP	55.50 .. 64.50 Hz	59.00 Hz	81-2 Pickup
5408	81-2 DELAY	0.00 .. 100.00 sec; ∞	30.00 sec	81-2 Time Delay
5409	81-3 PICKUP	45.50 .. 54.50 Hz	47.50 Hz	81-3 Pickup
5410	81-3 PICKUP	55.50 .. 64.50 Hz	57.50 Hz	81-3 Pickup
5411	81-3 DELAY	0.00 .. 100.00 sec; ∞	3.00 sec	81-3 Time delay
5412	81-4 PICKUP	45.50 .. 54.50 Hz	51.00 Hz	81-4 Pickup
5413	81-4 PICKUP	55.50 .. 64.50 Hz	61.00 Hz	81-4 Pickup
5414	81-4 DELAY	0.00 .. 100.00 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
5214	81 Under V Blk	OUT	81 Under Voltage Block
5232	81-1 picked up	OUT	81-1 picked up
5233	81-2 picked up	OUT	81-2 picked up
5234	81-3 picked up	OUT	81-3 picked up
5235	81-4 picked up	OUT	81-4 picked up
5236	81-1 TRIP	OUT	81-1 TRIP
5237	81-2 TRIP	OUT	81-2 TRIP
5238	81-3 TRIP	OUT	81-3 TRIP
5239	81-4 TRIP	OUT	81-4 TRIP

2.10 Thermal Overload Protection 49

The thermal overload protection is designed to prevent thermal overloads from damaging the protected equipment. The protection function models a thermal profile of the object being protected (overload protection with memory capability). Both the history of an overload and the heat loss to the environment are taken into account.

Applications

- In particular, the thermal overload protection allows the thermal status of motors, generators and transformers to be monitored.
- If an additional thermal input is available, the thermal profile may take the actual ambient or coolant temperature into consideration.

2.10.1 Description

Thermal Profile

The device calculates the overtemperatures in accordance with a single-body thermal model, based on the following differential equation:

$$\frac{d\Theta}{dt} + \frac{1}{\tau_{th}} \cdot \Theta = \frac{1}{\tau_{th}} \cdot \left(\left(\frac{I}{k \cdot I_{Nom\ Obj.}}\right)^2 + \Theta_u'\right)$$

with

Θ	Present overtemperature related to the final overtemperature at maximum allowed phase current $k \cdot I_{Nom\ Obj}$
τ_{th}	Thermal time constant of the protected object's heating
I	Present rms value of phase current
k	k–factor indicating the maximum permissible constant phase current referred to the nominal current of the protected object
$I_{Nom\ Obj.}$	Nominal current of protected object

$$\Theta_u' = \frac{\Theta_u - 40°C}{k^2 \cdot \Theta_{Nom}}$$

with

Θ_u	Measured ambient temperature or coolant temperature
Θ_{Nom}	Temperature at object nominal current

If the ambient or coolant temperature is not measured, a constant value of Θ_u = 40 °C or 104°F is assumed so that Θ_u'= 0.

The protection feature models a thermal profile of the equipment being protected (overload protection with memory capability). Both the history of an overload and the heat loss to the environment are taken into account.

When the calculated overtemperature reaches the first settable threshold **49 Θ ALARM**, an alarm annunciation is issued, e.g. to allow time for the load reduction measures to take place. When the calculated overtemperature reaches the second threshold, the protected equipment may be disconnected from the system. The highest overtemperature calculated from the three phase currents is used as the criterion.

The maximum thermally-permissible continuous current I_{max} is described as a multiple of the object nominal current $I_{Nom\ Obj.}$:

$I_{max} = k \cdot I_{Nom\ Obj.}$

In addition to the k factor (parameter **49 K-FACTOR**), the **TIME CONSTANT** τ_{th} and the alarm temperature **49 Θ ALARM** (in percent of the trip temperature Θ_{TRIP}) must be specified.

Overload protection also features a current warning element (**I ALARM**) in addition to the temperature warning stage. The current warning element may report an overload current prematurely, even if the calculated operating temperature has not yet attained the warning or tripping levels.

Coolant Temperature (Ambient Temperature)

The device can account for external temperatures. Depending on the type of application, this may be a coolant or ambient temperature. The temperature can be measured via a temperature detection unit (RTD-box). For this purpose, the required temperature detector is connected to detector input 1 of the first RTD-box (corresponds to RTD 1). If incorrect temperature values are measured or there are disturbances between the RTD-box and the device, an alarm will be issued and the standard temperature of Θ_u = 104° F or 40° C is used for calculation with the ambient temperature detection simply being ignored.

When detecting the coolant temperature, the maximum permissible current I_{max} is influenced by the temperature difference of the coolant (in comparison with the standard value = 104° F or 40° C). If the ambient or coolant temperature is low, the protected object can support a higher current than it does when the temperature is high.

Current Limiting

In order to ensure that overload protection, on occurrence of high fault currents (and with small time constants), does not result in extremely short trip times thereby perhaps affecting time grading of the short circuit protection, the thermal model is frozen (kept constant) as soon as the current exceeds the threshold value

1107

I MOTOR START.

Extension of Time Constants

When using the device to protect motors, the varying thermal response at standstill or during rotation may be correctly evaluated. When running down or at standstill, a motor without external cooling looses heat more slowly, and a longer thermal time constant must be used for calculation. For a motor that is switched off, the 7SJ62/63/64 increases the time constant τ_{th} by a programmable factor (kτ factor). The motor is considered to be off when the motor currents drop below a programmable minimum current setting **BkrClosed I MIN** (refer to "Current Flow Monitoring" in Section 2.1.3). For externally-cooled motors, cables and transformers, the **Kτ-FACTOR** = ***1***.

Blocking

The thermal memory may be reset via a binary input („>RES 49 Image“). The current-related overtemperature value is reset to zero. The same is accomplished via the binary input („>BLOCK 49 O/L“); in this case the entire overload protection is blocked completely, including the current warning stage.

When motors must be started for emergency reasons, temperatures above the maximum permissible overtemperature can be allowed by blocking the tripping signal via a binary input („>EmergencyStart“). Since the thermal profile may have exceeded the tripping temperature after initiation and drop out of the binary input has taken place, the protection function features a programmable run-on time interval (**T**

EMERGENCY) which is started when the binary input drops out and continues suppressing a trip signal. Tripping by the overload protection will be defeated until this time interval elapses. The binary input affects only the tripping signal. There is no effect on the trip log nor does the thermal profile reset.

Behaviour in Case of Power Supply Failure

Depending on the setting in address 235 **ATEX100** of Power System Data 1 (see Section 2.1.3) the value of the thermal replica is either reset to zero (**ATEX100** = ***NO***) if the power supply voltage fails, or cyclically buffered in a non-volatile memory (**ATEX100** = ***YES***) so that it is maintained in the event of auxiliary supply voltage failure. In the latter case, the thermal replica uses the stored value for calculation and matches it to the operating conditions. The first option is the default setting (see /5/). For further details, see /5/.

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

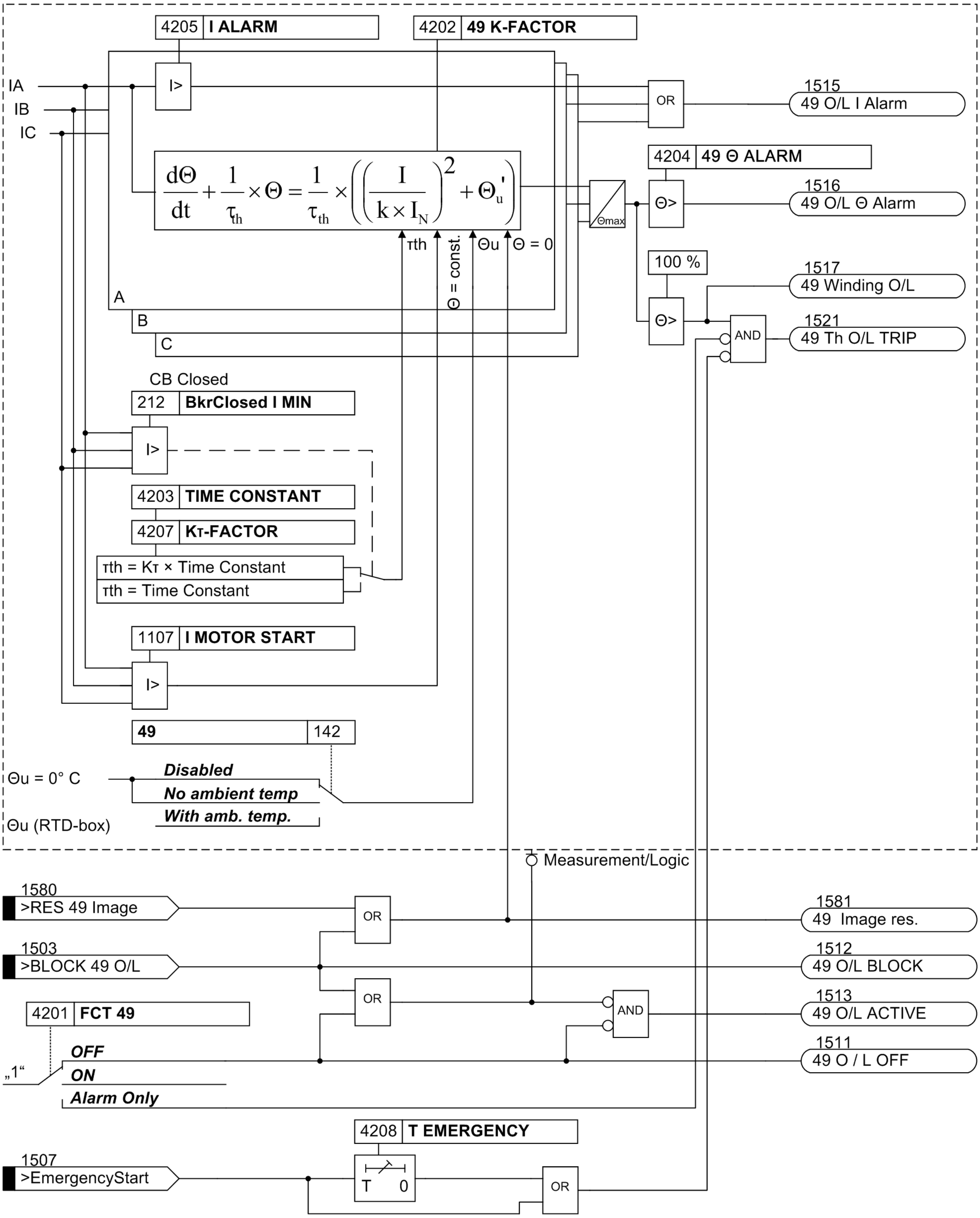


Figure 2-55 Logic diagram of the overload protection

2.10.2 Setting Notes

General

The overload protection is only in effect and accessible if address 142 **49** = ***No ambient temp*** or = ***With amb. temp.*** during configuration. If the function is not required ***Disabled*** is set.

Transformers and cable are prone to damage by overloads that last for an extended period of time. Overloads cannot and should not be detected by fault protection. Time overcurrent protection should be set high enough to only detect faults since these must be cleared in a short time. Short time delays, however, do neither allow measures to discharge overloaded equipment nor do they permit to take advantage of its (limited) overload capacity.

The protective relays 7SJ62/63/64 feature a thermal overload protective function with a thermal tripping curve which may be adapted to the overload tolerance of the equipment being protected (overload protection with memory capability).

Overload protection may be switched ***ON*** or ***OFF*** or ***Alarm Only*** at address 4201 **FCT 49**. If overload protection is ***ON***, tripping, trip log and fault recording is possible.

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

Note

Changing the function parameters resets the thermal replica. The thermal model is frozen (kept constant) as soon as the current exceeds the threshold value 1107 **I MOTOR START.**

Overload Parameter k-factor

The overload protection is set with quantities per unit. The nominal current $I_{\text{Nom Obj.}}$ of the protected object (motor, transformer, cable) is used as a basis for overload detection. The thermally permissible continuous current $I_{\text{max prim}}$ allows to calculate a factor k_{prim}:

$$k_{\text{prim}} = \frac{I_{\text{max prim}}}{I_{\text{Nom Obj.}}}$$

The thermally-permissible continuous current for the equipment being protected is known from the manufacturers specifications. This function is normally not applicable to overhead lines since the current capability of overhead lines is generally not specified. For cables, the permissible continuous current is dependent on the cross-section, insulating material, design, and the cable routing, among other things. It may be taken from pertinent tables, or is specified by the cable manufacturer. If no specifications are available, a value of 1.1 times the nominal current rating may be assumed.

The **49 K-FACTOR** to be set in the device (address 4202) refers to the secondary nominal current of the protective relay. The following data apply for the conversion:

Set the **49 K-FACTOR** $k = \frac{I_{max\ prim}}{I_{Nom\ Obj.}} \cdot \frac{I_{Nom\ Obj.}}{I_{Nom\ CT\ prim}}$

with

$I_{max\ prim}$	Permissible thermal primary current of the motor
$I_{Nom\ Obj.}$	Nominal current of the protected object
$I_{Nom\ CT\ prim}$	Nominal primary CT current

Example: Motor and transformer with the following data:

Permissible Continuous Current	$I_{max\ prim} = 1.2 \cdot I_{Nom\ Obj.}$
Nominal Motor Current	$I_{Nom\ Obj.} = 1100$ A
Current Transformer	1200 A / 1 A

Set the **49 K-FACTOR =** $1.2 \cdot \frac{1100\ A}{1200\ A} = 1.1$

Time Constant τ

The overload protection tracks overtemperature progression, employing a thermal differential equation whose steady state solution is an exponential function. The **TIME CONSTANT** τ_{th} (set at address 4203) is used in the calculation to determine the threshold of overtemperature and thus, the tripping temperature.

For cable protection, the heat-gain time constant τ is determined by cable specifications and by the cable environment. If no time-constant specification is available, it may be determined from the short-term load capability of the cable. The 1-sec current, i.e. the maximum current permissible for a one-second period of time, is often known or available from tables. Then, the time constant may be calculated with the formula:

$$\text{Set Value } \tau_{th}\ (\text{min}) = \frac{1}{60} \times \left|\frac{I_{1\ sec}}{I_{max\ Prim}}\right|^2$$

If the short-term load capability is given for an interval other than one sec, the corresponding short-term current is used in the above formula instead of the 1-sec current, and the result is multiplied by the given duration. For example, if the 0.5-second current rating is known:

$$\text{Set Value } \tau_{th}\ (\text{min}) = \frac{0.5}{60} \times \left|\frac{I_{0.5\ sec}}{I_{max\ Prim}}\right|^2$$

It is important to note, however, that the longer the effective duration, the less accurate the result.

Example: Cable and current transformer with the following data:

Permissible Continuous Current	I_{max} = 500 A at Θ_u = 104 °F or 40 °C
Maximum current for 1 s	$I_{1s} = 45 \cdot I_{max}$ = 22.5 kA
Current Transformer	600 A / 1 A

Example: Cable and current transformer with the following data:

Thus results:

$$k = \frac{I_{max}}{I_{Nom\ CT\ prim}} = \frac{500\ A}{600\ A} = 0.833$$

$$\tau_{th} = \frac{1}{60} \cdot \left(\frac{I_{1\ s}}{I_{max}}\right)^2 \cdot \frac{1}{60} \cdot 45^2 = 33.75\ \text{min}$$

The settings are: **49 K-FACTOR** = ***0.83***; **TIME CONSTANT** = ***33.7 min***

Warning Temperature Level

By setting the thermal warning level **49 Θ ALARM** at address 4204, a warning message can be issued prior to tripping, thus allowing time for load curtailment procedures to be implemented. This warning level simultaneously represents the dropout level for the tripping signal. Only when this threshold is undershot, the tripping command is reset and the protected equipment may be returned to service.

The thermal warning level is given in % of the tripping temperature level.

A current warning level is also available (address 4205 **I ALARM**). The setting corresponds to secondary amperes, and should be set equal to, or slightly less than, permissible continuous current ($k \cdot I_{Nom\ sec}$). It may be used in lieu of the thermal warning level by setting the thermal warning level to 100 % and thereby practically disabling it.

Extension of Time Constants

TIME CONSTANT set in address 4203 is valid for a running motor. When a motor without external cooling is running down or at standstill, the motor cools down more slowly. This behavior can be modeled by increasing the time constant by factor **Kτ-FACTOR**, set at address 4207. Motor stop is detected if the current falls below the threshold value **BkrClosed I MIN** of the current flow monitoring (see margin heading "Current Flow Monitoring" in Section 2.1.3.2). This assumes that the motor idle current is greater than this threshold. The pickup threshold **BkrClosed I MIN** affects also the following protection functions: breaker failure protection and restart inhibit for motors.

If no differentiation of the time constants is necessary (e.g. externally-cooled motors, cables, lines, etc.) the **Kτ-FACTOR** is set at ***1*** (default setting value).

Dropout Time after Emergency Starting

The dropout time to be entered at address 4208 **T EMERGENCY** must ensure that after an emergency startup and after dropout of the binary input „>EmergencyStart“ the trip command is blocked until the thermal replica is below the dropout threshold again.

Ambient or Coolant Temperature

The indications specified up to now are sufficient for a temperature rise replica. The ambient or coolant temperature, however, can also be processed. This has to be communicated to the device as digitalized measured value via the interface. During configuration the parameter 142 **49 must be set to** ***With amb. temp.***.

If the ambient temperature detection is used, the user must be aware that the **49 K-FACTOR** to be set refers to an ambient temperature of 104° F or 40° C, i.e. it corresponds to the maximum permissible current at a temperature of 104° F or 40° C.

All calculations are performed with standardized quantities. The ambient temperature must also be standardized. The temperature with nominal current is used as standardized quantity. If the nominal current deviates from the nominal CT current, the temperature must be adapted according to the following formula. In address 4209 or 4210 **49 TEMP. RISE I** the temperature adapted to the nominal transformer current is set. This setting value is used as standardization quantity of the ambient temperature input.

$$\Theta_{Nom\ sec} = \Theta_{Nom\,Mach} \cdot \left(\frac{I_{Nom\,prim\,CT}}{I_{Nom\,Mach}}\right)^2$$

with

$\Theta_{Nom\ sec}$	Machine temperature with secondary nominal current = setting at the protective relay (address 4209 or 4210)
$\Theta_{Nom\ mach}$	Machine temperature with nominal machine current
$I_{Nom\ CT\ prim}$	Nominal Primary CT Current
$I_{Nom\ mach}$	Nominal Current of the Machine

If the temperature input is used, the trip times change if the coolant temperature deviates from the internal reference temperature of 104° F or 40° C. The following formula can be used to calculate the trip time:

$$t = \tau_{th} \cdot \ln \frac{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 + \frac{\Theta_u - 40\ °C}{k^2 \cdot \Theta_{Nom}} - \left[\left(\frac{I_{pre}}{k \cdot I_N}\right)^2 + \frac{\Theta_{U_{t=0}} - 40\ °C}{k^2 \cdot \Theta_{Nom}}\right] \cdot \left(1 - e^{-\frac{t_{pre}}{\tau}}\right)}{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 + \frac{\Theta_u - 40\ °C}{k^2 \cdot \Theta_{Nom}} - 1}$$

with

τ_{th}	**TIME CONSTANT** (address 4203)
k	**49 K-FACTOR** (address 4202)
I_{Nom}	Nominal device current in A
I	Fault current through phase in A
I_{Pre}	Previous load current
$\Theta_{Ut=0}$	Coolant temperature input in °C with t=0
Θ_{Nom}	Temperature with Nominal Current I_{Nom}(Address 4209 **49 TEMP. RISE I**)
Θ_u	Coolant temperature input (scaling with address 4209 or 4210)

Example:

Machine: $I_{Nom\ Mach}$ = 483 A

$I_{max\ Mach}$=1.15 I_{Nom} at Θ_K = 104 °F or 40 °C

$\Theta_{Nom\ Mach}$ = 199.4° F or 93° C Temperature at $I_{Nom\ Mach}$

τ_{th} = 600 s (thermal time constant of the machine)

Current transformer: 500 A / 1 A

$$\textbf{K-FACTOR} = 1.15 \cdot \frac{483\ A}{500\ A} \approx 1.11$$ (to be set in address 4202)

$$\Theta_{Nom\ sec} = 93°\ C \cdot \left(\frac{500}{483}\right)^2 \approx 100°\ C$$ (to be set in address 4209 or 4210 **49 TEMP. RISE I**)

Motor Starting Recognition

The motor starting is detected when setting **I MOTOR START** at address 1107 is exceeded. Information on how to perform the configuration is given under "Recognition of Running Condition (only for motors)" in Subsection2.1.3.2.

2.10.3 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
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	
4207A	Kτ-FACTOR		1.0 .. 10.0	1.0	Kt-FACTOR when motor stops
4208A	T EMERGENCY		10 .. 15000 sec	100 sec	Emergency time
4209	49 TEMP. RISE I		40 .. 200 °C	100 °C	49 Temperature rise at rated sec. curr.
4210	49 TEMP. RISE I		104 .. 392 °F	212 °F	49 Temperature rise at rated sec. curr.

2.10.4 Information List

No.	Information	Type of Information	Comments
1503	>BLOCK 49 O/L	SP	>BLOCK 49 Overload Protection
1507	>EmergencyStart	SP	>Emergency start of motors
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
1580	>RES 49 Image	SP	>49 Reset of Thermal Overload Image
1581	49 Image res.	OUT	49 Thermal Overload Image reset

2.11 Monitoring Functions

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

2.11.1 Measurement Supervision

2.11.1.1 General

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

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

2.11.1.2 Hardware Monitoring

Auxiliary and Reference Voltages

The processor voltage of 5 VDC is monitored by the hardware since if it goes below the minimum value, the processor is no longer functional. The device is under such a circumstance removed from operation. When the supply voltage returns, the processor system is restarted.

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

The processor monitors the offset and reference voltage of the ADC (analog-digital converter). The protection is suspended if the voltages deviate outside an allowable range, and lengthy deviations are reported.

Buffer Battery

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

Memory Components

All working memories (RAMs) are checked during start-up. If a fault occurs, the start is aborted and an LED starts flashing. During operation the memories are checked with the help of their checksum. For the program memory, the cross sum is formed cyclically and compared to the stored program cross sum.

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

If a fault occurs the processor system is restarted.

Scanning

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

2.11.1.3 Software Monitoring

Watchdog

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

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

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

OffsetMonitoring

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. The eventual offset errors are detected using DC voltage filters and the associated samples are corrected up to a specific limit. If this limit is exceeded an indication is issued (191 „`Error Offset`“) that is part of the warn group annunciation (annunciation 160). As increased offset values affect the reliability of measurements taken, we recommend to send the device to the OEM plant for corrective action if this annunciation continuously occurs.

2.11.1.4 Monitoring of the 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 cyclically checked in the background for this purpose, as long as no system fault is present.

Measurement 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 star point or a separated ground current transformer of the line to be protected are connected to the device, their digitised sum must be zero. Faults in the current circuit are recognised if

$$I_F = | i_A + i_B + i_C + k_I \cdot i_N | > \Sigma\ \mathbf{I\ THRESHOLD} \cdot I_{Nom} + \Sigma\ \mathbf{I\ FACTOR} \cdot I_{max}$$

The factor k_I takes into account a possible difference in the neutral current transformer ratio I_N (e.g. toroidal current transformer see addresses 217, 218, 204 and 205):

$$k_I = \frac{\text{Ignd-CT PRIM} / \text{Ignd-CT SEC}}{\text{CT PRIMARY} / \text{CT SECONDARY}}$$

Σ **I THRESHOLD** and Σ **I FACTOR** are programmable settings. The component Σ **I FACTOR** · Imax takes into account the permissible current proportional ratio errors of the input transformer which are particularly prevalent during large short-circuit currents (Figure 2-56). The dropout ratio is about 97 %. This malfunction is reported as „`Failure Σ I`“.

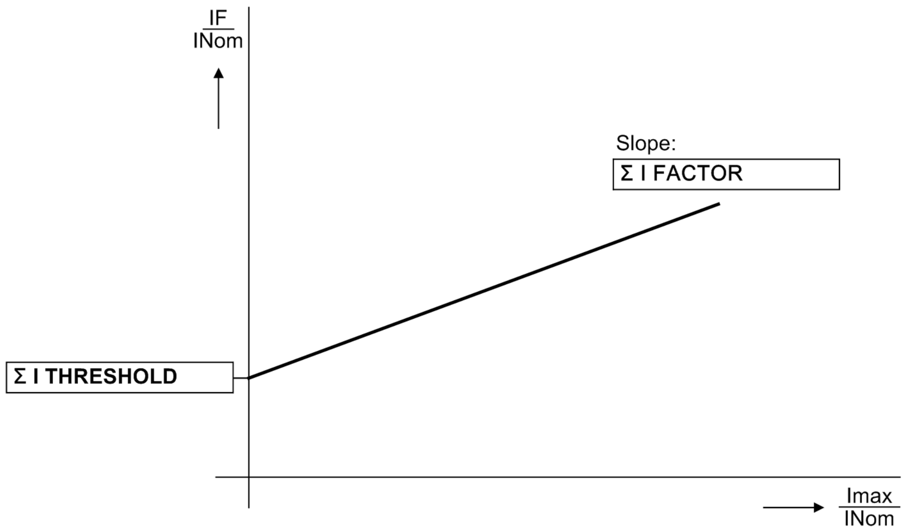


Figure 2-56 Current sum monitoring

CurrentSymmetry

During normal system operation, symmetry among the input currents is expected. The symmetry is monitored in the device by magnitude comparison. The smallest phase current is compared to the largest phase current. Asymmetry is detected if $| I_{min} | / | I_{max} |$ < **BAL. FACTOR I** as long as I_{max} / I_{Nom} > **BALANCE I LIMIT** / I_{Nom} is valid.

Thereby I_{max} is the largest of the three phase currents and I_{min} the smallest. The symmetry factor **BAL. FACTOR I** represents the allowable asymmetry of the phase currents while the limit value **BALANCE I LIMIT** is the lower limit of the operating range of this monitoring (see Figure 2-57). Both parameters can be set. The dropout ratio is about 97%.

This malfunction is reported as „`Fail I balance`“.

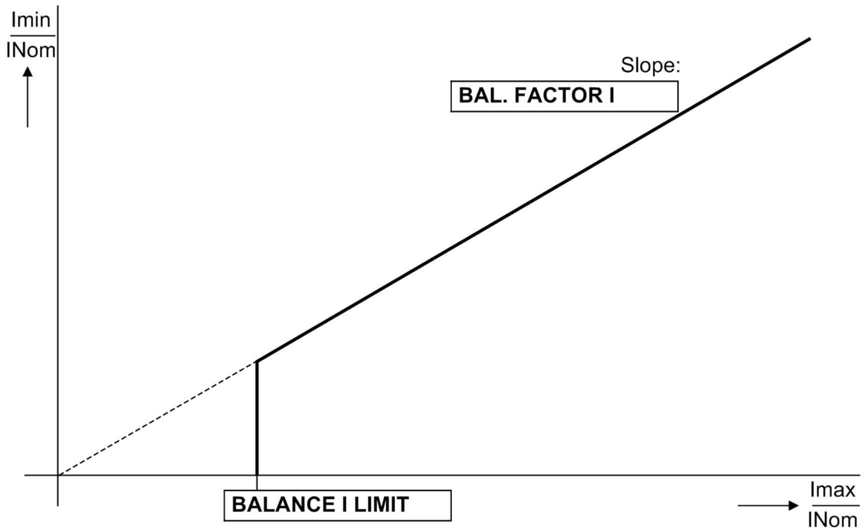


Figure 2-57 Current symmetry monitoring

VoltageSymmetry

During normal system operation (i.e. the absence of a short-circuit fault), symmetry among the input voltages is expected. Because the phase-to-phase voltages are insensitive to ground connections, the phase-to-phase voltages are used for the symmetry monitoring. If the device is connected to the phase-to-ground voltages, then the phase-to-phase voltages are calculated accordingly, whereas if the device is connected to phase-to-phase voltages and the displacement voltage, then the third phase-to-phase voltage is calculated accordingly. Whereas if the device is connected to phase-to-phase voltages and the displacement voltage V_0, then the third phase-to-phase voltage is calculated accordingly. From the phase-to-phase voltages, the protection generates the rectified average values and checks the symmetry of their absolute values. The smallest phase voltage is compared with the largest phase voltage. Asymmetry is recognized if:

$|V_{min}| / |V_{max}| <$ **BAL. FACTOR V** as long as $|V_{max}| >$ **BALANCE V-LIMIT**. Where V_{max} is the highest of the three voltages and V_{min} the smallest. The symmetry factor **BAL. FACTOR V** is the measure for the asymmetry of the conductor voltages; the limit value **BALANCE V-LIMIT** is the lower limit of the operating range of this monitoring (see Figure 2-58). Both parameters can be set. The dropout ratio is about 97%.

This malfunction is reported as „`Fail V balance`“.

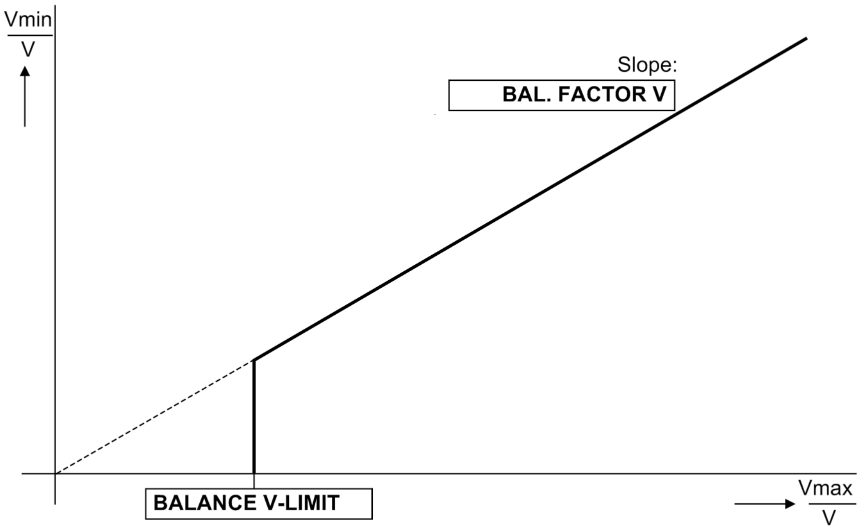


Figure 2-58 Voltage symmetry monitoring

Current and Voltage PhaseSequence

To detect swapped phase connections in the voltage and current input circuits, the phase sequence of the phase-to-phase measured voltages and the phase currents are checked by monitoring the sequence of same polarity zero transitions of the voltages.

Direction measurement with normal voltages, path selection for fault location, and negative sequence detection all assume a phase sequence of "abc". Phase rotation of measurement quantities is checked by verifying the phase sequences.

Voltages: $\underline{V}_A$ before $\underline{V}_B$ before $\underline{V}_C$ and

Currents: $\underline{I}_A$ before $\underline{I}_B$ before $\underline{I}_C$.

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

$|\underline{V}_A|, |\underline{V}_B|, |\underline{V}_C| > 40\ V/\sqrt{3}$.

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

$|\underline{I}_A|, |\underline{I}_B|, |\underline{I}_C| > 0.5\ I_N$.

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

For applications in which an opposite phase sequence is expected, the protective relay should be adjusted via a binary input or a programmable setting. If the phase sequence is changed in the device, phases B and C internal to the relay are reversed, and the positive and negative sequence currents are thereby exchanged (see also Section 2.21.2). The phase-related messages, malfunction values, and measured values are not affected by this.

2.11.1.5 Measurement Voltage Failure Detection

Requirements

The function measurement voltage failure detection, in given briefly „Fuse Failure Monitor“ (FFM), only operates under the following condition.

- Three phase-to-ground voltages are connected; with phase-phase voltages and V_N or single-phase connection, the function is disabled, as monitoring cannot occur.

Purpose of the Fuse Failure Monitor

In case of a measuring voltage failure caused by a fault or a broken wire in the voltage transformer secondary system, zero voltage may be "seen" by individual measuring loops. The displacement voltage element of the sensitive ground fault detection, the undervoltage protection and the synchronization function in the 7SJ64 can thereby acquire incorrect measuring results.

In grounded systems, the function „Fuse Failure Monitor“ (FFM) can take effect, unless three phase-to-ground voltages are connected to the device. Of course, supervision of the miniature circuit breaker and the Fuse Failure Monitor can be used at the same time.

Functionality

Depending on the settings and the MLFB, the FFM operates with the measured or the calculated values V_N or I_N. If zero sequence voltage occurs without a ground fault current being registered simultaneously, then there is an asymmetrical fault in the secondary circuit of the voltage transformer. The displacement voltage element of the sensitive ground fault detection, the directional time overcurrent protection (phase and ground function), the undervoltage protection and the synchronization function in the 7SJ64 are blocked. The latter, however is not blocked if **`Direct CO`** is selected and therefore no measurement is required.

Note

On systems where the ground fault current is very small or absent (e.g. ungrounded supply transformers), fuse failure monitoring must not be used!

The FFM will pick up on a ground voltage V_N which is bigger than the threshold specified under 5302 **FUSE FAIL 3Vo** and on a ground current IN which is smaller than the threshold specified under 5303 **FUSE FAIL RESID**.

Pickup will take place on the specified values. A hysteresis is integrated for dropout, of 105% where I_N or of 95% where V_N. In case of a low-current asymmetrical fault in the power system with weak infeed, the ground current caused by the fault might lie below the pickup threshold of the Fuse Failure Monitor. Overfunctioning of the Fuse Failure Monitor can, however, cause the feeder protection equipment to fail since it will block all protective functions that use voltage signals. Such an overfunction of the FFM is avoided by additionally checking the phase currents. If at least one phase currents lies above the pickup threshold of 5303 **FUSE FAIL RESID**, it can be assumed that the zero current created by a short-circuit would equally exceed this limit.

The following conditions hold to immediately detect a fault existing after activation of the FFM: If a ground current I_N occurs within 10 seconds after the Fuse-Failure criterion was detected, a fault is assumed and the blocking by the Fuse Failure Monitor is blocked for as long as the fault persists. If the voltage failure criterion applies for longer than approx. 10 seconds, the blocking takes permanent effect. After the time has elapsed it can be assumed that a Fuse Failure has actually occurred. The blocking is lifted automatically 10 seconds after the voltage criterion has disappeared as a result of the secondary circuit fault being cleared, and the entire protection function is released.

The following figure shows the logic diagram of the Fuse Failure Monitor.

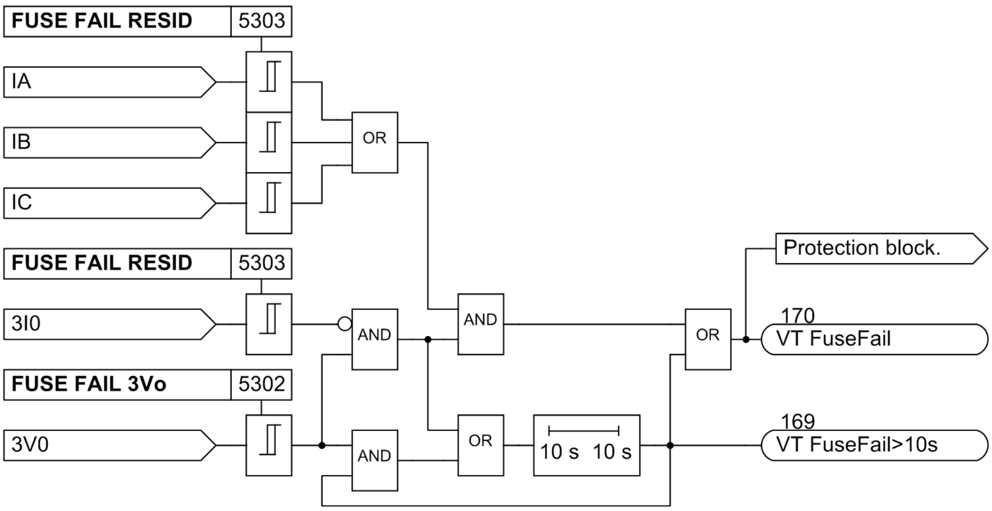


Figure 2-59 Logic diagram of the Fuse Failure Monitor

2.11.1.6 Setting Notes

General

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

The fuse–failure monitor can be set ***ON*** or ***OFF*** at address 5301 **FUSE FAIL MON.**.

Note

On systems where the ground fault current is very small or absent (e.g. ungrounded supply transformers), fuse failure monitoring must <u>not</u> be used!

Measured Value Monitoring

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

Address 8102 **BALANCE V-LIMIT** determines the limit voltage (phase-to-phase), above which the voltage symmetry monitor is effective. Address 8103 **BAL. FACTOR V** is the associated symmetry factor; that is, the slope of the symmetry characteristic curve.

Address 8104 **BALANCE I LIMIT** determines the limit current, above which the current symmetry monitor is effective. Address 8105 **BAL. FACTOR I** is the associated symmetry factor; that is, the slope of the symmetry characteristic curve.

Address 8106 **Σ I THRESHOLD** determines the limit current, above which the current sum monitor is activated (absolute portion, only relative to I_N). The relative portion (relative to the maximum conductor current) for activating the current sum monitor is set at address 8107 **Σ I FACTOR**.

Note

Current sum monitoring can operate properly only when the residual current of the protected line is fed to the fourth current input (I_N) of the relay.

Note

The connections of the ground paths and their adaption factors were set when configuring the general station data. These settings must be correct for the measured value monitoring to function properly.

Fuse Failure Monitor (FFM)

Note

The settings for the fuse failure monitor (address 5302 **FUSE FAIL 3Vo**) 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. Correspondingly address 5303 **FUSE FAIL RESID** must be set as sensitive as required (smaller than the smallest expected ground fault current). The function may be disabled in address 5301 **FUSE FAIL MON.**, e.g. when performing asymmetrical tests.

2.11.1.7 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
5301	FUSE FAIL MON.		ON OFF	OFF	Fuse Fail Monitor
5302	FUSE FAIL 3Vo		10 .. 100 V	30 V	Zero Sequence Voltage
5303	FUSE FAIL RESID	1A	0.10 .. 1.00 A	0.10 A	Residual Current
		5A	0.50 .. 5.00 A	0.50 A	
8101	MEASURE. SUPERV		OFF ON	ON	Measurement Supervision
8102	BALANCE V-LIMIT		10 .. 100 V	50 V	Voltage Threshold for Balance Monitoring
8103	BAL. FACTOR V		0.58 .. 0.90	0.75	Balance Factor for Voltage Monitor
8104	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	
8105	BAL. FACTOR I		0.10 .. 0.90	0.50	Balance Factor for Current Monitor
8106	Σ I THRESHOLD	1A	0.05 .. 2.00 A; ∞	0.10 A	Summated Current Monitoring Threshold
		5A	0.25 .. 10.00 A; ∞	0.50 A	
8107	Σ I FACTOR		0.00 .. 0.95	0.10	Summated Current Monitoring Factor

2.11.1.8 Information List

No.	Information	Type of Information	Comments
161	Fail I Superv.	OUT	Failure: General Current Supervision
162	Failure Σ I	OUT	Failure: Current Summation
163	Fail I balance	OUT	Failure: Current Balance
167	Fail V balance	OUT	Failure: Voltage Balance
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
175	Fail Ph. Seq. I	OUT	Failure: Phase Sequence Current
176	Fail Ph. Seq. V	OUT	Failure: Phase Sequence Voltage
197	MeasSup OFF	OUT	Measurement Supervision is switched OFF
6509	>FAIL:FEEDER VT	SP	>Failure: Feeder VT
6510	>FAIL: BUS VT	SP	>Failure: Busbar VT

2.11.2 Trip Circuit Supervision 74TC

Devices 7SJ62/63/64 are equipped with an integrated trip circuit supervision. Depending on the number of available binary inputs (not connected to a common potential), supervision with one or two binary inputs can be selected. If the allocation of the required binary inputs does not match the selected supervision type, then a message to this effect is generated („`74TC ProgFail`“).

Applications

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

Prerequisites

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

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

2.11.2.1 Description

Supervision with Two Binary Inputs

When using two binary inputs, these are connected according to Figure 2-60, parallel to the associated trip contact on one side, and parallel to the circuit breaker auxiliary contacts on the other.

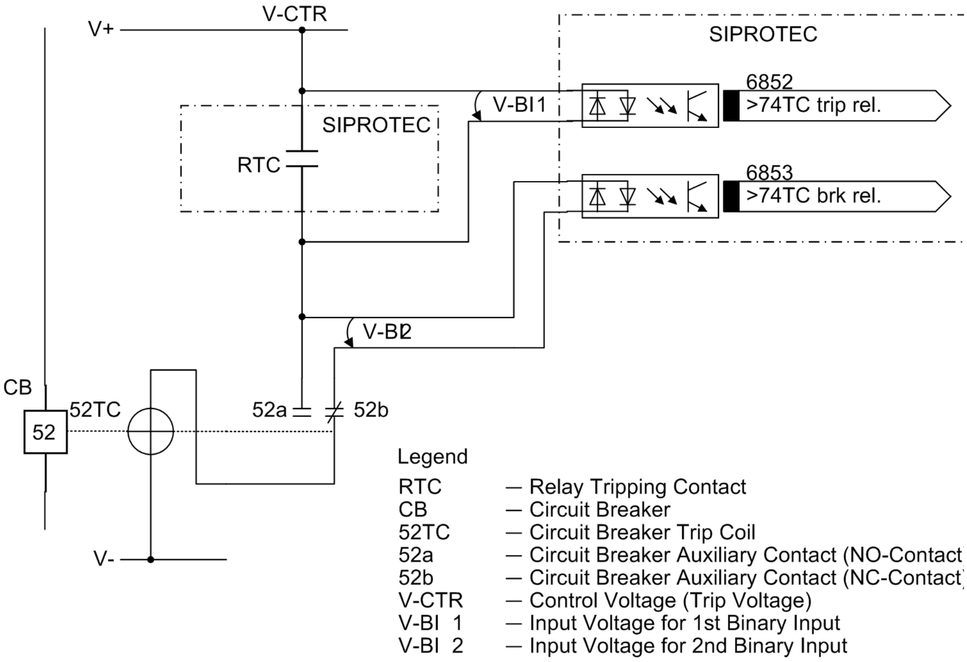


Figure 2-60 Principle of the trip circuit monitoring with two binary inputs

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

Depending on the conditions of the trip contact and the circuit breaker, the binary inputs are activated (logical condition "H" in Table 2-10), or not activated (logical condition "L").

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

Table 2-10 Condition table for binary inputs, depending on RTC and CB position

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

The conditions of the two binary inputs are checked periodically. A check takes place about every 600 ms. If three consecutive conditional checks detect an abnormality (after 1.8 s), an annunciation is reported (see Figure 2-61). The repeated measurements determine the delay of the alarm message and avoid that an alarm is output during short transition periods. After the malfunction in the trip circuit is cleared, the fault annunciation is reset automatically after the same time period.

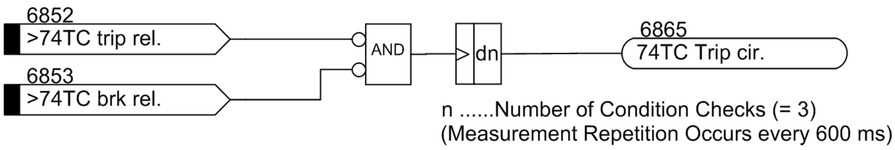


Figure 2-61 Logic diagram of the trip circuit supervision with two binary inputs

Supervision with One Binary Input

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

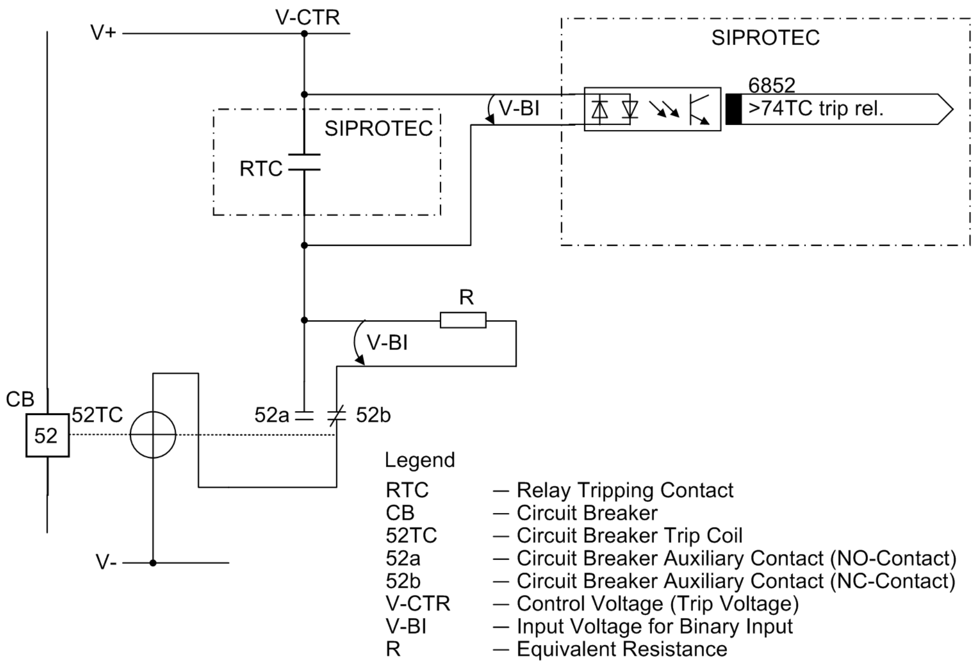


Figure 2-62 Trip circuit supervision with one binary input

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

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

The trip circuit monitor does not operate during system faults. A momentary closed tripping contact does not lead to a failure message. If, however, tripping contacts from other devices operate in parallel in the trip circuit, then the fault annunciation must be delayed (see also Figure 2-63). The state of the binary input is therefore, checked 500 times before an annunciation is sent. The state check takes place about every 600 ms, so that trip monitoring alarm is only issued in the event of an actual failure in the trip circuit (after 300 s). After the malfunction in the trip circuit is cleared, the fault annunciation is reset automatically after the same period.

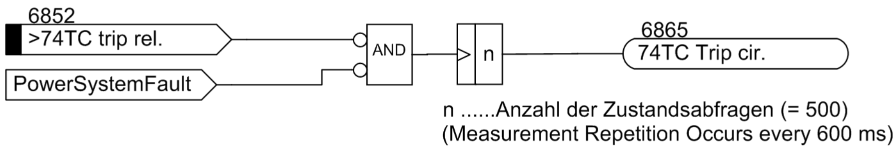


Figure 2-63 Logic diagram for trip circuit monitoring with one binary input

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

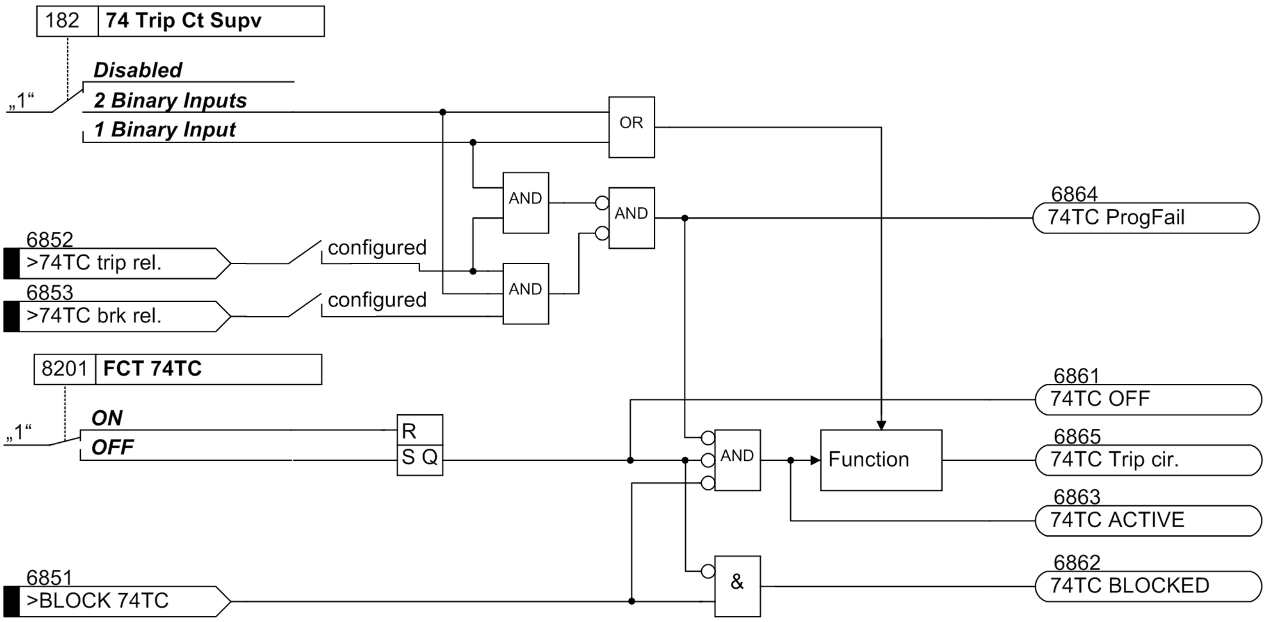


Figure 2-64 Message logic for the trip circuit monitor

2.11.2.2 Setting Notes

General

The function is only in effect and accessible if address 182 was set to either ***2 Binary Inputs*** or to ***1 Binary Input***, and the appropriate number of binary inputs have been allocated for this purpose (refer to Section 2.1.1.2). The function may be turned ***ON*** at address 8201 **FCT 74TC**. If the allocation of the required binary inputs does not match the selected monitoring type, then a message to this effect is generated („74TC ProgFail“). If the trip circuit monitor is not to be used at all, then address 182 ***Disabled*** should be set. Further parameters are not needed. The message of a trip circuit interruption is delayed by a fixed amount of time. For two binary inputs, the delay is about 2 seconds, and for one binary input, the delay is about 300 s. Thus, it is ensured that the longest duration of a trip command is reliably bridged for a certain time and that an annunciation is only caused in case of a real fault occured within the trip command.

Monitoring with One Binary Input

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

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

Information for dimensioning resistor R is given in Chapter "Installation and Commissioning" under configuration instructions in Section "Trip Circuit Monitoring"

2.11.2.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
8201	FCT 74TC	ON OFF	ON	74TC TRIP Circuit Supervision

2.11.2.4 Information List

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

2.11.3 Malfunction Responses of the Monitoring Functions

In the following malfunction responses of monitoring equipment are clearly listed.

2.11.3.1 Description

Malfunction Responses

Depending on the type of malfunction discovered, an annunciation is sent, a restart of the processor system is initiated, or the device is taken out of service. After three unsuccessful restart attempts, the device is taken out of service. The live status contact operates to indicate the device is malfunctioning. In addition, if the internal auxiliary supply is present, the red LED "ERROR" lights up on the front cover and the green "RUN" LED goes out. If the internal power supply fails, then all LEDs are dark. Table 2-11 shows a summary of the monitoring functions and the malfunction responses of the relay.

Table 2-11 Summary of Malfunction Responses by the Protection Relay

Monitoring	Possible Causes	Malfunction Response	Message (No.)	Output
AC/DC supply voltage loss	External (aux. voltage) internal (power supply)	Device shutdown	All LEDs dark	DOK[2)] drops out
Internal supply voltages	Internal (power supply)	Device shutdown	LED ”ERROR"	DOK[2)] drops out
Battery	Internal (battery)	Annunciation	„Fail Battery“ (177)	
Hardware Watchdog	Internal (processor failure)	Device shutdown [1)]	LED ”ERROR"	DOK[2)] drops out
Software watchdog	Internal (processor failure)	Restart attempt [1)]	LED ”ERROR"	DOK[2)] drops out
Working memory ROM	Internal (hardware)	Relay aborts restart, Device shutdown	LED blinks	DOK[2)] drops out
Program memory RAM	Internal (hardware)	During boot sequence	LED ”ERROR"	DOK[2)] drops out
		During operation: Restart attempt [1)]	LED ”ERROR"	
Settings	Internal (hardware)	Restart attempt [1)]	LED ”ERROR"	DOK[2)] drops out
Sampling frequency	Internal (hardware)	Device shutdown	LED ”ERROR"	DOK[2)] drops out
Error in the I/O-board	Internal (hardware)	Device shutdown	„I/O-Board error“ (178), LED ”ERROR"	DOK[2)] drops out
Module error	Internal (hardware)	Device shutdown	„Error Board 1“ to „Error Board 7“ (178 to 189), LED ”ERROR"	DOK[2)] drops out
Internal auxiliary voltage 5 V	Internal (hardware)	Device shutdown	„Error 5V“ (144), LED ”ERROR"	DOK[2)] drops out
0-V Monitoring	Internal (hardware)	Device shutdown	„Error 0V“ (145), LED ”ERROR"	DOK[2)] drops out
Internal auxiliary voltage –5 V	Internal (hardware)	Device shutdown	„Error -5V“ (146), LED ”ERROR"	DOK[2)] drops out
Offset monitoring	Internal (hardware)	Device shutdown	„Error Offset“ (191)	DOK[2)] drops out
Internal supply voltages	Internal (hardware)	Device shutdown	„Error PwrSupply“ (147), LED ”ERROR"	DOK[2)] drops out
Current Sum	Internal (measured value acquisition)	Annunciation	„Failure Σ I“ (162)	As allocated
Current symmetry	External (power system or current transformer)	Annunciation	„Fail I balance“ (163)	As allocated
Voltage symmetry	External (power system or voltage transformer)	Annunciation	„Fail V balance“ (167)	As allocated

Monitoring	Possible Causes	Malfunction Response	Message (No.)	Output
Voltage phase sequence	External (power system or connection)	Annunciation	„Fail Ph. Seq. V“ (176)	As allocated
Current phase sequence	External (power system or connection)	Annunciation	„Fail Ph. Seq. I“ (175)	As allocated
Fuse Failure Monitor	External (voltage transformers)	Annunciation	„VT FuseFail>10s“ (169) „VT FuseFail“ (170)	As allocated
Trip circuit monitoring	External (trip circuit or control voltage)	Annunciation	„74TC Trip cir.“ (6865)	As allocated
Calibration data fault	Internal (hardware)	Annunciation	„Alarm NO calibr“ (193)	As allocated

[1] After three unsuccessful restarts, the device is taken out of service.

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

Group Alarms

Certain messages of the monitoring functions are already combined to group alarms. A listing of the group alarms and their composition is given in the Appendix A.10. In this case, it must be noted that message 160 „`Alarm Sum Event`“ is only issued when the measured value monitoring functions (8101 **`MEASURE. SUPERV`**) are switched on.

2.12 Ground Fault Protection 64, 67N(s), 50N(s), 51N(s)

Depending on the variant, the fourth current input of the multi-functional protection relays 7SJ62/63/64 is equipped either with a sensitive input transformer or a standard transformer for 1/5 A.

In the first case, the active protective function is designed for ground fault detection in isolated or compensated systems due to its high sensitivity. It is not very suited for ground fault detection with large ground currents since the linear range is transcended at about 1.5 A at the sensitive ground fault detection relay terminals.

If the relay is equipped with standard transformers for 1/5 A, also large currents can be detected correctly.

Applications

- Sensitive ground fault detection may be used in isolated or compensated systems to detect ground faults, to determine phases affected by ground faults, and to specify the direction of ground faults.
- In solidly or low-resistance grounded systems, sensitive ground fault detection is used to detect high impedance ground faults.
- This function can also be used as supplementary ground fault protection.

2.12.1 Voltage Element 64

The voltage element relies on a pickup initiated by the displacement voltage V_0 or $3 \cdot V_0$. Additionally, the faulty phase is determined. The displacement voltage V_0 can be directly applied to the device, or the summary voltage $3 \cdot V_0$ can be calculated by the device based on the three phase–to–ground voltages. In the latter case, the three voltage inputs must be connected to voltage transformers in a grounded-wye configuration (see also address 213 **VT Connect. 3ph** in Section 2.1.3). If the device is only provided with phase-to-phase voltages, it is not possible to calculate a displacement voltage from them. In this case the direction cannot be determined.

If the displacement voltage is calculated, then:

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

If the displacement voltage is directly applied to the device, then V_0 is the voltage at the device terminals. It is not affected by parameter **Vph / Vdelta** (address 206).

The displacement voltage is used both to detect a ground fault and to determine direction. When the voltage element picks up, a preset time delay must elapse before detection of the displacement voltage is reported to ensure measurement free quantities. The time delay can be configured (**T-DELAY Pickup**) and its factory setting is 1 s.

Pickup initiated by the displacement voltage can be delayed (**64-1 DELAY**) for tripping.

It is important to note that the total tripping time consists of the displacement voltage measurement time (about 60 ms) plus the pickup time delay (address 3111 **T-DELAY Pickup**) plus the tripping time delay (address 3112 **64-1 DELAY**).

Determination of the Grounded Phase

After the voltage element picks up due to detection of a displacement voltage, the grounded phase is identified, if possible. To do this, the individual phase-to-ground voltages are measured. Of course, this is only possible if three phase-to-ground voltages are obtained from voltage transformers connected in a grounded-wye configuration. If the voltage magnitude for any given phase is below the setting value $V_{Ph\ min}$ that phase is detected as the grounded phase as long as the remaining phase-ground voltages are simultaneously above the setting value $V_{Ph\ max}$.

The following figure shows the logic for determining the grounded phase.

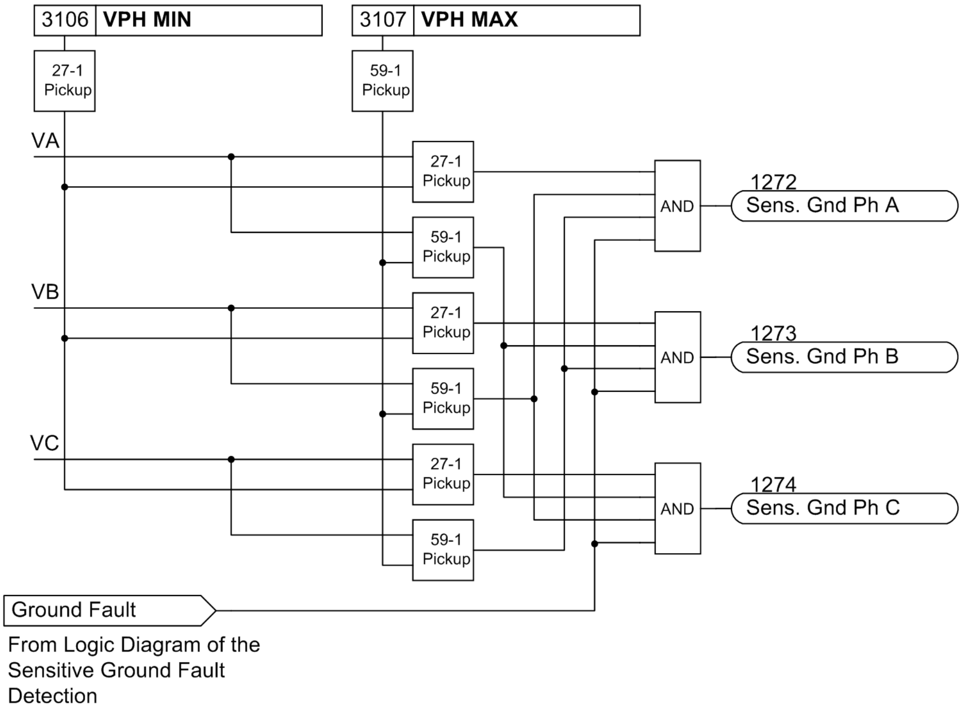


Figure 2-65 Determination of Grounded Phase

2.12.2 Current Elements 50Ns, 51Ns

The current elements for ground faults operate with the magnitudes of the ground current. They only make sense where the magnitude of the ground current can be used to specify the ground fault. This may be the case on grounded systems (solid or low-resistance) or on electrical machines which are directly connected to the busbar of an isolated power system, when in case of a network ground fault the machine supplies only a negligible ground fault current across the measurement location, which must be situated between the machine terminals and the network, whereas in case of a machine ground fault the higher ground fault current produced by the total network is available. Ground current protection is mostly used as backup protection for high resistance ground faults in solid or low resistance grounded systems when main fault protection does not pickup.

For ground fault detection, a two-step current/time characteristic can be set. Analog to the time overcurrent protection, the high-set current element is designated as **50Ns-2 PICKUP** and **50Ns-2 DELAY** and is provided with a definite time characteristic. The overcurrent element may be operated with either a definite time delay (**50Ns-1 PICKUP** and **50Ns-1 DELAY**) or with a user-defined characteristic (**51Ns PICKUP** and **51NsTIME DIAL**). Additionally, a current element with logarithmic inverse characteristic or logarithmic inverse characteristic with knee point is implemented. The characteristics of these current elements can be configured. Each of these elements may work directional or non-directional.

Settable Dropout Times

The pickup can be stabilized for ground fault protection with definite time curve by a settable dropout time. This facility comes into use in systems where intermittent faults occur. Combined with electromechanical relays, it allows different dropout responses to be adjusted and a time grading of numerical and electromechanical relays to be implemented.

2.12.3 Determination of Direction

Characteristics

When determining the sensitive ground fault direction it is not the current value that is crucial, but that part of the current which is perpendicular to an adjustable directional characteristic (axis of symmetry). As a prerequisite for determining the direction, the displacement voltage V_0 must be exceeded as well as a configurable current part influencing the direction (active or reactive component).

The following figure illustrates an example using a complex vector diagram in which the displacement voltage V_0 is the reference magnitude of the real axis. The active part $3I0_{real}$ of current $3I_0$ is calculated in reference to the displacement voltage V_0 and compared with the setting value **RELEASE DIRECT.**. The example is therefore suited for determining the ground fault direction in grounded systems where $3I_0 \cdot \cos \varphi$ is relevant. The directional limit lines are perpendicular to axis $3I0_{real}$.

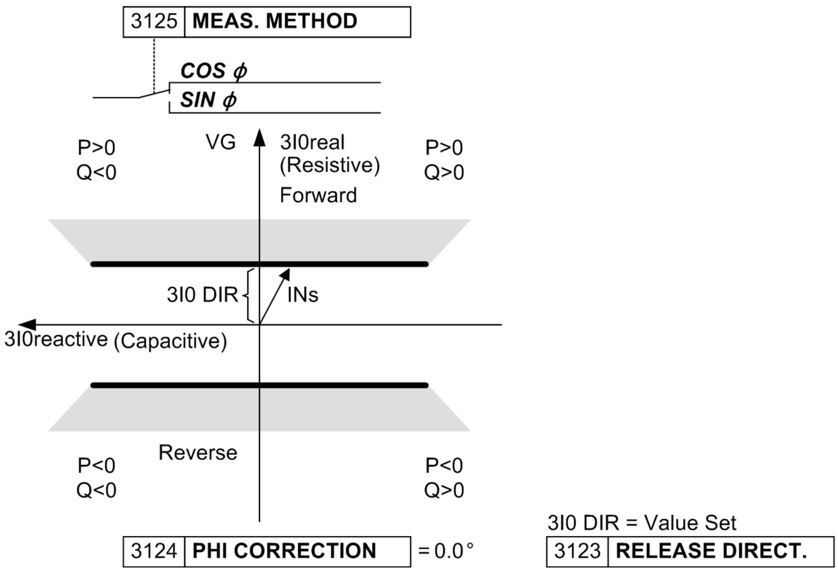


Figure 2-66 Directional characteristic for cos–φ–measurement

The directional limit lines may be rotated by a correction angle (address **PHI CORRECTION**) up to ± 45°. Therefore, in grounded systems it is possible, e.g. to increase sensitivity in the resistive-inductive range with a rotation of –45°, or in case of electric machines in busbar connection in the resistive-capacitive range with a rotation of +45° (see the following Figure). Furthermore the directional limit lines may be rotated by 90° to determine ground faults and their direction in isolated systems.

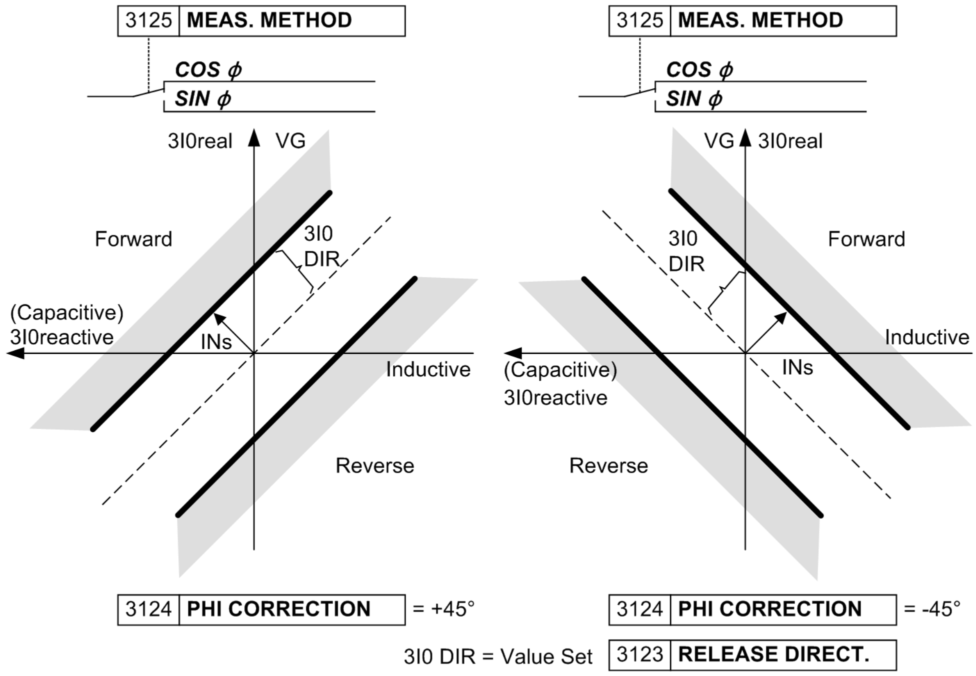


Figure 2-67 Directional characteristic for cos–φ–measurement

Method of Directional Measurement

Fault direction is calculated with the zero sequence values from the ground current $3I_0$ and displacement voltage V_0 or $3 \cdot V_0$. With these quantities, ground active power and ground reactive power is calculated.

The used calculation algorithm filters the measured values so that it is highly accurate and insensitive to higher harmonics (particularly the 3rd and 5th harmonics – which are often present in zero sequence currents). Direction determination relies on the sign of active and reactive power.

Since active and reactive components of the current - not the power - are relevant for pickup, current components are calculated from the power components. When determining the ground fault direction the active or reactive components of the ground current in reference to the displacement voltage as well as the direction of the active and reactive power are evaluated.

For measurements sin φ the following applies

- Ground fault (forward direction), if $Q_0 < 0$ and $3I0_{reactive}$ > setting value (**RELEASE DIRECT.**),
- Ground fault (reverse direction), if $Q_0 > 0$ and $3I0_{reactive}$ > setting value (**RELEASE DIRECT.**).

For measurements cos φ (for resonant-grounded systems) the following applies

- Ground fault (forward direction), if $P_0 > 0$ and $3I0_{reactive}$ > setting value (**RELEASE DIRECT.**),
- Ground fault (reverse direction), if $P_0 < 0$ and $3I0_{reactive}$ > setting value (**RELEASE DIRECT.**).

If **PHI CORRECTION** unequal 0°, the angle of the symmetrie lines is calculated by adding up active and reactive power components.

Application Instructions

In systems with isolated starpoint, ground fault current flows as capacitive current from healthy lines to the location of the ground fault via the measuring point. The capacitive reactive power is thus relevant for the direction.

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 directional determination. The residual current of the ground fault is only about some per cent of the capacitive ground fault current.

Please note that depending on the mounting location of the device, the real component of the current may only be a small fraction of the reactive current component (in extreme cases down to 1/50 th). The accuracy of the calculation algorithm which is extremely high is not sufficient if the instrument transformer is not able to transmit the primary values accuratetly.

The measuring input of the protection relay for high-sensitive ground fault detection is especially calibrated to these concerns and allows an extremely high sensitivity for the direction determination of the residual wattmetric current. In order to make use of this sensitivity, we recommend cable core balance current transformers for ground fault detection in resonant grounded systems. Furthermore, the angle error of the cable core balance current transformer can be compensated in the device. Since the angle error is non-linear, this is achieved by entering two operating points of the angle error curve of the transformer. The device then calculates the error curve with sufficient accuracy.

2.12.4 Logic

The following figure illustrates a state logic of the sensitive ground fault protection. Ground fault detection can be switched ***ON*** or ***OFF*** or set to ***Alarm Only*** (address 3101). When ground fault protection is ***ON***, tripping is possible. The pickup of the displacement voltage V_0 starts the ground fault recording. As the pickup of the V_0 element drops out, fault recording is terminated. In mode ***Alarm Only***, ground faults are recorded in a separate log file for ground faults. In this operating mode, the annunciation 303 „sens Gnd flt“ opens and closes the log file for ground faults and the present fault number is included (see logic diagrams from Figures 2-69 and 2-70).

The entire function may be blocked via binary input. Switching off or blocking means the measurement logic is deactivated. Therefore, time delays and pickup messages are reset.

All stages can be blocked individually via binary inputs. In this case pickup and, if possible, direction and grounded phase will still be reported, however, tripping does not take place since the time elements are blocked.

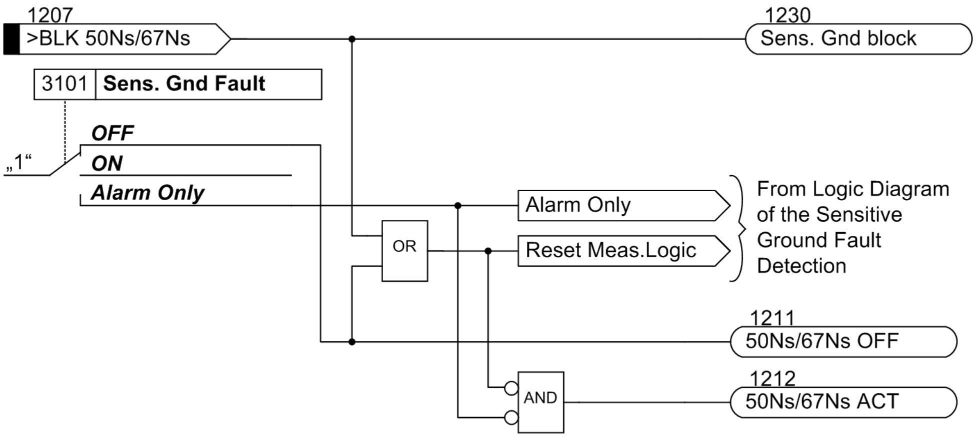


Figure 2-68 Activation of the sensitive ground current protection

Generation of a pickup message, for both current elements, is dependent on the direction selection for each element and the setting of parameters 3130 **PU CRITERIA**. If the element is set to ***Non-Directional*** and parameter **PU CRITERIA** = ***Vgnd OR INs***, a pickup message is generated as soon as the current threshold is exceeded, irrespective of the status of the V_0 element. If, however, the setting of parameter **PU CRITERIA** is ***Vgnd AND INs***, the V_0–element must have picked up also for non-directional mode.

But, if a direction is programmed, the current element must be picked up and the direction determination results must be present to generate a message. Once again, a condition for valid direction determination is that the voltage element V_0 be picked up.

Setting at address **PU CRITERIA** specifies, whether a fault is generated by means of the AND-function or the OR-combination of displacement voltage and pickup of the ground current. The former may be advantageous if the pickup setting of voltage element V_0 was chosen to be very low.

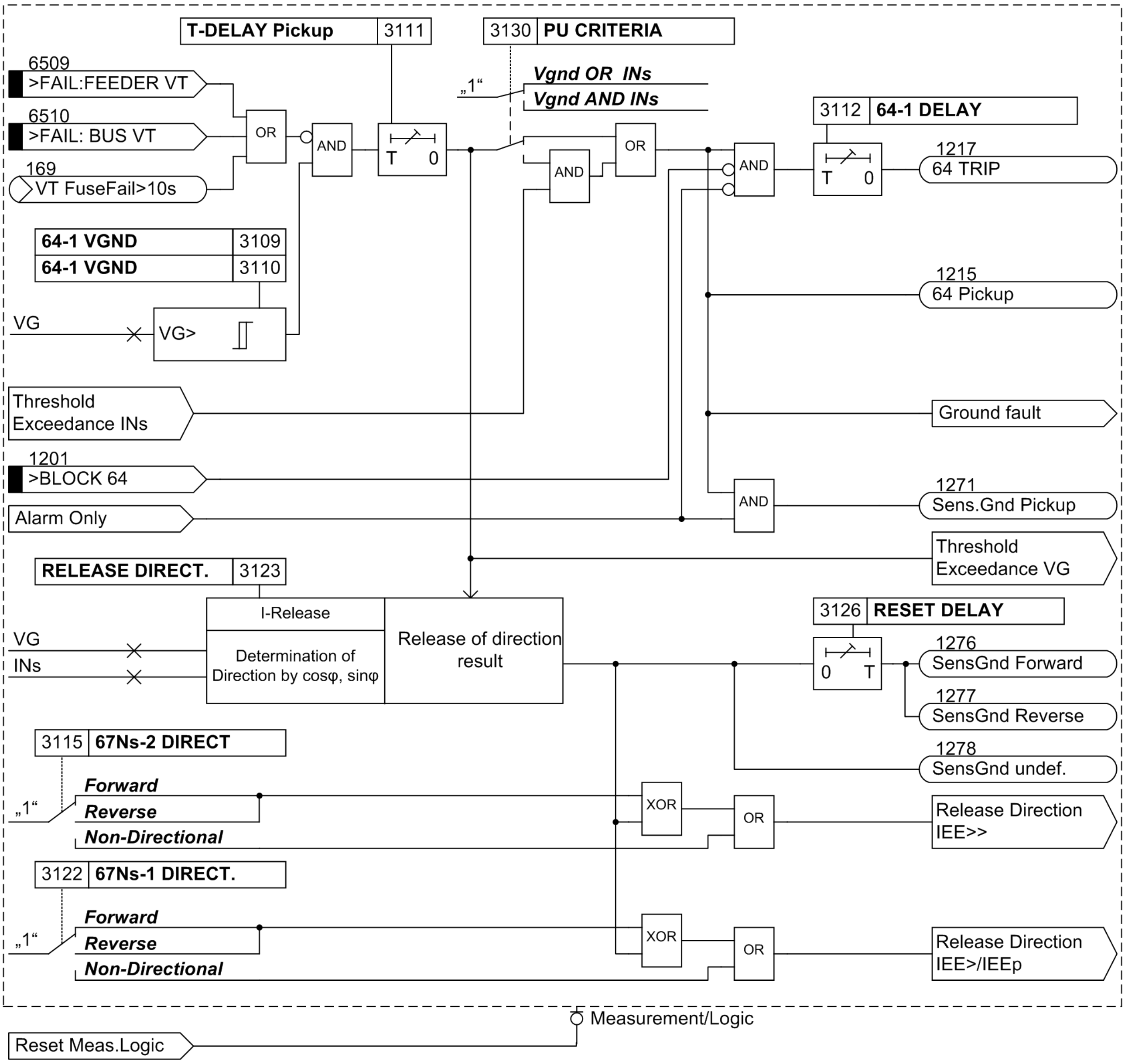


Figure 2-69 Logic diagram of the 64 element and determination of direction

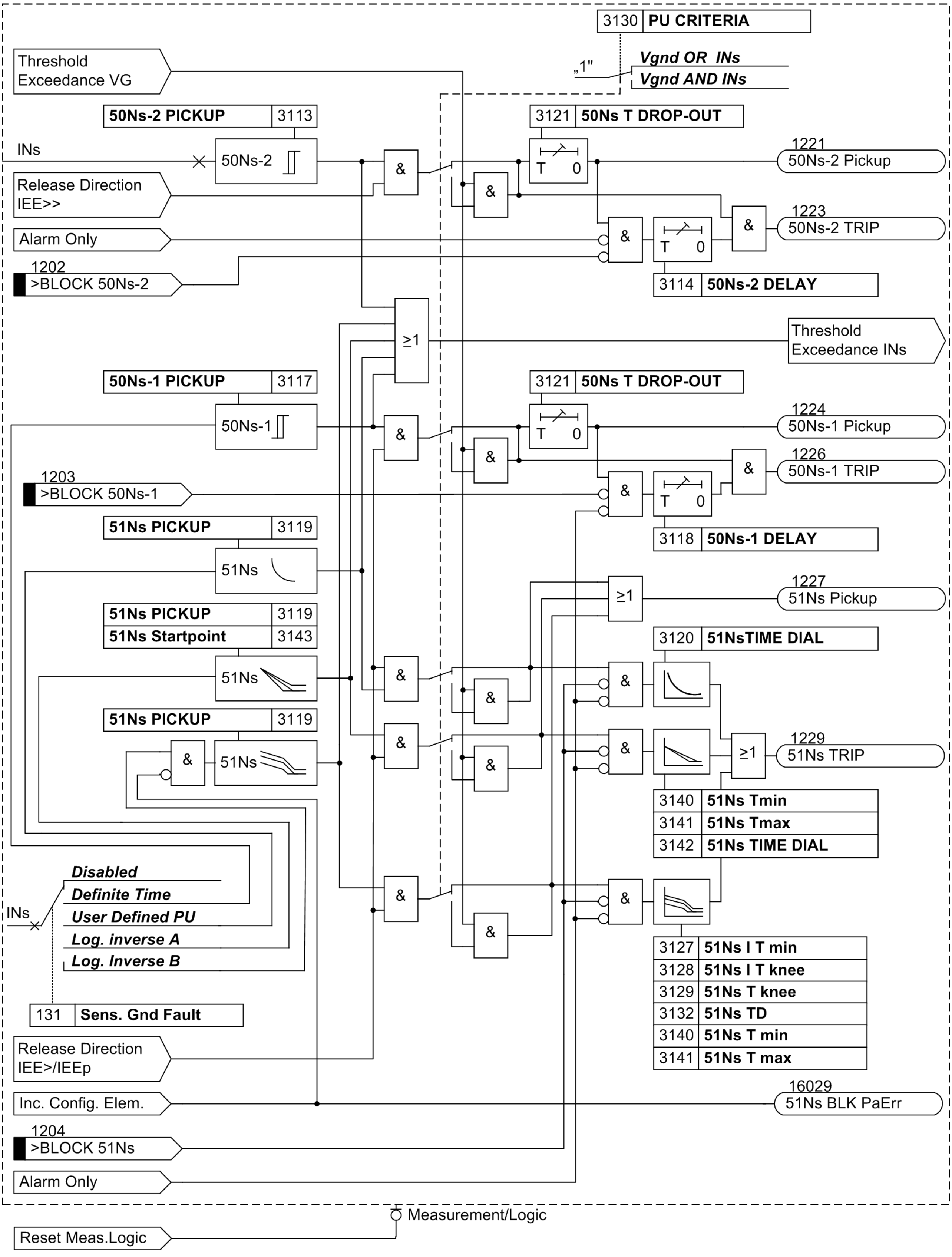


Figure 2-70 Logic diagram of the INs elements

Pickup of the definite time elements can be stabilized by setting the dropout time 3121 **50Ns T DROP-OUT**. This time is started and maintains the pickup condition if the current falls below the threshold. The function thus does not drop out instantaneously. The trip delay time continues in the meantime. After the dropout delay time has elapsed, the pickup is reported OFF and the trip delay time is reset unless the threshold has been violated again. If the threshold is exceeded again while the dropout delay time is still running, it will be cancelled. The trip delay time continues however. If the threshold is still exceeded after the time has elapsed, a trip will be initiated immediately. If the threshold violation then no longer exists, there will be no response. If the threshold is exceeded again after the trip command delay time has elapsed and while the dropout delay time is still running, a trip will be initiated at once.

2.12.5 Ground Fault Location (in isolated systems)

Application Example

Directional determination can often be used to locate ground faults. In radial systems, locating the ground fault is relatively simple. Since all feeders from a common busbar (Figure 2-71) deliver a capacitive charging current, nearly the total ground fault current of the system is available at the measuring point on the faulty line in the isolated system. In resonant-grounded system it is the residual wattmetric current of the Petersen Coil that flows via the measuring point. Therefore, on the faulty cables a clear "forward" decision is made whereas in other feeders either "reverse" direction is sent back or no measurement is carried out in case ground current is too low. Definitely the faulty line can be determined clearly.

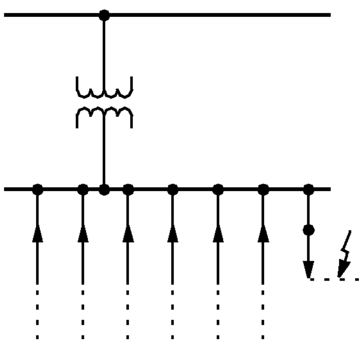


Figure 2-71 Location of ground faults in a radial network

In meshed or ring systems, the measuring points of the faulty line also may detect the maximum ground fault current (residual current). Only in this line, "forward" direction is signaled at both ends (Figure 2-72). However, also the rest of the direction indications in the system may be useful for ground fault detection. Some indications may not be output when ground current is too low.

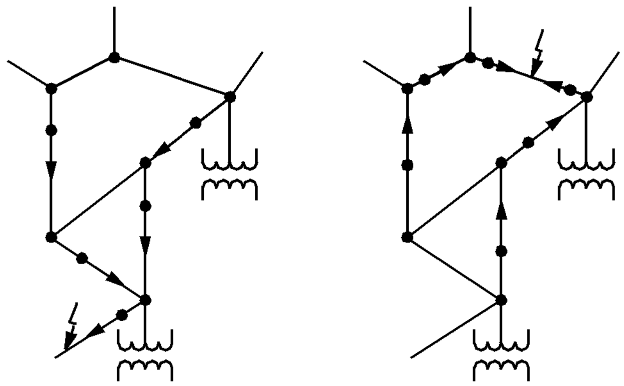


Figure 2-72 Determination of the ground fault location basing on directional indicators in the meshed system

2.12.6 Setting Notes

General Settings

The operating mode of the protective function is configured at address 131 **Sens. Gnd Fault** (see Section 2.1.1). If address **Sens. Gnd Fault** = ***Definite Time***, then only the settings for the definite-time elements are available. If the setting is **Sens. Gnd Fault** = ***Log. inverse A***, a logarithmic inverse characteristic is available. If the setting is **Sens. Gnd Fault** = ***Log. Inverse B***, a logarithmic inverse characteristic with knee point is active. Alternatively, user-defined characteristic can be used when setting **Sens. Gnd Fault** = ***User Defined PU***. The superimposed high-set element 50Ns-2 is available in all these cases. If the function is not required, ***Disabled*** is set.

Address 213 **VT Connect. 3ph** specifies how the voltage transformers are connected (phase-ground or phase-phase). Furthermore, adaption factor **Vph / Vdelta** for displacement voltage are properly set in address 206, primary and secondary nominal transformer current in the ground path are properly set in addresses 217 and 218.

Sensitive ground fault detection may be switched ***ON*** or ***OFF*** or to ***Alarm Only*** in address 3101 **Sens. Gnd Fault**. If sensitive ground fault protection is switched ***ON***, both tripping and message reporting is possible.

The ground fault is detected and reported only when the displacement voltage was present for at least the time **T-DELAY Pickup** (address 3111).

Address 3130 **PU CRITERIA** specifies whether ground fault detection is enabled only for pickups of V_0 and I_{Ns} (***Vgnd AND INs***) or as soon as one of the two has picked up (***Vgnd OR INs***).

A two-stage current/time characteristic may be set at addresses 3113 through 3120. Each of these elements may be directional or non-directional. These elements operate with the ground current magnitude. They only make sense where the magnitude of the ground current and maybe the direction can be used to specify the ground fault. This may be the case on grounded systems (solid or low-resistant) or on electrical machines which are directly connected to the busbar of an ungrounded power system, when in case of a network ground fault the machine supplies only a negligible ground fault current across the measurement location, which must be situated between the machine terminals and the network, whereas in case of a machine ground fault the total ground fault current produced by the total network is available.

50Ns–2 Element (Definite Time)

Similar to the time overcurrent protection function the high set element is named **50Ns-2 PICKUP** (address 3113). It is delayed with **50Ns-2 DELAY** (address 3114) and may be set to generate a message or to trip. The latter is only possible if address 3101 **Sens. Gnd Fault** is set to ***ON***.

50Ns–1 Element (Definite Time)

The definite tripping characteristic 50Ns-1 is set with addresses 3117 and 3118 (address 131 **Sens. Gnd Fault** = ***Definite Time***).

Pickup Stabilization (Definite Time)

Pickup of the definite time elements can be stabilized by means of a configurable dropout time. This dropout time is set in 3121 **50Ns T DROP-OUT**.

51Ns Element (Inverse Time)

The inverse tripping characteristic 51N-TOC is set with addresses 3119 and 3120 (address 131 **Sens. Gnd Fault** = ***User Defined PU***).

Logarithmic Inverse characteristic (Inverse Time)

The logarithmic inverse characteristic (see Figure 2-73) is set in parameters 3119 **51Ns PICKUP**, 3141 **51Ns Tmax**, 3140 **51Ns Tmin**, 3142 **51Ns TIME DIAL** and 3143 **51Ns Startpoint**. **51Ns Tmin** and **51Ns Tmax** define the tripping time range. The slope of the curve is defined in 3142 **51Ns TIME DIAL**. **51Ns PICKUP** is the reference value for all current values with **51Ns Startpoint** representing the beginning of the curve, i.e. the lower operating range on the current axis (related to **51Ns PICKUP**). This factor is preset to the value 1.1, analogous to the other inverse time curves. This factor can also be set to 1.0 since in logarithmic inverse curves the tripping time on a current value, which is identical to the specified pickup threshold, does not go towards infinity, but has a finite time value.

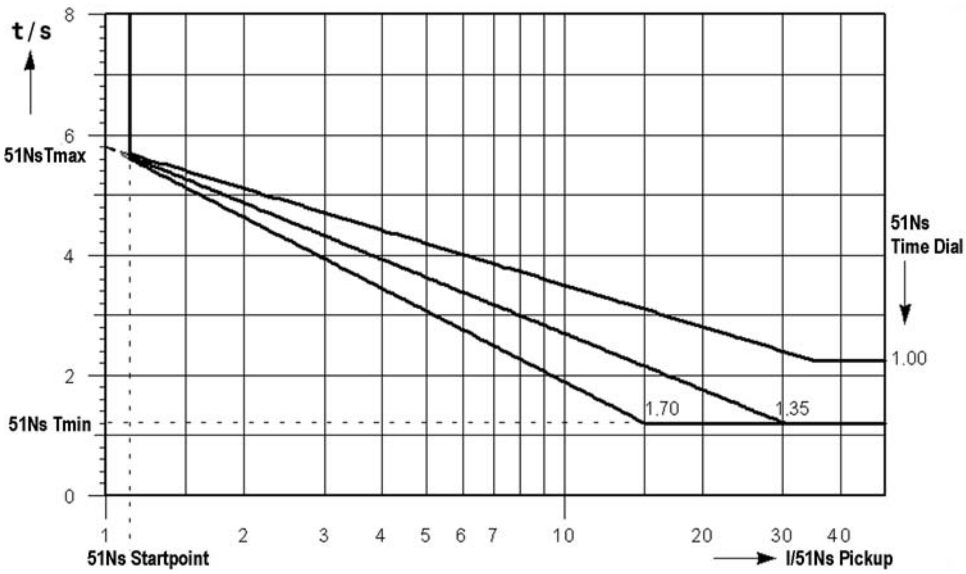


Figure 2-73 Trip-time characteristics of the inverse-time ground fault protection 51Ns with logarithmic inverse characteristic

Logarithmic inverse t = 51Ns MAX. TIME DIAL - 51Ns TIME DIAL·ln(I/**51Ns PICKUP**)

Note: For I/**51Ns PICKUP** > 35 the time applies for I/**51Ns PICKUP** = 35

Logarithmic Inverse characteristic with Knee Point (inverse time)

The logarithmic inverse characteristic with knee point (see figure 2-74) is set by means of the parameters 3119 **51Ns PICKUP**, 3127 **51Ns I T min**, 3128 **51Ns I T knee**, 3132 **51Ns TD**, 3140 **51Ns T min** and 3141 **51Ns T max**. **51Ns T min** and **51Ns T max** define the range of the tripping time where **51Ns T max** is assigned to the current threshold **51Ns PICKUP** and **51Ns T min** to the current threshold **51Ns I T min**. The knee-point time **51Ns T knee** specifies the tripping time in the transition point of two characteristic segments with different slope. The transition point is defined by the current threshold **51Ns I T knee**. **51Ns PICKUP** is the minimum pickup threshold for the ground-fault pickup current of the overcurrent element. The tripping time will assume a constant value after reaching a maximum secondary current of 1.4 A at the latest. The parameter **51Ns TD** serves as time multiplier for the tripping time.

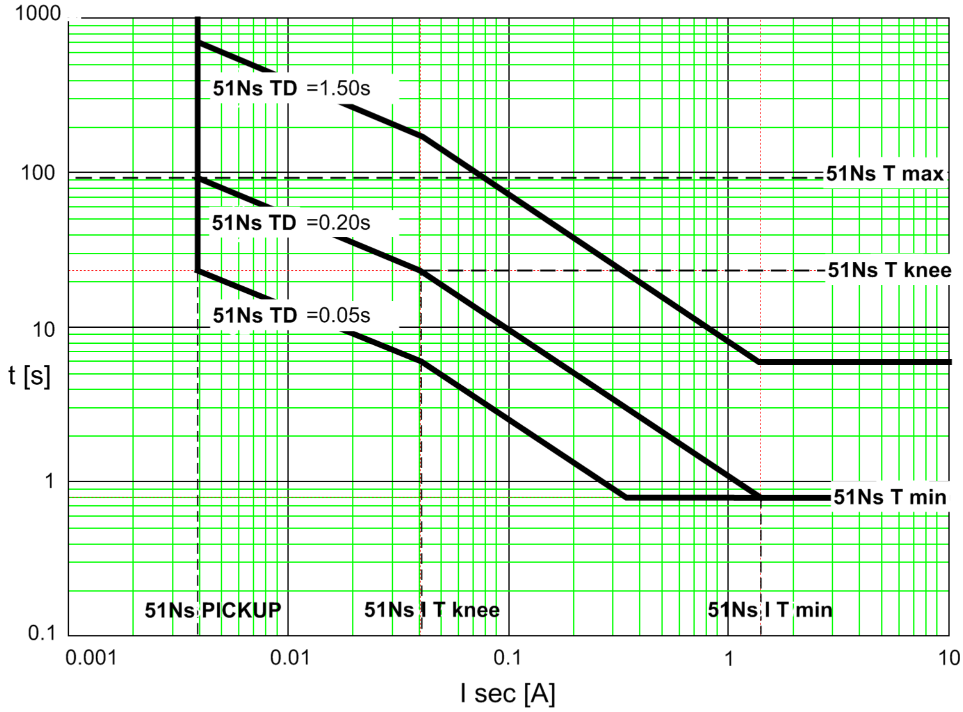


Figure 2-74 Trip-time characteristics of the inverse-time ground fault protection 51Ns with logarithmic inverse characteristic with knee point (example for 51Ns = 0.004 A)

User Defined characteristics (Inverse Time)

If a user-defined characteristic is configured at address 131, **Sens. Gnd Fault** ***User Defined PU***, it should be noted that there is a safety factor of 1.1 between pickup and setting value - as is standard for inverse curves. This means that pickup will only be initiated when current of 1.1 times the setting value flows.

Entry of the value pair (current and time) is a multiple of the settings at addresses 3119 **51Ns PICKUP** and 3120 **51NsTIME DIAL**. Therefore, it is recommended that these addresses are initially set to 1.00 for simplicity. Once the curve is entered, the settings at addresses 3119 and/or 3120 may be modified if necessary.

The default setting of current values is ∞. They are, therefore, not enabled — and no pickup or tripping of these protective functions will occur.

Up to 20 pairs of values (current and time) may be entered at address 3131 **M.of PU TD**. The device then approximates the characteristic, using linear interpolation.

The following must be observed:

- The value pairs should be entered in increasing sequence. Fewer than 20 pairs is also sufficient. In most cases, about 10 pairs is sufficient to define the characteristic accurately. A value pair which will not be used has to be made invalid by entering "∞" for the threshold! The user must ensure the value pairs produce a clear and constant characteristic.

  The current values entered should be those from Table 2-3, along with the matching times. Deviating values MofPU (multiples of PU-values) are rounded. This, however, will not be indicated.

  Currents less than the smallest current value entered will not lead to an extension of the tripping time. The pickup curve (see Figure 2-75) continues, from the smallest current point parallel to the current axis.

  Currents greater than the highest current value entered will not lead to a reduction of the tripping time. The pickup curve (see Figure 2-75) continues, from the largest current point parallel to the current axis.

Table 2-12 Preferential values of standardized currents for user-defined tripping curves

MofPU = 1 to 1.94		MofPU = 2 to 4.75		MofPU = 5 to 7.75		MofPU = 8 to 20	
1.00	1.50	2.00	3.50	5.00	6.50	8.00	15.00
1.06	1.56	2.25	3.75	5.25	6.75	9.00	16.00
1.13	1.63	2.50	4.00	5.50	7.00	10.00	17.00
1.19	1.69	2.75	4.25	5.75	7.25	11.00	18.00
1.25	1.75	3.00	4.50	6.00	7.50	12.00	19.00
1.31	1.81	3.25	4.75	6.25	7.75	13.00	20.00
1.38	1.88					14.00	
1.44	1.94						

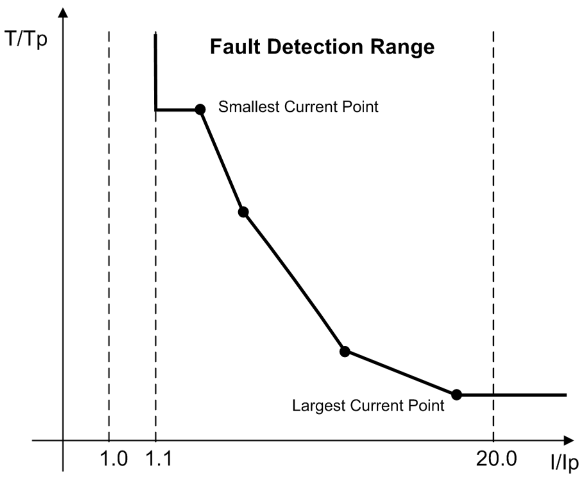


Figure 2-75 Use of a user-defined characteristic

Determination of Ground-Faulted Phase

The ground-faulted phase may be identified in an ungrounded or resonant-grounded system, if the device is supplied by three voltage transformers connected in a grounded-wye configuration. The phase in which the voltage lies below setting **VPH MIN** at address 3106 is identified as the faulty phase as long as the other two phase voltages simultaneously exceed the setting **VPH MAX** at address 3107. The setting **VPH MIN** must be set less than the minimum expected operational phase-to-ground voltage. A typical setting for this address would be 40 V. Setting **VPH MAX** must be greater than the maximum expected operational phase-to-ground voltage, but less than the minimum expected operational phase-to-phase voltage. For V_{Nom} = 100 V, approximately 75 V is a typical setting. These settings have no significance in a grounded system.

Displacement Voltage V_0

Displacement voltage **64-1 VGND** (address 3108 or 3109) or **64-1 VGND** (address 3110) is used to pick up ground fault detection. At the same time, pickup of the voltage element is a condition for initiation of directional determination. Depending on the setting at address 213 **VT Connect. 3ph**, only the applicable threshold address 3108 **64-1 VGND**, 3109 **64-1 VGND** or 3110 **64-1 VGND** is accessible:

That is, if two phase-to-phase voltages and the displacement voltage V_0 are supplied to the device, the measured displacement voltage is used directly for ground fault recognition. The threshold for V_0 is set at address 3108 (7SJ62/63) or 3109 (7SJ64), where a more sensitive setting can be made than with a calculated displacement voltage. The upper setting threshold for 7SJ64 is higher than for 7SJ62/63 (see Technical Data). Please note that with phase-to-phase voltage V_0, the factor (in normal case = 1.73; see also Section 2.1.3.2) specified with parameter 206 **Vph / Vdelta** is used. For display of parameter 3108 **64-1 VGND** or 3109 **64-1 VGND** in primary values, the following conversion formula applies:

$$V_{N\,PRIM.} = \text{Vph/Vdelta} \cdot \frac{\text{Vnom PRIMARY}}{\text{Vnom SECONDARY}} \cdot V_{N\,SEC.}$$

If three phase-to-ground voltages are connected to the device, the displacement voltage $3 \cdot V_0$ is calculated from the momentary values of phase-to-ground voltages, and address 3110 is where the threshold is to be set. For the display of the parameters 3110 in primary values, the following applies:

$$3V0_{PRIM.} = \frac{\text{Vnom PRIMARY}}{\text{Vnom SECONDARY}} \cdot 3V0_{SEC.}$$

If secondary values of (for example) parameter 3109 and 3110 are set the same, their primary values differ by the adaptation factor **Vph / Vdelta**.

Example:

Parameter 202	Vnom PRIMARY	= 12 kV
Parameter 203	Vnom SECONDARY	= 100 V
Parameter 206	Vph / Vdelta	= 1.73
Parameter 213	VT Connect. 3ph	= Vab, Vbc, VGnd
Parameter 3109	64-1 VGND	= 40 V

When changing to primary values, the following applies:

$$\texttt{3109 VGND(measured)} = 1.73 \cdot \frac{12\ \text{kV}}{100\ \text{V}} = 8.3\ \text{kV}$$

Motor with the parameterization:

Parameter 213	VT Connect. 3ph	= Van, Vbn, Vcn
Parameter 3110	64-1 VGND	= 40 V

When changing to primary values, the following applies:

$$\texttt{3110 VGND(calculated)} = \frac{12\ \text{kV}}{100\ \text{V}} = 4.8\ \text{kV}$$

With regard to a ground fault in a ungrounded or resonant-grounded system, nearly the entire displacement voltage appears at the device terminals, therefore the pickup setting is not critical, and typically lies between 30 V and 60 V (for **64-1 VGND** with a standard V0-connection) or 50 V and 100 V (for **64-1 VGND**). Large fault resistances may require higher sensitivity (i.e. a lower pickup setting).

With regard to a grounded system, a more sensitive (lower) pickup value may be set, but it must be above the maximum anticipated displacement voltage during normal (unbalanced) system operation.

Trip Time Delay

Pickup of just the voltage element may initiate time delayed tripping assuming that ground fault detection is configured to perform tripping (address 3101 **Sens. Gnd Fault** = ***ON***) and moreover address 3130 **PU CRITERIA** is configured ***Vgnd OR INs***. The tripping delay is then set at address 3112 **64-1 DELAY**. It is important to note that the total tripping time consists of the displacement voltage measurement time (about 50 ms) plus the pickup time delay (address 3111 **T-DELAY Pickup**) plus the tripping time delay (address 3112 **64-1 DELAY**).

Determination of Direction

Addresses 3115 to 3126 are for direction determination.

The direction of the definite high-set element 67Ns-2 is set at address 3115 **67Ns-2 DIRECT** and may be configured ***Forward*** or ***Reverse*** or ***Non-Directional***, i.e. to both directions. The direction of the definite time high-set element 67Ns-1 can be set at address 3122 **67Ns-1 DIRECT.** = ***Forward*** or ***Reverse*** or ***Non-Directional***, i.e. to both directions.

Current value **RELEASE DIRECT.** (address 3123) is the release threshold for directional determination. It is based on the current components which are perpendicular to the directional limit lines. The position of the directional limit lines themselves are based on the settings entered at addresses 3124 and 3125.

The following is generally valid for determination of direction during ground faults: The pickup current INs dir (=**RELEASE DIRECT.** address 3123) must be set as high as possible to avoid a false pickup of the device provoked by asymmetrical currents in the system and by current transformers (especially in a Holmgreen-connection).

If direction determination is used in conjunction with one of the current elements discussed above (**50Ns-1 PICKUP**, addresses 3117 ff, or **51Ns PICKUP**, addresses 3119 ff), a value for address **RELEASE DIRECT.** is only significant if it is less than or equal to the pickup value mentioned above.

A corresponding message (reverse, forward, or undefined) is issued upon direction determination. To avoid chatter for this message resulting from sharply-varying ground fault currents, a dropout delay **RESET DELAY**, entered at address 3126, is initiated when directional determination drops out, and the message is held for this period of time.

When address 3124 **PHI CORRECTION** is set to 0.0°, then the setting in address 3125 signifies the following:

- **MEAS. METHOD** = ***COS*** φ

  the resistive component of the ground current with respect to the displacement voltage is most relevant for the current value **RELEASE DIRECT.** (3I0dir)

  MEAS. METHOD = ***SIN*** φ

  the reactive (capacitive) component of the ground current with respect to the displacement voltage is most relevant for the current value **RELEASE DIRECT.** (3I0dir) (see Figure 2-76).

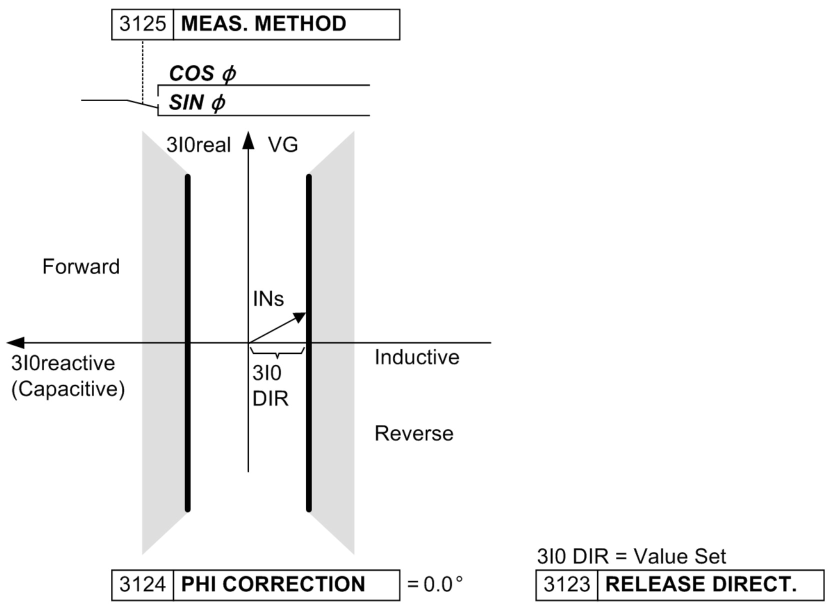


Figure 2-76 Directional characteristic for sin–φ–measurement

- In address 3124 **PHI CORRECTION** the directional line, in this respect, may be rotated within the range ± 45°. Figure "Directional characteristic for cos-φ-measurement" in the functional description of the sensitive ground fault detection gives an example regarding this topic.

Ungrounded System

In an ungrounded system with a ground fault on a cable, capacitive ground currents of the galvanically connected system flow via the measuring point, apart from the ground current generated on the faulty line, which flows directly via the fault location (i.e. not via the measuring point). A setting equal to about half of this ground current is to be selected. The measurement type should be ***SIN*** φ, since capacitive ground current is most relevant here.

Resonant-grounded System

In a resonant-grounded system, directional determination on the occurrence of a ground fault results more difficult since the small residual wattmetric current for measurement is usually dwarfed by a larger reactive current (be it capacitive or inductive) which is much larger. 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 relay, however, must evaluate only the active component of the ground fault current, that is, I_{Ns} cos φ. This demands extremely high accuracy, particularly with regard to phase angle measurement of all 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 by connecting cable core balance current transformers. Here the following rule of thumb applies: Set pickup values to about half of the expected measured current, thereby considering only the residual wattmetric current. Residual wattmetric current is mainly due to losses of the Petersen coil. Here, the ***COS*** φ measuring type is used since the resistive residual wattmetric current is relevant.

Grounded System

In grounded systems, a value is set below the minimum anticipated ground fault current. It is important to note that INs dir (current value **RELEASE DIRECT.**) only detects the current component that is perpendicular to the directional limit line defined at addresses 3124 and 3125. ***COS*** φ is the type of measurement used, and the correction angle is set to –45°, since the ground fault current is typically resistive-inductive (right section of Figure "Directional characteristic for cos-φ-measurement in the functional description of the sensitive ground fault detection).

Electrical Machines

One may set the value ***COS*** φ for the measurement type and use a correction angle of +45° for electrical motors supplied from a busbar in an ungrounded system, since the ground current is often composed of an overlap of the capacitive ground current from the system and the resistive current of the load resistance (Figure "Directional characteristic for cos-φ-measurement" in the functional description of the sensitive ground fault detection, left part).

Angular Error Compensation (CTs)

The high reactive component in a resonant grounded system and the inevitable air gap of the cable core balance current transformer often require the angle error of the cable core balance current transformer to be compensated. In addresses 3102 to 3105 the maximum angle error **CT Err. F1** and the associated secondary current **CT Err. I1** as well as another operating point **CT Err. F2**/**CT Err. I2** are set for the actually connected burden. The device thus approximates the transformation characteristic of the transformer with considerable accuracy. In ungrounded or grounded systems angle compensation is not required.

Note Regarding Settings List for Sensitive Ground Fault Detection

In devices with sensitive ground fault input, which is independent of the nominal current rating of the device, settings may in general also be entered as primary values under consideration of the current transformer ratio. However, problems related to the resolution of the pickup currents can occur when very small settings and small nominal primary currents are given. The user is therefore encouraged to enter settings for the sensitive ground fault detection in secondary values.

2.12.7 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
3101	Sens. Gnd Fault		OFF ON Alarm Only	OFF	(Sensitive) Ground Fault
3102	CT Err. I1		0.001 .. 1.600 A	0.050 A	Current I1 for CT Angle Error
3102	CT Err. I1	1A	0.05 .. 35.00 A	1.00 A	Current I1 for CT Angle Error
		5A	0.25 .. 175.00 A	5.00 A	
3103	CT Err. F1		0.0 .. 5.0 °	0.0 °	CT Angle Error at I1
3104	CT Err. I2		0.001 .. 1.600 A	1.000 A	Current I2 for CT Angle Error
3104	CT Err. I2	1A	0.05 .. 35.00 A	10.00 A	Current I2 for CT Angle Error
		5A	0.25 .. 175.00 A	50.00 A	
3105	CT Err. F2		0.0 .. 5.0 °	0.0 °	CT Angle Error at I2
3106	VPH MIN		10 .. 100 V	40 V	L-Gnd Voltage of Faulted Phase Vph Min
3107	VPH MAX		10 .. 100 V	75 V	L-Gnd Voltage of Unfaulted Phase Vph Max
3108	64-1 VGND		1.8 .. 200.0 V	40.0 V	64-1 Ground Displacement Voltage
3109	64-1 VGND		1.8 .. 170.0 V	40.0 V	64-1 Ground Displacement Voltage
3110	64-1 VGND		10.0 .. 225.0 V	70.0 V	64-1 Ground Displacement Voltage
3111	T-DELAY Pickup		0.04 .. 320.00 sec; ∞	1.00 sec	Time-DELAY Pickup
3112	64-1 DELAY		0.10 .. 40000.00 sec; ∞	10.00 sec	64-1 Time Delay
3113	50Ns-2 PICKUP		0.001 .. 1.500 A	0.300 A	50Ns-2 Pickup
3113	50Ns-2 PICKUP	1A	0.05 .. 35.00 A	10.00 A	50Ns-2 Pickup
		5A	0.25 .. 175.00 A	50.00 A	
3114	50Ns-2 DELAY		0.00 .. 320.00 sec; ∞	1.00 sec	50Ns-2 Time Delay
3115	67Ns-2 DIRECT		Forward Reverse Non-Directional	Forward	67Ns-2 Direction
3117	50Ns-1 PICKUP		0.001 .. 1.500 A	0.100 A	50Ns-1 Pickup
3117	50Ns-1 PICKUP	1A	0.05 .. 35.00 A	2.00 A	50Ns-1 Pickup
		5A	0.25 .. 175.00 A	10.00 A	
3118	50Ns-1 DELAY		0.00 .. 320.00 sec; ∞	2.00 sec	50Ns-1 Time delay
3119	51Ns PICKUP		0.001 .. 1.400 A	0.100 A	51Ns Pickup

Addr.	Parameter	C	Setting Options	Default Setting	Comments
3119	51Ns PICKUP		0.003 .. 0.500 A	0.004 A	51Ns Pickup
3119	51Ns PICKUP	1A	0.05 .. 4.00 A	1.00 A	51Ns Pickup
		5A	0.25 .. 20.00 A	5.00 A	
3120	51NsTIME DIAL		0.10 .. 4.00 sec; ∞	1.00 sec	51Ns Time Dial
3121A	50Ns T DROP-OUT		0.00 .. 60.00 sec	0.00 sec	50Ns Drop-Out Time Delay
3122	67Ns-1 DIRECT.		Forward Reverse Non-Directional	Forward	67Ns-1 Direction
3123	RELEASE DIRECT.		0.001 .. 1.200 A	0.010 A	Release directional element
3123	RELEASE DIRECT.	1A	0.05 .. 30.00 A	0.50 A	Release directional element
		5A	0.25 .. 150.00 A	2.50 A	
3124	PHI CORRECTION		-45.0 .. 45.0 °	0.0 °	Correction Angle for Dir. Determination
3125	MEAS. METHOD		COS φ SIN φ	COS φ	Measurement method for Direction
3126	RESET DELAY		0 .. 60 sec	1 sec	Reset Delay
3127	51Ns I T min		0.003 .. 1.400 A	1.333 A	51Ns Current at const. Time Delay T min
3127	51Ns I T min	1A	0.05 .. 20.00 A	15.00 A	51Ns Current at const. Time Delay T min
		5A	0.25 .. 100.00 A	75.00 A	
3128	51Ns I T knee		0.003 .. 0.650 A	0.040 A	51Ns Current at Knee Point
3128	51Ns I T knee	1A	0.05 .. 17.00 A	5.00 A	51Ns Current at Knee Point
		5A	0.25 .. 85.00 A	25.00 A	
3129	51Ns T knee		0.20 .. 100.00 sec	23.60 sec	51Ns Time Delay at Knee Point
3130	PU CRITERIA		Vgnd OR INs Vgnd AND INs	Vgnd OR INs	Sensitive Ground Fault PICKUP criteria
3131	M.of PU TD		1.00 .. 20.00 MofPU; ∞ 0.01 .. 999.00 TD		Multiples of PU Time-Dial
3132	51Ns TD		0.05 .. 1.50	0.20	51Ns Time Dial
3140	51Ns Tmin		0.00 .. 30.00 sec	1.20 sec	51Ns Minimum Time Delay
3140	51Ns T min		0.10 .. 30.00 sec	0.80 sec	51Ns Minimum Time Delay
3141	51Ns Tmax		0.00 .. 30.00 sec	5.80 sec	51Ns Maximum Time Delay
3141	51Ns T max		0.50 .. 200.00 sec	93.00 sec	51Ns Maximum Time Delay (at 51Ns PU)
3142	51Ns TIME DIAL		0.05 .. 15.00 sec; ∞	1.35 sec	51Ns Time Dial
3143	51Ns Startpoint		1.0 .. 4.0	1.1	51Ns Start Point of Inverse Charac.

2.12.8 Information List

No.	Information	Type of Information	Comments
1201	>BLOCK 64	SP	>BLOCK 64
1202	>BLOCK 50Ns-2	SP	>BLOCK 50Ns-2
1203	>BLOCK 50Ns-1	SP	>BLOCK 50Ns-1
1204	>BLOCK 51Ns	SP	>BLOCK 51Ns
1207	>BLK 50Ns/67Ns	SP	>BLOCK 50Ns/67Ns
1211	50Ns/67Ns OFF	OUT	50Ns/67Ns is OFF
1212	50Ns/67Ns ACT	OUT	50Ns/67Ns is ACTIVE
1215	64 Pickup	OUT	64 displacement voltage pick up
1217	64 TRIP	OUT	64 displacement voltage element TRIP
1221	50Ns-2 Pickup	OUT	50Ns-2 Pickup
1223	50Ns-2 TRIP	OUT	50Ns-2 TRIP
1224	50Ns-1 Pickup	OUT	50Ns-1 Pickup
1226	50Ns-1 TRIP	OUT	50Ns-1 TRIP
1227	51Ns Pickup	OUT	51Ns picked up
1229	51Ns TRIP	OUT	51Ns TRIP
1230	Sens. Gnd block	OUT	Sensitive ground fault detection BLOCKED
1264	IEEa =	VI	Corr. Resistive Earth current
1265	IEEr =	VI	Corr. Reactive Earth current
1266	IEE =	VI	Earth current, absolute Value
1267	VGND, 3Vo	VI	Displacement Voltage VGND, 3Vo
1271	Sens.Gnd Pickup	OUT	Sensitive Ground fault pick up
1272	Sens. Gnd Ph A	OUT	Sensitive Ground fault picked up in Ph A
1273	Sens. Gnd Ph B	OUT	Sensitive Ground fault picked up in Ph B
1274	Sens. Gnd Ph C	OUT	Sensitive Ground fault picked up in Ph C
1276	SensGnd Forward	OUT	Sensitive Gnd fault in forward direction
1277	SensGnd Reverse	OUT	Sensitive Gnd fault in reverse direction
1278	SensGnd undef.	OUT	Sensitive Gnd fault direction undefined
16029	51Ns BLK PaErr	OUT	Sens.gnd.flt. 51Ns BLOCKED Setting Error

2.13 Intermittent Ground Fault Protection

A typical characteristic of intermittent ground faults is that they often disappear automatically to strike again after some time. They can last between a few milliseconds and several seconds. This is why such faults are not detected at all or not selectively by the ordinary time overcurrent protection. If pulse durations are extremely short, not all protection devices in a short-circuit path may pick up; selective tripping is thus not ensured.

Due to the time delay of the overcurrent protection function such faults are too short to initiate shutdown of the faulted cable. Only when they have become permanent such ground faults can be removed selectively by the short-circuit protection.

But such intermittent ground faults already bear the risk of causing thermal damage to equipment. This is why devices 7SJ62/63/64 feature a protective function that is able to detect such intermittent ground faults and accumulates their duration. If within a certain time their sum reaches a settable value, the thermal load limit has been reached. If the ground faults are distributed over a long period of time or if the ground fault goes off and does not re-ignite after some time, the equipment under load is expected to cool down. Tripping is not necessary in this case.

Applications

- Protection from intermittent ground faults which occur, e.g. in cables due to poor insulation or water ingress in cable joints.

2.13.1 Description

Acquisition of Measured Quantities

The intermittent ground fault can either be detected via the ordinary ground current input (I_N), the sensitive ground current input (I_{NS}), or it is calculated from the sum of the three phase currents (3 I0). Unlike the overcurrent protection which uses the fundamental wave, the intermittent ground fault protection creates the r.m.s. value of this current and compares it to a settable threshold **`Iie>`**. This method accounts for higher order harmonics contents (up to 400 Hz) and for the direct component since both factors contribute to the thermal load.

Pickup/Tripping

When the pickup threshold **`Iie>`** is exceeded, a pickup message („`IIE Fault det`“, see Figure 2-77) is issued. The pickups are also counted; as soon as the counter content has reached the value of parameter **`Nos.det.`**, the message „`Intermitt.EF`“ is issued. A stabilized pickup is obtained by prolonging the pickup message „`IIE Fault det`“ by a settable time **`T-det.ext.`**. This stabilization is especially important for the coordination with existing static or electromechanical overcurrent relays.

The duration of the stabilized pickups „`IIE stab.Flt`“ is summated with an integrator **`T-sum det.`**. If the accumulated pickup time reaches a settable threshold value, a corresponding message is generated („`IEF Tsum exp.`“). Tripping takes place, however, only while a ground fault is present (message „`IEF Trip`“). The trip command is maintained during the entire minimum tripping time specified for the device, even if the ground fault is of short duration. After completion of the tripping command all memories are reset and the protection resumes normal condition.

The (much longer) resetting time **`T-sum det.`** (message **`T-reset`**) is launched simultaneously with „`IEF Tres run.`“ when a ground fault occurs. Unlike **`T-sum det.`** each new ground fault resets this time to its initial value and it expires anew. If **`T-reset`** expires and no new ground fault is recorded during that time, all memories are reset and the protection returns to its quiescent state. **T-reset** thus determines the time during which the next ground fault must occur to be processed yet as intermittent ground fault in connection with the previous fault. A ground fault that occurs later will be considered a new fault event.

The message „IIE Fault det“ will be entered in the fault log and reported to the system interface only until the message „Intermitt.EF“ is issued. This prevents a burst of messages. If the message is allocated to an LED or a relay, this limitation does not apply. This is accomplished by doubling the message (message numbers 6924, 6926).

Interaction with the Automatic Reclosure Function

Automatic reclosure is not an effective measure against intermittent ground faults as the function only trips after repeated detection of a fault or after expiration of the summation monitoring time **T-sum det.** and besides this, its basic design is to prevent thermal overload. For these reasons, the intermittent ground fault protection is not implemented as starting feature of the automatic reclosing function.

Interaction with Breaker Failure Protection

A pickup that is present when the time delay **TRIP-Timer** has expired is interpreted by the breaker failure protection as a criterion for a tripping failure. Since permanent pickup is not ensured after a tripping command by the intermittent ground fault protection, cooperation with the breaker failure protection is not sensible. Therefore, this function is not activated by the intermittent ground fault protection.

Logic Diagram

The following figure shows the logic diagram for the intermittent ground fault protection function.

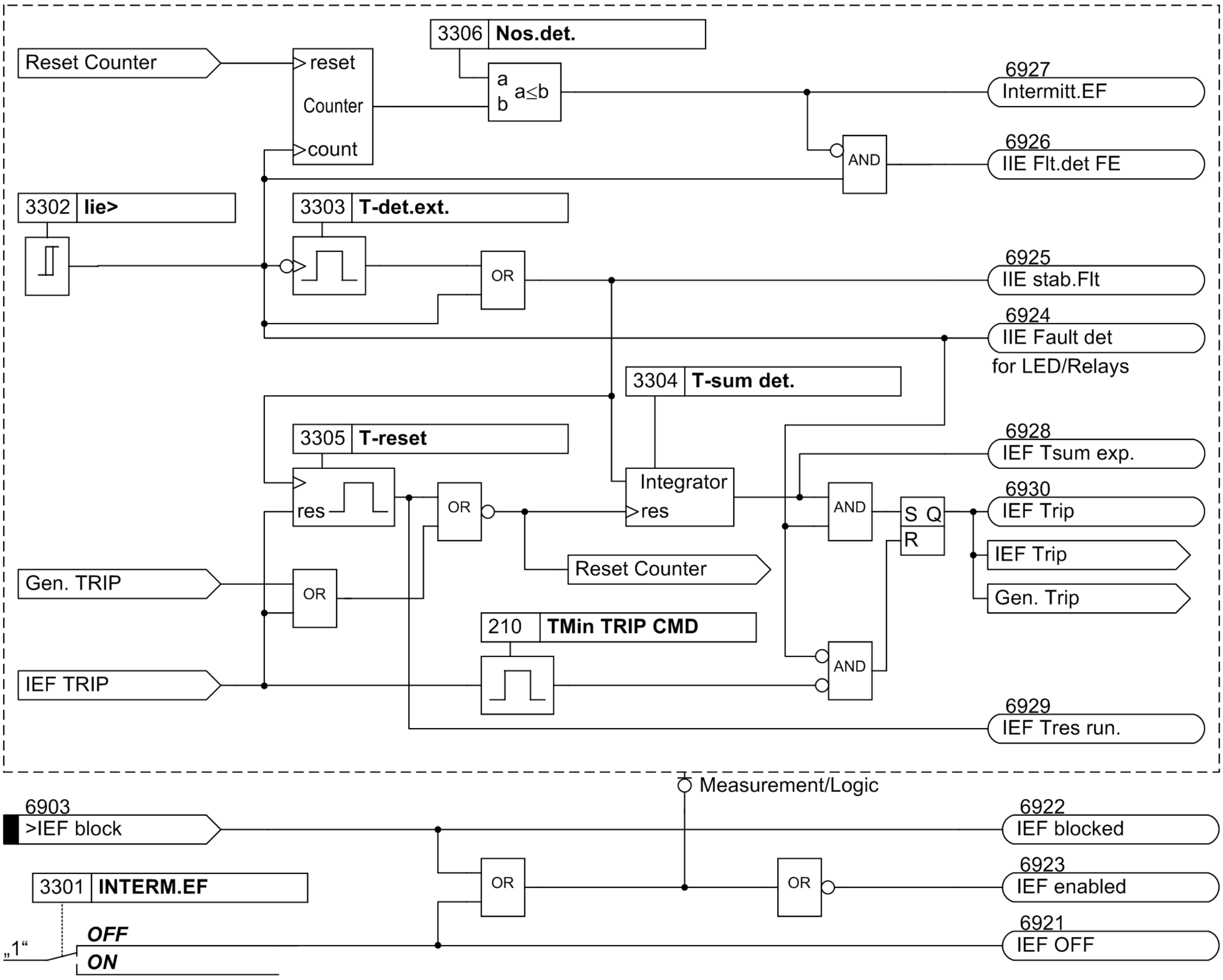


Figure 2-77 Logic diagram of the intermittent ground fault protection – principle

Fault Logging

A fault event and thus fault logging is initiated when the non-stabilized IN element picks up for the first time. A message „`IIE Fault det`“ is produced. The message „`IIE Fault det`“ is issued and entered in the fault log (and reported to the system interface) so often until the number of pickups „`IIE Fault det`“ has reached the value set for parameter **`Nos.det.`**. When this happens, the message „`Intermitt.EF`“ is issued and „`IIE Fault det`“ is blocked for the fault log and the system interface. This method accounts for the fact that the IN element may also pick up for a normal short-circuit. In this case the pickup does not launch the alarm „`Intermitt.EF`“.

Intermittent ground faults may cause other time overcurrent elements to pick up (e.g. 50-1, 50N-1, 50Ns-1) and produce a burst of messages. To avoid overflow of the fault log, messages are not entered anymore in the fault log after detection of an intermittent ground fault (message „`Intermitt.EF`“) unless they cause a tripping command. If an intermittent ground fault has been detected, the following pickup messages of the time overcurrent protection will still be reported without restraint (see Table 2-13):

Table 2-13 Unrestricted Messages

FNo.	Message	Description
1800	„50-2 picked up“	50-2 picked up
2642	„67-2 picked up“	67-2 picked up
7551	„50-1 InRushPU“	50-1 InRush picked up
7552	„50N-1 InRushPU“	50N-1 InRush picked up
7553	„51 InRushPU“	51 InRush picked up
7554	„51N InRushPU“	51N InRush picked up
7559	„67-1 InRushPU“	67-1 InRush picked up
7560	„67N-1 InRushPU“	67N-1 InRush picked up
7561	„67-TOC InRushPU“	67-TOC InRush picked up
7562	„67N-TOCInRushPU“	67N-TOC InRush picked up
7565	„Ia InRush PU“	Phase A InRush picked up
7566	„Ib InRush PU“	Phase B InRush picked up
7567	„Ic InRush PU“	Phase C InRush picked up
7564	„Gnd InRush PU“	Ground InRush picked up

Table 2-14 shows all messages subject to a restraint mechanism avoiding a message burst during an intermittent ground fault:

Table 2-14 Buffered Messages

FNo.	Message	Explanation
1761	„50(N)/51(N) PU“	50(N)/51(N) picked up
1762	„50/51 Ph A PU“	50/51 Phase A picked up
1763	„50/51 Ph B PU“	50/51 Phase B picked up
1764	„50/51 Ph C PU“	50/51 Phase C picked up
1810	„50-1 picked up“	50-1 picked up
1820	„51 picked up“	51 picked up
1765	„50N/51NPickedup“	50N/51N picked up
1831	„50N-2 picked up“	50N-2 picked up
1834	„50N-1 picked up“	50N-1 picked up
1837	„51N picked up“	51N picked up
2691	„67/67N pickedup“	67/67N picked up
2660	„67-1 picked up“	67-1 picked up
2670	„67-TOC pickedup“	67-TOC picked up
2692	„67 A picked up“	67/67-TOC Phase A picked up
2693	„67 B picked up“	67/67-TOC Phase B picked up
2694	„67 C picked up“	67/67-TOC Phase C picked up
2646	„67N-2 picked up“	67N-2 picked up
2681	„67N-1 picked up“	67N-1 picked up
2684	„67N-TOCPickedup“	67N-TOC picked up
2695	„67N picked up“	67N/67N—TOC picked up
5159	„46-2 picked up“	46-2 picked up
5165	„46-1 picked up“	46-1 picked up
5166	„46-TOC pickedup“	46-TOC picked up
1215	„64 Pickup“	64 displacement voltage pick up
1221	„50Ns-2 Pickup“	50Ns-2 picked up
1224	„50Ns-1 Pickup“	50Ns-1 picked up
1227	„51Ns Pickup“	51Ns picked up
6823	„START-SUP pu“	Startup supervision Pickup

Before they are entered in the fault log (event buffer) and transmitted to the system interface or CFC, the messages of table 2-14 are buffered (starting with the first pickup message received after „`Intermitt.EF`“ was signalled). The buffering does not apply for signalling to relays and LEDs as it is required by time-graded protection systems for reverse interlocking. The intermediate buffer can store a maximum of two status changes (the most recent ones) for each message.

Buffered messages are signalled to the fault log, CFC and to the system interface with the original time flag only when a TRIP command is initiated by a protective function other than the intermittent ground fault protection. This ascertains that a pickup, although delayed, is always signalled in association with each TRIP command.

All pickup messages which usually do not occur during an intermittent ground fault are not affected by this mechanism. Among others this includes the pickup and TRIP commands of the following protective functions:

- Breaker failure protection,
- Overload protection,
- Frequency protection and
- Voltage protection.

The pickup signals of these functions will still be logged immediately. A TRIP command of one of these protective functions will cause the buffered messages to be cleared since no connection exists between tripping function and buffered message.

A fault event is cleared when the time **T-reset** has expired or the TRIP command „IEF Trip“ has been terminated.

Terminating a fault event for the intermittent ground fault protection thus is a special case. It is the time **T-reset** that keeps the fault event opened and not the pickup.

2.13.2 Setting Notes

General

The protection function for intermittent ground faults can only take effect and is only accessible if the current to be evaluated (133, **INTERM.EF** or ***with Ignd***) was configured in address ***with 3I0 with Ignd,sens.***. If not required, this function is set to ***Disabled***.

The function can be turned ***ON*** or ***OFF*** under address 3301 **INTERM.EF**.

The pickup threshold (r.m.s. value) is set in address 3302 **Iie>**. A rather sensitive setting is possible to respond also to short ground faults since the pickup time shortens as the current in excess of the setting increases. The setting range depends on the selection of the current to be evaluated at address 133 **INTERM.EF**.

The pickup time can be prolonged at address 3303 **T-det.ext.**. This pickup stabilization is especially important for the coordination with existing analog or electromechanical overcurrent relays. The time **T-det.ext.** can also be disabled (**T-det.ext.** = 0).

The stabilized pickup starts the counter **T-sum det.**. This counter is stopped but not reset when the picked up function drops out. Based on the last counter content the counter resumes counting when the stabilized function picks up next. This sum of individual pickup times, which are to initiate tripping, is set at address 3304 **T-sum det.**. It represents one of the four selectivity criteria (pickup value **Iie>**, detection extension time **T-det.ext.**, counter **T-sum det.** and reset time **T-reset**) for coordinating the relays on adjacent feeders and is comparable to the time grading of the time overcurrent protection. The relay in the radial network which is closest to the intermittent fault and picks up, will have the shortest summation time **T-sum det.**.

The reset time, after which the summation is reset in healthy operation and the protection resumes normal status, is configured to **T-reset** at address 3305.

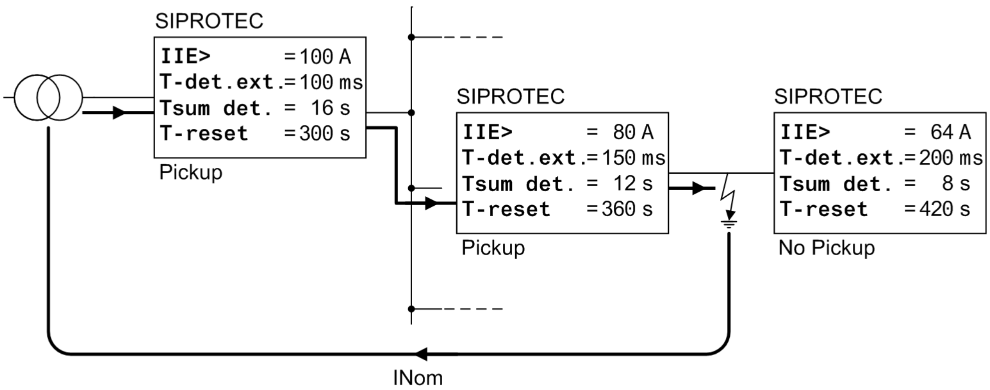


Figure 2-78 Example of selectivity criteria of the intermittent ground fault protection

Address 3306 **Nos.det.** specifies the number of pickups after which a ground fault is considered intermittent.

2.13.3 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
3301	INTERM.EF		OFF ON	OFF	Intermittent earth fault protection
3302	Iie>	1A	0.05 .. 35.00 A	1.00 A	Pick-up value of interm. E/F stage
		5A	0.25 .. 175.00 A	5.00 A	
3302	Iie>	1A	0.05 .. 35.00 A	1.00 A	Pick-up value of interm. E/F stage
		5A	0.25 .. 175.00 A	5.00 A	
3302	Iie>		0.005 .. 1.500 A	1.000 A	Pick-up value of interm. E/F stage
3303	T-det.ext.		0.00 .. 10.00 sec	0.10 sec	Detection extension time
3304	T-sum det.		0.00 .. 100.00 sec	20.00 sec	Sum of detection times
3305	T-reset		1 .. 600 sec	300 sec	Reset time
3306	Nos.det.		2 .. 10	3	No. of det. for start of int. E/F prot

2.13.4 Information List

No.	Information	Type of Information	Comments
6903	>IEF block	SP	>block interm. E/F prot.
6921	IEF OFF	OUT	Interm. E/F prot. is switched off
6922	IEF blocked	OUT	Interm. E/F prot. is blocked
6923	IEF enabled	OUT	Interm. E/F prot. is active
6924	IIE Fault det	OUT	Interm. E/F detection stage Iie>
6925	IIE stab.Flt	OUT	Interm. E/F stab detection
6926	IIE Flt.det FE	OUT	Interm.E/F det.stage Iie> f.Flt. ev.Prot
6927	Intermitt.EF	OUT	Interm. E/F detected
6928	IEF Tsum exp.	OUT	Counter of det. times elapsed
6929	IEF Tres run.	OUT	Interm. E/F: reset time running
6930	IEF Trip	OUT	Interm. E/F: trip
6931	Iie/In=	VI	Max RMS current value of fault =
6932	Nos.IIE=	VI	No. of detections by stage Iie>=

2.14 Automatic Reclosing System 79

From experience, about 85 % of insulation faults associated with overhead lines are arc short circuits which are temporary in nature and disappear when protection takes effect. This means that the line can be connected again. The reconnection is accomplished after a dead time via the automatic reclosing system.

If the fault still exists after automatic reclosure (arc has not disappeared, there is a metallic fault), then the protective elements will re-trip the circuit breaker. In some systems several reclosing attempts are performed.

Applications

- The automatic reclosure system integrated in the 7SJ62/63/64 can also be controlled by an external protection device (e.g. backup protection). For this application, an output contact from the tripping relay must be wired to a binary input of the 7SJ62/63/64 relay.
- It is also possible to allow the relay 7SJ62/63/64 to work in conjunction with an external reclosing device.
- The automatic reclosure system can also operate in interaction with the integrated synchronizing function (only 7SJ64) or with an external synchrocheck.
- Since the automatic reclosing function is not applied when the 7SJ62/63/64 is used to protect generators, motors, transformers, cables and reactors etc., it should be disabled for this application.

2.14.1 Program Execution

The 7SJ62/63/64 is equipped with three-pole, single-shot and multi-shot automatic reclosure (AR). Figure 2-79 shows an example of a timing diagram for a successful second reclosure.

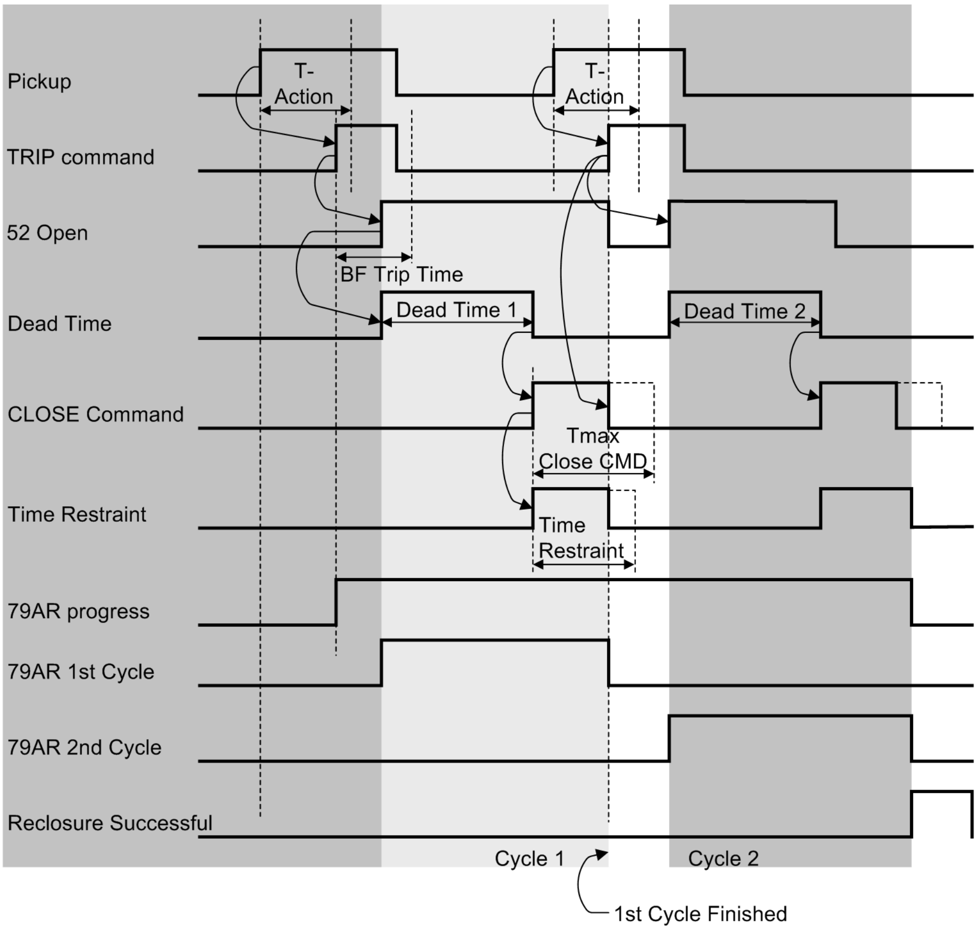


Figure 2-79 Timing diagram showing two reclosing shots, first cycle unsuccessful, second cycle successful

The following figure shows an example of a timing diagram showing for two unsuccessful reclosing shots, with no additional reclosing of the circuit breaker.

The number of reclose commands initiated by the automatic reclosure function are counted. A statistical counter is available for this purpose for the first and all subsequent reclosing commands.

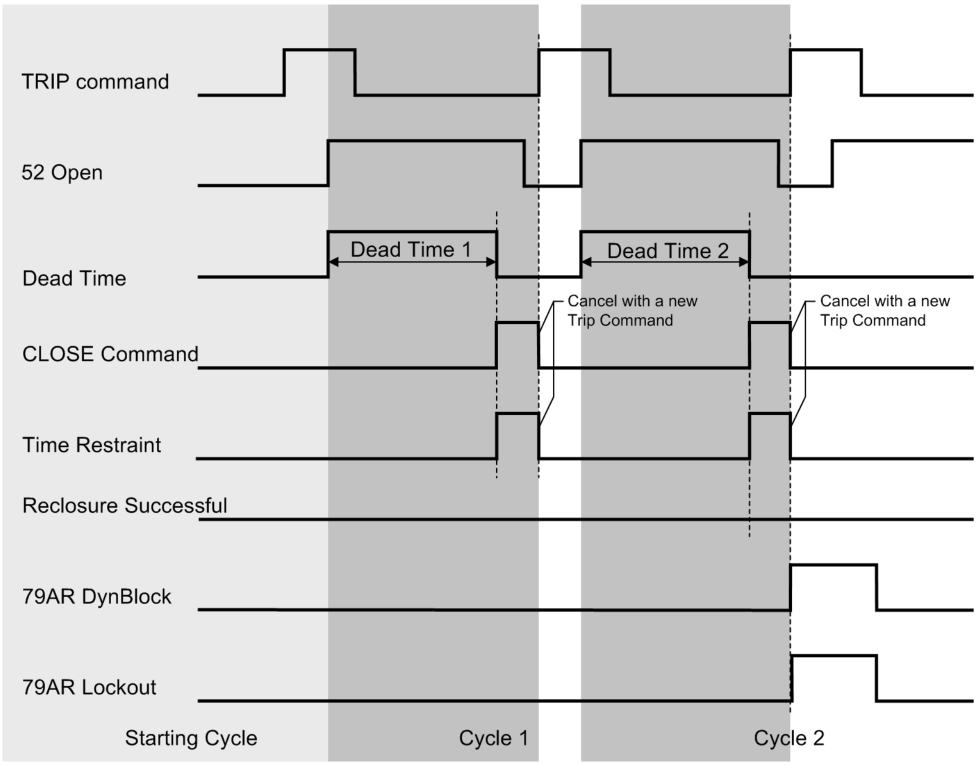


Figure 2-80   Timing diagram showing two unsuccessful reclosing shots

Initiation

Initiation of the automatic reclosing function can be caused by internal protective functions or externally using a binary input. The automatic reclosing system can be programmed such that any of the elements of Table 2-15 can initiate (***Starts 79***), not initiate (***No influence***), or block reclosing (***Stops 79***):

Table 2-15   79 start

Non-directional Start	Directional Start	Start Other
50-1	67-1	SENS. GROUND FLT (50Ns, 51Ns)
50N-1	67N-1	46
50-2	67-2	BINARY INPUT
50N-2	67N-2	
51	67-TOC	
51N	67N-TOC	

With the initiation the automatic reclosure function is informed that a trip command is output and the appropriate reclosing program is executed.

The binary input messages 2715 „>Start 79 Gnd“ and 2716 „>Start 79 Ph“ for starting an automatic reclosure program can also be activated via CFC (fast PLC task processing). Automatic reclosure can thus be initiated via any messages (e.g. protective pickup) if address 7164 **BINARY INPUT** is set to ***Starts 79***.

Action Time

The action time serves for monitoring the time between a device pickup and the trip command of a protective function configured as starter. The action time is launched when pickup of any function is detected, which is set as source of the automatic reclosure program. Protection functions which are set to ***Alarm Only*** or which in principle should not start a reclosing program do not trigger the action time.

If a protective function configured as starter initiates a trip command during the action time, the automatic reclosure program is started. Trip commands of a protective function configured as starter occurring in the time between expiration of the action time and dropout of the device pickup cause the dynamic blocking of the automatic reclosing program. Trip commands of protective functions which are not configured as starter do not affect the action time.

If the automatic reclosure program interacts with an external protection device, the device pickup for start of the operating time is communicated to the automatic reclosing program via binary input 2711 „>79 Start“.

Delay of Dead Time Start

The initiation of the dead time can be delayed after a 79 start of the binary input message 2754 „>79 DT St.Delay“. The dead time is not initiated as long as the binary input is active. The initiation takes place only with dropout of the binary input. The delay of the dead time start can be monitored at parameter 7118 **T DEAD DELAY**. If the time elapses and the binary input is still active, the **Automatic Reclosing System 79** changes to the status of the dynamic blocking via (2785 „79 DynBlock“). The maximal time delay of the dead time start is logged by the annunciation 2753 „79 DT delay ex.“.

Reclosing Programs

Depending on the type of fault, two different reclosing programs can be used. The following applies:

- The single phase fault (**ground** fault) reclosing program applies when all fault protection functions, which initiate automatic reclosure, detected a phase-to-ground fault. The following conditions must apply: only one phase, only one phase and ground or only ground have picked up. This program can be started via a binary input as well.
- The multiple phase fault (**phase** fault program) reclosing program applies to all other cases. That is, when elements associated with two or more phases pickup, with or without the pickup of ground elements, the phase reclosing program is executed. In addition, when automatic reclosing is initiated by other functions, such as negative sequence elements, this program is started. This program can be started via a binary input as well.

The reclosure program evaluates only elements during pick up as elements dropping out may corrupt the result if they drop out at different times when opening the circuit breaker. Therefore, the ground fault reclosure program is executed only when the elements associated with one particular phase pick up until the circuit breaker is opened; all others conditions will initiate the phase fault program.

For each of the programs, up to 9 reclosing attempts can be separately programmed. The first four reclosing attempts can be set differently for each of the two reclosing programs. The fifth and following automatic reclosures will correspond to the fourth dead time.

Reclosing Before Selectivity

For the automatic reclosure sequence to be successful, faults on any part of the line must be cleared from the feeding line end(s) within the same – shortest possible – time. Usually, therefore, an instantaneous protection element is set to operate before an automatic reclosure. Fast fault termination thus has priority over selectivity aspects as the reclosing action aims at maintaining normal system operation. For this purpose all protective functions which can initiate the automatic reclosure function are set such that they may trip instantaneously or with a very small time delay before auto-reclosure.

With the final reclosing attempt, i.e. when no automatic reclosure is expected, protection is to trip with delay according to the grading coordination chart of the network, since selectivity has priority. For details see also information at margin heading "Using the Automatic Reclosure Function" which can be found with the setting notes of the time overcurrent protection functions and the functional description of the intermittent ground fault protection.

Single-shot Reclosing

When a trip signal is programmed to initiate the automatic reclosing system, the appropriate automatic reclosing program will be executed. Once the circuit breaker has opened, a dead time interval in accordance with the type of fault is started (see also margin heading "Reclosing Programs"). Once the dead time interval has elapsed, a closing signal is issued to reclose the circuit breaker. A blocking time interval **TIME RESTRAINT** is started at the same time. Within this restraint time it is checked whether the automatic reclosure was performed successfully. If a new fault occurs before the restraint time elapses, the automatic reclosing system is dynamically blocked causing the final tripping of the circuit breaker. The dead time can be set individually for each of the two reclosing programs.

Criteria for opening the circuit breaker may either be the auxiliary contacts of the circuit breaker or the dropout of the general device pickup if auxiliary contacts are not configured.

If the fault is cleared (successful reclosing attempt), the blocking time expires and automatic reclosing is reset in anticipation of a future fault. The fault is cleared.

If the fault is not cleared (unsuccessful reclosing attempt), then a final tripping signal is initiated by one or more protective elements.

Multi-shot Reclosing

7SJ62/63/64 permits up to 9 reclosings. The number can be set differently for the phase fault reclosing program and the ground fault reclosing program.

The first reclose cycle is, in principle, the same as the single-shot auto-reclosing. If the first reclosing attempt is unsuccessful, this does not result in a final trip, but in a reset of the restraint time interval and start of the next reclose cycle with the next dead time. This can be repeated until the set number of reclosing attempts for the corresponding reclose program has been reached.

The dead time intervals for the first four reclosing attempts can be set differently for each of the two reclosing programs. The dead time intervals from the fifth cycle on will be equal to that of the fourth cycle.

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

If none of the reclosing attempts is successful, then a final circuit breaker trip (according to the grading coordination chart) will take place after the last allowable reclosing attempt has been performed by the protection function. All reclosing attempts were unsuccessful

After the final circuit breaker trip, the automatic reclosing system is dynamically blocked (see below).

Restraint Time

The function of the restraint time has already been described in the paragraphs at side title "Single-/Multi-Shot Reclosing". The restraint time can be prolonged when the following conditions are fulfilled.

The time 211 **TMax CLOSE CMD** defines the maximum time during which a close command can apply. If a new trip command occurs before this time has run out, the close command will be aborted. If the time **TMax CLOSE CMD** is set longer than the restraint time **TIME RESTRAINT**, the restraint time will be extended to the remaining close command duration after expiry!

A pickup from a protective function that is set to initiate the automatic reclosing system will also lead to an extension of the restraint time should it occur during this time!

2.14.2 Blocking

Static Blocking

Static blocking means that the automatic reclosing system is not ready to initiate reclosing, and cannot initiate reclosing as long as the blocking signal is present. A corresponding message „79 is NOT ready“ (FNo. 2784) is generated. The static blocking signal is also used internally to block the protection elements that are only supposed to work when reclosing is enabled (see also side title "Reclosing Before Selectivity" further above).

The automatic reclosing system is statically blocked if:

- The signal „>BLOCK 79“ FNo.2703) is present at a binary input, as long as the automatic reclosing system is not initiated (associated message: „>BLOCK 79“),
- The signal „>CB Ready“ (FNo. 2730) indicates that the circuit breaker disappears via the binary input, if the automatic reclosing system is not initiated (associated message: „>CB Ready“),
- The number of allowable reclosing attempts set for both reclosing programs is zero (associated message: „79 no cycle“),
- No protective functions (parameters 7150 to 7163) or binary inputs are set to initiate the automatic reclosing system (associated message: „79 no starter“),
- The circuit breaker position is reported as being "open" and no trip command applies (associated message: „79 BLK: CB open“). This presumes that 7SJ62/63/64 is informed of the circuit breaker position via the auxiliary contacts of the circuit breaker.

Dynamic Blocking

Dynamic blocking of the automatic reclosure program occurs in those cases where the reclosure program is active and one of the conditions for blocking is fulfilled. The dynamic blocking is signalled by the message „79 DynBlock“. The dynamic blocking is associated to the configurable blocking time **SAFETY 79 ready**. This blocking time is usually started by a blocking condition that has been fulfilled. After the blocking time has elapsed the device checks whether or not the blocking condition can be reset. If the blocking condition is still present or if a new blocking condition is fulfilled, the blocking time is restarted. If, however, the blocking condition no longer holds after the blocking time has elapsed, the dynamic blocking will be reset.

Dynamic blocking is initiated if:

- The maximum number of reclosure attempts has been achieved. If a trip command now occurs within the dynamic blocking time, the automatic reclosure program will be blocked dynamically, (indicated by „79 Max. No. Cyc“).
- The protection function has detected a three-phase fault and the device is programmed not to reclose after three-phase faults, (indicated by „79 BLK:3ph p.u.“).
- When the maximal waiting time **T DEAD DELAY** for the delay of the dead time initiation by binary inputs runs off without that the binary input „>79 DT St.Delay“ during this time frame has become inactive.
- The action time has elapsed without a TRIP command being issued. Each TRIP command that occurs after the action time has expired and before the picked-up element drops out, will initiate the dynamic blocking (indicated by „79 Tact expired“).
- A protective function trips which is to block the automatic reclosure function (as configured). This applies irrespective of the status of the automatic reclosure system (started / not started) if a TRIP command of a blocking element occurs (indicated by „79 BLK by trip“).
- The circuit breaker failure function is initiated.
- The circuit breaker does not trip within the configured time **T-Start MONITOR** after a trip command was issued, thus leading to the assumption that the circuit breaker has failed. (The breaker failure monitoring is primarily intended for commissionnig purposes. Commissionnig safety checks are often conducted with the circuit breaker disconnected. The breaker failure monitoring prevents unexpected reclosing after the circuit breaker has been reconnected, indicated by „79 T-Start Exp“).
- The circuit breaker is not ready after the breaker monitoring time has elapsed, provided that the circuit breaker check has been activated (address 7113 **CHECK CB?** = ***Chk each cycle***, indicated by „79 T-CBreadyExp“).
- The circuit breaker is not ready after maximum extension of the dead time **Max. DEAD EXT.**. The monitoring of the circuit breaker status and the synchrocheck may cause undesired extension of the dead time. To prevent the automatic reclosure system from assuming an undefined state, the extension of the dead time is monitored. The extension time is started when the regular dead time has elapsed. When it has elapsed, the automatic reclosure function is blocked dynamically and the lock-out time launched. The automatic reclosure system resumes normal state when the lock-out time has elapsed and new blocking conditions do not apply (indicated by „79 TdeadMax Exp“).
- Manual closing has been detected (externally) and parameter **BLOCK MC Dur.** (T = 0) was set such that the automatic reclosing system responds to manual closing,
- Via a correspondingly masked binary input (FNo. 2703 „>BLOCK 79“). If the blocking takes places while the automatic recloser is in normal state, the latter will be blocked statically („79 is NOT ready“). The blocking is terminated immediately when the binary input has been cleared and the automatic reclosure function resumes normal state. If the automatic reclosure function is already running when the blocking arrives, the dynamic blocking takes effect („79 DynBlock“). In this case the activation of the binary input starts the dynamic blocking time **SAFETY 79 ready**. Upon its expiration the device checks if the binary input is still activated. If this is the case, the automatic reclosure program changes from dynamic blocking to static blocking. If the binary input is no longer active when the time has elapsed and if no new blocking conditions apply, the automatic reclosure system resumes normal state.

2.14.3 Status Recognition and Monitoring of the Circuit Breaker

Circuit Breaker Status

The detection of the actual circuit breaker position is necessary for the correct functionality of the auto reclose function. The breaker position is detected by the circuit breaker auxiliary contacts and is communicated to the device via binary inputs 4602 „>52-b“ and 4601 „>52-a“.

Here the following applies:

- If binary input 4601 „>52-a“ and binary input 4602 „>52-b“ are used, the automatic reclosure function can detect whether the circuit breaker is open, closed or in intermediate position. If both auxiliary contacts detect that the circuit breaker is open, the dead time is started. If the circuit breaker is open or in intermediate position without a trip command being present, the automatic reclosure function is blocked dynamically if it is already running. If the automatic reclosure system is in normal state, it will be blocked statically. When checking whether a trip command applies, all trip commands of the device are taken into account irrespective of whether the function acts as starting or blocking element on behalf of the automatic reclosure program.
- If binary input 4601 „>52-a“ alone is allocated, the circuit breaker is considered open while the binary input is not active. If the binary input becomes inactive while no trip command of (any) function applies, the automatic reclosure system will be blocked. The blocking will be of static nature if the automatic reclosure system is in normal state at this time. If the automatic reclosing system is already running, the blocking will be a dynamic one. The dead time is started if the binary input becomes inactive following the trip command of a starting element 4601 „>52-a“ = inactive). An intermediate position of the circuit breaker cannot be detected for this type of allocation.
- If binary input 4602 „>52-b“ alone is allocated, the circuit breaker is considered open while the binary input is active. If the binary input becomes active while no trip command of (any) function applies, the automatic reclosure system will be blocked dynamically provided it is already running. Otherwise the blocking will be a static one. The dead time is started if the binary input becomes active following the trip command of a starting element. An intermediate position of the circuit breaker cannot be detected for this type of allocation.
- If neither binary input 4602 „>52-b“ nor 4601 „>52-a“ are allocated, the automatic reclosure program cannot detect the position of the circuit breaker. In this case, the automatic reclosure system will be controlled exclusively via pickups and trip commands. Monitoring for "52-b without TRIP" and starting the dead time in dependence of the circuit breaker feedback is not possible in this case.

Circuit Breaker Monitoring

The time needed by the circuit breaker to perform a complete reclose cycle can be monitored by the 7SJ62/63/64. Breaker failure is detected:

A precondition for a reclosing attempt, following a trip command initiated by a protective relay element and subsequent initiation of the automatic reclosing function, is that the circuit breaker is ready for at least one TRIP-CLOSE-TRIP cycle. The readiness of the circuit breaker is monitored by the device using a binary input „>CB Ready“. In the case where this signal from the breaker is not available, the circuit breaker monitoring feature should be disabled, otherwise reclosing attempts will remain blocked.

- 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 to each reclosing attempt. A reclosing attempt 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 7SJ62/63/64. The monitoring time **CB TIME OUT** expires for as long as the circuit breaker does not indicate that it is ready via binary input „>CB Ready“ (FNo. 2730). Meaning that as the binary input „>CB Ready“ is cleared, the monitoring time **CB TIME OUT** is started. If the binary input returns before the monitoring time has elapsed, the monitoring time will be cancelled and the reclosure process is continued. If the monitoring time runs longer than the dead time, the dead time will be extended accordingly. If the monitoring time elapses before the circuit breaker signals its readiness, the automatic reclosure function will be blocked dynamically.

Interaction with the synchronism check may cause the dead time to extend inadmissibly. To prevent the automatic reclosure function from remaining in an undefined state, dead time extension is monitored. The maximum extension of the dead time can be set at **Max. DEAD EXT.**. The monitoring time **Max. DEAD EXT.** is started when the regular dead time has elapsed. If the synchronism check responds before the time has elapsed, the monitoring time will be stopped and the close command generated. If the time expires before the synchronism check reacts, the automatic reclosure function will be blocked dynamically.

Please make sure that the above mentioned time is not shorter than the monitoring time **CB TIME OUT**.

The time 7114 **T-Start MONITOR** serves for monitoring the response of the automatic reclosure function to a breaker failure. It is activated by a trip command arriving before or during a reclosing operation and marks the time that passes between tripping and opening of the circuit breaker. If the time elapses, the device assumes a breaker failure and the automatic reclosure function is blocked dynamically. If parameter **T-Start MONITOR** is set to ∞, the start monitoring is disabled.

2.14.4 Controlling Protective Elements

Depending on the reclosing cycle it is possible to control elements of the directional and non-directional overcurrent protection by means of the automatic reclosure system (Protective Elements Control). There are three mechanisms:

1. Time overcurrent elements may trip instantaneously depending on the automatic reclosure cycle (T = 0), they may remain unaffected by the auto reclosing function AR (T = T) or may be blocked (T = ∞). For further information see side title "Cyclic Control".
2. The automatic reclosure states "79M Auto Reclosing ready" and "79M Auto Reclosing not ready" can activate or deactivate the dynamic cold load pick-up function. This function is designed to influence time overcurrent elements (see also Section 2.14.6 and Section 2.4) regarding thresholds and trip time delays.
3. The time overcurrent address 1x14A 50(N)-2 ACTIVE defines whether the 50(N)2 elements are to operate always or only with "79M Auto Reclosing ready" (see Section 2.2).

Cyclic Control

Control of the overcurrent protection elements takes effect by releasing the cycle marked by the corresponding parameter. The cycle zone release is indicated by the messages „`79 1.CycZoneRel`“ to „`79 4.CycZoneRel`“. If the automatic reclosure system is in normal state, the settings for the starting cycle apply. These settings always take effect when the automatic reclosure system assumes normal state.

The settings are released for each following cycle when issuing the close command and starting the blocking time. Following a successful auto reclosing operation (restraint time elapsed) or when reset after blocking, the automatic reclosure system assumes normal state. Control of the protection is again assumed by the parameters for the starting cycle.

The following figure illustrates the control of the protective stages 50-2 and 50N-2.

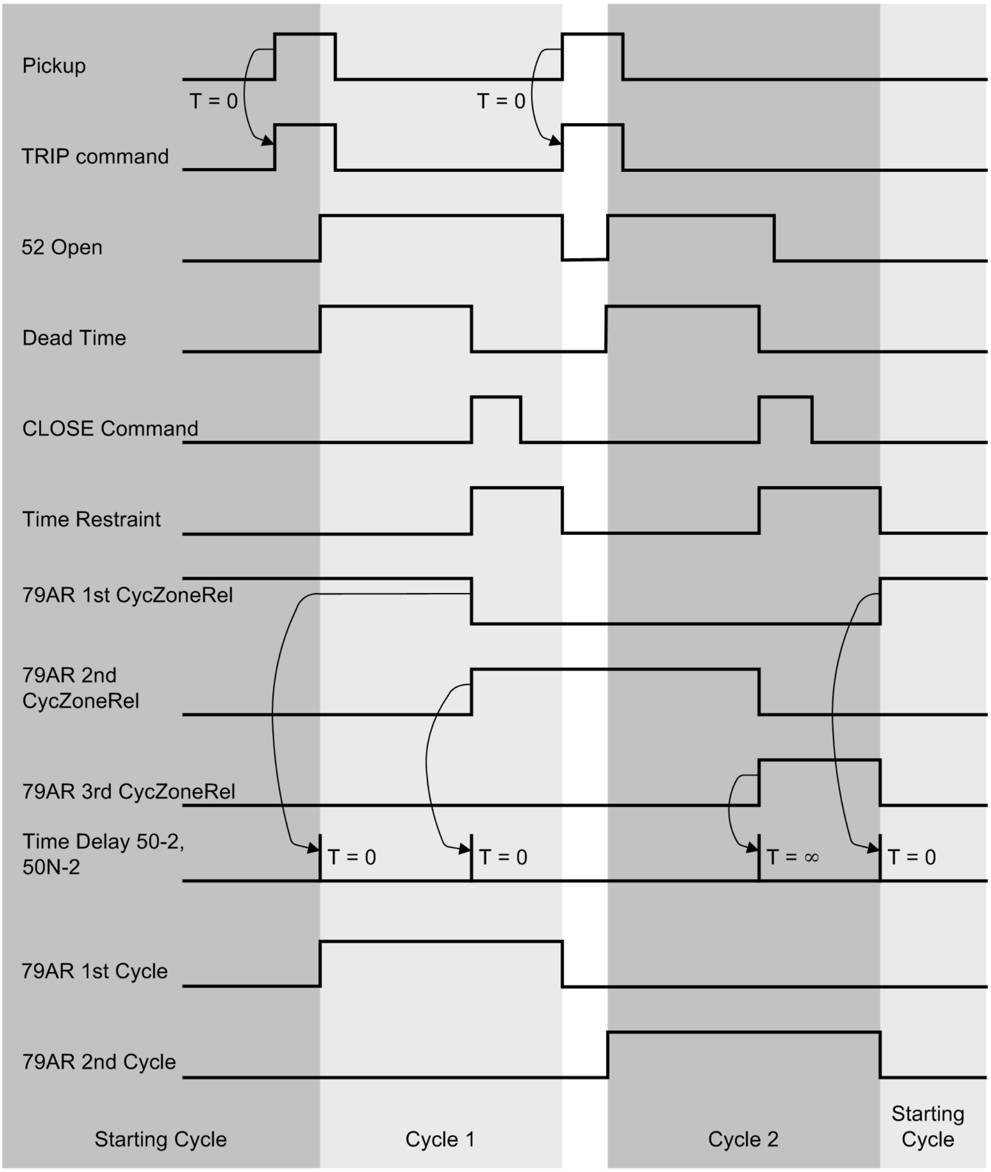


Figure 2-81 Control of protection elements for two-fold, successful auto-reclosure

Example

Before the first reclosure faults are to be eliminated quickly applying stages 50-2 or 50N-2. Fast fault termination thus has priority over selectivity aspects as the reclosing action aims at maintaining normal system operation. If the fault prevails, a second tripping is to take place instantaneously and subsequently, a second reclosure.

After the second reclosure, however, elements 50-2 or 50N-2 are to be blocked so the fault can be eliminated applying elements 50-1 or 50N-1 according to the networks time grading schedule giving priority to selectivity concerns.

Addresses 7202 **bef.1.Cy:50-2**, 7214 **bef.2.Cy:50-2** and 7203 **bef.1.Cy:50N-2** and 7215 **bef.2.Cy:50N-2** are set to ***instant. T=0*** to enable the stages after the first reclosure. Addresses 7226 **bef.3.Cy:50-2** and 7227 **bef.3.Cy:50N-2**, however, are set to ***blocked T=∞*** to ensure that elements 50-2 and 50N-2 are blocked when the second reclosure applies. The back-up stages e.g., 50-1 and 50N-1 must obviously not be blocked (addresses 7200, 7201, 7212, 7213, 7224 and 7225).

The blocking applies only after reclosure according to the settings address. Hence, it is possible to specify again other conditions for a third reclosure.

The blocking conditions are also valid for the zone sequence coordination, provided it is available and activated (address 7140, see also margin heading "Zone Sequencing").

2.14.5 Zone Sequencing (not available for models 7SJ6***-**A**-)

It is the task of the zone sequence coordination to harmonize the automatic reclosure function of this device with that of another device that is part of the same power system. It is a complementary function to the automatic reclosure program and allows for example to perform group reclosing operations in radial systems. In case of multiple reclosures, groups may also be in nested arrangement and further high-voltage fuses can be overgraded or undergraded.

Zone sequencing works by blocking certain protective functions depending on the reclose cycle. This is implemented by the protective stages control (see margin heading "Controlling Protective Stages").

As a special feature, changing from one reclosing cycle to the next is possible without trip command only via pickup/dropout of the 50-1 or 50N-1element.

The following figure shows an example of a group reclosure at feeder 3. Assume that reclosure is performed twice.

For fault F1 at Tap Line #5, protection relays protecting the bus supply and Feeder #3 pickup. The time delay of the 50-2 element protecting Feeder #3 is set so that the Feeder #3 circuit breaker will clear the fault before the fuse at Tap Line #5 is damaged. If the fault was cleared, normal service is restored and all functions return to quiescent after restraint time has expired. Thus the fuse has been protected as well.

If the fault continues to exist, a second reclosing attempt will follow in the same manner.

High speed element 50-2 is now being blocked at relay protecting Feeder #3. If the fault still remains, only element 50-1 continues being active in Feeder #3 which, however, **overgrades** the fuse with a time delay of 0.4 s. After the fuse operated to clear the fault, the relays nearer to the fault location will drop out. If the fuse fails to clear the fault, then the 50-1 element protecting Feeder #3 will operate as backup protection.

The 50-2 element at the busbar relay is set with a delay of 0.4 seconds, since it supposed to trip the 50-2 elements and the fuses as well. For the second reclosure, the 50-2 element also has to be blocked to give preference to the feeder relay (element 50-1 with 0.4 s). For this purpose, the device has to "know" that two reclosing attempts have already been performed.

With this device, zone sequence coordination must be switched off: When pickup of 50-1 or 50N-2 drops out, zone sequence coordination provokes that the reclosing attempts are counted as well. If the fault still persists after the second reclosure, the 50-1 element, which is set for 0.9 seconds, would serve as backup protection.

For the busbar fault F2, the 50-2 element at the bus would have cleared the fault in 0.4 seconds. Zone sequence coordination enables the user to set a relative short time period for element 50-2. element 50-2 is only used as backup protection. If zone sequence coordination is not applied, element 50-1 is to be used only with the relative long time period (0.9 s).

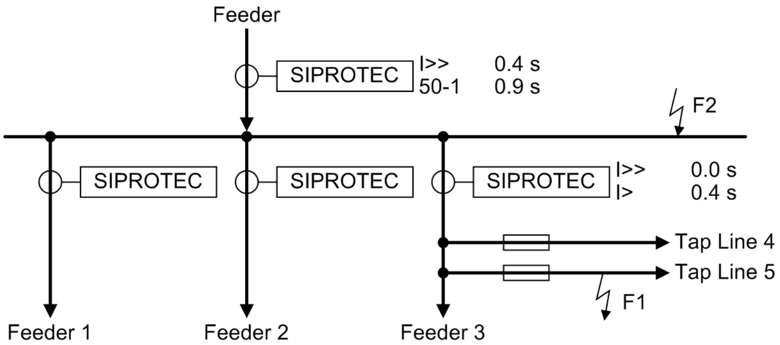


Figure 2-82 Zone sequencing with a fault occurring at Tap Line 2 and the busbar

2.14.6 Setting Notes

General Settings

The internal automatic reclosure system will only be effective and accessible if address 171 **79 Auto Recl.** is set ***Enabled*** during configuration. If not required, this function is set to ***Disabled***. The function can be turned ***ON*** or ***OFF*** under address 7101 **FCT 79**.

If no automatic reclosures are performed on the feeder for which the 7SJ62/63/64 is used (e.g. cables, transformers, motors, etc.), the automatic reclosure function is disabled by configuration. The automatic reclosure function is then completely disabled, i.e. the automatic reclosure function is not processed in the 7SJ62/63/64. No messages exist for this purpose and binary inputs for the automatic reclosure function are ignored. All parameters of block 71 are inaccessible and of no significance.

Blocking Duration for Manual-CLOSE Detection

Parameter 7103 **BLOCK MC Dur.** defines the reaction of the automatic reclosure function when a manual closing signal is detected. The parameter can be set to specify how long the auto reclose function will be blocked dynamically in case of an external manual close-command being detected via binary input (356 „>Manual Close“). If the setting is 0, the automatic reclosure system will not respond to a manual close-signal.

Restraint Time and Dynamic Blocking

The blocking time **TIME RESTRAINT** (address 7105) defines the time that must elapse, after a successful reclosing attempt, before the automatic reclosing function is reset. If a protective function configured for initiation of the auto-reclosure function provokes a new trip before this time elapses, the next reclosing cycle is started in case of multiple reclosures. If no further reclosure is allowed, the last reclosure will be classed as unsuccessful.

In general, a few seconds are 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 flashovers.

A longer restraint time should be chosen if there is no possibility to monitor the circuit breaker (see below) during multiple reclosing (e.g. because of missing auxiliary contacts and 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.

If a dynamic blocking of the automatic reclosing system was initiated, then reclosing functions remain blocked until the cause of the blocking has been cleared. The functional description gives further information on this topic, see marginal heading "Dynamic Blocking". The dynamic blocking is associated with the configurable blocking time **SAFETY 79 ready**. Dynamic blocking time is usually started by a blocking condition that has picked up.

Circuit Breaker Monitoring

Reclosing after a fault clearance presupposes that the circuit breaker is ready for at least one TRIP-CLOSE-TRIP cycle at the time when the reclosing function is initiated (i.e. at the beginning of a trip command):

The readiness of the circuit breaker is monitored by the device using a binary input „>CB Ready“ (FNo. 2730).

- It is possible to check the status of the circuit breaker before each reclosure or to disable this option (address 7113, **CHECK CB?**):

  CHECK CB? = ***No check***, deactivates the circuit breaker check,

  CHECK CB? = ***Chk each cycle***, to verify the circuit breaker status before each reclosing command.

  Checking the status of the circuit breaker is usually recommended. Should the breaker not provide such a signal, you can disable the circuit breaker check at address 7113 **CHECK CB?** (***No check***), as otherwise auto-reclosure would be impossible.

  The status monitoring time **CB TIME OUT** can be configured at address 7115 if the circuit breaker check was enabled at address 7113. This time is set slightly higher than the maximum recovery time of the circuit breaker following reclosure. If the circuit breaker is not ready after the time has expired, reclosing is omitted and dynamic blocking is initiated. Automatic reclosure thus is blocked.

Time **Max. DEAD EXT.** serves for monitoring the dead time extension. The extension can be initiated by the circuit breaker monitoring time **CB TIME OUT** and the synchronization function.

The monitoring time **Max. DEAD EXT.** is started after the configured dead time has elapsed.

This time must not be shorter than **CB TIME OUT**. When using the monitoring time **CB TIME OUT**, the time **Max. DEAD EXT.** should be set to a value ≥ **CB TIME OUT**.

If the auto-reclose system is operated with a synchronization function (internal or external), **Max. DEAD EXT.** assures that the auto-reclose system does not remain in undefined state when the synchronism check fails to check back.

If the synchronization is used as synchronism check (for synchronous systems), the monitoring time may be configured quite short, e.g. to some seconds. In this case the synchronizing function merely checks the synchronism of the power systems. If synchronism prevails it switches in instantaneously, otherwise it will not.

If the synchronization is used for synchronous/asynchronous networks, the monitoring time must grant sufficient time for determining the time for switching in. This depends on the frequency slip of the two subnetworks. A monitoring time of 100 s should be sufficient to account for most applications for asynchronous networks.

Generally, the monitoring time should be longer than the maximum duration of the synchronization process (parameter 6x12).

The breaker failure monitoring time 7114 **T-Start MONITOR** determines the time between tripping (closing the trip contact) and opening the circuit breaker (checkback of the CB auxiliary contacts). This time is started each time a tripping operation takes place. When time has elapsed, the device assumes breaker failure and blocks the auto-reclose system dynamically.

Action Time

The action time monitors the time between interrogation of the device and trip command of a protective function configured as starter while the auto-reclosure system is ready but not yet running. A trip command issued by a protective function configured as starter occurring within the action time will start the automatic reclosing function. If this time differs from the setting value of **T-ACTION** (address 7117), the automatic reclosing system will be blocked dynamically. The trip time of inverse tripping characteristics is considerably determined by the fault location or fault resistance. The action time prevents reclosing in case of far remote or high-resistance faults with long tripping time. Trip commands of protective functions which are not configured as starter do not affect the action time.

Delay of Dead Time Start

The dead time start can be delayed by pickup of the binary input message 2754 „>79 DT St.Delay“. The maximum time for this can be parameterized under 7118 **T DEAD DELAY**. The binary input message must be deactivated again within this time in order to start the dead time. The exact sequence is described in the functional description at margin heading "Delay of Dead Time Start".

Number of Reclosing Attempts

The number of reclosing attempts can be set separately for the "phase program" (address 7136 **# OF RECL. PH**) and "ground program" (address 7135 **# OF RECL. GND**). The exact definition of the programs is described in the functional description at margin heading "Reclosing Programs".

Close Command: Direct or via Control

Address 7137 **Cmd.via control** can be set to either generate directly the close command via the automatic reclosing function (setting **Cmd.via control** = ***none***) or have the closing initiated by the control function.

If the AR is to be intended to close via the control function, the Manual Close command has to be suppressed during an automatic reclose command. The example in Section 2.2.10 of a MANUAL CLOSE for commands via the integrated control function, has to be extended in this case (see Fig. 2-83). It is detected via the annunciations 2878 „79 L-N Sequence“ and 2879 „79 L-L Sequence“ that the automatic reclosure has been started and a reclosure will be initiated after the dead time. The annunciations set the flipflop and suspend the manual close signal until the AR has finished the reclosure attempts. The flipflop is reset via the OR-combination of the annunciations 2784 „79 is NOT ready“, 2785 „79 DynBlock“ and 2862 „79 Successful“. ManCl is initiated if a CLOSE command comes from the control function.

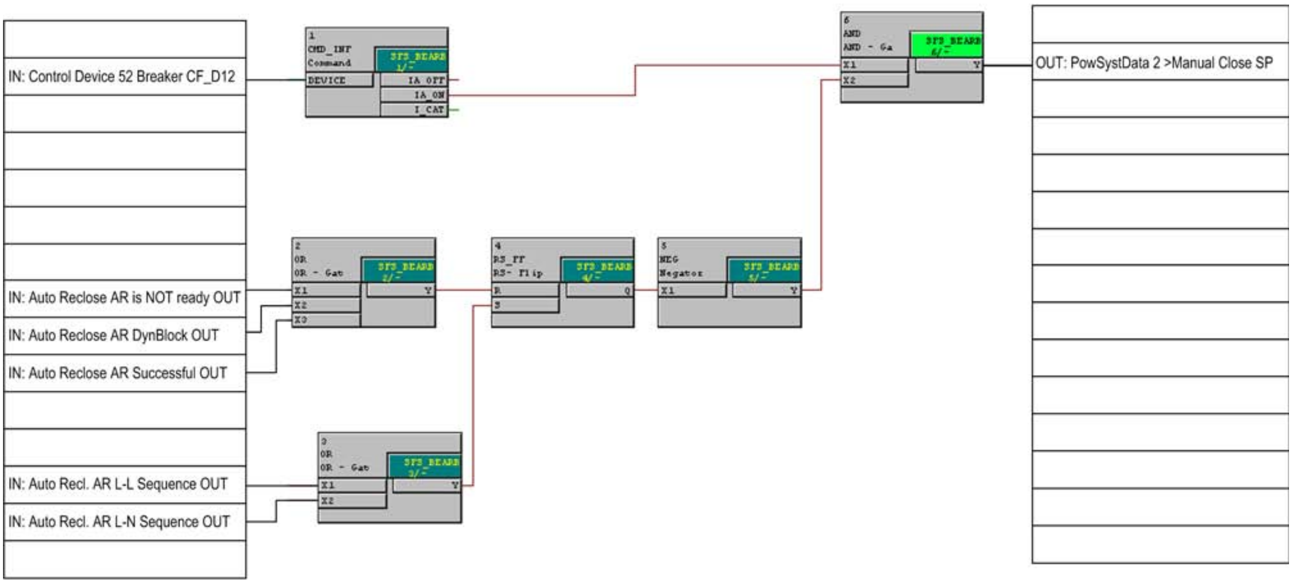


Figure 2-83 CFC Logic for ManCl with AR via Control

The selection list for parameter 7137 is created dynamically depending on the allocated switchgear components. If one of the switchgear components is selected, usually the circuit breaker „52Breaker“, reclosure is accomplished via control. In this case, the automatic reclosure function does not create a close command but issues a close request. It is forwarded to the control which then takes over the switching. Thus, the properties defined for the switchgear component such as interlocking and command times apply. Hence, it is possible that the close command will not be carried out due to an applying interlocking condition.

If this behavior is not desired, the auto-reclose function can also generate the close command „79 Close“ directly which must be allocated to the associated contact. The CFC Chart as in Figure 2-83 is not needed in this case.

Connection to Internal Synchrocheck (only 7SJ64)

The auto-reclose function can interact with the internal synchronizing function of the 7SJ64 relay. If this is desired as well as the Manual Close functionality, the CFC chart depicted in Figure 2-83 is obligatory since the synchronizing function always works together with the control function. In addition, one of the four synchronization groups must be selected via parameter 7138 **Internal SYNC**. Thus, synchronization conditions for automatic reclosing are specified. The selected synchronization group defines in that case the switchgear component to be used (usually the circuit breaker „52Breaker“). The switchgear component defined there and the one specified at 7137 **Cmd.via control** must be identical. Synchronous reclosing via the close command „79 Close“ is not possible.

If interaction with the internal synchronization is not desired, the CFC Chart, as in Figure 2-83, is not required and the parameter 7138 is set to ***none***.

Auto-Reclosing with External Synchrocheck

Parameter 7139 **External SYNC** can be set to determine that the auto-reclose function operates with external synchrocheck. External synchronization is possible if the parameter is set to ***YES*** and 7SJ64 is linked to the external synchrocheck via the message 2865 „79 Sync.Request“ and the binary input „>Sync.release“.

Note: The automatic reclosure function cannot be connected to the internal and external synchrocheck at the same time !

Initiation and Blocking of Auto-reclosure by Protective Elements (configuration)

At addresses 7150 to 7164, reclosing can be initiated or blocked for various types of protective elements. They constitute the interconnection between protective elements and auto-reclose function. Each address designates a protective function together with its ANSI synonym e.g., **50-2** for the high-set element of the non-directional time overcurrent protection (address 7152).

The setting options have the following meaning:

- ***Starts 79*** The protective element initiates the automatic reclosure via its trip command;

  No influence the protective element does not start the automatic reclosure, it may however be initiated by other functions;

  Stops 79 the protective element blocks the automatic reclosure, it cannot be started by other functions; a dynamic blocking is initiated.

Dead Times (1st AR)

Addresses 7127 and 7128 are used to determine the duration of the dead times of the 1st cycle. The time defined by this parameter is started when the circuit breaker opens (if auxiliary contacts are allocated) or when the pickup drops out following the trip command of a starter. Dead time before first auto-reclosure for reclosing program "Phase" is set in address 7127 **DEADTIME 1: PH**, for reclosing program "ground" in address 7128 **DEADTIME 1: G**. The exact definition of the programs is described in the functional description at margin heading "Reclosing Programs". The length of the dead time should relate to the type of application. With longer lines they should be long enough to make sure that the fault arc disappears and that the air surrounding it is deionized and auto-reclosure can successfully take place (usually 0.9 s to 1.5 s). For lines supplied by more than one side, mostly system stability has priority. Since the de-energized line cannot transfer synchronizing energy, only short dead times are allowed. Standard values are 0.3 s to 0.6 s. In radial systems longer dead times are allowed.

Cyclic Control of Protective Functions via Automatic Reclosure

Addresses 7200 to 7211 allow cyclic control of the various protective functions by the automatic reclosing function. Thus protective elements can be blocked selectively, made to operate instantaneously or according to the configured delay times. The following options are available:

The following options are available:

- ***Set value T=T*** The protective element is delayed as configured i.e., the auto-reclose function does not effect this element;

  instant. T=0 The protective element becomes instantaneous if the auto-reclose function is ready to perform the mentioned cycle;

  blocked T=∞ The protective element is blocked if the auto-reclose function reaches the cycle defined in the parameter.

Dead Times (2nd to 4th AR)

If more than one reclosing cycle was set, you can now configure the individual reclosing settings for the 2nd to 4th cycle. The same options are available as for the first cycle.

For the 2nd cycle:

Address 7129	DEADTIME 2: PH	Dead time for the 2nd reclosing attempt "Phase"
Address 7130	DEADTIME 2: G	Dead time for the 2nd reclosing attempt ground
Addresses 7212 to 7223		allow cyclic control of the various protective functions by the 2nd reclosing attempt

For the 3rd cycle:

Address 7131	DEADTIME 3: PH	Dead time for the 3rd reclosing attempt "Phase"
Address 7132	DEADTIME 3: G	Dead time for the 3th reclosing attempt ground
Addresses 7224 to 7235		allow cyclic control of the various protective functions by the 3rd reclosing attempt

For the 4th cycle:

Address 7133	DEADTIME 4: PH	Dead time for the 4th reclosing attempt "Phase"
Address 7134	DEADTIME 4: G	Dead time for the 4th reclosing attempt ground
Addresses 7236 to 7247		allow cyclic control of the various protective functions by the 4th reclosing attempt

Fifth to Ninth Reclosing Attempt

If more than four cycles are configured, the dead times set for the fourth cycle also apply to the fifth through to ninth cycle.

Blocking Three-Phase Faults

Regardless of which reclosing program is executed, automatic reclosing can be blocked for trips following three-phase faults (address 7165 **3Pol.PICKUP BLK**). The pickup of all three phases for a specific overcurrent element is the criterion required.

Blocking of Auto-reclose via Internal Control

The auto-reclose function can be blocked, if control commands are issued via the integrated control function of the device. The information must be routed via CFC (interlocking task-level) using the CMD_Information function block (see the following figure).

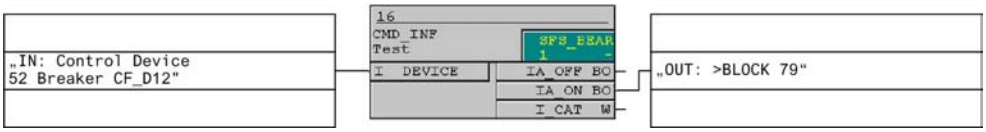


Figure 2-84 Blocking of the automatic reclose function using the internal control function

Zone Sequencing

Not available for models 7SJ62/63/64**-**A**-

At address 7140 **ZONE SEQ.COORD.**, the zone sequencing feature can be turned ***ON*** or ***OFF***.

If multiple reclosures are performed and the zone sequencing function is deactivated, only those reclosing cycles are counted which the device has conducted after a trip command. With the zone sequencing function switched on, an additional sequence counter also counts such auto-reclosures which (in radial systems) are carried out by relays connected on load side. This presupposes that the pickup of the 50-1/50N-1 elements drops out without a trip command being issued by a protective function initiating the auto-reclose function. The parameters at addresses 7200 through 7247 (see paragraph below at "Initiation and Blocking of Reclosing by Protective Functions" and "Controlling Directional/Non-Directional Overcurrent Protection Stages via Cold Load Pickup") can thus be set to determine which protective elements are active or blocked during what dead time cycles (for multiple reclosing attempts carried out by relays on the load side).

In the example shown in Figure 2-52 "Zone sequencing with a fault occurring at Tap Line #5 and the busbar" in the functional description, the zone sequencing was applied in the bus relay. Moreover, the 50-2 elements would have to be blocked after the second reclosure, i.e. address 7214 **bef.2.Cy:50-2** is to be set to ***blocked T=∞***. The zone sequencing of the feeder relays is switched off but the 50-2 elements must also be blocked here after the second reclosing attempt. Moreover, it must be ensured that the 50-2 elements start the automatic reclosing function: address 7152 **50-2** set to ***Starts 79***.

Controlling Directional / Non-Directional Overcurrent Protection Elements via Cold Load Pickup

The cold load pickup function provides a further alternative to control the protection via the automatic reclosing system (see also Section 2.4). This function provides the address 1702 **Start Condition** It determines the starting conditions for the increased setting values of current and time of the cold load pickup that must apply for directional and non-directional overcurrent protection.

If address 1702 **Start Condition** = ***79 ready***, the directional and non-directional overcurrent protection always employ the increased setting values if the automatic reclosing system is ready. The auto-reclosure function provides the signal ***79 ready*** for controlling the cold load pickup. The signal ***79 ready*** is always active if the auto-reclosing system is available, active, unblocked and ready for another cycle. Control via the cold load pickup function is non-cyclic.

Since control via cold load pickup and cyclic control via auto-reclosing system can run simultaneously, the directional and non-directional overcurrent protection must coordinate the input values of the two interfaces. In this context the cyclic auto-reclosing control has the priority and thus overwrites the release of the cold load pickup function.

If the protective elements are controlled via the automatic reclosing function, changing the control variables (e.g. by blocking) has no effect on elements that are already running. The elements in question are continued.

Note Regarding Settings List for Automatic Reclosure Function

The setting options of address 7137 **`Cmd.via control`** are generated dynamically according to the current configuration.

Address 7138 **`Internal SYNC`** is only available for 7SJ64.

2.14.7 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
7101	FCT 79	OFF ON	OFF	79 Auto-Reclose Function
7103	BLOCK MC Dur.	0.50 .. 320.00 sec; 0	1.00 sec	AR blocking duration after manual close
7105	TIME RESTRAINT	0.50 .. 320.00 sec	3.00 sec	79 Auto Reclosing reset time
7108	SAFETY 79 ready	0.01 .. 320.00 sec	0.50 sec	Safety Time until 79 is ready
7113	CHECK CB?	No check Chk each cycle	No check	Check circuit breaker before AR?
7114	T-Start MONITOR	0.01 .. 320.00 sec; ∞	0.50 sec	AR start-signal monitoring time
7115	CB TIME OUT	0.10 .. 320.00 sec	3.00 sec	Circuit Breaker (CB) Supervision Time
7116	Max. DEAD EXT.	0.50 .. 1800.00 sec; ∞	100.00 sec	Maximum dead time extension
7117	T-ACTION	0.01 .. 320.00 sec; ∞	∞ sec	Action time
7118	T DEAD DELAY	0.0 .. 1800.0 sec; ∞	1.0 sec	Maximum Time Delay of Dead-Time Start
7127	DEADTIME 1: PH	0.01 .. 320.00 sec	0.50 sec	Dead Time 1: Phase Fault
7128	DEADTIME 1: G	0.01 .. 320.00 sec	0.50 sec	Dead Time 1: Ground Fault
7129	DEADTIME 2: PH	0.01 .. 320.00 sec	0.50 sec	Dead Time 2: Phase Fault
7130	DEADTIME 2: G	0.01 .. 320.00 sec	0.50 sec	Dead Time 2: Ground Fault
7131	DEADTIME 3: PH	0.01 .. 320.00 sec	0.50 sec	Dead Time 3: Phase Fault
7132	DEADTIME 3: G	0.01 .. 320.00 sec	0.50 sec	Dead Time 3: Ground Fault
7133	DEADTIME 4: PH	0.01 .. 320.00 sec	0.50 sec	Dead Time 4: Phase Fault
7134	DEADTIME 4: G	0.01 .. 320.00 sec	0.50 sec	Dead Time 4: Ground Fault
7135	# OF RECL. GND	0 .. 9	1	Number of Reclosing Cycles Ground
7136	# OF RECL. PH	0 .. 9	1	Number of Reclosing Cycles Phase
7137	Cmd.via control	(Setting options depend on configuration)	None	Close command via control device
7138	Internal SYNC	(Setting options depend on configuration)	None	Internal 25 synchronisation
7139	External SYNC	YES NO	NO	External 25 synchronisation
7140	ZONE SEQ.COORD.	OFF ON	OFF	ZSC - Zone sequence coordination

Addr.	Parameter	Setting Options	Default Setting	Comments
7150	50-1	No influence Starts 79 Stops 79	No influence	50-1
7151	50N-1	No influence Starts 79 Stops 79	No influence	50N-1
7152	50-2	No influence Starts 79 Stops 79	No influence	50-2
7153	50N-2	No influence Starts 79 Stops 79	No influence	50N-2
7154	51	No influence Starts 79 Stops 79	No influence	51
7155	51N	No influence Starts 79 Stops 79	No influence	51N
7156	67-1	No influence Starts 79 Stops 79	No influence	67-1
7157	67N-1	No influence Starts 79 Stops 79	No influence	67N-1
7158	67-2	No influence Starts 79 Stops 79	No influence	67-2
7159	67N-2	No influence Starts 79 Stops 79	No influence	67N-2
7160	67 TOC	No influence Starts 79 Stops 79	No influence	67 TOC
7161	67N TOC	No influence Starts 79 Stops 79	No influence	67N TOC
7162	sens Ground Flt	No influence Starts 79 Stops 79	No influence	(Sensitive) Ground Fault
7163	46	No influence Starts 79 Stops 79	No influence	46
7164	BINARY INPUT	No influence Starts 79 Stops 79	No influence	Binary Input
7165	3Pol.PICKUP BLK	YES NO	NO	3 Pole Pickup blocks 79
7200	bef.1.Cy:50-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 50-1

Addr.	Parameter	Setting Options	Default Setting	Comments
7201	bef.1.Cy:50N-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 50N-1
7202	bef.1.Cy:50-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 50-2
7203	bef.1.Cy:50N-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 50N-2
7204	bef.1.Cy:51	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 51
7205	bef.1.Cy:51N	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 51N
7206	bef.1.Cy:67-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67-1
7207	bef.1.Cy:67N-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67N-1
7208	bef.1.Cy:67-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67-2
7209	bef.1.Cy:67N-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67N-2
7210	bef.1.Cy:67 TOC	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67 TOC
7211	bef.1.Cy:67NTOC	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67N TOC
7212	bef.2.Cy:50-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 50-1
7213	bef.2.Cy:50N-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 50N-1
7214	bef.2.Cy:50-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 50-2
7215	bef.2.Cy:50N-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 50N-2
7216	bef.2.Cy:51	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 51

Addr.	Parameter	Setting Options	Default Setting	Comments
7217	bef.2.Cy:51N	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 51N
7218	bef.2.Cy:67-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67-1
7219	bef.2.Cy:67N-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67N-1
7220	bef.2.Cy:67-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67-2
7221	bef.2.Cy:67N-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67N-2
7222	bef.2.Cy:67 TOC	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67 TOC
7223	bef.2.Cy:67NTOC	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67N TOC
7224	bef.3.Cy:50-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 50-1
7225	bef.3.Cy:50N-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 50N-1
7226	bef.3.Cy:50-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 50-2
7227	bef.3.Cy:50N-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 50N-2
7228	bef.3.Cy:51	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 51
7229	bef.3.Cy:51N	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 51N
7230	bef.3.Cy:67-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67-1
7231	bef.3.Cy:67N-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67N-1
7232	bef.3.Cy:67-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67-2

Addr.	Parameter	Setting Options	Default Setting	Comments
7233	bef.3.Cy:67N-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67N-2
7234	bef.3.Cy:67 TOC	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67 TOC
7235	bef.3.Cy:67NTOC	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67N TOC
7236	bef.4.Cy:50-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 50-1
7237	bef.4.Cy:50N-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 50N-1
7238	bef.4.Cy:50-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 50-2
7239	bef.4.Cy:50N-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 50N-2
7240	bef.4.Cy:51	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 51
7241	bef.4.Cy:51N	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 51N
7242	bef.4.Cy:67-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67-1
7243	bef.4.Cy:67N-1	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67N-1
7244	bef.4.Cy:67-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67-2
7245	bef.4.Cy:67N-2	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67N-2
7246	bef.4.Cy:67 TOC	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67 TOC
7247	bef.4.Cy:67NTOC	Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67N TOC

2.14.8 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
2715	>Start 79 Gnd	SP	>Start 79 Ground program
2716	>Start 79 Ph	SP	>Start 79 Phase program
2722	>ZSC ON	SP	>Switch zone sequence coordination ON
2723	>ZSC OFF	SP	>Switch zone sequence coordination OFF
2730	>CB Ready	SP	>Circuit breaker READY for reclosing
2731	>Sync.release	SP	>79: Sync. release from ext. sync.-check
2753	79 DT delay ex.	OUT	79: Max. Dead Time Start Delay expired
2754	>79 DT St.Delay	SP	>79: Dead Time Start Delay
2781	79 OFF	OUT	79 Auto recloser is switched OFF
2782	79 ON	IntSP	79 Auto recloser is switched ON
2784	79 is NOT ready	OUT	79 Auto recloser is NOT ready
2785	79 DynBlock	OUT	79 - Auto-reclose is dynamically BLOCKED
2788	79 T-CBreadyExp	OUT	79: CB ready monitoring window expired
2801	79 in progress	OUT	79 - in progress
2808	79 BLK: CB open	OUT	79: CB open with no trip
2809	79 T-Start Exp	OUT	79: Start-signal monitoring time expired
2810	79 TdeadMax Exp	OUT	79: Maximum dead time expired
2823	79 no starter	OUT	79: no starter configured
2824	79 no cycle	OUT	79: no cycle configured
2827	79 BLK by trip	OUT	79: blocking due to trip
2828	79 BLK:3ph p.u.	OUT	79: blocking due to 3-phase pickup
2829	79 Tact expired	OUT	79: action time expired before trip
2830	79 Max. No. Cyc	OUT	79: max. no. of cycles exceeded
2844	79 1stCyc. run.	OUT	79 1st cycle running
2845	79 2ndCyc. run.	OUT	79 2nd cycle running
2846	79 3rdCyc. run.	OUT	79 3rd cycle running
2847	79 4thCyc. run.	OUT	79 4th or higher cycle running
2851	79 Close	OUT	79 - Close command
2862	79 Successful	OUT	79 - cycle successful
2863	79 Lockout	OUT	79 - Lockout
2865	79 Sync.Request	OUT	79: Synchro-check request
2878	79 L-N Sequence	OUT	79-A/R single phase reclosing sequence
2879	79 L-L Sequence	OUT	79-A/R multi-phase reclosing sequence
2883	ZSC active	OUT	Zone Sequencing is active
2884	ZSC ON	OUT	Zone sequence coordination switched ON
2885	ZSC OFF	OUT	Zone sequence coordination switched OFF
2889	79 1.CycZoneRel	OUT	79 1st cycle zone extension release
2890	79 2.CycZoneRel	OUT	79 2nd cycle zone extension release
2891	79 3.CycZoneRel	OUT	79 3rd cycle zone extension release

No.	Information	Type of Information	Comments
2892	79 4.CycZoneRel	OUT	79 4th cycle zone extension release
2899	79 CloseRequest	OUT	79: Close request to Control Function

2.15 Fault Locator

The measurement of the distance to a fault is a supplement to the protection functions.

Applications

- Power transmission within the system can be increased when the fault is located and cleared faster.

2.15.1 Description

Initiation

Fault location is initiated if the directional or non-directional overcurrent relay elements have initiated a trip signal. Once initiated, the fault locator determines the valid measurement loop and measurement window. Sampled value pairs of short-circuit current and short-circuit voltage, are stored in a buffer, and made available for the impedance calculations R (Resistance) and X (Reactance). Measured quantity filtering and the number of impedance calculations are adjusted automatically to the number of stable measured value pairs.

Fault location can also be initiated using a binary input. However, it is a prerequisite that pickup of the time overcurrent protection is performed at the same time (directional or non-directional). This feature allows fault location calculations to proceed even if another protective relay cleared the fault.

Measurement Process

The evaluation of the measured quantities takes place after the fault has been cleared. At least three result pairs of R and X are calculated from the stored and filtered measured quantities in accordance with the line equations. If fewer than three pairs of R and X are calculated, then the fault location feature will generate no information. Average and standard deviations are calculated from the result pairs. After eliminating "questionable results", which are recognized via a large variance from the standard deviation, average values are calculated once again for X. This average is the fault reactance, and is proportional to the fault distance.

Note

No calculation of the fault locations is carried out if the voltages are connected phase-phase!

Loop Selection

Using the pickup of the overcurrent time elements (directional or non-directional), the valid measurement loops for the calculation of fault reactances are selected. The fault reactances can, of course, only be calculated for phase-to-ground loops if the device is connected to three current transformers connected in a grounded-wye configuration and three voltage transformers connected in a grounded-wye configuration.

Table 2-16 shows the assignment of the evaluated loops to the possible pickup scenarios of the protective elements given that the device is supplied from three voltage transformers connected in a grounded-wye configuration. If the voltage transformers are connected in an open delta configuration, then Table 2-17 applies. Of course, no phase-to-ground loops can be measured in this case.

In addition, loops are not available for further calculation if one of the two currents in a loop is less than 10% of the other current in that loop, or if any currents in the loop are less than 10% of the nominal device current.

Table 2-16 Selection of the loops to be reported for wye-connected voltage transformers

Pickup	Possible Loops	Evaluated Loops	Comments
A	A–N, A–B, C–A	A–N or A–N and least Ph–Ph	If only one phase is picked up, then only the appropriate phase-to-ground loop is displayed. If the reactance(s) of one or both Ph–Ph loops is/are less than the Ph–N reactance, the Ph–Ph loop with the least reactance is also displayed.
B	B–N, A–B, B–C	B–N or B–N and least Ph–Ph	
C	C–N, C–A, B–C	C–N or C–N and least Ph–Ph	
N	A–N, B–N, C–N	least Ph–N	Only the Ph–N loop with the least reactance is displayed.
A, N	A–N	A–N	The appropriate phase-to-ground loop is displayed.
B, N	B–N	B–N	
C, N	C–N	C–N	
A, B	A–B	A–B	The appropriate Ph–Ph loop is displayed.
B, C	B–C	B–C	
A, C	C–A	C–A	
A, B, N	A–B, A–N, B–N	A–B or A–B and A–N and B–N	The appropriate Ph–Ph loop is always displayed; if the reactance differential between the Ph–N loops is larger than 15% of the larger Ph–N loop, both Ph–N loops are also displayed.
B, C, N	B–C, B–N, C–N	B–C or B–C and B–N and C–N	
A, C, N	C–A, A–N, C–N	C–A or C–A and A–N and C–N	
A, B, C	A–B, B–C, C–A	least Ph–Ph loop	Only the least Ph–Ph loop is displayed
A, B, C, N	A–B, B–C, C–A	least Ph–Ph loop	

Table 2-17 Selection of the loops to be reported for phase-phase connection of voltages

Pickup	Possible Loops	Evaluated Loops	Comments
A	A–B, C–A	least Ph–Ph	The least Ph–Ph loop is displayed.
B	A–B, B–C	least Ph–Ph	
C	C–A, B–C	least Ph–Ph	
A, B	A–B	A–B	The appropriate Ph–Ph loop is displayed.
B, C	B–C	B–C	
A, C	C–A	C–A	
A, B, C	A–B, B–C, C–A	least Ph–Ph loop	The least Ph–Ph loop is displayed.

Result

As result of the fault location, the following is output at the device display or obtained using DIGSI® 4:

- One or more short-circuit loops from which the fault reactance was derived,
- One or more reactances per phase in Ω secondary,
- The fault distances, proportional to the reactances, in km or miles of line, converted on the basis of the set line reactance (entered at address 1105 or 1106, see Section 2.1.6.2).

Note: The distance result, in miles or kilometers, can only be accurate for homogenous feeder sections. If the feeder is made up of several sections with different reactances, e.g. overhead line - cable sections, then the reactance derived by the fault location can be evaluated with a separate calculation to obtain the fault distance. For transformers, reactors, electrical machines, only the reactance result, not the distance result, is significant.

2.15.2 Setting Notes

General

The calculation of fault distance will only take place if address 180 is set to **Fault Locator** = ***Enabled***. If the fuction is not required ***Disabled*** is set.

Initiation of Measurement

Normally the fault location calculation is started when a protective element initiates a trip signal (address 8001 **START** = ***TRIP***). However, it may also be initiated when pickup drops out (address 8001 **START** = ***Pickup***), e.g. when another protective element clears the fault. Irrespective of this fact, calculation of the fault location can be triggered from external via binary input (FNo. 1106 „>Start Flt. Loc“).

Line Constants

To calculate the fault distance in miles or kilometers, the device needs the per distance reactance of the line in Ω/mile or Ω/kilometer. These values were entered during setting of the general protection data (Power System Data 2) under address 1105 or 1106 (see Section 2.1.6.2).

2.15.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
8001	START	Pickup TRIP	Pickup	Start fault locator with

2.15.4 Information List

No.	Information	Type of Information	Comments
1106	>Start Flt. Loc	SP	>Start Fault Locator
1118	Xsec =	VI	Flt Locator: secondary REACTANCE
1119	dist =	VI	Flt Locator: Distance to fault
1123	FL Loop AG	OUT	Fault Locator Loop AG
1124	FL Loop BG	OUT	Fault Locator Loop BG
1125	FL Loop CG	OUT	Fault Locator Loop CG
1126	FL Loop AB	OUT	Fault Locator Loop AB
1127	FL Loop BC	OUT	Fault Locator Loop BC
1128	FL Loop CA	OUT	Fault Locator Loop CA
1132	Flt.Loc.invalid	OUT	Fault location invalid

2.16 Breaker Failure Protection 50BF

The breaker failure protection function monitors the reaction of a circuit breaker to a trip signal.

2.16.1 Description

General

If after a programmable time delay, the circuit breaker has not opened, breaker failure protection issues a trip signal via a superordinate circuit breaker (see Figure 2-85, as an example).

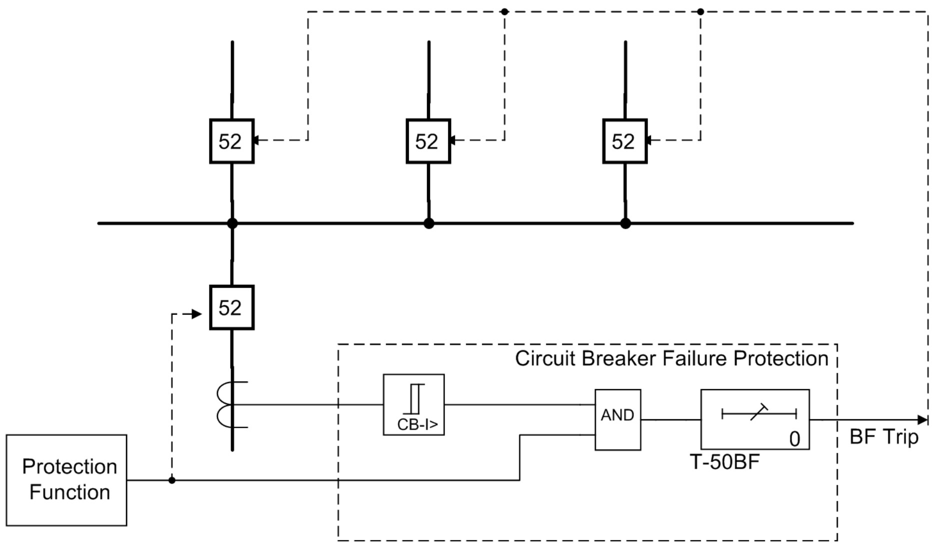


Figure 2-85 Functional principle of the breaker failure protection function

Initiation

The breaker failure protection function can be initiated by two different sources:

- Trip signals of internal protective functions of the 7SJ62/63/64,
- External trip signals via binary inputs („>50BF ext SRC“).

For each of the two sources, a unique pickup message is generated, a unique time delay is initiated, and a unique trip signal is generated. The setting values of current threshold and delay time apply to both sources.

Criteria

There are two criteria for breaker failure detection:

- Checking whether the actual current flow effectively disappeared after a tripping command had been issued,
- Evaluate the circuit breaker auxiliary contact status.

The criteria used to determine if the circuit breaker has operated is selectable and should depend on the protective function that initiated the breaker failure function. When tripping without fault current, e.g. by voltage protection, the current is not a reliable indication as to whether the circuit breaker operated properly. In this case, the position of the breaker auxiliary contact should be used to determine if the circuit breaker properly operated. However, for protective functions that operate in response to currents (i.e. all fault protection functions) both the current criterion and the criterion derived from the circuit breaker auxiliary contact must be fulfilled. Only in case the information retrieved by means of the auxiliary contact criterion is contradictory and therefore erroneous, the current criterion will be used as unique criterion.

The current criterion is met if at least one of the three phase currents exceeds a settable threshold (**BkrClosed I MIN**) (see Section 2.1.3.2, margin heading "Current Flow Monitoring"). This pickup threshold is also used by other protective functions.

Evaluation of the circuit breaker auxiliary contacts depends on the type of contacts, and how they are connected to the binary inputs:

- Auxiliary contacts for circuit breaker "open" and "closed" are allocated,
- Only the auxiliary contact for circuit breaker "open" is allocated,
- Only the auxiliary contact for circuit breaker "closed" is allocated,
- No auxiliary contact is allocated.

Feedback information of the auxiliary contact(s) of the circuit breaker is evaluated, depending on the allocation of binary inputs and auxiliary contacts. After a trip command has been issued it is the aim to detect — if possible — by means of the feedback of the circuit breaker's auxiliary contacts whether the breaker is open or in intermediate position. If valid, this information can be used for a proper initiation of the breaker failure protection function.

Logic

If breaker failure protection is initiated, an alarm message is generated and a settable delay time is started. If once the time delay has elapsed, criteria for a pick-up are still met, a trip signal is issued to a superordinate circuit breaker. Therefore, the trip signal issued by the circuit breaker failure protection is configured to one of the output relays.

The following figure shows the logic diagram for the breaker failure protection function. The entire breaker failure protection function may be turned on or off, or it can be blocked dynamically via binary inputs.

If one of the criteria (current value, auxiliary contacts) that caused the breaker failure scheme to pickup is no longer met when time delay elapses, pickup drops out and no trip signal is issued by the breaker failure protection function.

To protect against spurious tripping due to excessive contact bounce, a stabilization of the binary inputs for external trip signals takes place. This external signal must be present during the entire period of the delay time, otherwise the timer is reset and no tripping signal is issued.

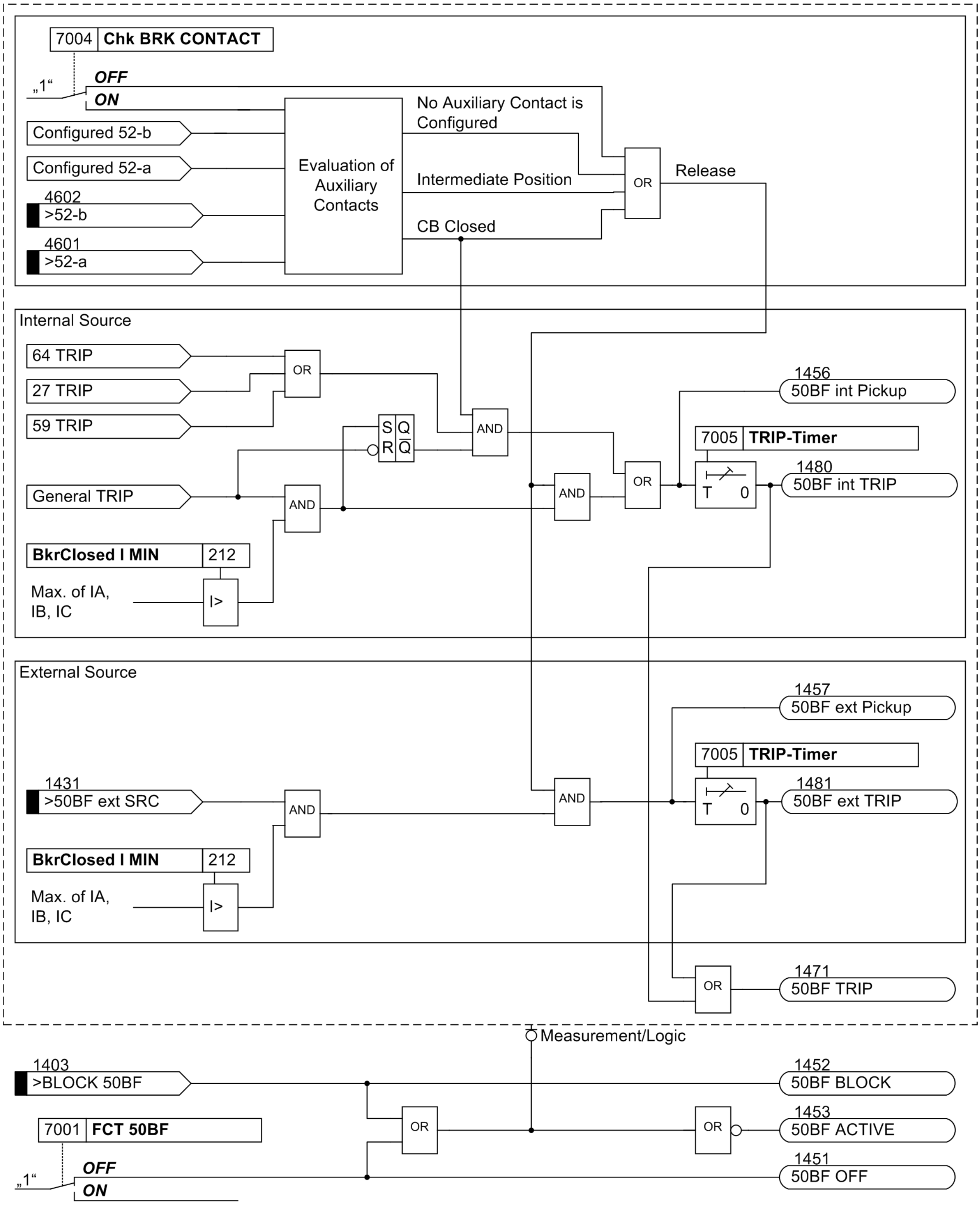


Figure 2-86 Logic diagram for breaker failure protection

2.16.2 Setting Notes

General

Breaker failure protection is only in effect and accessible if address 170 **50BF** is set to ***Enabled*** during configuration of protective functions. If not required, this function is set to ***Disabled***. The function can be turned ***ON*** or ***OFF*** under address 7001 **FCT 50BF**.

Criteria

Address 7004 **Chk BRK CONTACT** establishes whether or not a breaker auxiliary contact is used, via a binary input, as criteria for pickup. If this address is set to ***ON***, then current criterion and/or the auxiliary contact criterion apply. This is important if the current is smaller than the configured current threshold (**BkrClosed I MIN**, address 212) despite of the fact that the circuit breaker is closed. The latter may apply if protective tripping was caused by a voltage measurement (e.g. 64 TRIP, 59–1 TRIP / 59–2 TRIP, 27–1 TRIP / 27–2 TRIP). If these protective functions issue a trip command, the criteria for current and auxiliary contacts are linked by a logical OR operation. Without the auxiliary contact criterion the circuit breaker failure protection would not be able to take effect in this case.

For all other protection functions the current and auxiliary contact criteria are combined by logical AND as long as the address **Chk BRK CONTACT** is set to ***ON***.

The pickup threshold **BkrClosed I MIN** setting of integrated current supervision (address 212) refers to all three phases. The threshold value must be set at a level below the minimum fault current for which the function must operate. A setting of 10% below the minimum fault current for which breaker failure protection must operate is recommended.

The pickup value should not be set too low, otherwise, the danger exists that switching off transients in the current transformer secondary circuit could lead to extended drop out times under conditions of extremely high current to be switched off.

In addition, it should be noted that other protection functions depend on the pickup value **BkrClosed I MIN** as well (e.g. voltage protection, overload protection, and restart inhibit for motors).

Time Delay

The time delay is entered at address 7005 **TRIP-Timer**. This setting 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 2-87 illustrates the time sequences.

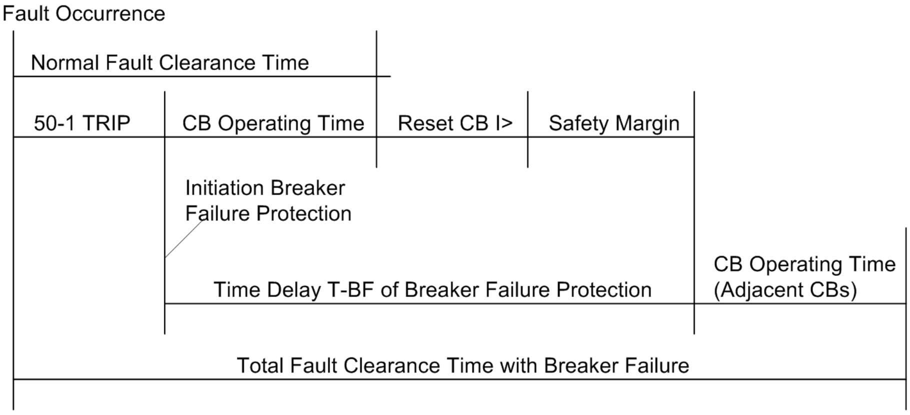


Figure 2-87 Timing for a Typical Breaker Failure Scenario

2.16.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
7001	FCT 50BF	OFF ON	OFF	50BF Breaker Failure Protection
7004	Chk BRK CONTACT	OFF ON	OFF	Check Breaker contacts
7005	TRIP-Timer	0.06 .. 60.00 sec; ∞	0.25 sec	TRIP-Timer

2.16.4 Information List

No.	Information	Type of In-formation	Comments
1403	>BLOCK 50BF	SP	>BLOCK 50BF
1431	>50BF ext SRC	SP	>50BF initiated externally
1451	50BF OFF	OUT	50BF is switched OFF
1452	50BF BLOCK	OUT	50BF is BLOCKED
1453	50BF ACTIVE	OUT	50BF is ACTIVE
1456	50BF int Pickup	OUT	50BF (internal) PICKUP
1457	50BF ext Pickup	OUT	50BF (external) PICKUP
1471	50BF TRIP	OUT	50BF TRIP
1480	50BF int TRIP	OUT	50BF (internal) TRIP
1481	50BF ext TRIP	OUT	50BF (external) TRIP

2.17 Flexible Protection Functions (7SJ64 only)

The flexible protection function is a general function applicable for a variety of protection principles depending on its parameter settings. The user can create up to 20 flexible protection functions. 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.

2.17.1 Functional Description

General

The function is a combination of a standard protection logic and a characteristic (measured quantity or derived quantity) that is adjustable via parameters. The characteristics listed in table 2-18 and the derived protection functions are available.

Table 2-18 Possible Protection Functions

Characteristic Group	Characteristic / Measured Quantity		Protective Function	ANSI No.	Operating Mode	
					3-phase	1-phase
Current	I	RMS value of fundamental component	- Time overcurrent protection	50, 50G	X	X
	I_{rms}	True RMS (r.m.s. value)	- Time overcurrent protection - Overload protection	50, 50G	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	
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	Active 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	- External trip commands		without phase reference	

Section 2.18 gives an application example of the function „reverse power protection“.

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 2-88 illustrates the description.

Function 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 via local operating terminal („Control“ -> „Tagging“ -> „Set“). Blocking will reset the function's entire measurement logic as well as all running times and indications. Blocking via the local operating terminal may be useful if the function is in a status of permanent pickup which does not allow the function to be reset. In context with voltage-based characteristics, the function can be blocked if one of the measuring voltages fails. Recognition of this status is either accomplished by the relay's internal „Fuse-Failure-Monitor“ (FNo. 170 „VT FuseFail“; see chapter 2.11.1) or via auxiliary contacts of the voltage transformer CB (FNo. 6509 „>FAIL:FEEDER VT“ and FNo. 6510 „>FAIL: BUS VT“). This blocking mechanism can be enabled or disabled in the according parameters. The associated parameter **BLK.by Vol.Loss** is only available if the characteristic is based on a voltage measurement.

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

Operating Mode, Measured Quantity, Measurement Method

The flexible function can be tailored to assume a specific protective function for a concrete application in parameters **OPERRAT. MODE**, **MEAS. QUANTITY**, **MEAS. METHOD** and **PICKUP WITH**. Parameter **OPERRAT. MODE** can be set to specify whether the function works ***3-phase***, ***1-phase*** 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 ***Vn***. 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 delay time is not affected by the measured quantity.

Function Logic

Figure 2-88 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.

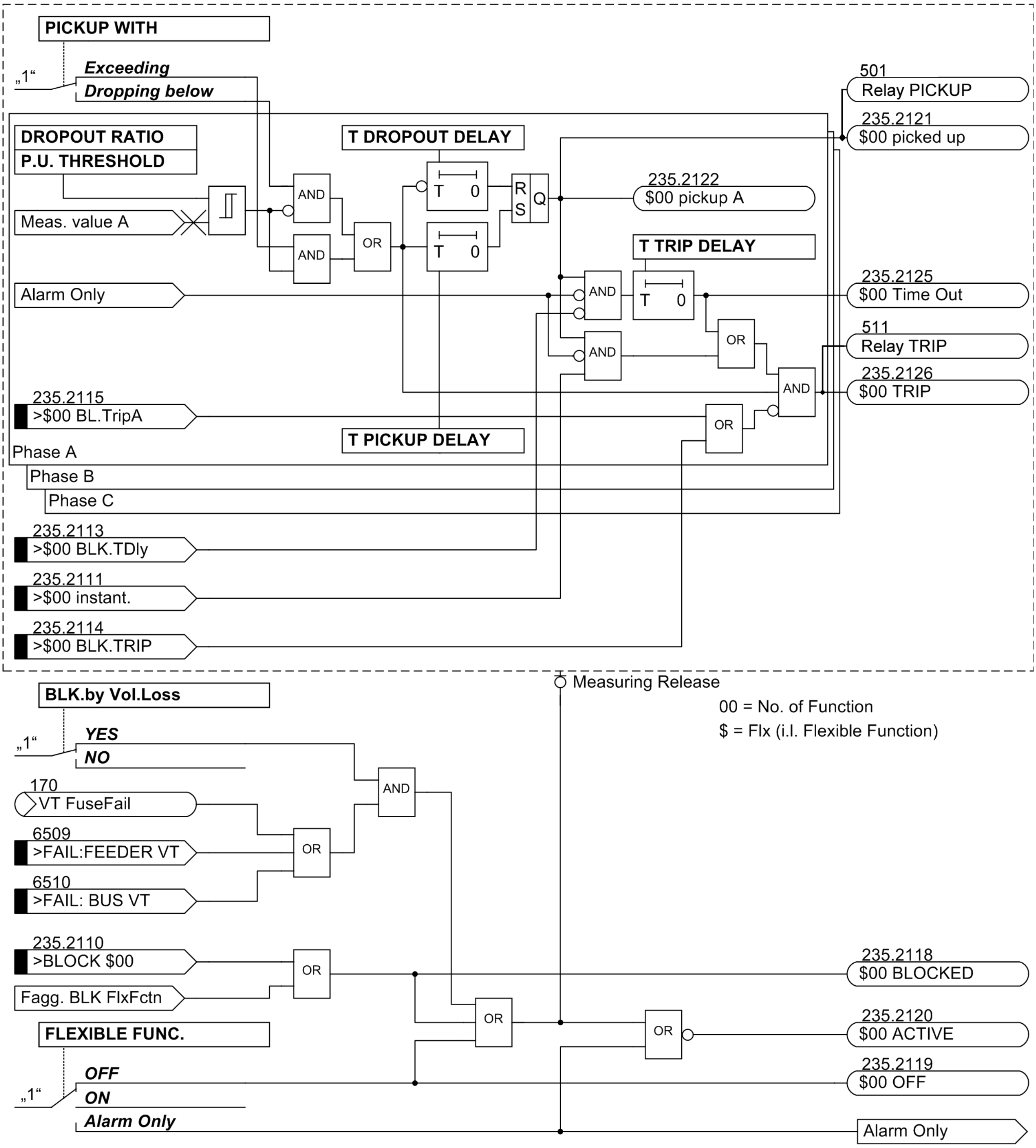


Figure 2-88 Logic diagram of the flexible protection functions

The parameters can be set to monitor either exceeding or dropping below of the threshold. The configurable pickup delay time will be started once the threshold (>-element) has been exceeded. When the delay time 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 delay time and the fault log. This is not the case if set to "Alarm only". If the threshold violation persists after the trip delay time 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 delay time can be blocked via binary input (no. 235.2113 „>$00 BLK.TDly“). The delay time will not be started as long as the binary input is active; a trip can thus be initiated. The delay time 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 delay time 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 delay time will be started. The pickup is maintained during that time, a started trip delay time continues to count down. If the trip delay time has elapsed while the dropout delay time 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 delay time 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 delay time is started. If the pickup delay time is set to zero, the pickup condition will be reported immediately starting the trip delay time. Otherwise, the logic is the same as depicted in Figure 2-88.

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 212 **BkrClosed I MIN** (Power System Data 1) has been exceeded.

- Automatic reclosing (AR):

  The AR cannot be started directly. In order to interact with the AR, the trip command of the flexible function needs be linked in CFC to binary input no. 2716 „>Start 79 Ph“ or no. 2715.„>Start 79 Gnd“. Using an operating time requires the pickup of the flexible function to be linked to binary input no. 2711 „>79 Start“.

- Fuse-Failure-Monitor (see description at „Blocking Functions“).

- Inrush restraint:

  Direct interaction with the inrush restraint is not possible. In order to block a flexible function by the inrush restraint, the blocking must be carried out in CFC. The flexible function provides three binary inputs for blocking trip commands selectively for each phase (no. 235.2115 to 235.2117). They have to be linked with the phase-selective indications for detecting the inrush (no. 1840 to 1842). Activating a crossblock function requires the phase-selective inrush indications to be logically combined with the binary input for blocking the function trip command (no. 235.2114 „>$00 BLK.TRIP“). The flexible function also needs to be delayed by at least 20 ms to make sure that the inrush restraint picks up before the flexible function.

- Entire relay logic:

  The pickup signal of the flexible function is added to the general device pickup, the trip signal is added to the general device trip (see also Chapter 2.22). All functions associated with general device pickup and tripping are thus also applied to the flexible function.

  After the picked up element has dropped out, the trip signals of the flexible protection functions are held up at least for the specified minimum trip command time 210 T TRIPCOM MIN.

2.17.2 Setting Notes

The Device Configuration allows the user to specify the number of flexible protection functions to be used (see also chapter 2.1.1). If a flexible function is disabled in the Device Configuration (removing the checkmark), all settings and configurations associated with this function are deleted or reset to their default values.

General

The „General“ dialog box in DIGSI offers parameter **FLEXIBLE FUNC.** which can be set to ***OFF***, ***ON*** or ***Alarm Only***. In ***Alarm Only*** mode, the function does not open fault logs, initiate „Active“ indications or trip commands and nor does it influence the breaker failure protection. This operating mode is therefore preferable if a flexible function is not desired to work as protective function. Besides that the **OPERRAT. MODE** can be configured:

3-phase – The functions evaluate the three-phase measuring system, i.e. all three phases are covered in parallel. A typical example is the three-phase time overcurrent protection.

1-phase – The functions evaluate only the individual measured value. This may be an individual phase value (e.g. V_B) or a ground quantity (V_N or I_N).

If set to ***no reference***, the measured values are evaluated irrespective of whether current and voltage are connected in one or three phases. Table 2.17 provides an overview of which characteristics can be operated in which mode.

Measured Quantity

In the „Measured quantity“ dialog box, the user can select the measured value the protective function evaluates. This value may be calculated or measured directly. The offered setting options depend on the type of measured value processing in parameter **OPERRAT. MODE** (see following table).

Table 2-19 Parameters “Operating Mode” and “Measured Quantity”

Parameter **OPERRAT. MODE** Setting	Parameter **MEAS. QUANTITY** Setting option
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 Binray Input

Measurement Method

The measurement methods listed in the following tables can be set for the measured quantities of current, voltage and power. They also indicate how the available measurement method, depend on the selected operating mode and the measured quantity.

Table 2-20 Parameters in dialog box “Measurement Method”, 3-phase operation

Operating Mode	Measured Quantity		Notes
3-phase	Current, Voltage	Parameter **MEAS. METHOD** Setting Options	
		Fundamental wave	Only the fundamental wave is evaluated, harmonics are suppressed. This is the standard measurement method of the protection functions. **Attention**: The voltage threshold value does not depend on the parameter **VOLTAGE SYSTEM** and is always configured as phase-to-phase voltage.
		True RMS	The "true" r.m.s value is determined, i.e. harmonics are evaluated. This procedure is used for, example, if a simple overload protection is realized on the basis of a current measurement since harmonics contribute to thermal heating. **Attention**: The voltage threshold value does not depend on the parameter **VOLTAGE SYSTEM** and is always configured as phase-to-phase voltage.
		Positive sequence system, Negative sequence system, Zero-sequence system	In order to implement certain applications, it is possible to enable either the positive or the negative sequence system as measurement method. Examples are: - I2 (negative sequence protection) - V2 (voltage asymmetry) If the zero sequence system is selected, additional zero-current or zero-voltage functions can be implemented that work independently of the ground quantities IN and VN measured directly via transformers. **Attention**:The parameterization of the voltage threshold depends on the parameter **VOLTAGE SYSTEM**: - **VOLTAGE SYSTEM** = Phase-to-phase:sym. component * $\sqrt{3}$ - **VOLTAGE SYSTEM** = Phase-to-ground:sym. component * 3
	Voltage	Parameter **VOLTAGE SYSTEM** Setting option	
		Phase-to-phase Phase-to-ground	If phase-to-ground voltages are connected to the device (see setting 213 VT Connect. 3ph), the user can select whether a 3-phase voltage function should evaluate the phase-to-ground or the phase-to-phase voltages. If phase-to-phase is selected, these values are calculated from the phase-to-ground voltages. This selection is significant, e.g. for single-phase faults. If the faulted voltage breaks down to zero, the affected phase-to-ground voltage is zero, whereas the affected phase-to-phase voltages collapse to the amount of a phase-to-ground voltage. The parameter is hidden if phase-to-phase voltages are connected.

Note

The three-phase voltage protection with phase-to-phase quantities (measured or calculated) offers a special behavior for phase-selective pickup messages since the phase-selective pickup message “Flx01 Pickup ABC” is assigned to the corresponding measured value channel “abc”.

Single-phase faults:

If, for example,the voltage V_A collapses to such an extent that the voltages V_{AB} and V_{CA} fall below their thresholds, the device will report the messages “Flx01 Pickup A” and “Flx01 Pickup C” since the undershooting was detected on the first and third measured value channel.

Two-phase faults:

If, for example, voltage V_{AB} collapses to such an extent that it falls below its threshold, the device will report the pickup signal “Flx01 Pickup A” since the undershooting was detected on the first measured value channel.

Note

In three-phase voltage protection, the configured voltage threshold is always interpreted as phase-to-phase quantity. This applies also if a phase-to-ground system is connected in 213 **VT Connect. 3ph** (Power System Data 1) and the parameter **VOLTAGE SYSTEM** of the flexible function also evaluates the phase-to-ground system.

Table 2-21 Parameter in dialog box “Measurement Method”, 1-phase operation

Operating Mode	Measured Quantity		Notes
1-phase	Current, Voltage	Parameter **MEAS. METHOD** Setting option	
		Fundamental wave	Only the fundamental wave is evaluated, harmonics are suppressed. This is the standard measurement method of the protection functions.
		True RMS	The „true“ r.m.s value is determined, i.e. harmonics are evaluated. This procedure is used for, example, if a simple overload protection is realized on the basis of a current measurement since harmonics contribute to thermal heating.
	Current	Parameter **CURRENT** Setting option	
		Ia Ib Ic IN INs	It is determined which current measuring channel will be evaluated by the function. According to device variant, either IN (normally sensitive ground current input) or INs (sensitive ground current input) are available.
	Voltage	Parameter **VOLTAGE** Setting option	
		Vab Vbc Vca Vag Vbg Vcg VN	It is determined which voltage measuring channel will be evaluated by the function. When selecting a phase-to-phase voltage, the threshold must be set as phase-to-phase value; when selecting a phase-to-ground value as phase-to-ground voltage. The scope of the function texts depends on the voltage transformer connection (see address 213 VT Connect. 3ph).
	P forward, P reverse, Q forward, Q reverse	Parameter **POWER** Setting option	
		Ia Vag Ib Vbg Ic Vcg	It is determined which power measuring channel (current and voltage) will be evaluated by the function. The parameter is hidden if phase-to-phase voltages are connected (see address 213 VT Connect. 3ph).

Note

In single-phase voltage protection, the configured voltage threshold is always interpreted as voltage at the terminal. The setting in 213 **`VT Connect. 3ph`** (Power System Data 1) is ignored in this case.

Forward direction of power quantities (P forward, Q forward) is in direction of the line. The flexible function ignores parameter (1108 **`P,Q sign`**) for sign inversion of the power display in the operational measured values.

Parameter **`PICKUP WITH`** specifies whether the function picks up on undershooting or overshooting of the configured threshold.

Settings

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

The function's pickup threshold is set in parameter **P.U. THRESHOLD**. The TRIP delay time is set in parameter **T TRIP DELAY**. Both setting values must be selected to suit the required application.

The pickup may be delayed via parameter **T PICKUP DELAY**. This parameter is usually set to zero for protective applications (default) since a protective function is desired to pick up as soon as possible. A setting other than zero may be useful if it is not desired that a fault log is opened each time the pickup threshold is briefly violated. This is the case, for example, with line protection, or if the function is used not for protection but for monitoring purposes.

When setting small power thresholds, it must be observed that a power calculation requires at least a current of 0.03 I_{Nom}. The power calculation is blocked for smaller currents.

Dropout of the pickup condition can be delayed in parameter **T DROPOUT DELAY**. This setting, too, is set to zero by default. A setting other than zero may be useful if the device interacts with electro-mechanical devices whose dropout times are significantly longer than those of the numerical protection device (see also section 2.2). When using the dropout delay time, it is recommended to set it shorter than the TRIP delay time to avoid "race conditions" of the two times.

In parameter **BLK.by Vol.Loss**, the user can specify whether a function, whose measured quantity is based on a voltage measurement (voltage measured quantities, P forward, P reverse, Q forward, Q reverse and power factor), is blocked in the event of a measuring voltage failure (setting Yes) or not (setting No).

The function's dropout ratio can be set in parameter **DROPOUT RATIO**. The standard dropout ratio of protective functions is 0.95 (default). When using the function as power protection, the dropout ratio should be set to at least 0.9. The same applies when using the symmetrical components of current and voltage. If the dropout ratio is reduced, it is recommended to test pickup of the function for any signs of "chattering".

Moreover, it is important that no dropout ratio is configured for the measured values of frequency (f) and frequency change (df/dt) since it employs a fixed dropout difference.

Renaming Messages, Checking Allocations

After setting a flexible function, the following additional steps are necessary:

- Open the Configuration Matrix in DIGSI.
- Rename the neutral message texts to suit the application.
- Check configurations for contacts and in operating and fault buffers or set according to the requirements.

Additional Information

The following additional note must be observed:

- Since the power factor is not capable of distinguishing between capacitive and inductive, the sign of the reactive power may be used as an additional criterion by means of CFC.

2.17.3 Settings

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

Addr.	Parameter	Setting Options	Default Setting	Comments
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 Binray Input	Please select	Selection of Measured Quantity
0	MEAS. METHOD	Fundamental True RMS Positive seq. Negative seq. Zero sequence	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 Vn	Please select	Voltage
0	POWER	Ia Va-n Ib Vb-n Ic Vc-n	Ia Va-n	Power
0	VOLTAGE SYSTEM	Phase-Phase Phase-Earth	Phase-Phase	Voltage System
0	P.U. THRESHOLD	0.05 .. 35.00 A	2.00 A	Pickup Threshold
0	P.U. THRESHOLD	0.05 .. 35.00 A	2.00 A	Pickup Threshold
0	P.U. THRESHOLD	0.001 .. 1.500 A	0.100 A	Pickup Threshold

Addr.	Parameter	Setting Options	Default Setting	Comments
0	P.U. THRESHOLD	2.0 .. 260.0 V	110.0 V	Pickup Threshold
0	P.U. THRESHOLD	2.0 .. 200.0 V	110.0 V	Pickup Threshold
0	P.U. THRESHOLD	45.50 .. 54.50 Hz	51.00 Hz	Pickup Threshold
0	P.U. THRESHOLD	55.50 .. 64.50 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	0.5 .. 10000.0 W	200.0 W	Pickup Threshold
0	P.U. THRESHOLD	-0.99 .. 0.99	0.50	Pickup Threshold
0	T TRIP DELAY	0.00 .. 3600.00 sec	1.00 sec	Trip Time Delay
0A	T PICKUP DELAY	0.00 .. 60.00 sec	0.00 sec	Pickup Time Delay
0A	T DROPOUT DELAY	0.00 .. 60.00 sec	0.00 sec	Dropout Time Delay
0A	BLK.by Vol.Loss	NO YES	YES	Block in case of Meas.-Voltage Loss
0A	DROPOUT RATIO	0.70 .. 0.99	0.95	Dropout Ratio
0A	DROPOUT RATIO	1.01 .. 3.00	1.05	Dropout Ratio

2.17.4 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
236.2127	BLK. Flex. Fct.	IntSP	BLOCK Flexible Function

2.18 Reverse-Power Protection Application with Flexible Protection Function

2.18.1 Description

General

The flexible protection functions allow a single-element or multi-element directional protection to be implemented. Each directional element can be operated on one or on three phases. The elements can optionally use the active power forward, active power reverse, reactive power forward or reactive power reverse as measuring quantity. The elements can pick up on undershooting or on overshooting of the threshold. Table 2-22 shows possible applications for directional protection.

Table 2-22 Overview of directional protection applications

		Type of Evaluation	
	Direction	**Overshooting**	**Undershooting**
P	forward	– Monitoring of the forward power thresholds of equipment (transformers, lines)	– detection of motors running at no-load
	reverse	– protection of a local industrial network against feeding energy back into the utility grid – detection of reverse energy supply from motors	
Q	forward	– monitoring of reactive power thresholds of equipment (transformers, lines) – connecting a capacitor bank for reactive power compensation	
	reverse	– monitoring of reactive power thresholds of equipment (transformers, lines) – de-energizing a capacitor bank	

The following example depicts a typical application where the flexible function acts as reverse-power protection.

Disconnecting Facility

The example in figure 2-89 shows an industrial substation with autonomous power supply from the illustrated generator. All lines and the busbar have a three-phase layout (with exception of the ground connections and the connection to the voltage measurement at the generator). Feeder 1 and 2 supply the consumers on customer side. Industrial customers usually obtain their power from the utility. The generator runs only in synchronous operation without supplying power. If the utility can no longer maintain the required supply quality, the substation is disconnected from the utility grid and the generator assumes the autonomous supply. In the example, the substation is disconnected from the utility grid when the frequency leaves the nominal range (e.g. 1 to 2% deviation from the nominal frequency), the voltage exceeds or falls under a certain preset value or the generator feeds back active power into the utility grid. Depending on the user's requirements, some of these criteria are linked further. This would be implemented using CFC.

The example illustrates how a reverse-power protection is implemented by means of the flexible protection functions. Frequency protection and voltage protection are described in Sections 2.9 and 2.6.

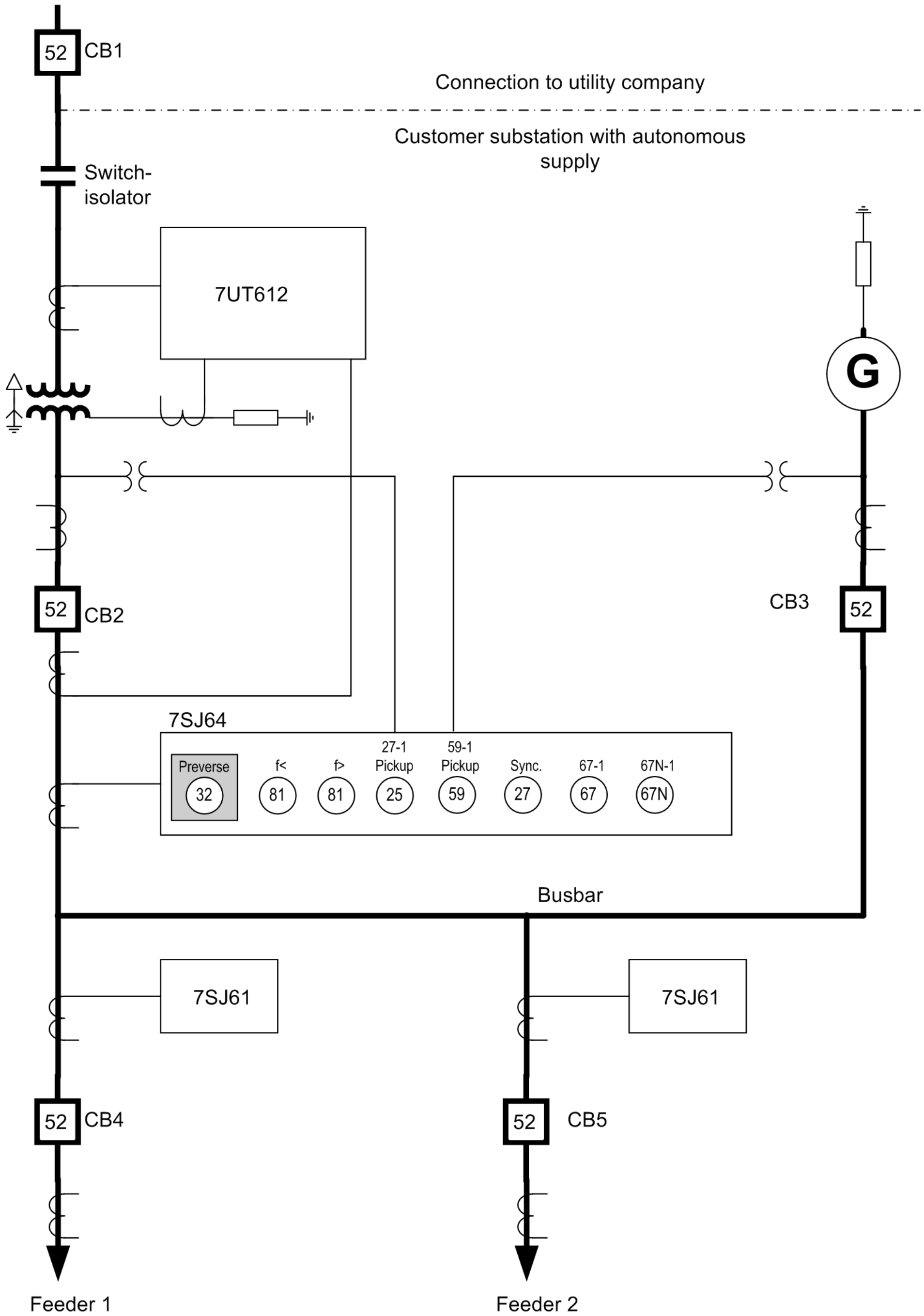


Figure 2-89 Example of a substation with autonomous generator supply

Substation Layout

A 110-kV line connects the substation to the utility grid on high-voltage side. Circuit-breaker CB1 belongs to the utility grid. The switch-disconnector separates the substation from the utility grid if necessary. The transformer with a ratio of 10:1 transforms the voltage level to 11 kV. On low-voltage side, transformer, generator and the two feeders are connected on a busbar. The circuit-breakers CB2 to CB5 disconnect consumers and equipment from the busbar.

Table 2-23 System data for the application example

Power System Data	
Generator nominal power	$S_{N,Gen}$ = 38.1 MVA
Transformer nominal power	$S_{N,Transformer}$ = 38.1 MVA
Nominal voltage of high-voltage side	V_{Nom} = 110 kV
Nominal voltage of busbar side	V_{Nom} = 11 kV
Nominal primary CT current on busbar side	$I_{N,prim}$ = 2000 A
Nominal secondary CT current on busbar side	$I_{N,sec}$ = 1 A
Nominal primary VT voltage on busbar side	$V_{N,prim}$ = 11 kV
Secondary primary VT voltage on busbar side	$V_{N,sec}$ = 100 V

Protective Functionality

The 7SJ64 protective relay will disconnect the substation from the utility grid in case the generator feeds back energy into the utility grid (protective function **P rev>**). This functionality can be achieved using a flexible protection function. Disconnection will also be initiated if frequency or voltage fluctuations occur in the utility grid (protective functions **81**, **27-1**, **59-1**, **67-1**, **67N-1**). The protective relay obtains the measured values via a three-phase current and voltage transformer set and a single-phase connection to the generator voltage transformer (for synchronization). Circuit-breaker CB2 will be activated in case of disconnection.

The transformer is protected by a differential protection and inverse and definite time overcurrent protection functions for the phase-to-phase currents. In the event of a fault, circuit-breaker CB1 in the utility grid will be activated via a remote link. Circuit-breaker CB2 is activated in addition.

Time overcurrent protective functions protect the feeders 1 and 2 against short-circuits and overload caused by the connected consumers. The phase-to-phase currents and the zero currents of the feeders can be protected by inverse and definite time overcurrent protection elements. Circuit-breakers CB4 and CB5 are activated in the event of a fault.

In addition, the busbar could be equipped with the 7UT635 differential protective relay for multiple ends. The current transformers required to this end are already included in Figure 2-89.

Synchronization Before Connecting the Generator

In most cases, it is the power customer who is responsible for restoring normal system operation after disconnection. The 7SJ64 relay tests whether the synchronous system conditions are satisfied. After successful synchronization the generator is connected to the busbar.

The voltages required for synchronization are measured at the transformer and at the generator. The voltage at the transformer is measured in all three phases since they are also necessary to determine the direction. A generator supplies the phase-to-phase voltage Vca across a star-delta transformer to device input V4 (see Figure 2-90).

Wiring Diagram, Power Direction

Figure 2-90 shows the wiring of the device for reverse-power protection and synchronization. The power flow in positive or forward direction occurs from the high-voltage busbar (not shown) via the transformer to the low-voltage busbar.

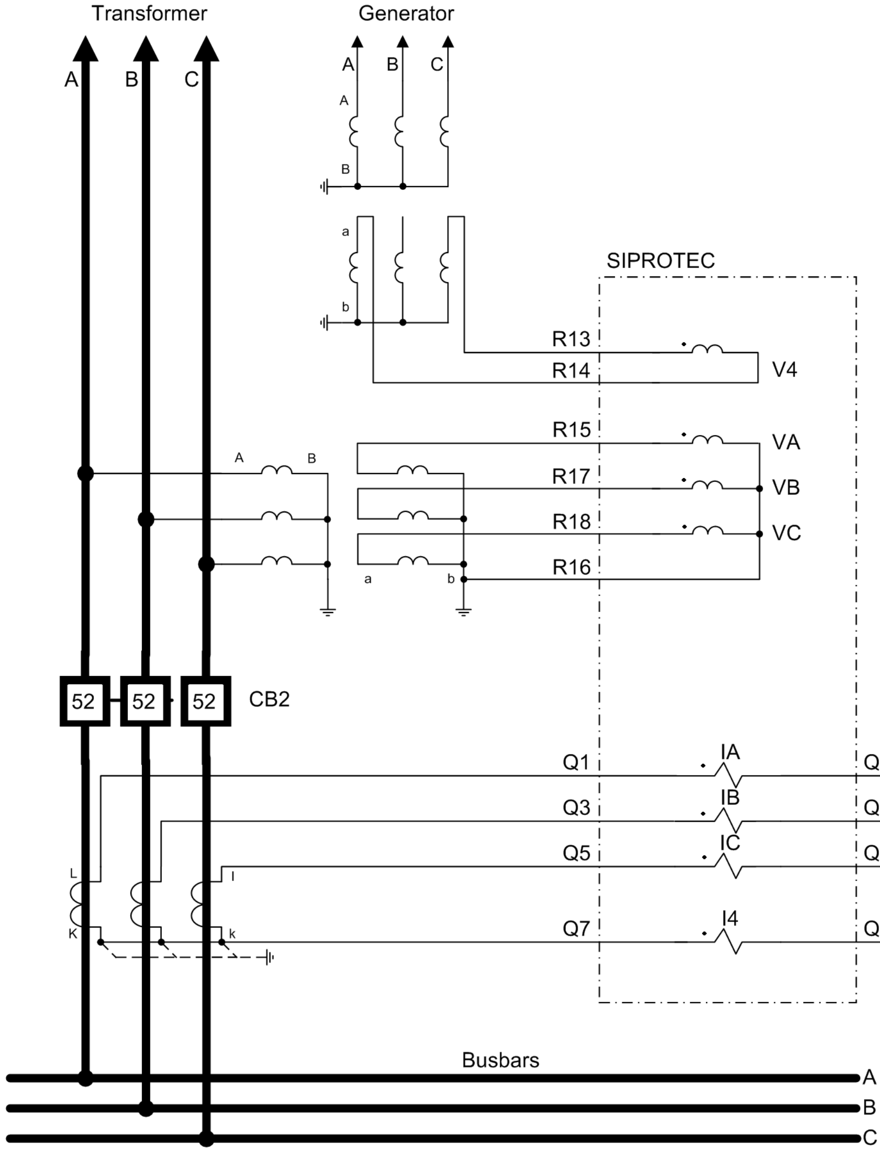


Figure 2-90 Wiring diagram for a 7SJ642 as reverse-power protection (flush-mounted case)

2.18.2 Implementation of the Reverse-Power Protection

General

The names of the indications can be edited in DIGSI and were tailored to this example. The parameter names are fixed.

Determination of the Reverse Power

The reverse-power protection evaluates the active power from the symmetrical fundamental components of voltages and currents. Evaluation of the positive-sequence systems secures reverse-power detection against asymmetries occurring in the voltages and currents and reflects the real load of the drive side. The calculated active power value corresponds to the total active power. The relay measures the power in direction of the busbar as being positive for the connection shown in the example.

Functional Logic

The following logic diagram depicts the functional logic of the reverse-power protection.

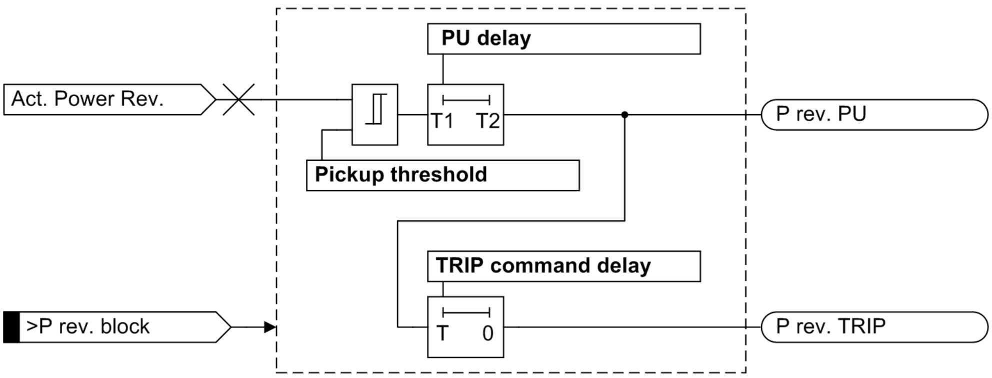


Figure 2-91 Logic diagram of the reverse-power determination with flexible protection function

The reverse-power protection picks up once the configured pickup threshold has been exceeded. If the pickup condition persists during the equally settable pickup delay, the pickup message **P.rev.PU** is generated and starts the trip delay time. If the pickup condition does not drop out while the trip delay time is counting down, the trip indication **P. rev. TRIP** and the timeout indication **P. rev. timeout** are generated. The picked up element drops out when the value falls below the dropout threshold. The blocking input **>P rev. block** blocks the entire function, i.e. pickup, trip and running times are reset. After the blocking has been released, the reverse power must exceed the pickup threshold and both times must run out before the protective function trips.

Pickup Value, Dropout Ratio

The pickup value of the reverse-power protection is set to 10% of the generator nominal output. In this example, the setting value is configured as secondary power in watts. The following relationship exists between the primary and the secondary power:

$$P_{sec} = P_{prim} \cdot \frac{V_{Nom,\,sec}}{V_{Nom,\,prim}} \cdot \frac{I_{Nom,\,sec}}{I_{Nom,\,prim}}$$

On the basis of the indicated data, the pickup values are calculated considering P_{prim} = 3.81 MW (10% of 38.1 MW) on the primary level to

$$P_{sec} = 3.81\text{MW} \cdot \frac{100\text{V}}{11000\text{V}} \cdot \frac{1\text{A}}{2000\text{A}} = 17.3\text{W}$$

on the secondary level. The dropout ratio is set to 0.9. This yields a secondary dropout threshold of $P_{sec,\,dropout}$ = 15.6 W. If the pickup threshold is reduced to a value near the lower setting limit of 0.5 W, the dropout ratio should equally be reduced to approximately 0.7.

Delay for Pickup, Dropout and Trip

The reverse-power protection does not require short tripping times as protection from undesired power feedback. In the present example, it is useful to delay pickup and dropout by about 0.5 s and the trip by approx. 1 s. Delaying the pickup will minimize the number of fault logs which are opened when the reverse power oscillates around the threshold.

When using the reverse-power protection to disconnect the switchgear quickly from the utility grid if faults occur, it is useful to select a larger pickup value (e.g. 50% of nominal power) and shorter time delays.

2.18.3 Configuring the Reverse-Power Protection in DIGSI

First create and open a 7SJ64x (e.g. 7SJ642) device in DIGSI Manager. Configure a flexible protection function (flexible function 01) for the present example in the Device Configuration (figure 2-92).

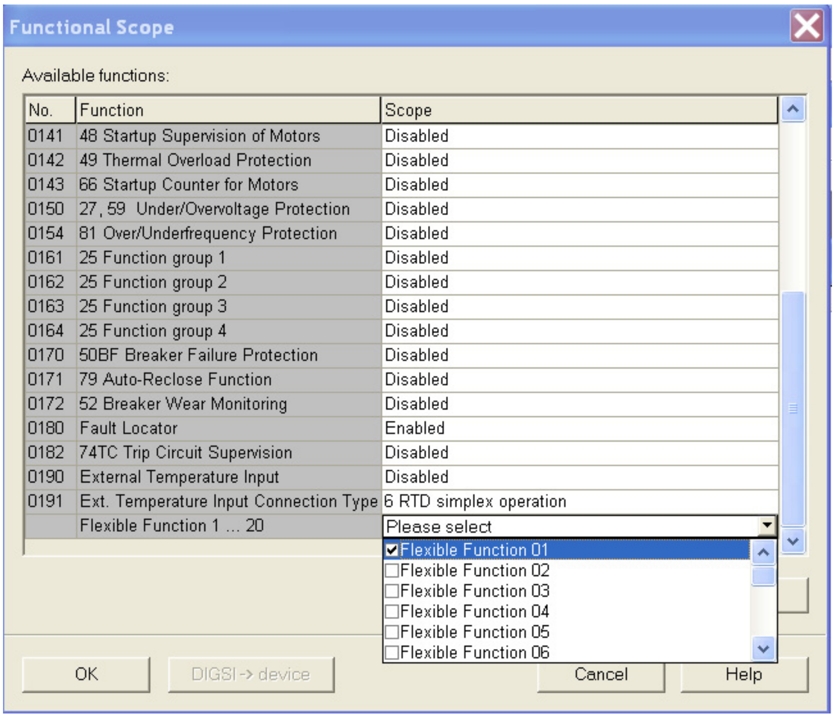


Figure 2-92 Configuration of a flexible protection function

Select „Additional functions“ in the „Parameters“ menu to view the flexible function (figure 2-93).

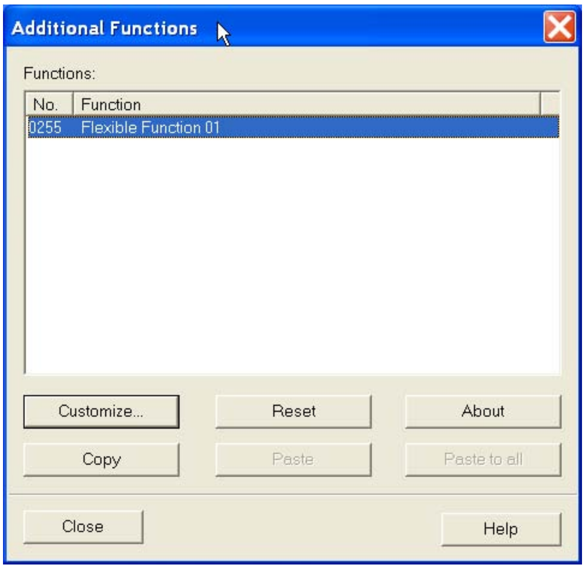


Figure 2-93 The flexible function appears in the function selection.

First activate the function at „Settings --> General“ and select the operating mode „3-phase“ (figure 2-94):

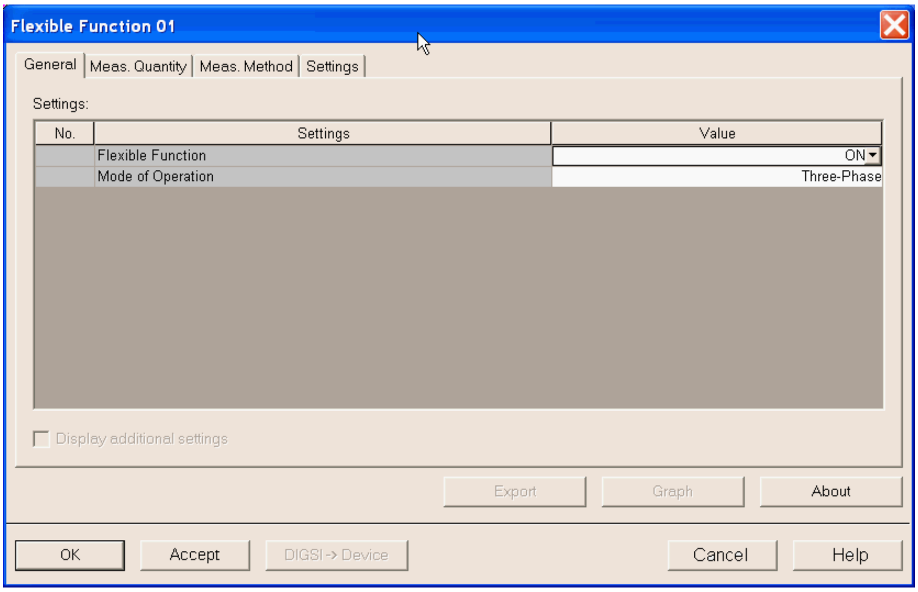


Figure 2-94 Selection of the three-phase operating mode

Select „Active power reverse “ and „Overshooting“ in the menu items „Measured Quantity“ and „Measurement Method“. Open the menu item „Settings“ and set a checkmark in the box „Display additional settings“ to configure threshold, pickup delay and trip delay (Figure 2-95). Since it is not possible to determine the power direction during a failure of the measuring voltage, it is useful to activate a blocking in this case.

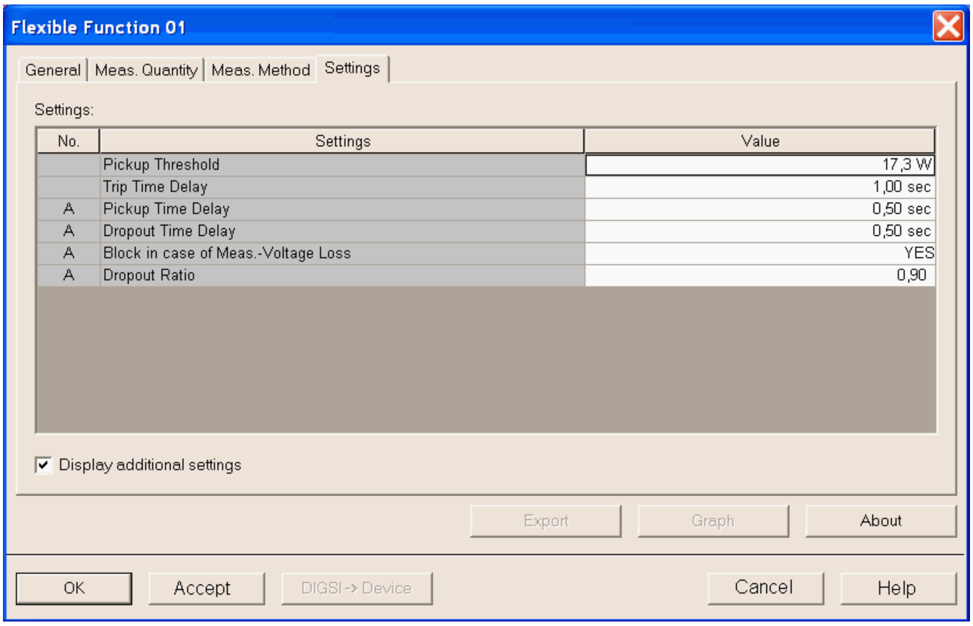


Figure 2-95 Setting options of the flexible function

Allocating the Reverse-Power Protection in DIGSI Configuration Matrix

The DIGSI configuration matrix initially shows the following indications (after selecting „Indications and commands only“ and „No filter“, Figure 2-96):

Flx 01	235.2110.01	>BLOCK Flx01	>BLOCK Function Flx01	SP
	235.2111.01	>Flx01 instant.	>Function Flx01 instantaneous TRIP	SP
	235.2113.01	>Flx01 BLK.TDelay	>Function Flx01 BLOCK TRIP Time Delay	SP
	235.2114.01	>Flx01 BLK. TRIP	>Function Flx01 BLOCK TRIP	SP
	235.2118.01	Flx01 BLOCKED	Function Flx01 is BLOCKED	OUT
	235.2119.01	Flx01 OFF	Function Flx01 is switched OFF	OUT
	235.2120.01	Flx01 ACTIVE	Function Flx01 is ACTIVE	OUT
	235.2121.01	Flx01 picked up	Function Flx01 picked up	OUT
	235.2125.01	Flx01 Time Out	Function Flx01 TRIP Delay Time Out	OUT
	235.2126.01	Flx01 TRIP	Function Flx01 TRIP	OUT

Figure 2-96 Indications prior to editing

Clicking the texts allows short text and long text to be edited as required by the application (Figure 2-97):

Flx 01	235.2110.01	>P rev. block	>Active power reverse block	SP
	235.2111.01	>P rev. instant	>Active pow. rev. OFF instantaneous trip	SP
	235.2113.01	>P rev. BLK. T	>Active pow. rev. BLOCK TRIP Time Delay	SP
	235.2114.01	>P rev.BLK.TRIP	>Active pow. rev. BLOCK TRIP	SP
	235.2118.01	P rev. BLOCKED	Active pow. rev. is BLOCKED	OUT
	235.2119.01	P rev. OFF	Active pow. rev. is switched OFF	OUT
	235.2120.01	P rev. ACTIVE	Active pow. rev. is ACTIVE	OUT
	235.2121.01	P rev.picked up	Active pow. rev. picked up	OUT
	235.2125.01	P rev.Time Out	Active pow. rev. TRIP Delay Time Out	OUT
	235.2126.01	P rev. TRIP	Active pow. rev. TRIP	OUT

Figure 2-97 Indications after editing

The indications are allocated in the same way as the indications of other protective functions.

2.19 Synchronism and Voltage Check 25 (7SJ64 only)

The synchronization function is only available for device 7SJ64. It has configuration options for four different synchronization functions. The function and operation is described in the following using the **SYNC Function group 1**. The same applies to function groups 2 to 4.

2.19.1 SYNC Function group 1

When connecting two sections of a power system, the synchronism check verifies that the start does not endanger the stability of the power system.

Applications

- Typical applications are, for example, the synchronism check of a feeder and a busbar (see Figure 2-98) or the synchronism check of two busbars via bus coupler (see Figure 2-99).

Prerequisites

The synchronism check is only available for 7SJ64.

2.19.1.1 General

For comparing the two voltages the synchronism check uses the reference voltage V_1 and an additional voltage to be connected V_2.

If a transformer is connected between the two voltage transformers (Figure 2-98), its vector group can be adapted in the 7SJ64 relay so that external adaptors are not required.

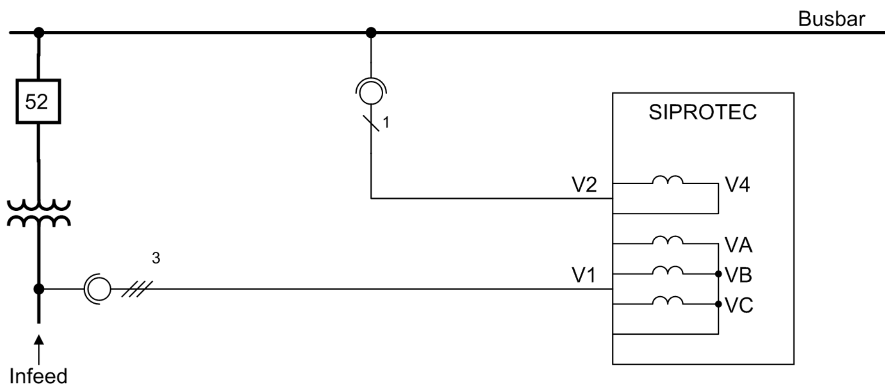


Figure 2-98 Infeed

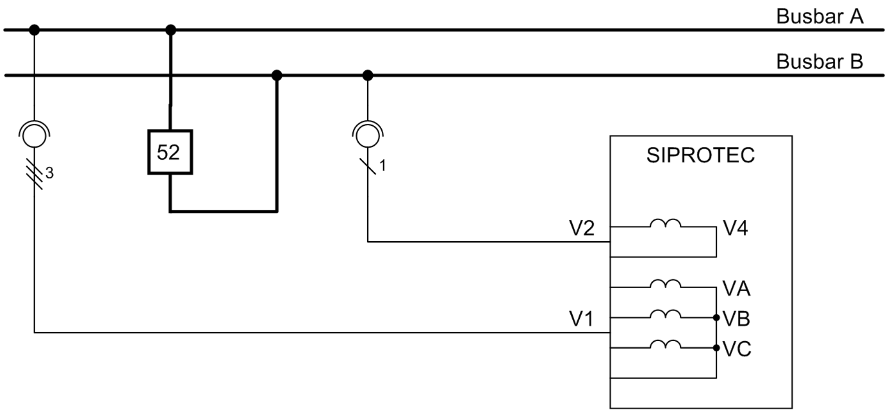


Figure 2-99 Bus coupler

The synchronism check of 7SJ64 usually cooperates with the integrated automatic reclosing system and the control functions of the control function. It is also possible to employ an external automatic reclosing system. In such a case signal exchange between the devices is accomplished via binary inputs and outputs.

The configuration decides whether the synchronism check is carried out only for automatic reclosing or only for circuit breaker control or both. It is also possible to specify different release criteria for automatic close or control close. Synchronous connection is always accomplished via the integrated control.

The release command for closing under satisfied synchronism conditions can be deactivated by parameter 6x13 **25 Synchron**. The disabled closing release can, however, be activated via binary input („>25 synchr.“). It is intended for special applications (see„de-energized switching“).

Connection, Multi-ple-phase

For comparing the two voltages the synchronism check takes the reference voltage V_1 and an additional voltage to be connected V_2. The reference voltage V_1 is derived from the multi-phase system, usually the three phase-ground voltages. The voltage to be synchronized V_2 is assigned to the single-phase connection and may be any phase-ground or phase-phase voltage.

The device can also be connected in V-connection using two phase-phase voltages. In that case, a phase-to-phase voltage must be connected to the voltage to be synchronized V_2. Please observe also that a V-connection does not allow the zero sequence voltage to be determined. The functions „Directional Time Overcurrent Protection Ground“, „Directional Ground Fault Detection“ and „Fuse-Failure-Monitor (FFM)“ must be disabled.

Connection, Single-phase

If there is only one primary voltage to represent the reference voltage V_1, the device can be informed of this fact via the power system data. Also in this case the synchronism check can be fully applied.

Operating Modes

The synchronism check can be operated in two modes:

- Synchrocheck
- Synchronous / Asynchronous

Synchronous power systems exhibit small differences regarding phase angle and voltage magnitude. Before connection it is checked whether conditions are synchronous or not. If synchronism prevails the system is energized, with asynchronous conditions it is not. The circuit breaker operating time is not taken into consideration. The ***SYNCHROCHECK*** mode is used. It corresponds to the classic synchrocheck function.

On the other hand, asynchronous systems include bigger differences and the time window for switching passes relatively quick. It is useful to consider the operating time of the circuit breaker. The ***ASYN/SYNCHRON*** mode is used.

Functional Sequence

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

The measurement request performs certain plausibility checks (for further information see „Plausibility Check"). If there is a condition which is not plausible, a message „25 Sync. Error" is output. The measurement is then not carried out. If conditions are plausible, measurement is initiated (message „25x meas."; with x = 1..n, according to the function group). Depending on the selected operating mode, the configured release conditions are then checked (see margin headings „Synchrocheck" / „Synchronous/Asynchronous").

Each condition met is indicated explicitly (messages „25 Vdiff ok", „25 fdiff ok", „25 αdiff ok"). Also conditions not fulfilled are indicated, for example, when voltage differences (messages „25 V2>V1", „25 V2<V1"), frequency differences (messages „25 f2>f1", „25 f2<f1") or angle differences (messages „25 α2>α1", „25 α2<α1") lie outside the threshold values. For these messages to be sent, both voltages must lie within the operating range of the synchrocheck (see margin heading „Operating Range").

If these conditions are met, the synchrocheck function issues a release signal for closing the breaker („25 CloseRelease"). This release signal is only available for the configured duration of the CLOSE command and is always processed by the control, which issues the actual CLOSE command for controlling the circuit breaker (see also margin heading „Interaction with the control"). The annunciation „25 Synchron" is applied as long as the synchronous conditions are fulfilled.

Measuring the synchronism conditions can be confined to a maximum monitoring time **T-SYN. DURATION**. If the conditions are not fulfilled during **T-SYN. DURATION**, the release is cancelled (message „25 MonTimeExc"). A new synchrocheck can only be performed if a new measurement request is received.

Plausiblity Check / SYNC Error

A parameter plausibility check is carried out upon device startup. Message „25 Set-Error" is displayed if a fault is detected. If an implausible condition is detected after a measurement request, message „25 Sync. Error" is generated. The measurement is not initiated in that case.

The following plausibility checks are carried out:

- Checking unique function group identification
- Checking the configuration
- Evaluation of monitoring functions

If one and the same SYNC function group has multiple selections, error message „25 FG-Error" is output additionally. The synchrocheck cannot be bypassed via binary input.

Concerning configuration it is also checked if power system address 213 is set to ***Van,Vbn,Vcn,VSy***. Otherwise message „25 Sync. Error" is output. Furthermore, specific thresholds and settings of the selected function group are checked. If there is a condition which is not plausible, error message „25 Set-Error" is output additionally. Here, please make sure that Address 6x06 (threshold V1, V2 energized) is smaller than Address 6x03 (lower voltage limit **Vmin**). The synchrocheck cannot be bypassed via binary input.

If the monitoring function Fuse-Failure-Monitor is used and if it has picked up at the same time as the measurement of the synchronization was requested, the synchronization is not started either (message „25 Sync. Error“). The same applies, if a voltage transformer failure (m.c.b. tripping) is communicated to the device via binary inputs 6509 „>FAIL:FEEDER VT“ or 6510 „>FAIL: BUS VT“. In this case, the synchrocheck can be bypassed via binary input.

Operating Range

The operating range of the synchrocheck is defined by the configured voltage thresholds **Vmin** and **Vmax**, and the fixed frequency band $f_{Nom} \pm 3$ Hz.

If measurement is started and one or both voltages are outside the operating range, or one voltage leaves the permissible range, corresponding messages indicate this behaviour („25 f1>>“, „25 f1<<“, „25 V1>>“, „25 V1<<“, etc.).

Measured Values

The measured values of the synchrocheck are displayed in separate boxes for primary, secondary and percentage values. The measured values are displayed and updated only while a synchrocheck is requested.

The following is displayed:

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

2.19.1.2 Synchrocheck

Having selected operating mode ***SYNCHROCHECK*** the mode verifies the synchronism before connecting the two system components and cancels the connecting process if parameters for synchronism lie outside the configured thresholds.

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

- Is the reference voltage V_1 above the setting value **Vmin** but below the maximum voltage **Vmax**?
- Is the voltage V_2 to be synchronized above the setting value **Vmin** but below the maximum voltage **Vmax**?
- Is the voltage difference $V_2 – V_1$ within the permitted threshold **dV SYNCHK V2>V1**?
- Is the voltage difference $V_1 – V_2$ within the permitted threshold **dV SYNCHK V2<V1**?
- Are the two frequencies f_1 and f_2 within the permitted operating range $f_N \pm 3$ Hz?
- Is the frequency difference $f_2 – f_1$ within the permitted threshold **df SYNCHK f2>f1**?
- Is the frequency difference $f_1 – f_2$ within the permitted threshold **df SYNCHK f2<f1**?
- Is the angle difference $\alpha_2 – \alpha_1$ within the permitted threshold **dα SYNCHK α2>α1**?
- Is the angle difference $\alpha_1 – \alpha_2$ within the permitted threshold **dα SYNCHK α2<α1**?

2.19.1.3 Synchronous / Asynchronous

The operating mode ***ASYN/SYNCHRON*** uses the frequency slip of the two power systems (parameter **F SYNCHRON**) to determine whether the power systems are asynchronous to each other ("Switching under Asynchronous System Conditions") or synchronous ("Switching under Synchronous System Conditions"). If systems are asynchronous, the time window for switching is passed relatively quickly. Therefore, it is reasonable to take into account the operating time of the circuit breaker. Thus the device can issue the ON command at a time where asynchronous conditions prevail. When the poles make contact the conditions will be synchronous.

It is also possible to generally take into account the operating time of the circuit breaker, i.e. also with synchronous conditions prevailing.

Switching under Synchronous System Conditions

Switching under synchronous conditions means that the ON command will be released as soon as the characteristic data (voltage difference, angle difference) are within the thresholds specified by configuration.

Before granting a release for closing under synchronous conditions, the following conditions are checked:

- Is the reference voltage V_1 above the setting value **Vmin** but below the maximum voltage **Vmax**?
- Is the voltage V_2 to be synchronized above the setting value **Vmin** but below the maximum voltage **Vmax**?
- Is the voltage difference $V_2 – V_1$ within the permitted threshold **dV SYNC V2>V1**?
- Is the voltage difference $V_1 – V_2$ within the permitted threshold **dV SYNC V2<V1**?
- Are the two frequencies f_1 and f_2 within the permitted operating range f_{Nom} ± 3 Hz?
- Is the frequency difference smaller than the configured threshold frequency difference **F SYNCHRON** which defines the transition from synchronous to asynchronous systems?
- Is the angle difference $\alpha_2 – \alpha_1$ within the permitted threshold **dα SYNC α2> α1**?
- Is the angle difference $\alpha_1 – \alpha_2$ within the permitted threshold **dα SYNC α2< α1**?

As soon as all synchronism conditions are fulfilled, the message „25 Synchron“ is issued.

Switching under Asynchronous System Conditions

For switching under asynchronous system conditions the device determines the time for issuing the ON command from the angle difference and the frequency difference such that the voltages (of busbar and feeder) are identical at the instant the poles make contact. For this purpose the device must be informed of the operating time of the circuit breaker for closing.

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

- Is the reference voltage V_1 above the setting value **Vmin** but below the maximum voltage **Vmax**?
- Is the voltage V_2 to be synchronized above the setting value **Vmin** but below the maximum voltage **Vmax**?
- Is the voltage difference $V_2 – V_1$ within the permitted threshold **dV ASYN V2>V1**?
- Is the voltage difference $V_1 – V_2$ within the permitted threshold **dV ASYN V2<V1**?
- Are the two frequencies f_1 and f_2 within the permitted operating range f_{Nom} ± 3 Hz?
- Is the frequency difference $f_2 – f_1$ within the permitted threshold **df ASYN f2>f1**?
- Is the frequency difference $f_1 – f_2$ within the permitted threshold **df ASYN f2<f1**?

When the check has been terminated successfully, the device determines the next instant at which the two systems are in phase from the angle difference and the frequency difference. The ON command is issued at this instant minus the operating time of the circuit breaker.

2.19.1.4 De-energized Switching

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

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

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

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

Synchronization thus takes place by involving the additional parameter 6x13 **25 Synchron** (set to ***NO***) also, e.g. for connecting a ground switch. In such a case, the switch may only be connected if no voltage applies on load side, i.e. connection is not permitted under synchronous conditions.

The release conditions can be configured individually either for automatic reclosing or for manual closing via control commands. You can, for example, allow manual closing for synchronism or for de-energized feeder whereas before an automatic reclosing operation, checking only de-energized conditions at one feeder terminal and afterwards only synchronism at the other.

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

Before granting a release for connecting the energized component V_1 and the de-energized component $V_{2,}$ the following conditions are checked:

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

After successful termination of the check the release is granted.

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

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

Via binary input „>25 V1>V2<“, „>25 V1<V2>“ and „>25 V1<V2<“ release conditions can be issued externally provided the synchrocheck is controlled externally.

Parameter **TSUP VOLTAGE** (address 6111) can be set to configure a monitoring time which requires above stated release conditions for de-energized connection to be fulfilled at least this time before switching is allowed.

2.19.1.5 Direct Command / Blocking

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

If the synchrocheck fails, depending on the type of failure a direct command bypassing any checks may be issued or not (also see "Plausibility check / SYNC Error").

Via binary input „>25direct CO“ this release can also be granted externally.

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

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

2.19.1.6 SYNC Function Groups

The 7SJ64 relay comprises 4 SYNC function groups (SYNC function group 1 to 4) whereby each group contains all setting parameters required by a SYNC function. This generally includes the switchgear component for which the SYNC function settings are to be applied.

However, several SYNC function groups may be used for one point of synchronization/switching object if synchronismn is to be performed with different parameters. Allocation of switchgear component and SYNC function group must then be accomplished dynamically (whichever is the function group to operate with) via one of the binary inputs from „>25-1 act“ to „>25-4 act“.

If the assignment to the SYNC groups is clear, the binary inputs are not required.

Selecting one SYNC function group several times, causes output of error message („25 FG-Error“).

2.19.1.7 Interaction with Control, AR and External Control

With Control

Basically, the synchrocheck interacts with the device control. The switchgear component to be synchronized is selected via a parameter. If an ON command is issued, the control takes into account that the switchgear component requires synchronism. The control sends a measurement request („`25 Measu. req.`“) to the synchrocheck which is then started. Having completed the check, the synchrocheck issues the release message („`25 CloseRelease`“) to which the control responds by terminating the switching operation positively or negatively (see Figure 2-100).

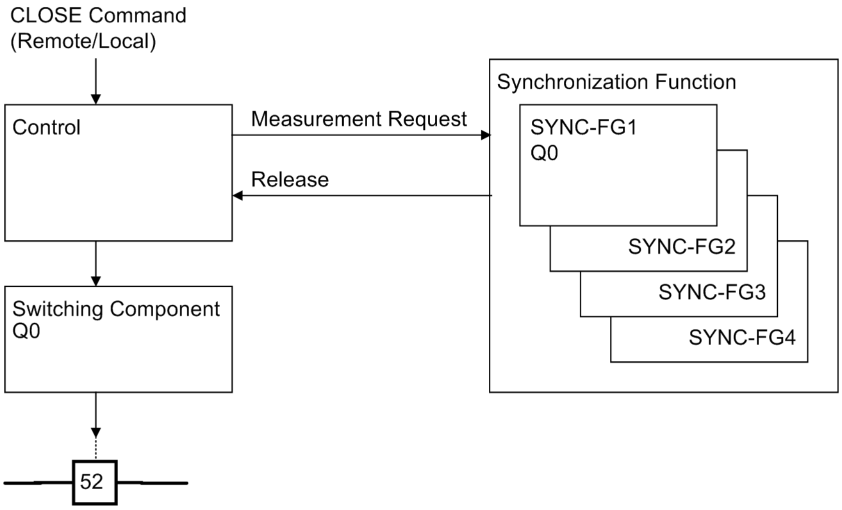


Figure 2-100 Interaction of control and synchrocheck

With AR

The automatic reclosing (AR) function can also interact with the synchronizing function. They are linked via the device control. The selection is made via parameter setting of the automatic reclosing function. The AR parameters (7138 **`Internal SYNC`**) determine which SYNC function group (SYNC FG) is used. The applicable switch is defined in the selected function group. The switchgear component indicated in the AR parameters (7137 **`Cmd.via control`**) and the selected SYNC function group should be identical. If their settings differ, the SYNC function group setting will overwrite that of the AR function. If no SYNC function group is entered in the AR parameter, the close command of the auto reclose function is carried out in unsynchronized form via the switchgear component indicated in the AR parameters. Equally, the close command „`79 Close`“ (message 2851) allows only unsynchronized switching. If e.g. circuit breaker Q0 is configured as component to be switched synchronized, a CLOSE command of the AR function will address this breaker and assign it a CLOSE command which will be processed by the control. As this breaker requires synchronization, the control launches the synchronizing function and awaits release. If the configured conditions are fulfilled, the release is granted and the control issues the CLOSE command (see Figure 2-101).

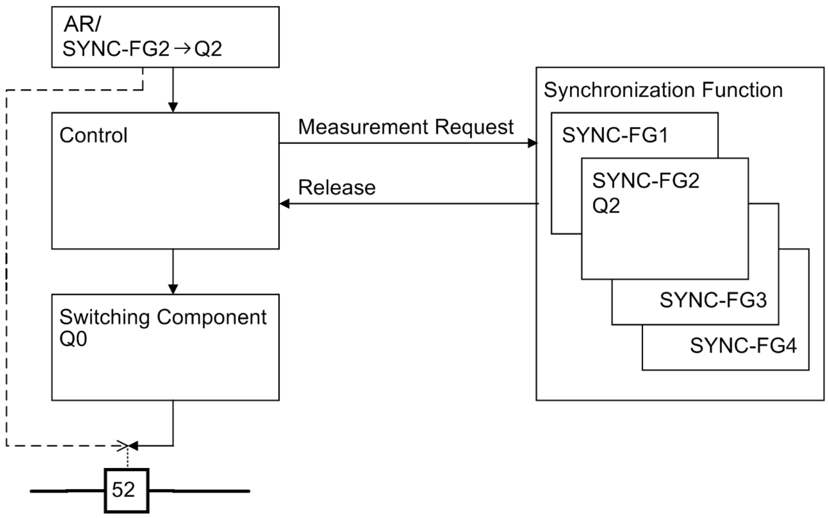


Figure 2-101 Connection of the automatic reclosing function to the synchrocheck

With External Control

As another option the synchronizing function can be activated via external measurement request. The synchronizing function can be started via binary input using a measurement request („`>25 Measu. Only`“ or pulse-like start and stop signals „`>25 Start`“ „`>25 Stop`“). After the synchronizing function has completed the check, it issues a release message („`25 CloseRelease`“see Figure 2-102). Measurement is finished as soon as the measurement request is reset via the binary input. In this case there is no need to configure any control device to be synchronized.

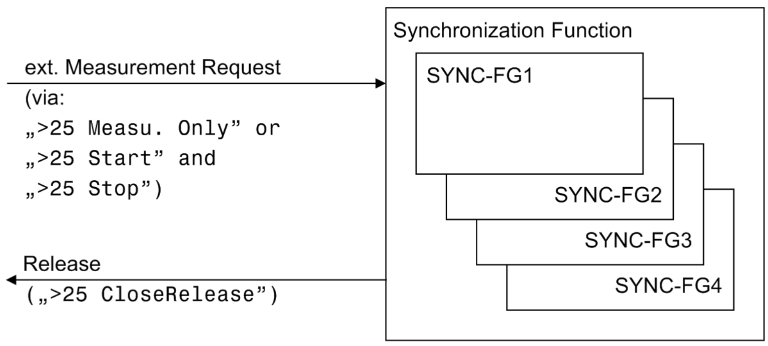


Figure 2-102 Interaction of synchronizing function and external control

2.19.1.8 Setting Notes

General

The synchrocheck function is only included in the 7SJ64 relay with its four voltage inputs.

While setting the power system data 1 (see section 2.1.3.2) the device was already provided with data relevant for the measured values and the operating principle of the synchrocheck function. This concerns the following parameters:

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

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

213 **VT Connect. 3ph** defines the way voltage transformers are connected if there is more than one voltage transformer at the primary side.

When using the synchronization function, setting ***Van,Vbn,Vcn,VSy*** must always be selected independent of whether there are phase-ground or phase-phase voltages at the primary side. Two phase-phase voltages are V-connected to the device (see also connection examples for 7SJ64 in the AppendixA.3). However, a zero sequence voltage cannot be determined in that case. The functions „Directional Time Overcurrent Protection Ground“, „Directional Ground Fault Detection“ and „Fuse-Failure-Monitor (FFM)“ must be disabled.

240 **VT Connect. 1ph** specifies the voltage connected at side V_1 if only one voltage transformer is available at the primary side. If the parameter is set different from **NO**, setting of address 213 is no more relevant. With single-phase connection the device generally assumes the voltage at the fourth voltage transformer (V_4) as the voltage V_2 to be synchronized.

214 **Rated Frequency** the operating range of the synchrocheck refers to the nominal frequency of the power system (f_{Nom} ± 3 Hz);

The synchrocheck function can only operate if at least one of the addresses 161 **25 Function 1** to 164 **25 Function 4** is set to ***Enabled*** during configuration of the functional scope (see section 2.1.1.2). The operating mode can be preselected: ***ASYN/SYNCHRON*** means that switching will take place under synchronous and asynchronous conditions. ***SYNCHROCHECK*** corresponds to the classic synchrocheck function. If not required, this function is set to ***Disabled***. A synchrocheck function group thus rendered ineffective is disabled in the menu item **Synchronization**; other groups in this menu are displayed.

Only the corresponding messages of SYNC Function Group 1 are pre-allocated for IEC 60870–5–103 (VDEW). If other function groups (2 to 4) are configured and if their messages are to be disposed of via VDEW, they must first be configured to the system interface.

Selecting one of the displayed SYNC function groups in DIGSI opens a dialog box with the tabs "General", "Power System Data", "asyn. operation", "syn. operation" and "Synchrocheck" in which the individual settings for synchronism can be made. For SYNC function group x the following holds:

General Settings

The general thresholds for the synchronizing function are set at addresses 6x01 to 6x12.

Address 6x01 **Synchronizing** x can be set to switch the entire synchronizing function group x ***ON*** or ***OFF***. If switched off, the synchronous check does not verify the synchronization conditions and release is not granted.

Address 6x02**SyncCB** is used to select the switchgear component to which the synchronizing settings will be applied. Select the option ***none*** to use the function as external synchronizing feature. It will then be triggered via binary input messages.

Addresses 6x03**Vmin** and 6x04**Vmax** set the upper and lower limits for the operating voltage range V1 or V2 and thus determine the operating range for the synchronizing function. If the values leave this band, a message will be output.

Address 6x05 **V<** indicates the voltage threshold below which the feeder or the busbar can safely be considered switched off (for checking a de-energized feeder or busbar).

Address 6x06**V>** indicates the voltage threshold above which the feeder or busbar can safely be considered energized (for checking an energized feeder or busbar). It must be set below the anticipated operational undervoltage.

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

Addresses 6x07 to 6x10 are set to specify the release conditions for the closing check. Where:

6x07 **SYNC V1<V2>** = Component V_1 must be de-energized, component V_2 must be energized (connection to reference without voltage, dead line);

6x08 **SYNC V1>V2<** = Component V_1 must be energized, component V_2 voltage value must be de-energized (connection to feeder without voltage, dead bus);

6x09 **SYNC V1<V2<** = Component V_1 and Component V_2 must be de-energized (connection when reference and feeder are de-energized, dead bus/dead bus);

6x10A **Direct CO** = Command is released without checks.

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

Parameter **TSUP VOLTAGE** (address 6x11A) can be set to configure a monitoring time which requires above stated release conditions to be present for at least de-energized switching before switching is allowed. The preset value of 0.1 s accounts for transient responses and can be applied without modification.

Release via synchronous check can be limited to a configurable synchronous monitoring time **T-SYN. DURATION** (address 6x12). The configured conditions must be fulfilled within this time. Otherwise release is not granted and the synchronizing function is terminated. If this time is set to ∞, the conditions will be checked until they are fulfilled.

For special applications (e.g. connecting a ground switch), the closing release under satisfied synchronism conditions can be activated or deactivated in parameter 6x13A **25 Synchron**.

Power System Data

The power system data for the synchronizing function are set at addresses 6x20 to 6x25.

The circuit breaker closing time **T-CB close** at address 6x20 is required if the device is to close also under asynchronous system conditions, no matter whether for manual closing, for automatic reclosing after three-pole tripping, or for both. The device will then calculate the time for the close command such that the voltages are synchronous the instant the breaker poles make contact. Please note that this should include the operating time of the breaker as well as the operating time of an auxiliary relay that may be connected in the closing circuit.

The parameter **Balancing V1/V2** (address 6x21) can be set to account for different VT ratios of the two parts of the power system (see example in Figure 2-103).

If a transformer is located between the system parts to be synchronized, its vector group can be accounted for by angle adjustment so that no external adjusting measures are required. Parameter **ANGLE ADJUSTM.** (address 6x22A) is used to this end.

The phase angle from V_1 to V_2 is evaluated positively.

Example: (see also Figure 2-103):

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

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

Address 6x22A: **ANGLE ADJUSTM.** = ***150***°.

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

Address 6x21:**Balancing V1/V2** = 100 V/110 V = ***0.91***.

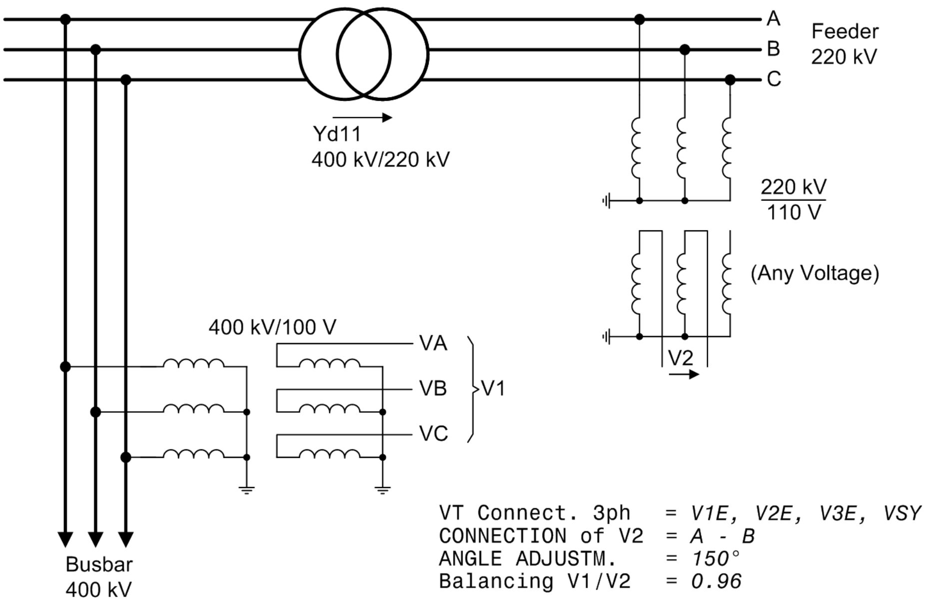


Figure 2-103 Busbar voltage measured accross transformer

Connections

7SJ64 provides three voltage inputs for the connection of voltage V_1 and one voltage input for voltage V_2 (see Figure 2-104 and Figure 2-103). According to definition, the three-phase voltage is the reference voltage V_1. To compare the three-phase voltage V_1 with voltage V_2 correctly, the connection type of voltage V_2 must be signalled to the device. Address **CONNECTIONof V2** assumes this task (parameter 6x23).

If three phase-to-ground voltages are connected to side V_1, then any phase-phase or phase-to-ground voltage can be used and configured as voltage to be synchronized V_2. If two phase-phase voltages are connected in V-connection to side V_1, then the voltage V_2 to be synchronized must be a phase-phase voltage. It must be connected and configured.

Single-phase connection is also possible for side V_1. In Address 240 **VT Connect. 1ph** this information must be communicated to the device (see above). Setting of address 213 is not relevant in that case. Compared to voltage of side 1 the voltage to be synchronized must be equal in type and phase. Address 6x23 **CONNECTIONof V2** is hidden for single-phase connection. Figure 2-105 shows an example for a single-phase connection.

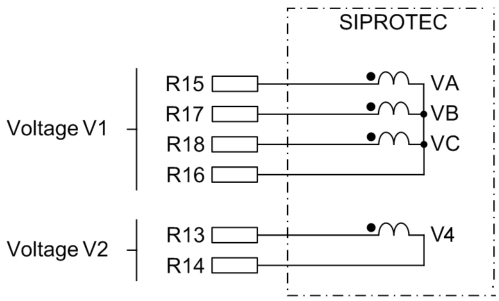
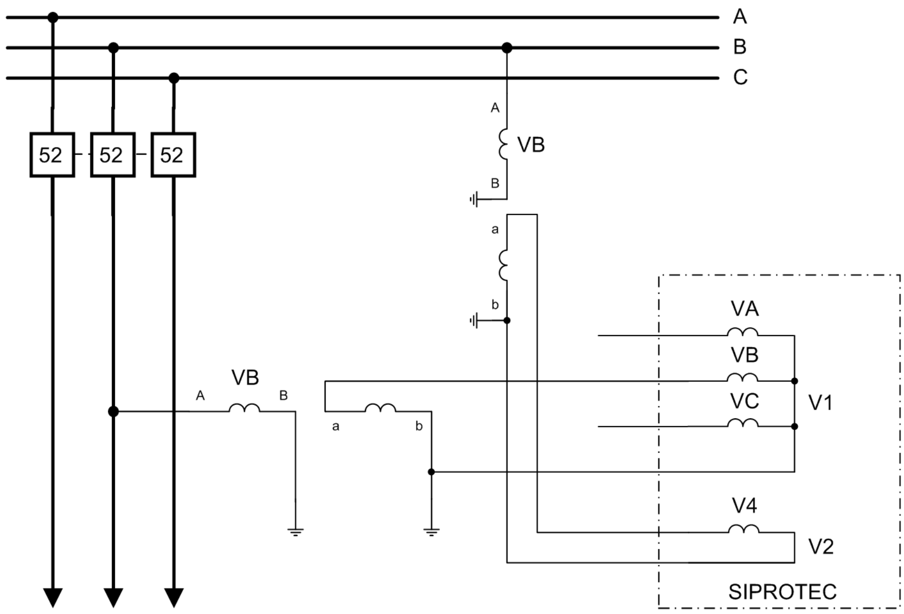


Figure 2-104 Connection of V1 and V2 at device



VT Connect. 3ph = (Not Relevant)
VT Connect. 1ph = Vbn

Figure 2-105 Single-phase connection (phase-ground) to side V_1

For the device to perform the internal conversion to primary values, the primary rated transformer voltage of the measured quantity V_2 must be entered via parameter 6x25 **VT Vn2, primary** if a transformer is located between the system parts to be synchronized.

Asynchronous Conditions

The synchronizing function of the 7SJ64 can issue a close command also for asynchronous power systems such that, considering the circuit breaker operating time (address 6x20), the power systems are coupled when the phases are equal.

Parameters 6x30**dV ASYN V2>V1** and 6x31**dV ASYN V2<V1** can be set to adjust the permissible voltage differences asymmetrically.

Parameters 6x32**df ASYN f2>f1** and 6x33**df ASYN f2<f1** limit the operating range for asynchronous switching. The availability of two parameters enables an asymmetrical range for closing to be set.

Synchronous Conditions

With address 6x40 **SYNC PERMIS.** a selection can be made to only check for synchronism conditions when the frequency is below the threshold **F SYNCHRON** (***YES***) or whether to operate with the asynchronous conditions over the entire frequency range (***NO***).

Address 6x41**F SYNCHRON** is an automatic threshold between synchronous and asynchronous switching. If the frequency difference is below the specified threshold, the power systems are considered to be synchronous and the conditions for synchronous switching apply. If it is above the threshold, the switching is asynchronous with consideration of the time left until the voltages are in phase.

Address 6x42**dV SYNC V2>V1** and 6x43**dV SYNC V2<V1** can be used to set the permissible voltage differences asymmetrically.

Address 6x44**dα SYNC α2> α1** and 6x45**dα SYNC α2< α1** confine the operating range for synchronous switching. These two parameters allow an asymmetrical switching range to be configured (see Figure 2-106).

Moreover, the release time delay **T SYNC-DELAY** (address 6x46) can be set during which all synchronous conditions must at least be fulfilled for the closing command to be generated after expiration of this time.

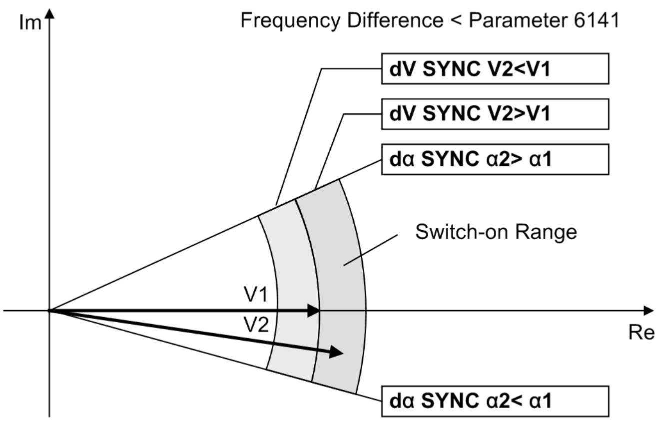


Figure 2-106 Switching under synchronous system conditions

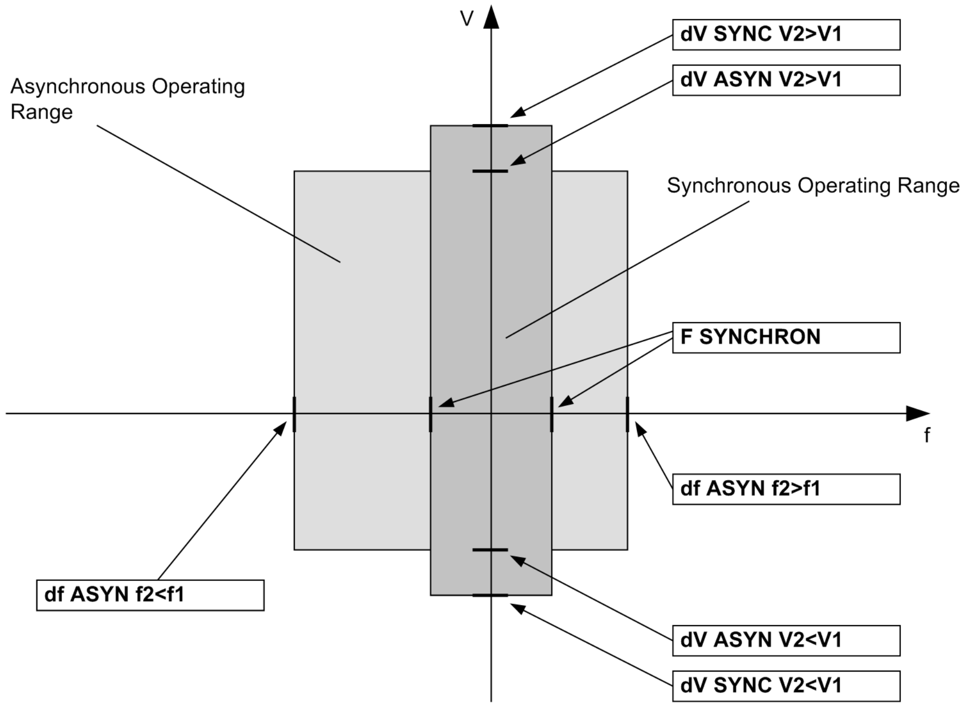


Figure 2-107 Operating range under synchronous and asynchronous conditions for voltage (V) and frequency (f)

Synchrocheck

Address 6x50**dV SYNCHK V2>V1** and 6x51**dV SYNCHK V2<V1** can be used to configure the permitted voltage difference also asymmetrically. The availability of two parameters enables an asymmetrical release range to be set.

Address 6x52**df SYNCHK f2>f1** and 6x53**df SYNCHK f2<f1** determine the permissible frequency differences. The availability of two parameters enables an asymmetrical release range to be set.

Addresses 6x54**dα SYNCHK α2>α1** and 6x55**dα SYNCHK α2<α1** confine the operating range for synchronous switching. The availability of two parameters enables an asymmetrical release range to be set.

Settings and Information

The following tables only list settings and messages for function group 1. The settings and messages of function groups 2 to 4 are the same type.

2.19.1.9 Settings

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

Addr.	Parameter	Setting Options	Default Setting	Comments
6101	Synchronizing	ON OFF	OFF	Synchronizing Function
6102	SyncCB	(Setting options depend on configuration)	None	Synchronizable circuit breaker
6103	Vmin	20 .. 125 V	90 V	Minimum voltage limit: Vmin
6104	Vmax	20 .. 140 V	110 V	Maximum voltage limit: Vmax
6105	V<	1 .. 60 V	5 V	Threshold V1, V2 without voltage
6106	V>	20 .. 140 V	80 V	Threshold V1, V2 with voltage
6107	SYNC V1<V2>	YES NO	NO	ON-Command at V1< and V2>
6108	SYNC V1>V2<	YES NO	NO	ON-Command at V1> and V2<
6109	SYNC V1<V2<	YES NO	NO	ON-Command at V1< and V2<
6110A	Direct CO	YES NO	NO	Direct ON-Command
6111A	TSUP VOLTAGE	0.00 .. 60.00 sec	0.10 sec	Supervision time of V1>;V2> or V1<;V2<
6112	T-SYN. DURATION	0.01 .. 1200.00 sec; ∞	30.00 sec	Maximum duration of Synchronization
6113A	25 Synchron	YES NO	YES	Switching at synchronous condition
6120	T-CB close	0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
6121	Balancing V1/V2	0.50 .. 2.00	1.00	Balancing factor V1/V2
6122A	ANGLE ADJUSTM.	0 .. 360 °	0 °	Angle adjustment (transformer)
6123	CONNECTIONof V2	A-G B-G C-G A-B B-C C-A	A-B	Connection of V2
6125	VT Vn2, primary	0.10 .. 800.00 kV	12.00 kV	VT nominal voltage V2, primary
6130	dV ASYN V2>V1	0.5 .. 50.0 V	2.0 V	Maximum voltage difference V2>V1
6131	dV ASYN V2<V1	0.5 .. 50.0 V	2.0 V	Maximum voltage difference V2<V1
6132	df ASYN f2>f1	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6133	df ASYN f2<f1	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1

Addr.	Parameter	Setting Options	Default Setting	Comments
6140	SYNC PERMIS.	YES NO	YES	Switching at synchronous conditions
6141	F SYNCHRON	0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6142	dV SYNC V2>V1	0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6143	dV SYNC V2<V1	0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6144	dα SYNC α2> α1	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6145	dα SYNC α2< α1	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6146	T SYNC-DELAY	0.00 .. 60.00 sec	0.00 sec	Release delay at synchronous conditions
6150	dV SYNCHK V2>V1	0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6151	dV SYNCHK V2<V1	0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6152	df SYNCHK f2>f1	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6153	df SYNCHK f2<f1	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6154	dα SYNCHK α2>α1	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6155	dα SYNCHK α2<α1	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1

2.19.1.10 Information List

No.	Information	Type of Information	Comments
170.0001	>25-1 act	SP	>25-group 1 activate
170.0043	>25 Measu. Only	SP	>25 Sync. Measurement Only
170.0049	25 CloseRelease	OUT	25 Sync. Release of CLOSE Command
170.0050	25 Sync. Error	OUT	25 Synchronization Error
170.0051	25-1 BLOCK	OUT	25-group 1 is BLOCKED
170.2007	25 Measu. req.	SP	25 Sync. Measuring request of Control
170.2008	>BLK 25-1	SP	>BLOCK 25-group 1
170.2009	>25direct CO	SP	>25 Direct Command output
170.2011	>25 Start	SP	>25 Start of synchronization
170.2012	>25 Stop	SP	>25 Stop of synchronization
170.2013	>25 V1>V2<	SP	>25 Switch to V1> and V2<
170.2014	>25 V1<V2>	SP	>25 Switch to V1< and V2>
170.2015	>25 V1<V2<	SP	>25 Switch to V1< and V2<
170.2016	>25 synchr.	SP	>25 Switch to Sync
170.2022	25-1 meas.	OUT	25-group 1: measurement in progress

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

2.20 Temperature Detection via RTD Boxes

Up to two temperature detection units (RTD-boxes) with 12 measuring sensors in total can be applied for temperature detection and are recognized by the protection device.

Applications

- In particular the RTDs enable the thermal status of motors, generators and transformers to be monitored. Rotating machines are additionally monitored for a violation of the bearing temperature thresholds. The temperatures are measured in different locations of the protected object by employing temperature sensors (RTD = Resistance Temperature Detector) and are transmitted to the device via one or two 7XV566 RTD-boxes.

2.20.1 Description

RTD-box 7XV56

The RTD-box 7XV566 is an external device mounted on a standard DIN rail. It features 6 temperature inputs and one RS485 interface for communication with the protection device. The RTD-box detects the coolant temperature of each measuring point from the resistance value of the temperature detectors (Pt 100, Ni 100 or Ni 120) connected via two- or three-wires and converts it to a numerical value. The numerical values are made available at a serial port.

Communication with the Protection Device

The protection device can employ up to two RTD-boxes via its service port (port C), 7SJ64 also via the additional port (port D).

Up to 12 temperature measuring points are available in this way. For greater distances to the protection device the communication via fibre optic cables is recommended. Alternative communication structures are shown in Appendix A.3.

Processing Temperatures

The transmitted raw temperature data is converted to a temperature in degrees Celsius or Fahrenheit. The conversion depends on the temperature sensor used.

For each temperature detector two threshold decisions can be performed which are available for further processing. The user can make the corresponding allocations in the configuration matrix.

Each temperature input issues an alarm in case of a short-circuit or an interruption of the sensor circuit or if a sensor is configured, but not assigned. Additionally, a group annunciation is generated via all 6 temperature inputs of an RTD-box (14101 „`Fail: RTD`“). In case of a communication fault, an alarm of the entire RTD-box is issued (264 „`Fail: RTD-Box 1`“ or 267 „`Fail: RTD-Box 2`“).

The following figure shows the logic diagram for temperature processing.

The manual supplied with the RTD-box contains a connection diagram and dimensioned drawing.

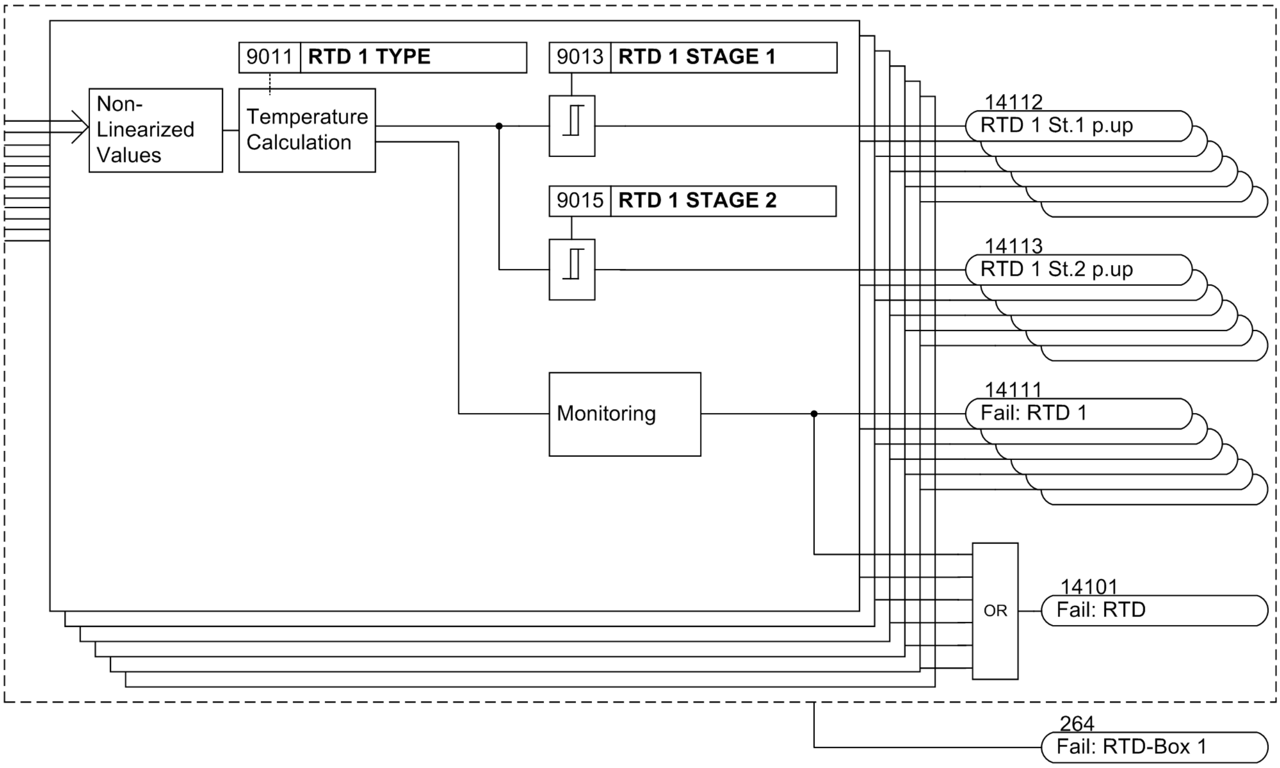


Figure 2-108 Logic diagram of the temperature processing for RTD-box 1

2.20.2 Setting Notes

General

The temperature detection function is only effective and accessible if it has been assigned to an interface during the configuration of the protection functions (Section 2.1.1). At address 190 **RTD-BOX INPUT** the RTD-box(es) is allocated to the interface at which it will be operated (e.g. port C). The number of sensor inputs and the communication mode were set at address 191 **RTD CONNECTION**. The temperature unit (°C or °F) was set in the Power System Data 1 at address 276 **TEMP. UNIT**.

Operating the RDT boxes in half-duplex mode requires „/CTS controlled by /RTS“ to be enabled for CTS (Clear-To-Send) via plug-in jumper (see Section 3.1.2 in Chapter „Mounting and Commissioning“).

Device Settings

The settings are the same for each input and are here shown at the example of measuring input 1.

Set the type of temperature detector for RTD 1 (temperature sensor for measuring point 1) at address 9011 **RTD 1 TYPE**. You can choose between ***Pt 100*** Ω, ***Ni 120*** Ω and ***Ni 100*** Ω. If no temperature detector is available for RTD 1, set **RTD 1 TYPE** = ***Not connected***. This setting is only possible via DIGSI® at "**Additional Settings**".

Address 9012 **RTD 1 LOCATION** informs the device on the mounting location of RTD 1. You can choose between ***Oil***, ***Ambient***, ***Winding***, ***Bearing*** and ***Other***. This setting is only possible via DIGSI® at **Additional Settings**.

Furthermore, you can set an alarm temperature and a tripping temperature. Depending on the temperature unit selected in the Power System Data (Section 2.1.1.2 in address 276 **TEMP. UNIT**), the alarm temperature can be expressed in Celsius (°C) (address 9013 **RTD 1 STAGE 1**) or Fahrenheit (°F) (address 9014 **RTD 1 STAGE**

1). The tripping temperature is set at address 9015 **RTD 1 STAGE 2** in degrees Celsius (°C) or Fahrenheit (°F) at address 9016 **RTD 1 STAGE 2**.

The settings for all temperature detectors connected are made accordingly.

RTD-box Settings

If temperature detectors are used with two-wire connection, the line resistance (for short-circuited temperature detector) must be measured and adjusted. For this purpose, select mode 6 in the RTD-box and enter the resistance value for the corresponding temperature detector (range 0 to 50.6 Ω). If a 3-wire connection is used, no further settings are required to this end.

A baudrate of 9600 bits/s ensures communication. Parity is even. The factory setting of the bus number 0. Modifications at the RTD-box can be made in mode 7. The following convention applies:

Table 2-24 Setting the bus address at the RTD-box

Mode	Number of RTD-boxes	Address
simplex	1	0
half duplex	1	1
half duplex	2	1. RTD-box: 1
		2. RTD-box: 2

Further information is provided in the operating manual of the RTD-box.

Processing Measured Values and Messages

The RTD-box is visible in DIGSI as part of the 7SJ62/63/64 protection devices, i.e. messages and measured values appear in the configuration matrix just like those of internal functions, and can be masked and processed in the same way. Messages and measured values can thus be forwarded to the integrated user-defined logic (CFC) and interconnected as desired. Pickup signals „RTD x St. 1 p.up“ and „RTD x St. 2 p.up“, however, are neither included in the group alarms 501 „Relay PICKUP“ and 511 „Relay TRIP“ nor do they trigger a trip log.

If it is desired that a message should appear in the event log, a cross must be entered in the intersecting box of column/row.

2.20.3 Settings

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

Addr.	Parameter	Setting Options	Default Setting	Comments
9011A	RTD 1 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Pt 100 Ω	RTD 1: Type
9012A	RTD 1 LOCATION	Oil Ambient Winding Bearing Other	Oil	RTD 1: Location
9013	RTD 1 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD 1: Temperature Stage 1 Pickup
9014	RTD 1 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD 1: Temperature Stage 1 Pickup
9015	RTD 1 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD 1: Temperature Stage 2 Pickup
9016	RTD 1 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD 1: Temperature Stage 2 Pickup
9021A	RTD 2 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 2: Type
9022A	RTD 2 LOCATION	Oil Ambient Winding Bearing Other	Other	RTD 2: Location
9023	RTD 2 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD 2: Temperature Stage 1 Pickup
9024	RTD 2 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD 2: Temperature Stage 1 Pickup
9025	RTD 2 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD 2: Temperature Stage 2 Pickup
9026	RTD 2 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD 2: Temperature Stage 2 Pickup
9031A	RTD 3 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 3: Type
9032A	RTD 3 LOCATION	Oil Ambient Winding Bearing Other	Other	RTD 3: Location
9033	RTD 3 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD 3: Temperature Stage 1 Pickup

Addr.	Parameter	Setting Options	Default Setting	Comments
9034	RTD 3 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD 3: Temperature Stage 1 Pickup
9035	RTD 3 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD 3: Temperature Stage 2 Pickup
9036	RTD 3 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD 3: Temperature Stage 2 Pickup
9041A	RTD 4 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 4: Type
9042A	RTD 4 LOCATION	Oil Ambient Winding Bearing Other	Other	RTD 4: Location
9043	RTD 4 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD 4: Temperature Stage 1 Pickup
9044	RTD 4 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD 4: Temperature Stage 1 Pickup
9045	RTD 4 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD 4: Temperature Stage 2 Pickup
9046	RTD 4 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD 4: Temperature Stage 2 Pickup
9051A	RTD 5 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 5: Type
9052A	RTD 5 LOCATION	Oil Ambient Winding Bearing Other	Other	RTD 5: Location
9053	RTD 5 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD 5: Temperature Stage 1 Pickup
9054	RTD 5 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD 5: Temperature Stage 1 Pickup
9055	RTD 5 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD 5: Temperature Stage 2 Pickup
9056	RTD 5 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD 5: Temperature Stage 2 Pickup
9061A	RTD 6 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 6: Type
9062A	RTD 6 LOCATION	Oil Ambient Winding Bearing Other	Other	RTD 6: Location

Addr.	Parameter	Setting Options	Default Setting	Comments
9063	RTD 6 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD 6: Temperature Stage 1 Pickup
9064	RTD 6 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD 6: Temperature Stage 1 Pickup
9065	RTD 6 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD 6: Temperature Stage 2 Pickup
9066	RTD 6 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD 6: Temperature Stage 2 Pickup
9071A	RTD 7 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 7: Type
9072A	RTD 7 LOCATION	Oil Ambient Winding Bearing Other	Other	RTD 7: Location
9073	RTD 7 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD 7: Temperature Stage 1 Pickup
9074	RTD 7 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD 7: Temperature Stage 1 Pickup
9075	RTD 7 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD 7: Temperature Stage 2 Pickup
9076	RTD 7 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD 7: Temperature Stage 2 Pickup
9081A	RTD 8 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 8: Type
9082A	RTD 8 LOCATION	Oil Ambient Winding Bearing Other	Other	RTD 8: Location
9083	RTD 8 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD 8: Temperature Stage 1 Pickup
9084	RTD 8 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD 8: Temperature Stage 1 Pickup
9085	RTD 8 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD 8: Temperature Stage 2 Pickup
9086	RTD 8 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD 8: Temperature Stage 2 Pickup
9091A	RTD 9 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 9: Type

Addr.	Parameter	Setting Options	Default Setting	Comments
9092A	RTD 9 LOCATION	Oil Ambient Winding Bearing Other	Other	RTD 9: Location
9093	RTD 9 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD 9: Temperature Stage 1 Pickup
9094	RTD 9 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD 9: Temperature Stage 1 Pickup
9095	RTD 9 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD 9: Temperature Stage 2 Pickup
9096	RTD 9 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD 9: Temperature Stage 2 Pickup
9101A	RTD10 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD10: Type
9102A	RTD10 LOCATION	Oil Ambient Winding Bearing Other	Other	RTD10: Location
9103	RTD10 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD10: Temperature Stage 1 Pickup
9104	RTD10 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD10: Temperature Stage 1 Pickup
9105	RTD10 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD10: Temperature Stage 2 Pickup
9106	RTD10 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD10: Temperature Stage 2 Pickup
9111A	RTD11 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD11: Type
9112A	RTD11 LOCATION	Oil Ambient Winding Bearing Other	Other	RTD11: Location
9113	RTD11 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD11: Temperature Stage 1 Pickup
9114	RTD11 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD11: Temperature Stage 1 Pickup
9115	RTD11 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD11: Temperature Stage 2 Pickup
9116	RTD11 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD11: Temperature Stage 2 Pickup

Addr.	Parameter	Setting Options	Default Setting	Comments
9121A	RTD12 TYPE	Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD12: Type
9122A	RTD12 LOCATION	Oil Ambient Winding Bearing Other	Other	RTD12: Location
9123	RTD12 STAGE 1	-50 .. 250 °C; ∞	100 °C	RTD12: Temperature Stage 1 Pickup
9124	RTD12 STAGE 1	-58 .. 482 °F; ∞	212 °F	RTD12: Temperature Stage 1 Pickup
9125	RTD12 STAGE 2	-50 .. 250 °C; ∞	120 °C	RTD12: Temperature Stage 2 Pickup
9126	RTD12 STAGE 2	-58 .. 482 °F; ∞	248 °F	RTD12: Temperature Stage 2 Pickup

2.20.4 Information List

No.	Information	Type of Information	Comments
264	Fail: RTD-Box 1	OUT	Failure: RTD-Box 1
267	Fail: RTD-Box 2	OUT	Failure: RTD-Box 2
14101	Fail: RTD	OUT	Fail: RTD (broken wire/shorted)
14111	Fail: RTD 1	OUT	Fail: RTD 1 (broken wire/shorted)
14112	RTD 1 St.1 p.up	OUT	RTD 1 Temperature stage 1 picked up
14113	RTD 1 St.2 p.up	OUT	RTD 1 Temperature stage 2 picked up
14121	Fail: RTD 2	OUT	Fail: RTD 2 (broken wire/shorted)
14122	RTD 2 St.1 p.up	OUT	RTD 2 Temperature stage 1 picked up
14123	RTD 2 St.2 p.up	OUT	RTD 2 Temperature stage 2 picked up
14131	Fail: RTD 3	OUT	Fail: RTD 3 (broken wire/shorted)
14132	RTD 3 St.1 p.up	OUT	RTD 3 Temperature stage 1 picked up
14133	RTD 3 St.2 p.up	OUT	RTD 3 Temperature stage 2 picked up
14141	Fail: RTD 4	OUT	Fail: RTD 4 (broken wire/shorted)
14142	RTD 4 St.1 p.up	OUT	RTD 4 Temperature stage 1 picked up
14143	RTD 4 St.2 p.up	OUT	RTD 4 Temperature stage 2 picked up
14151	Fail: RTD 5	OUT	Fail: RTD 5 (broken wire/shorted)
14152	RTD 5 St.1 p.up	OUT	RTD 5 Temperature stage 1 picked up
14153	RTD 5 St.2 p.up	OUT	RTD 5 Temperature stage 2 picked up
14161	Fail: RTD 6	OUT	Fail: RTD 6 (broken wire/shorted)
14162	RTD 6 St.1 p.up	OUT	RTD 6 Temperature stage 1 picked up
14163	RTD 6 St.2 p.up	OUT	RTD 6 Temperature stage 2 picked up
14171	Fail: RTD 7	OUT	Fail: RTD 7 (broken wire/shorted)
14172	RTD 7 St.1 p.up	OUT	RTD 7 Temperature stage 1 picked up
14173	RTD 7 St.2 p.up	OUT	RTD 7 Temperature stage 2 picked up
14181	Fail: RTD 8	OUT	Fail: RTD 8 (broken wire/shorted)
14182	RTD 8 St.1 p.up	OUT	RTD 8 Temperature stage 1 picked up
14183	RTD 8 St.2 p.up	OUT	RTD 8 Temperature stage 2 picked up
14191	Fail: RTD 9	OUT	Fail: RTD 9 (broken wire/shorted)
14192	RTD 9 St.1 p.up	OUT	RTD 9 Temperature stage 1 picked up
14193	RTD 9 St.2 p.up	OUT	RTD 9 Temperature stage 2 picked up
14201	Fail: RTD10	OUT	Fail: RTD10 (broken wire/shorted)
14202	RTD10 St.1 p.up	OUT	RTD10 Temperature stage 1 picked up
14203	RTD10 St.2 p.up	OUT	RTD10 Temperature stage 2 picked up
14211	Fail: RTD11	OUT	Fail: RTD11 (broken wire/shorted)
14212	RTD11 St.1 p.up	OUT	RTD11 Temperature stage 1 picked up
14213	RTD11 St.2 p.up	OUT	RTD11 Temperature stage 2 picked up
14221	Fail: RTD12	OUT	Fail: RTD12 (broken wire/shorted)
14222	RTD12 St.1 p.up	OUT	RTD12 Temperature stage 1 picked up
14223	RTD12 St.2 p.up	OUT	RTD12 Temperature stage 2 picked up

2.21 Phase Rotation

A phase rotation feature via binary input and parameter is implemented in devices 7SJ62/63/64.

Applications

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

2.21.1 Description

General

Various functions of the 7SJ62/63/64 only operate correctly if the phase rotation of the voltages and currents is known. Among these functions are negative sequence protection, undervoltage protection (based only on positive sequence voltages), directional overcurrent protection (direction with cross-polarized voltages), and measured value monitors.

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

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

Logic

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

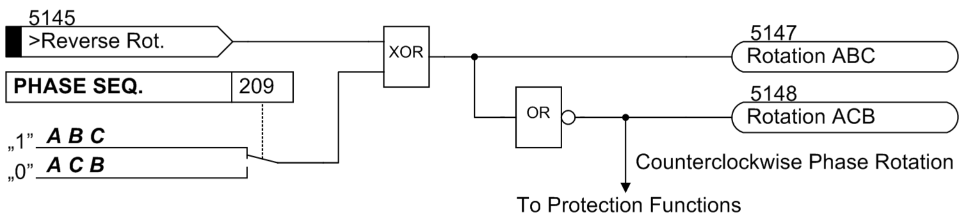


Figure 2-109 Message logic of the phase-sequence reversal

Influence on Protective and Monitoring Functions

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

2.21.2 Setting Notes

Programming Settings

The normal phase sequence is set at `209` (see Section 2.1.3). If, on the system side, phase rotation is reversed temporarily, then this is communicated to the protective device using the binary input „`>Reverse Rot.`“ (5145).

2.22 Function Logic

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

– Fault Detection / Pickup Logic

– Processing Tripping Logic

2.22.1 Pickup Logic for the Entire Device

General Pickup

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

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

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

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

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

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

2.22.2 Tripping Logic of the Entire Device

General Tripping

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

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

Terminating the Trip Signal

Once the trip command is output by the protection function, it is recorded as message „`Relay TRIP`“ (see figure 2-110). At the same time, the minimum trip command duration **`TMin TRIP CMD`** is started. This ensures that the command is transmitted to the circuit breaker for a sufficient amount of time, even if the function which issued the trip signal drops out quickly. The trip commands can be terminated first when the last protection function has dropped out (no function is in pickup mode) AND the minimum trip signal duration has expired.

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

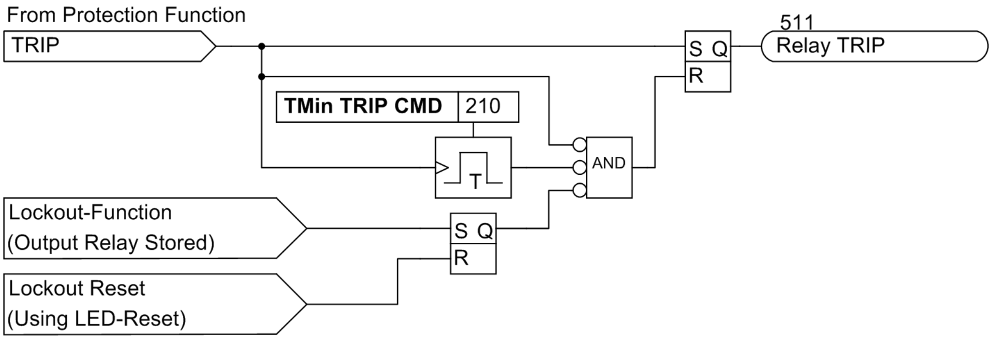


Figure 2-110 Terminating the Trip Signal

2.22.3 Setting Notes

Trip Signal Duration

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

2.23 Auxiliary Functions

Chapter Auxiliary Functions describes the general device functions.

2.23.1 Commissioning Aids with Browser (7SJ64 only)

2.23.1.1 Functional Description

The device is provided with a comprehensive commissioning and monitoring tool that checks the whole protection system: the Web-Monitor. The documentation for this tool is available on CD-ROM with DIGSI, and in the Internet under www.siprotec.com.

To ensure a proper communication between the device and the PC browser the transmission speed must be equal for both. Furthermore, the user must set an IP-address so that the browser can identify the device.

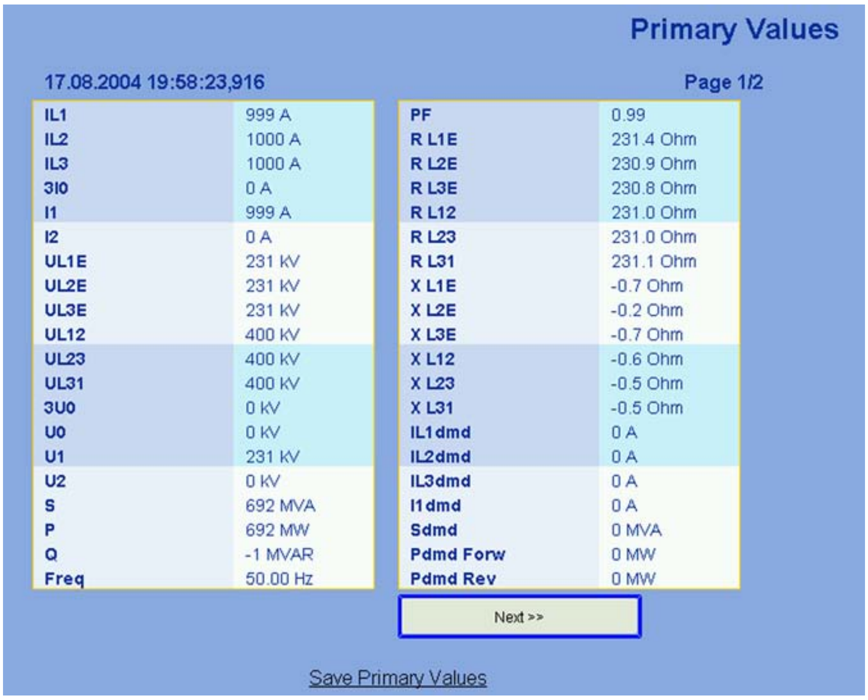
Thanks to the Web-Monitor the user is able to operate the device with the PC. On the PC screen the front panel of the device is emulated, a function that can also be deactivated by the settings. The actual operation of the device can now be simulated with the mouse pointer. This possibility can be disabled.

If the device is equipped with an EN100 module, operation by DIGSI or the Web-Monitor is also possible via Ethernet. All that has to be done is to set the IP configuration of the device accordingly. Parallel operation using DIGSI and Web-Monitor via different interfaces is possible.

Web-Monitor

The Web-Monitor provides quick and easy access to the most important data in the device. Using a personal computer equipped with a web browser, the Web-Monitor offers a detailed illustration of the most important measured values and of the protection data required for directional checks.

The measured values list can be selected from the navigation toolbar. A list with the desired information is displayed (see Figure 2-111).



Primary Values

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IL1	999 A	PF	0.99
IL2	1000 A	R L1E	231.4 Ohm
IL3	1000 A	R L2E	230.9 Ohm
3I0	0 A	R L3E	230.8 Ohm
I1	999 A	R L12	231.0 Ohm
I2	0 A	R L23	231.0 Ohm
UL1E	231 KV	R L31	231.1 Ohm
UL2E	231 KV	X L1E	-0.7 Ohm
UL3E	231 KV	X L2E	-0.2 Ohm
UL12	400 KV	X L3E	-0.7 Ohm
UL23	400 KV	X L12	-0.6 Ohm
UL31	400 KV	X L23	-0.5 Ohm
3U0	0 KV	X L31	-0.5 Ohm
U0	0 KV	IL1dmd	0 A
U1	231 KV	IL2dmd	0 A
U2	0 KV	IL3dmd	0 A
S	692 MVA	I1dmd	0 A
P	692 MW	Sdmd	0 MVA
Q	-1 MVAR	Pdmd Forw	0 MW
Freq	50.00 Hz	Pdmd Rev	0 MW

Next >>

Save Primary Values

Figure 2-111 Measured values in the Web-Monitor — examples for measured values

The currents, voltages and their phase angles derived from the primary and secondary measured values, are graphically displayed as phasor diagrams (see Figure 2-112). In addition to phasor diagrams of the measured values, numerical values as well as frequency and device address are indicated. For details please refer to the documentation provided for the Web-Monitor.

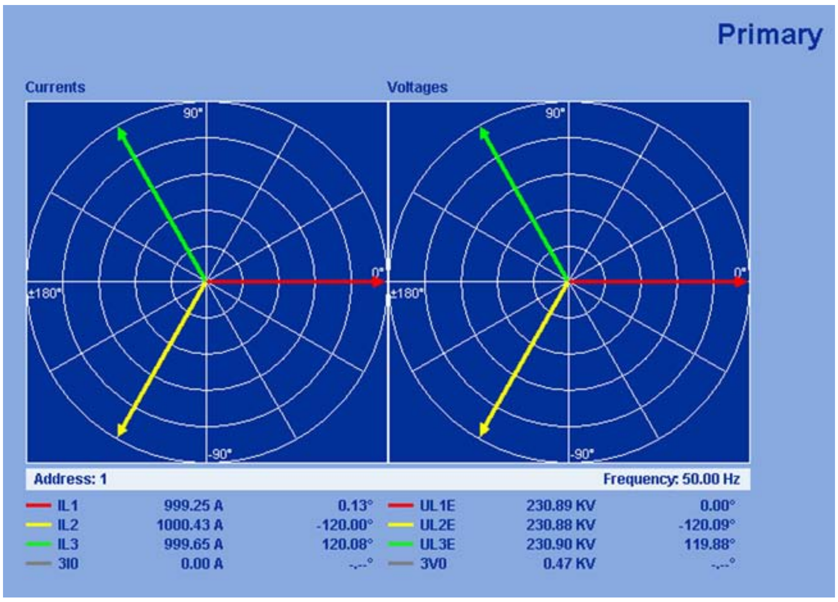


Figure 2-112 Phasor diagram of the primary measured values — Example

The following types of indications can be retrieved and displayed with the Web-Monitor

- Event Log (operational indications),
- Trip Log (fault indications),
- Earth Faults (Sensitive Earth Fault Log),
- Spontaneous indications

You can print these lists with the „Print event buffer“ button.

2.23.1.2 Setting Notes

The parameters of the Web-Monitor can be set separately for the front operator interface and the service interface. The relevant IP addresses are those which relate to the interface that is used for communication with the PC and the Web-Monitor.

Make sure that the 12-digit IP address valid for the browser is set correctly via DIGSI in the format ***.***.***.***.

2.23.2 Message Processing

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

Applications

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

Prerequisites

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

2.23.2.1 LED Display and Binary Outputs (output relays)

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

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

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

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

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

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

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

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

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

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

Classification of Messages

The messages are categorized as follows:

- Operational messages (event log); messages generated while the device is operating: Information regarding the status of device functions, measured data, power system data, control command logs etc.
- Fault messages (trip log): messages from the last 8 network faults that were processed by the device.
- Ground fault messages (when the device has sensitive ground fault detection).
- Messages of "statistics"; they include a counter for the trip commands initiated by the device, maybe 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 Displays on the Device Front

For devices featuring a four-line text display the most relevant fault data appears without further operating actions, automatically after a general pickup of the device, in the sequence shown in Figure 2-113.

If the device features a graphical display, these messages will only occur if they were set at address `611` unlike the default setting to allow for spontaneous fault messages.

`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 2-113 Display of spontaneous messages in the display – example

Retrieved 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.

Ground Faults (Sensitive Ground Fault Log)

For ground faults, there are available special ground fault logs for devices with sensitive ground fault detection. Messages are provided if the sensitive ground fault detection function is not set to ***`Alarm Only`*** (address `3101` = ***`Alarm Only`***). The pickup of the 64 element (VN>) starts the ground fault log. The drop out of this pickup finishes the ground fault log. The ground fault log starts by issuing the annunciation 303 „`sens Gnd flt`“ (ON), the function closes by issuing the annunciation OFF.

Up to 45 ground fault messages can be recorded for the last 3 ground faults. If more ground fault messages are generated, the oldest are deleted consecutively.

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.

2.23.2.3 Information to a Substation Control Center

If the device has a serial system interface, stored information may additionally be transferred via this interface to a centralized control and storage device. Transmission is possible via different transmission protocols.

2.23.3 Statistics

The number of trips initiated by the 7SJ62/63/64, the number of close commands initiated by the AR and the operating hours under load are counted. An additional counter allows the number of hours to be determined in which the circuit breaker is positioned in condition „open“. Further statistical data can be gained to optimize the intervals for circuit breaker maintenance.

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

2.23.3.1 Description

Number of Trips

In order to count the number of trips of the 7SJ62/63/64, the position of the circuit breaker must be monitored via breaker auxiliary contacts and binary inputs of the 7SJ62/63/64. Hereby it is necessary that the internal pulse counter is allocated in the matrix to a binary input that is controlled by the circuit breaker OPEN position. The pulse count value "Number of TRIPs CB" can be found in the "Statistics" group if the option "Measured and Metered Values Only" was enabled in the configuration matrix.

Number of Automatic Reclosing Commands

The number of reclosing commands initiated by the automatic reclosing function is summed up in separate counters for the 1st and ≥ 2nd cycle.

Operating Hours

The operating hours under load are also stored (= the current value in at least one phase is greater than the limit value **BkrClosed I MIN** set under address 212).

Hours counter “Circuit breaker is open”.

A counter can be implemented as CFC application which, similarly to the operating hours counter, counts the hours in the condition „circuit breaker open“. The universal hours counter is connected to a corresponding binary input and starts counting if the respective binary input is active. Alternatively, the counter can be started when the parameter value 212 **BkrClosed I MIN** is undershot. The counter can be set or reset. A CFC application example for such a counter is available on the Internet (SIPROTEC Download Area).

2.23.3.2 Circuit-Breaker Maintenance

General

The procedures aiding in CB maintenance allow maintenance intervals of the CB poles to be carried out when their actual degree of wear makes it necessary. Saving on maintenance and servicing costs is one of the main benefits this functionality offers.

The universal CB maintenance accumulates the tripping currents of the trips initiated by the protective functions and comprises the four following autonomous subfunctions:

- Summation tripping current (ΣI-procedure)
- Summation of tripping powers (ΣI^x-procedure)
- Two-point procedure for calculating the remaining lifetime (2P-procedure)
- Summation of all squared tripping current integrals (I^2t-procedure; only 7SJ64)

Measured value acquisition and preparation operates phase-selectively for all four subfunctions. The three results are each evaluated using a threshold which is specific for each procedure (see Figure 2-114).

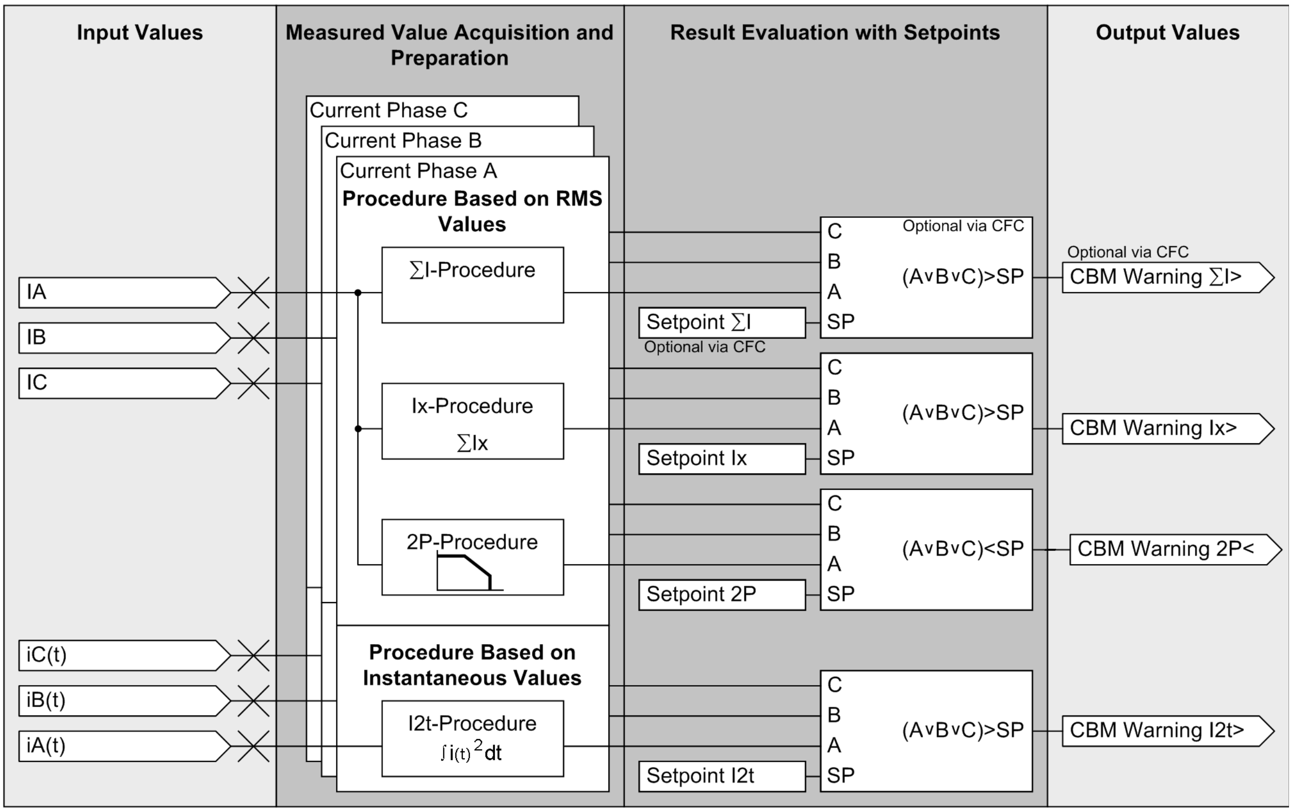


Figure 2-114 Diagram of CB maintenance procedures

Being a basic function, the ΣI-procedure is always enabled and active. The other procedures (ΣI^x, 2P and I^2t) can be selected by way of a shared configuration parameter. The I^2t-procedure is only implemented in the 7SJ64.

Current level and duration during the actual switching operation including arc extinction are crucial to the lifetime of the CB. Therefore, major importance is attached to the criteria for start and end. The procedures ΣI^x, 2P and I^2t make use of the same criteria for this purpose. Figure 2-115 depicts the logic of the start and end criterion.

The start criterion is satisfied by the group indication “Relay TRIP” in the event of an internal trip. Trips initiated by the internal control function are take into account for CB maintenance, provided parameter 265 **Cmd.via control** is set such that the relevant command is generated. A trip command initiated from an external source can be considered if the indication „>52 Wear start“ is produced simultaneously via binary input. A further criterion can be the edge of the going indication „>52-a“ in order to signalize that the mechanical system of the CB has started moving to separate the poles.

If the start criterion is satisfied, the configured CB operating time on tripping is launched. It determines the instant in which the CB poles start going apart. As an additional ex-manufacturer parameter, the CB operating time determines the end of the tripping operation including arc extinction.

To prevent calculation procedures being corrupted in the event of CB failure, current criterion 212 **BkrClosed I MIN** checks whether the current has really become zero after two additional periods. If the current criterion satisfies the phase-selective logic release, the calculation and evaluation procedures are triggered for each procedure. Once they have been terminated, the end criterion of CB maintenance is satisfied and it is ready for retriggering.

Please note that CB maintenance will be blocked if parameter settings are made incorrectly. This condition is indicated by the message „52 WearSet.fail“, „52WL.blk n PErr“ or „52WL.blk I PErr“ (see section 2.1.6.2, „Power System Data 2“). The latter two indications can only take effect if the 2P-procedure was configured.

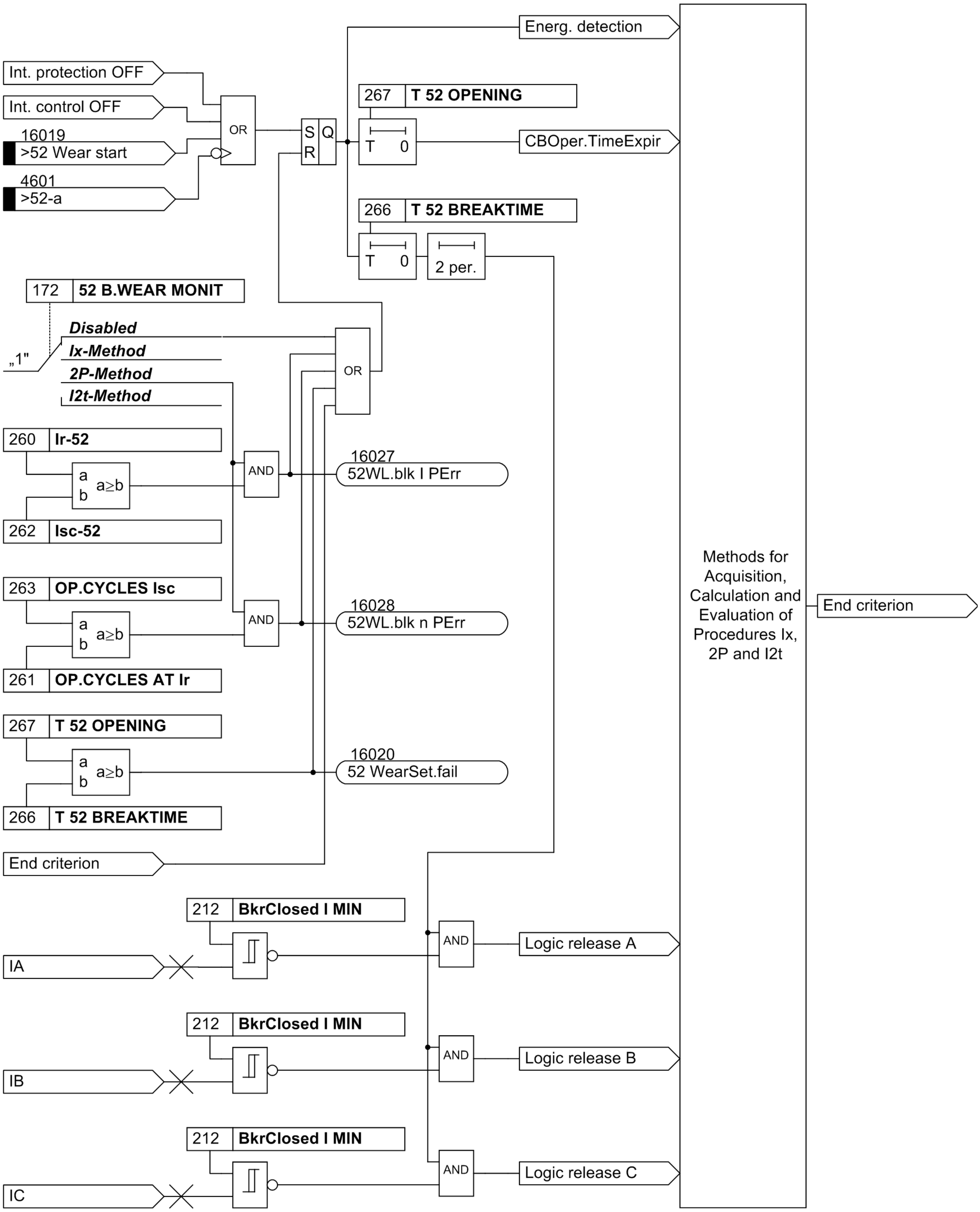


Figure 2-115 Logic of the start and end criterion

Σ I-Procedure

Being a basic function, the ΣI-procedure is unaffected by the configuration and does not require any procedure-specific settings. All tripping currents occurring $1^1/_2$ periods after a protective trip, are summed up for each phase. These tripping currents are rms values of the fundamental harmonic.

The interrupted current in each pole is determined for each trip signal. The interrupted fault current is indicated in the fault messages and is added up with previously stored fault current values in the statistic-counters. Measured values are indicated in primary terms.

The ΣI method does not feature integrated threshold evaluation. But using CFC it is possible to implement a threshold, which logically combines and evaluates the three summation currents via an OR operation. Once the summation current exceeds the threshold, a corresponding message will be triggered.

Σ I^x Procedure

While the ΣI-procedure is always enabled and active, use of the ΣI^x-procedure depends on the CB maintenance configuration. This procedure operates analogously to the ΣI-procedure. The differences relate to the involution of the tripping currents and their reference to the exponentiated rated operating current of the CB. Due to the reference to I_r^x, the result is an approximation to the number of make-break operations specified by the CB manufacturer. The displayed values can be interpreted as the number of trips at rated operational current of the CB. They are displayed in the statistics values without unit and with two decimal places.

The tripping currents used for calculation are a result of the rms values of the fundamental harmonic, which is recalculated each cycle.

If the start criterion is satisfied (as described in Section „General"), the rms values, which are relevant after expiration of the opening time, are checked for each phase as to whether they comply with the current criterion. If one of the values does not satisfy the criterion, its predecessor will be used instead for calculation. If no rms value satisfies the criterion until the predecessor of the starting point, which is marked by the start criterion, a trip has taken place which only affects the mechanical lifetime of the breaker and is consequently not detected by this procedure.

If the current criterion grants the logic release after the opening time has elapsed, the recent primary tripping currents (I_b) are involuted and related to the exponentiated rated operating current of the CB. These values are then added to the existing statistic values of the ΣI^x-procedure. Subsequently, threshold comparison is started using threshold „`ΣI^x>`", and the new related summation tripping current powers are output. If one of the new statistic values lies above the threshold, the message „`Threshold ΣI^x>`" is generated.

2P-Procedure

Availability of the two-point procedure for calculating the remaining lifetime depends on the CBM configuration. The data supplied by the CB manufacturer are thus converted that measurement of the tripping currents allows a reliable statement to be made concerning the still possible make-break operations. This is based on the double-logarithmic operating cycles diagrams of the CB manufacturers and the tripping currents measured the moment the poles part. The tripping currents are determined analogously to the method described previously for the ΣI^x-procedure.

The three results of the calculated remaining lifetime are represented as statistic value. The results represent the number of still possible trips, if the tripping takes place when the current reaches the rated operational current. They are displayed without unit and without decimals.

As with the other procedures, a threshold logically combines the three „remaining lifetime results" via an OR operation and evaluates them. It forms the „lower threshold", since the remaining lifetime is decremented with each trip by the corresponding number of operating cycles. If one of the three phase values drops below the threshold, a corresponding message will be triggered.

A double-logarithmic diagram provided by the CB manufacturer illustrates the relationship of operating cycles and tripping current (see example in Figure 2-116). This diagram allows the number of yet possible trips to be determined (for tripping with equal tripping current). According to the example, approximately 1000 trips can yet be carried out at a tripping current of 10 kA. The characteristic is determined by two vertices and their connecting line. Point P1 is determined by the number of permitted operating cycles at rated operating current Ir, point P2 by the maximum number of operating cycles at rated fault tripping current Isc. The associated four values can be configured.

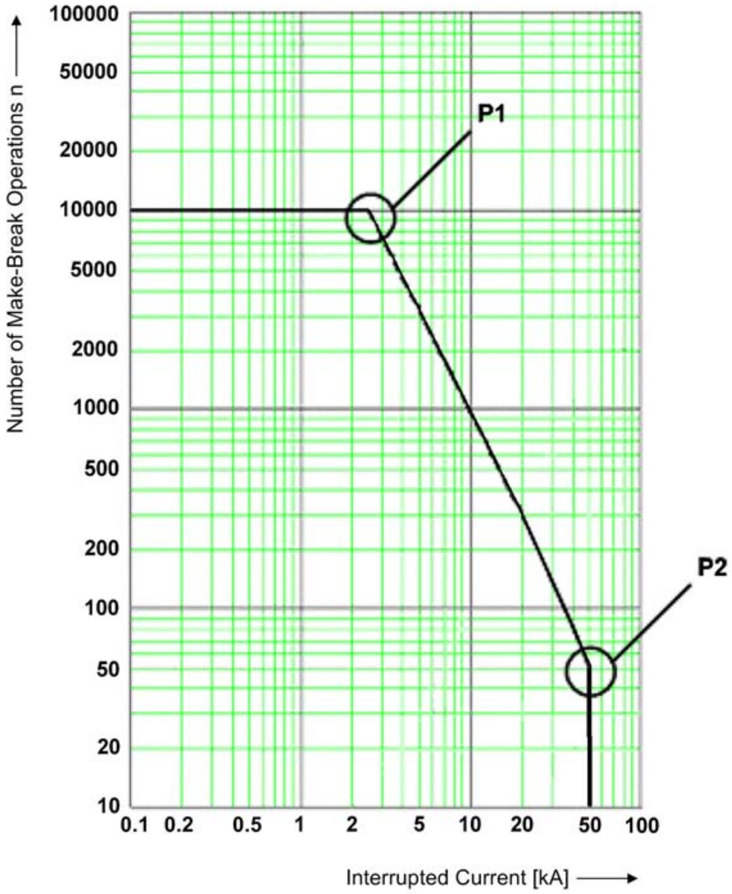


Figure 2-116 Diagram of operating cycles for the 2P procedure

Since figure 2-116 shows a double-logarithmic representation, the line connecting P1 and P2 can be described by means of the following exponential equation:

$n = b \cdot I_b^m$

where n is the number of operating cycles, b the operating cycles at I_b = 1A, I_b the tripping current, and m the directional coefficient.

The general line equation for the double-logarithmic representation can be derived from the exponential function and leads to the coefficients b and m.

Note

Since a directional coefficient of m < -4 is technically irrelevant, but could theoretically be the result of incorrect settings, it is limited to -4. If a coefficient is smaller than -4, the exponential function in the operating cycles diagram is deactivated. The maximum number of operating cycles with Isc (263 **OP.CYCLES Isc**) is used instead as the calculation result for the current number of operating cycles, see Figure 2-117.

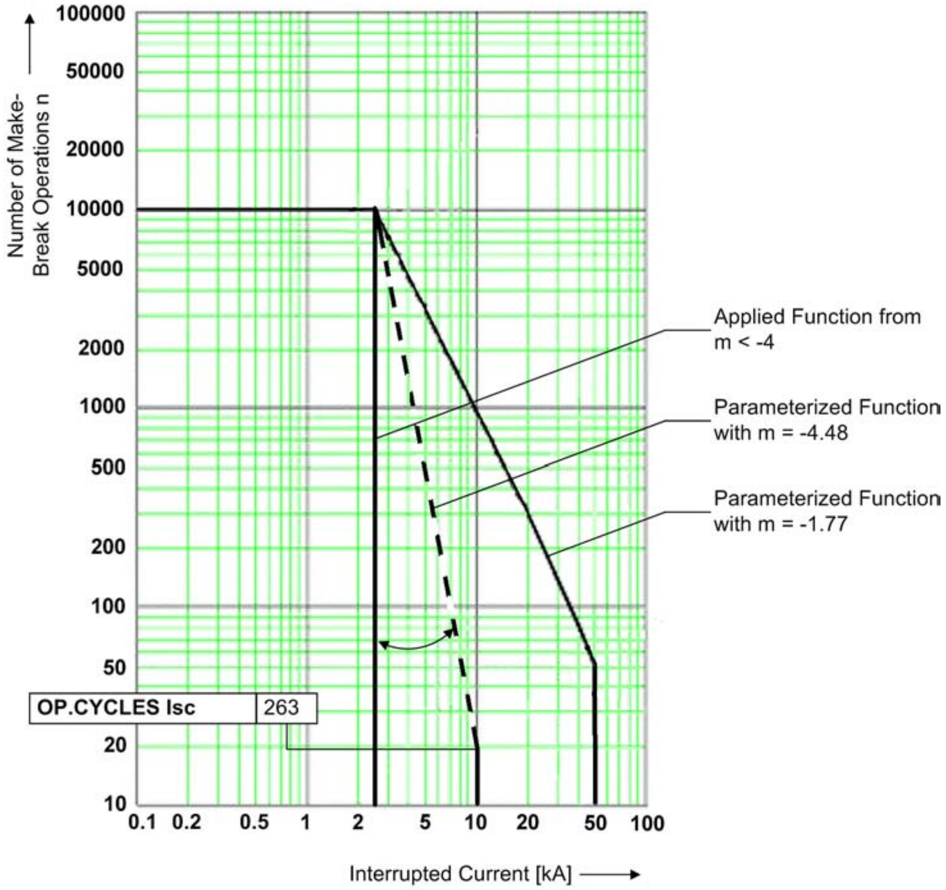


Figure 2-117 Value limitation of directional coefficient

If the current criterion described in the Section „General“ grants the phase-selective logic release, the present number of operating cycles is calculated based on the tripping currents determined when the CB operating time on tripping has elapsed. They are set off against the remaining lifetime allowing the present statistic values to be displayed and the evaluation to be started using the specified threshold. If one of the new values lies above the threshold, the message „Thresh.R.Endu.<“ is generated.

Three additional phase-selective statistic values are provided to determine the portion of purely mechanical trips among the results of the remaining lifetime (e.g. for phase A: „mechan.TRIP A=“). They act as counters which count only the trips whose tripping currents are below the value of the current criterion.

I^2t-Procedure

The I^2t-procedure depends on the CBM configuration and is only implemented in the 7SJ64. The squared tripping current integral is summated phase-selectively. The integral is calculated by means of the instantaneous values of the currents present during CB arcing time. This yields:

T CB arc = (parameter 266 **T 52 BREAKTIME**) – (parameter 267 **T 52 OPENING**).

The three sums of the calculated integrals are represented as statistic values referred to the squared device nominal current (I_{nom}^2). As with the other procedures, a threshold logically combines the three sums via an OR operation and evaluates them.

The calculated squared tripping currrent integrals are added to the existing statistic values. Subsequently, threshold comparison is started using threshold „ΣI^2t>“, and the new statistic values are output. If one of the values lies above the threshold, the message „Thresh. ΣI^2t>“ is generated.

Commissioning

No measures are usually required for commissioning. If the protective relay is replaced (i.e. old CB and new protective relay), the initial values of the limit and statistic values must be determined by means of a switching statistics of the CB in question.

2.23.3.3 Setting Notes

Reading/Setting/Resetting Counters

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

Circuit-Breaker Maintenance

One of the options ΣI^x-procedure, 2P-procedure, I^2t-procedure (only 7SJ64) or ***Disabled*** can be selected for CB maintenance at address 172.**52 B.WEAR MONIT**. All relevant parameters for these functions are available in settings block **P.System Data 1** (see section 2.1.3).

The following setting values are important input values the subfunctions require in order to operate correctly:

The CB Tripping Time is a characteristic value provided by the manufacturer. It covers the entire tripping process from the trip command (applying auxiliary power to the trip element of the circuit breaker) up to arc extinction in all poles. The time is set at address 266 **T 52 BREAKTIME**.

The CB Operating Time **T 52 OPENING** is equally a characteristic value of the circuit breaker. It covers the time span between the trip command (applying auxiliary power to the trip element of the circuit breaker) and separation of CB contacts in all poles. It is entered at address 267 **T 52 OPENING**.

The following diagram illustrates the relationship between these CB times.

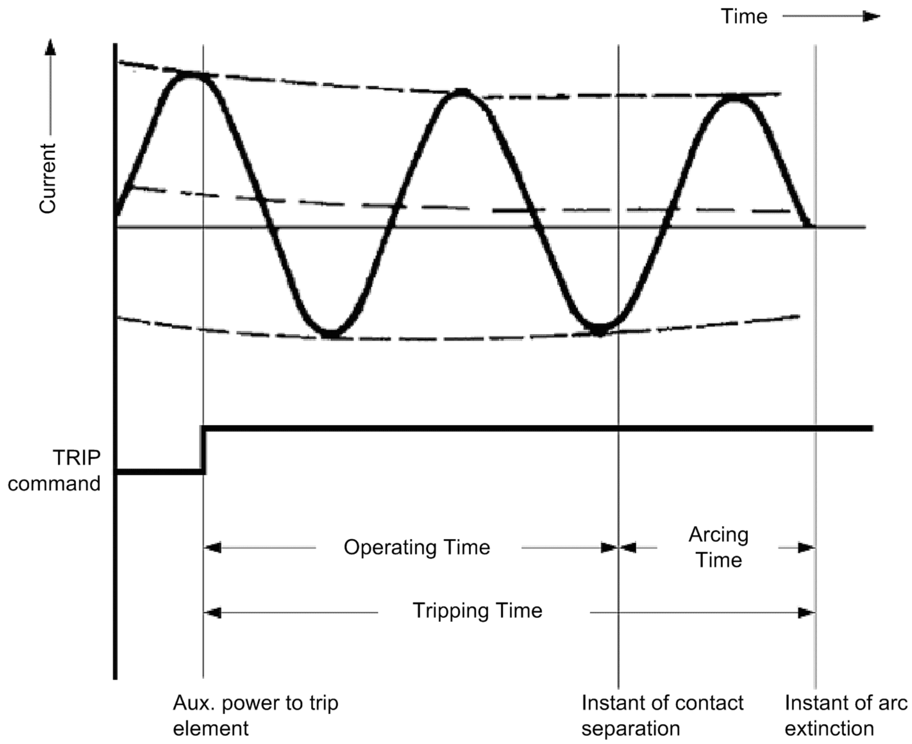


Figure 2-118 Illustration of the CB times

Current flow monitoring 212 **BkrClosed I MIN**, which some protective functions rely upon to detect a closed CB, is used as the current zero criterion. It should be set with respect to the actually used device functions (see also margin heading „Current Flow Monitoring (CB)“ in Section 2.1.3.2.

Σ I Procedure

Being the basic function of summation current formation, the ΣI-procedure is always active and does not require any additional settings. This is irrespective of the configuration in address 172 **52 B.WEAR MONIT**. This method does not offer integrated threshold evaluation. The latter could, however, be implemented using CFC.

Σ I^x Procedure

Parameter 172 **52 B.WEAR MONIT** can be set to activate the ΣI^x procedure. In order to facilitate evaluating the sum of all tripping current powers, the values are referred to the involuted CB rated operational current. This value is indicated in the CB data at address 260 **Ir-52** in the **P.System Data 1** and can be set as primary value. This reference allows the threshold of the ΣI^x procedure to correspond to the maximum number of make-break operations. For a circuit breaker, whose contacts have not yet been worn, the maximum number of make-break operations can be entered directly as threshold. The exponent for the involution of the rated operational current and of the tripping currents is set at address 264 **Ix EXPONENT**. To meet different customer requirements, this exponent 264**Ix EXPONENT** can be increased from ***1.0*** (default setting = ***2.0***) to ***3.0***.

For the procedure to operate correctly, the time response of the circuit breaker must be specified in parameters 266 **T 52 BREAKTIME** and 267 **T 52 OPENING**.

The summated values can be interpreted as the number of tripping operations at rated operational current of the CB. They are displayed in the statistics values without unit and with two decimal places.

2P-Procedure

Parameter 172 **52 B.WEAR MONIT** can be set to activate the 2P-procedure. An operating cycles diagram (see sample diagram in the functional description of the 2P-procedure), provided by the manufacturer, shows the relationship of make-break operations and tripping current. The two vertices of this characteristic in a double-logarithmic scale are decisive for the setting of address 260 to 263:

Point P1 is determined by the number of permitted make-break operations (parameter 261 **OP.CYCLES AT Ir**) for rated operational current Ir (parameter 260 **Ir-52**)

Point P2 is determined by the maximum number of make-break operations (parameter 263 **OP.CYCLES Isc**) for rated fault tripping current Isc (parameter 262 **Isc-52**).

For the procedure to operate correctly, the time response of the circuit breaker must be specified in parameters 266**T 52 BREAKTIME** and 267**T 52 OPENING**.

I^2t-Procedure

Parameter 172 **52 B.WEAR MONIT** is set to activate the I^2t-procedure (only 7SJ64). The squared tripping currrent integrals are referred to the squared nominal current of the device. In order to calculate the arcing time, the device requires the CB tripping time **T 52 BREAKTIME** and the CB operating time **T 52 OPENING**. The „current zero“ criterion is required to recognize the last zero crossing (arc extinction) of the currents after a trip.

2.23.3.4 Information List

No.	Information	Type of Information	Comments
-	#of TRIPs=	PMV	Number of TRIPs=
409	>BLOCK Op Count	SP	>BLOCK Op Counter
1020	Op.Hours=	VI	Counter of operating hours
1021	Σ Ia =	VI	Accumulation of interrupted current Ph A
1022	Σ Ib =	VI	Accumulation of interrupted current Ph B
1023	Σ Ic =	VI	Accumulation of interrupted current Ph 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
16001	ΣI^x A=	VI	Sum Current Exponentiation Ph A to Ir^x
16002	ΣI^x B=	VI	Sum Current Exponentiation Ph B to Ir^x
16003	ΣI^x C=	VI	Sum Current Exponentiation Ph C to Ir^x
16006	Resid.Endu. A=	VI	Residual Endurance Phase A
16007	Resid.Endu. B=	VI	Residual Endurance Phase B
16008	Resid.Endu. C=	VI	Residual Endurance Phase C
16011	mechan.TRIP A=	VI	Number of mechanical Trips Phase A
16012	mechan.TRIP B=	VI	Number of mechanical Trips Phase B
16013	mechan.TRIP C=	VI	Number of mechanical Trips Phase C
16014	ΣI^2t A=	VI	Sum Squared Current Integral Phase A
16015	ΣI^2t B=	VI	Sum Squared Current Integral Phase B
16016	ΣI^2t C=	VI	Sum Squared Current Integral Phase C

2.23.4 Measurement

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

Applications

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

Prerequisites

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

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

2.23.4.1 Display of Measured Values

Table 2-25 Conversion formulae between secondary values and primary/percentage values

Measured Values	secondary	primary	%
I_A, I_B, I_C, I_1, I_2	I_{sec}	$\frac{\text{CT PRIMARY}}{\text{CT SECONDARY}} \cdot I_{SEC.}$	$\frac{I_{prim.}}{\text{FullScaleCurr.}}$
$I_N = 3 \cdot I_0$ (calculated)	$I_{N\ sec}$	$\frac{\text{CT PRIMARY}}{\text{CT SECONDARY}} \cdot I_{NSEC.}$	$\frac{I_{N\,prim.}}{\text{FullScaleCurr.}}$
I_N = measured value of I_N input	$I_{N\ sec}$	$\frac{\text{Ignd} - \text{CT PRIM}}{\text{Ignd} - \text{CT SEC}} \cdot I_{N\ SEC.}$	$\frac{I_{N\,prim.}}{\text{FullScaleCurr.}}$
I_{Ns} (I_{Ns}, $I_{3I0real}$, $I_{3I0reactive}$	$I_{Ns\ sec.}$	$\frac{\text{Ignd} - \text{CT PRIM}}{\text{Ignd} - \text{CT SEC}} \cdot I_{Ns\ SEC.}$	$\frac{I_{Ns\ prim.}}{\text{FullScaleCurr.}}$
V_A, V_B, V_C, V_0, V_1, V_2, V_4	$V_{Ph\text{-}N\ sec.}$	$\frac{\text{Vnom PRIMARY}}{\text{Vnom SECONDARY}} \cdot V_{\phi g\ SEC.}$	$\frac{V_{prim.}}{\text{FullScaleVolt.}/(\sqrt{3})}$
V_{A-B}, V_{B-C}, V_{C-A}	$V_{Ph\text{-}Ph\ sec.}$	$\frac{\text{Vnom PRIMARY}}{\text{Vnom SECONDARY}} \cdot V_{\phi\phi\ SEC.}$	$\frac{V_{prim.}}{\text{FullScaleVolt.}}$
V_N	$V_{N\ sec.}$	$\text{Vph}/\text{Vdelta} \cdot \frac{\text{Vnom PRIMARY}}{\text{Vnom SECONDARY}} \cdot V_{N\ SEC.}$	$\frac{V_{prim.}}{\sqrt{3} \cdot \text{FullScaleVolt.}}$

Measured Values	second-ary	primary	%
P, Q, S (P and Q phase-segregated)	No secondary measured values		$\frac{\text{Power}_{\text{prim.}}}{\sqrt{3} \cdot (\text{FullScaleVolt.}) \cdot (\text{FullScaleCurr.})}$
Power Factor (phase-segregated)	cos φ	cos φ	cos φ · 100 in %
Frequency Protec-tion	f in Hz	f in Hz	$\frac{\text{f in Hz}}{f_{\text{Nom}}} \cdot 100$

Table 2-26 Legend with conversion formulae

Parameter	Address	Parameter	Address
Vnom PRIMARY	202	Ignd-CT PRIM	217
Vnom SECONDARY	203	Ignd-CT SEC	218
CT PRIMARY	204	FullScaleVolt.	1101
CT SECONDARY	205	FullScaleCurr.	1102
Vph / Vdelta	206		

Depending on the type of device ordered and the device connections, some of the operational measured values listed below may not be available. The phase–to–ground voltages are either measured directly, if the voltage inputs are connected phase–to–ground, or they are calculated from the phase–to–phase voltages V_{A-B} and V_{B-C} and the displacement voltage V_N.

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

$V_N = 3V_0/(V_{ph} / V_{delta})$ with $3V_0 = (V_a + V_b + V_c)$

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

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

The ground current I_N is either measured directly or calculated from the conductor currents:

$$I_N = \frac{3 \cdot I_0}{I_{gnd\text{-}CT} / (CT)}$$

with $3\underline{I}_0 = (I_a + I_b + I_c)$

$I_{gnd\text{-}CT}$ = Parameter 0217 or 0218

CT = Parameter 0204 or 0205

In addition, the following may be available:

- Θ/Θ_{Trip} **thermal measured value** of overload protection value for stator in % of the trip initiating overtemperature
- Θ/Θ_{LTrip} **thermal measured value** of restart inhibit (rotor winding)
- $\Theta_{Restart}$ **restarting limit** of restart inhibit
- $T_{Reclose}$ **total time**, before the motor can be restarted
- $\Theta_{RTD\ 1}$ to $\Theta_{RTD\ 12}$ **temperature values** at the RTD-boxes.

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 to the power factor cosφ. It is occasionally desired to define the power draw from the line (e.g. as seen from the consumer) positively. Parameter 1108 **P,Q sign** allows the signs for these componenets to be inverted.

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

2.23.4.2 Transfer of Measured Values

Measured values can be transferred via the interfaces to a central control and storage unit.

2.23.4.3 Information List

No.	Information	Type of Information	Comments
268	Superv.Pressure	OUT	Supervision Pressure
269	Superv.Temp.	OUT	Supervision Temperature
601	Ia =	MV	Ia
602	Ib =	MV	Ib
603	Ic =	MV	Ic
604	In =	MV	In
605	I1 =	MV	I1 (positive sequence)
606	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

No.	Information	Type of Information	Comments
627	VN =	MV	VN
629	V1 =	MV	V1 (positive sequence)
630	V2 =	MV	V2 (negative sequence)
632	Vsync =	MV	Vsync (synchronism)
641	P =	MV	P (active power)
642	Q =	MV	Q (reactive power)
644	Freq=	MV	Frequency
645	S =	MV	S (apparent power)
661	Θ REST. =	MV	Threshold of Restart Inhibit
701	INs Real	MV	Resistive ground current in isol systems
702	INs Reac	MV	Reactive ground current in isol systems
805	Θ Rotor	MV	Temperature of Rotor
807	Θ/Θtrip	MV	Thermal Overload
809	T reclose=	MV	Time untill release of reclose-blocking
830	INs =	MV	INs Senstive Ground Fault Current
831	3Io =	MV	3Io (zero sequence)
832	Vo =	MV	Vo (zero sequence)
901	PF =	MV	Power Factor
991	Press =	MVU	Pressure
992	Temp =	MVU	Temperature
996	Td1=	MV	Transducer 1
997	Td2=	MV	Transducer 2
1068	Θ RTD 1 =	MV	Temperature of RTD 1
1069	Θ RTD 2 =	MV	Temperature of RTD 2
1070	Θ RTD 3 =	MV	Temperature of RTD 3
1071	Θ RTD 4 =	MV	Temperature of RTD 4
1072	Θ RTD 5 =	MV	Temperature of RTD 5
1073	Θ RTD 6 =	MV	Temperature of RTD 6
1074	Θ RTD 7 =	MV	Temperature of RTD 7
1075	Θ RTD 8 =	MV	Temperature of RTD 8
1076	Θ RTD 9 =	MV	Temperature of RTD 9
1077	Θ RTD10 =	MV	Temperature of RTD10
1078	Θ RTD11 =	MV	Temperature of RTD11
1079	Θ RTD12 =	MV	Temperature of RTD12
30701	Pa =	MV	Pa (active power, phase A)
30702	Pb =	MV	Pb (active power, phase B)
30703	Pc =	MV	Pc (active power, phase C)
30704	Qa =	MV	Qa (reactive power, phase A)
30705	Qb =	MV	Qb (reactive power, phase B)
30706	Qc =	MV	Qc (reactive power, phase C)
30707	PFa =	MV	Power Factor, phase A
30708	PFb =	MV	Power Factor, phase B
30709	PFc =	MV	Power Factor, phase C

2.23.5 Average Measurements

The long-term averages are calculated and output by the 7SJ62/63/64.

2.23.5.1 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.

2.23.5.2 Setting Notes

Average Calculation

The selection of the time period for measured value averaging is set with parameter 8301 **DMD Interval** in the corresponding setting group from A to D under **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: Time average is generated for all measured values with a window of 15 minutes. The output is updated every 15/3 = 5 minutes.

With address 8302 **DMD Sync.Time**, the starting time for the averaging window set under address 8301 is determined. This setting specifies if the window should start on the hour (***On The Hour***) or 15 minutes later (***15 After Hour***) or 30 minutes / 45 minutes after the hour (***30 After Hour***, ***45 After Hour***).

If the settings for averaging are changed, then 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.

2.23.5.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
8301	DMD Interval	15 Min., 1 Sub 15 Min., 3 Subs 15 Min.,15 Subs 30 Min., 1 Sub 60 Min., 1 Sub 60 Min.,10 Subs 5 Min., 5 Subs	60 Min., 1 Sub	Demand Calculation Intervals
8302	DMD Sync.Time	On The Hour 15 After Hour 30 After Hour 45 After Hour	On The Hour	Demand Synchronization Time

2.23.5.4 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

2.23.6 Min/Max Measurement Setup

Minimum and maximum values are calculated by the 7SJ62/63/64. Time and date of the last update of the values can also be read out.

2.23.6.1 Description

Minimum and Maximum Values

The minimum and maximum values for the three phase currents I_x, the three phase-to-ground voltages V_{xg}, the three phase-to-phase voltages V_{xy}, the positive sequence components I_1 and V_1, the displacement voltage V_0, the thermal measured value of overload protection Θ/Θ_{off}, the real power P, reactive power Q, and apparent power S, the frequency; and the power factor cos φ are calculated 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 previous section are also calculated.

At any time the min/max values can be reset via binary inputs, via DIGSI ® or via the integrated control panel. In addition, the reset can also take place cyclically, beginning with a pre-selected point in time.

2.23.6.2 Setting Notes

Minimum and Maximum Values

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

2.23.6.3 Settings

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

2.23.6.4 Information List

No.	Information	Type of Information	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
412	> Θ MiMa Reset	SP	>Theta 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 Minimum
848	QdMax=	MVT	Reactive Power Maximum
849	SdMin=	MVT	Apparent Power Minimum
850	SdMax=	MVT	Apparent Power Maximum
851	Ia Min=	MVT	Ia Min
852	Ia Max=	MVT	Ia Max
853	Ib Min=	MVT	Ib Min

No.	Information	Type of Information	Comments
854	Ib Max=	MVT	Ib Max
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
872	Vn Min =	MVT	V neutral Min
873	Vn Max =	MVT	V neutral Max
874	V1 Min =	MVT	V1 (positive sequence) Voltage Minimum
875	V1 Max =	MVT	V1 (positive sequence) Voltage Maximum
876	Pmin=	MVT	Active Power Minimum
877	Pmax=	MVT	Active Power Maximum
878	Qmin=	MVT	Reactive Power Minimum
879	Qmax=	MVT	Reactive Power Maximum
880	Smin=	MVT	Apparent Power Minimum
881	Smax=	MVT	Apparent Power Maximum
882	fmin=	MVT	Frequency Minimum
883	fmax=	MVT	Frequency Maximum
884	PF Max=	MVT	Power Factor Maximum
885	PF Min=	MVT	Power Factor Minimum
1058	Θ/ΘTrpMax=	MVT	Overload Meter Max
1059	Θ/ΘTrpMin=	MVT	Overload Meter Min

2.23.7 Set Points for Measured Values

SIPROTEC® devices allow limit values (set points) to be set for some measured and metered values. If, during operation, a value reaches one of these limit values, the device generates an alarm which is indicated as an operational message. This can be configured to LEDs and/or binary outputs, transferred via the ports and interconnected in DIGSI® CFC. In addition you can use DIGSI® CFC to configure limit values for further measured and metered values and allocate these via the DIGSI® device matrix. In contrast to the actual protection functions the limit value monitoring function operates in the background; therefore it may not pick up if measured values are changed spontaneously in the event of a fault and if protection functions are picked up. Furthermore, since a message is only issued when the limit value is repeatedly exceeded, the limit value monitoring functions do not react as fast as protection functions trip signals.

Applications

- This monitoring program works with multiple measurement repetitions and lower priority than the protection functions. For that reason, in the event of a fault it may not respond to fast measured value changes before protection functions are started and tripped. This monitoring program is not suitable for blocking protection functions.

2.23.7.1 Description

Limit Value Monitoring

Ex works, the following individual limit value levels are configured:

- IAdmd>: Exceeding a preset maximum average value in Phase A.
- IBdmd>: Exceeding a preset maximum average value in Phase B.
- ICdmd>: Exceeding a preset maximum average value in Phase C.
- I1dmd>: Exceeding a preset maximum average positive sequence current.
- |Pdmd|> : Exceeding a preset maximum average active power.
- |Qdmd|>: Exceeding a preset maximum average reactive power.
- Sdmd>: Exceeding a preset maximum average value of reactive power.
- Temp>: Exceeding a preset temperature (if measuring transducer available).
- Pressure<: Exceeding a preset pressure (if measuring transducer available).
- IL<: Falling below a preset current in any phase.
- |cosφ |<: Falling below a preset power factor.

2.23.7.2 Setting Notes

Limit Values for Measured Values

Setting is performed in the DIGSI Configuration Matrix under **Settings**, **Masking I/O (Configuration Matrix)**. Set the filter "Measured and Metered Values Only" and select the configuration group "Setpoints (LV)". Here, default settings may be changed or new limit values defined.

Settings must be applied in percent and usually refer to nominal values of the device.

2.23.7.3 Information List

<table>
<tr><th>No.</th><th>Information</th><th>Type of Information</th><th>Comments</th></tr>
<tr><td>-</td><td>I Admd></td><td>LV</td><td>I A dmd></td></tr>
<tr><td>-</td><td>I Bdmd></td><td>LV</td><td>I B dmd></td></tr>
<tr><td>-</td><td>I Cdmd></td><td>LV</td><td>I C dmd></td></tr>
<tr><td>-</td><td>I1dmd></td><td>LV</td><td>I1dmd></td></tr>
<tr><td>-</td><td>|Pdmd|></td><td>LV</td><td>|Pdmd|></td></tr>
<tr><td>-</td><td>|Qdmd|></td><td>LV</td><td>|Qdmd|></td></tr>
<tr><td>-</td><td>|Sdmd|></td><td>LV</td><td>|Sdmd|></td></tr>
<tr><td>-</td><td>Press<</td><td>LVU</td><td>Pressure<</td></tr>
<tr><td>-</td><td>Temp></td><td>LVU</td><td>Temp></td></tr>
<tr><td>-</td><td>37-1</td><td>LV</td><td>37-1 under current</td></tr>
<tr><td>-</td><td>|PF|<</td><td>LV</td><td>|Power Factor|<</td></tr>
<tr><td>270</td><td>SP. Pressure<</td><td>OUT</td><td>Set Point Pressure<</td></tr>
<tr><td>271</td><td>SP. Temp></td><td>OUT</td><td>Set Point Temp></td></tr>
<tr><td>273</td><td>SP. I A dmd></td><td>OUT</td><td>Set Point Phase A dmd></td></tr>
<tr><td>274</td><td>SP. I B dmd></td><td>OUT</td><td>Set Point Phase B dmd></td></tr>
<tr><td>275</td><td>SP. I C dmd></td><td>OUT</td><td>Set Point Phase C dmd></td></tr>
<tr><td>276</td><td>SP. I1dmd></td><td>OUT</td><td>Set Point positive sequence I1dmd></td></tr>
<tr><td>277</td><td>SP. |Pdmd|></td><td>OUT</td><td>Set Point |Pdmd|></td></tr>
<tr><td>278</td><td>SP. |Qdmd|></td><td>OUT</td><td>Set Point |Qdmd|></td></tr>
<tr><td>279</td><td>SP. |Sdmd|></td><td>OUT</td><td>Set Point |Sdmd|></td></tr>
<tr><td>284</td><td>SP. 37-1 alarm</td><td>OUT</td><td>Set Point 37-1 Undercurrent alarm</td></tr>
<tr><td>285</td><td>SP. PF(55)alarm</td><td>OUT</td><td>Set Point 55 Power factor alarm</td></tr>
</table>

2.23.8 Set Points for Statistic

2.23.8.1 Description

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

2.23.8.2 Setting Notes

Limit Values for the Statistic Counter

Limit values for the statistic counter are entered in the DIGSI® menu item **Annunciation** → **Statistic** into the submenu **Limit Values for Statistic**. Double-click to display the corresponding contents in another window. By overwriting the previous value you can change the settings (please refer to the SIPROTEC® 4 System Description).

2.23.8.3 Information List

No.	Information	Type of Information	Comments
-	OpHour>	LV	Operating hours greater than
272	SP. Op Hours>	OUT	Set Point Operating Hours
16004	ΣI^x>	LV	Threshold Sum Current Exponentiation
16005	Threshold ΣI^x>	OUT	Threshold Sum Curr. Exponent. exceeded
16009	Resid.Endu. <	LV	Lower Threshold of CB Residual Endurance
16010	Thresh.R.Endu.<	OUT	Dropped below Threshold CB Res.Endurance
16017	ΣI^2t>	LV	Threshold Sum Squared Current Integral
16018	Thresh. ΣI^2t>	OUT	Threshold Sum Squa. Curr. Int. exceeded

2.23.9 Energy Metering

Metered values for active and reactive energy are determined by the device. 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.

2.23.9.1 Description

Metered Values for Active and Reactive Energy

Metered values of the real power W_p and reactive power (W_q) are acquired in kilowatt, megawatt or gigawatt hours primary or in kVARh, MVARh or GVARh primary, separately according to the input (+) and output (–), or capacitive and inductive. The measured-value resolution can be configured. The signs of the measured values appear as configured in address 1108 **P,Q sign** (see Section „Display of Measured Values“).

2.23.9.2 Setting Notes

Setting of parameter for meter resolution

Parameter 8315 **MeterResolution** can be used to maximize the resolution of the metered energy values by ***Factor 10*** or ***Factor 100*** compared to the ***Standard*** setting.

2.23.9.3 Settings

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

2.23.9.4 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	WpForward	MVMV	Wp Forward
925	WqForward	MVMV	Wq Forward
928	WpReverse	MVMV	Wp Reverse
929	WqReverse	MVMV	Wq Reverse

2.23.10 Commissioning Aids

Device data sent to a central or master computer system during test mode or commissioning can be influenced. There are tools for testing the system interface and the binary inputs and outputs of the device.

Applications

- Test Mode
- Commissioning

2.23.10.1 Description

Test Messages to the SCADA Interface during Test Operation

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.

Depending on the type of protocol, all messages and measured values transferred to the central control system can be identified with an added message "test operation"-bit while the device is being tested on site (test mode). This identification prevents the messages from being incorrectly interpreted as resulting from an actual power system disturbance or event. As another option, all messages and measured values normally transferred via the system interface can be blocked during the testing ("block data transmission").

Data transmission block can be accomplished by controlling binary inputs, by using the operating panel on the device, or with a PC and DIGSI via the operator interface.

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

Checking the System Interface

If the device features a system port and uses it to communicate with the control centre, the DIGSI device operation can be used to test if messages are transmitted correctly.

A dialog box shows the display texts of all messages which were allocated to the system interface in the configuration matrix. In another column of the dialog box you can specify a value for the messages you intend to test (e.g. ON/OFF). Having entered password no. 6 (for hardware test menus) a message can then be generated. 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.

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

Checking the Binary Inputs and Outputs

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

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

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

Creating a Test Oscillographic Recording

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

Along with the capability of storing fault recordings via pickup of the protection function, the 7SJ62/63/64 also has the capability of capturing the same data when commands are given to the device via the service program DIGSI, the serial interface, or a binary input. For the latter, event „`>Trig.Wave.Cap.`“ must be allocated to a binary input. Triggering for the oscillographic recording then occurs, for instance, via the binary input when the protection object is energized.

An oscillographic recording that is 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 log buffer in the display, as they are not network fault events.

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

2.24 Protection for Single-phase Voltage Transformer Connection

Devices 7SJ62/63/64 may also be connected to only one primary voltage transformer. Impacts on protective functions to be taken into consideration are described in this section.

Applications

- For some applications there is only one voltage transformer on the primary voltage side. Usually it is a phase voltage. However, it may also be a phase-to-phase voltage. Via configuration the device may be adapted for such an application.

2.24.1 Connection

The device may optionally be supplied with a phase-ground voltage (e.g. V_{A-N}) or a phase-phase voltage (e.g. V_{A-B}). The connection mode has been specified during the configuration (see Section 2.1.3.2) in parameter 240 **VT Connect. 1ph**. The following figure shows a connection example. Further examples can be found in the Appendix in Section A.3.

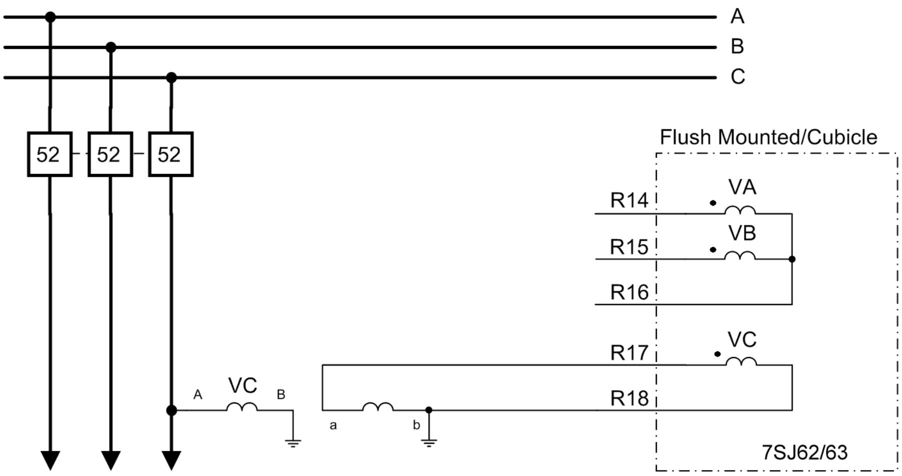


Figure 2-119 Connection example for single-phase voltage transformer for 7SJ62/63 with phase-to-ground-voltage V_{C-N}

2.24.2 Impacts on the Functionality of the Device

When a device is operated by only one voltage transformer, this will have an impact on several device functions. The ones affected are described in the following. Furthermore, this type of connection is dealt with in the functional descriptions. Functions not mentioned in the following are not affected by this type of connection.

Undervoltage Protection, Overvoltage Protection (27, 59 Elements)

Depending on the configuration in address 240 voltage protection is either operated by a phase-ground or a phase-phase voltage. Therefore, if the device is connected to a phase-ground voltage, set the phase voltage threshold. If connected to a phase-phase voltage, set the phase-to-phase voltage threshold. In contrast, with three-phase connection the threshold generally represents a phase-to-phase quantity. See also section 2.6.4.

Functional logic, scope of settings and information of this function are described in Section 2.6.

Frequency Protection (81 Elements)

Depending on the configuration in address 240 frequency protection is either operated by a phase-ground or a phase-phase voltage. A minimum voltage may be configured. If the value set is undershot, frequency protection is blocked. Therefore, if the device is connected to a phase-ground voltage, set the phase voltage threshold. If connected to a phase-phase voltage, set the phase-to-phase voltage threshold.

Functional logic, scope of settings and information of this function are described in Section 2.9.

Directional Time Overcurrent Protection (67 and 67N Elements)

If the device is connected to only one voltage transformer, the function is set to inactive and hidden.

Synchronism and Voltage Check (25) (7SJ64 only)

The synchronizing function can be applied without any restrictions. Connection examples are shown in the following figure and in the Appendix A.3.

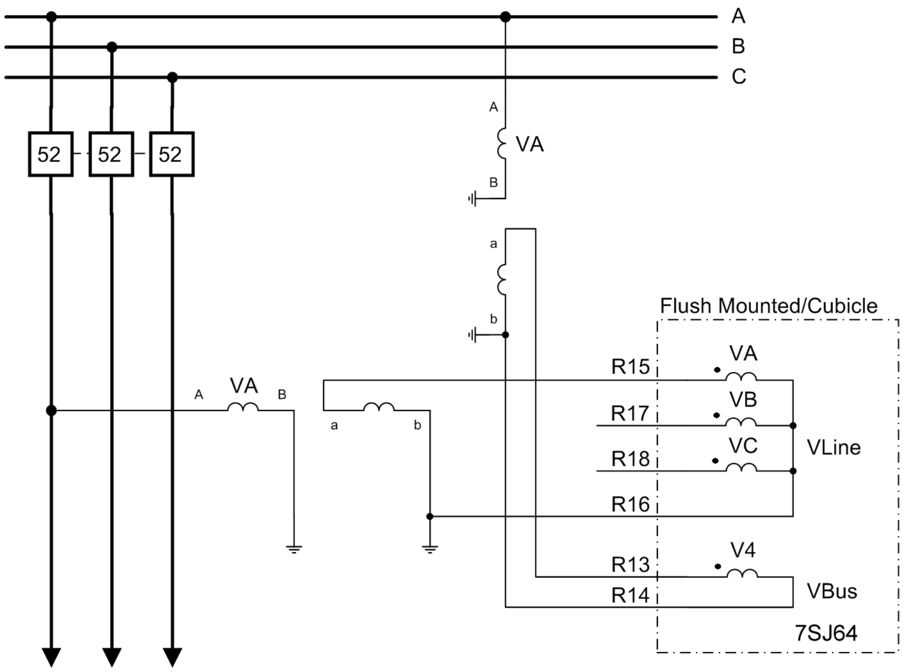


Figure 2-120 Connection example for single-phase voltage transformer for 7SJ64 (phase-to-ground voltages)

If phases of voltages V1 and V2 differ, phase displacement may be adjusted in address 6122 **ANGLE ADJUSTM.**.

(Sensitive) Ground Fault Detection (64, 50Ns, 67Ns)

The directional functionality and the displacement voltage element of this function cannot be applied since there is no displacement voltage. Current elements of this function, however, can be operated in non-directional mode

Except for the above-mentioned restriction the functional logic, scope of settings and information are described in Section 2.12.

Fault Location

If the device is connected to only one voltage transformer, this function is set to inactive and hidden.

Monitoring Functions

Voltage-measuring monitoring functions such as "Voltage symmetry" and "Fuse-Failure-Monitor" cannot be applied. They are set inactive and are hidden.

Operational Measured Values

Several operational measured values cannot be calculated. If whole groups of operational measured values are concerned, they will be hidden. If only parts of a group are concerned, corresponding operational measured values are set invalid (values are replaced by dashes) or reset.

2.24.3 Setting Notes

Voltage Connection

Address 240 **VT Connect. 1ph** is set to ensure that only **one** voltage transformer is connected to the device and to define the type of voltage transformer connected to it. Thus, the user specifies which primary voltage is connected to which analog input. If one of the voltages offered is selected, i.e. a setting unequal ***NO***, setting of address 213 for multiple-phase connection is no more relevant. Only address 240 is to be set.

With 7SJ64 and single-phase voltage transformer connection the voltage connected to voltage input V_4 is always used for synchronization.

Nominal Values of Voltage Transformers

In addresses 202 **Vnom PRIMARY** and 203 **Vnom SECONDARY** set, as usual, the voltage transformer nominal values defined as phase-to-phase quantities. This depends on whether the device is connected to a phase voltage or phase-to-phase voltage.

Undervoltage Protection, Overvoltage Protection, Frequency Protection

If phase-ground voltage connection is selected for address 240, voltage thresholds of this function also have to be set as phase-ground voltages. If phase-phase voltage connection is selected for address 240, also voltage thresholds of this function have to be set as phase-phase voltages.

Sensitive Ground Fault Detection

All directional- and voltage-type settings (addresses 3102 to 3107, 3109 to 3112 and 3123 to 3126) are of no significance. Thus, their settings may not be modified.

Current elements are to be set to ***Non-Directional*** in addresses 3115 and 3122.

Set address 3130 to ***Vgnd OR INs***. Thus, current elements are operated independent of VN.

Example:

In a system with a primary nominal voltage of 138 kV and a secondary nominal voltage of 115 V, single-phase voltage V_{A-N} is connected (see Figure 2-121).

Threshold values for voltage protection are set as follows:

Overvoltage 59-1: to 120 % V_{Nom}

Undervoltage 27-1: to 60 % V_{Nom}

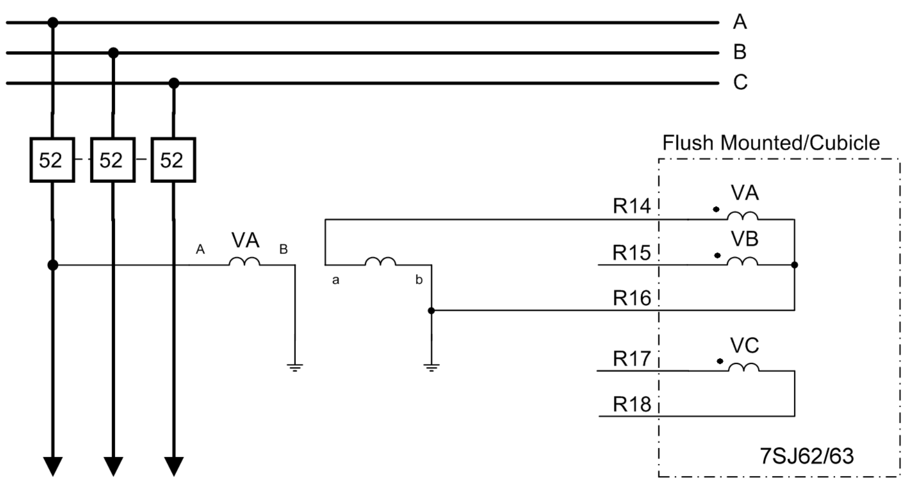


Figure 2-121 Example of a single-phase voltage transformer connection (Phase-ground)

Apply the following settings to the device:

Address 202 **Vnom PRIMARY** = 138 kV

Address 203 **Vnom SECONDARY** = 115 V

Address 240 **VT Connect. 1ph** = ***Van***

Address 5003 **59-1 PICKUP:** $\frac{115\ \text{V}}{\sqrt{3}} \cdot 1.2 = 80\ \text{V}$

Address 5103 **27-1 PICKUP:** $\frac{115\ \text{V}}{\sqrt{3}} \cdot 0.6 = 40\ \text{V}$

2.25 Breaker Control

A control command process is integrated in the SIPROTEC ® 7SJ62/63/64 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.

2.25.1 Control Device

Devices with integrated or detached operator panel can control switchgear via the operator panel of the device. It is also possible to control switchgear via the operating port using a personal computer and via the serial port with a link to the substation control equipment.

Applications

- Switchgears with single and double busbars

Prerequisites

The number of switchgear devices to be controlled is limited by the

– binary inputs present

– binary outputs present

2.25.1.1 Description

Operation Using the Keypad with Text Display

Using the navigation keys ▲, ▼, ◀, ▶, the control menu can be accessed and the switching device to be operated selected. After entering a password, a new window is displayed where multiple control actions (e.g. ON, OFF, ABORT) are available for selection using the ▼ and ▲ keys. Thereafter a query for security reasons appears. After the security check is completed, the ENTER key must be pressed again to carry out the command. If this release does not occur within one minute, the process is aborted. Cancellation via the ESC key is possible at any time before the control command is issued.

Operation Using the Keypad with Graphic Display

Commands can be initiated using the keypad on the local user interface of the relay. For this purpose, there are three independent keys located below the graphic display. The key CTRL causes the control display to appear in the LCD. Controlling of switchgears is only possible within this control display, since the two control keys OPEN and CLOSE only become active as long as the control display is present. The LCD must be changed back to the default display for other, non-control, operational modes.

The navigation keys ▲, ▼, ◀, ▶ are used to select the desired device in the Control Display. The `I` key or the `O` key is then pressed to convey the intended control command.

Consequently, the switch icon in the control display flashes in setpoint direction. At the lower display edge, the user is requested to confirm the switching operation via the ENTER key. Thereafter a query for security reasons appears. After the security check is completed, the ENTER key must be pressed again to carry out the command. If this confirmation is not performed within one minute, the setpoint flashing changes again to the corresponding actual status. Cancellation via the ESC key is possible at any time before the control command is issued.

During normal processing, the control display indicates the new actual status after the control command was executed and the message „`command end`“ at the lower display edge. The indication „`FB reached`“ is displayed briefly before the final indication in the case of switching commands with a feedback.

If the attempted command fails, because an interlocking condition is not met, then an error message appears in the display. The message indicates why the control command was not accepted (see also SIPROTEC ® 4 System Description). This message must be acknowledged with ENTER before any further control commands can be issued.

Operation Using DIGSI®

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

Operation Using the System Interface

Control of switching devices can be performed via the serial system interface and a connection to the switchgear control system. For this the required peripherals physically must exist both in the device and in the power system. Also, a few settings for the serial interface in the device are required (see SIPROTEC ® 4 System Description).

2.25.1.2 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
-	UnlockDT	IntSP	Unlock data transmission via BI
-	Q2 Op/Cl	CF_D2	Q2 Open/Close
-	Q2 Op/Cl	DP	Q2 Open/Close

No.	Information	Type of Information	Comments
-	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=

2.25.2 Types of Commands

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

2.25.2.1 Description

Commands to the System

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

- Switching commands for the control of circuit breakers (not synchronized), disconnectors and ground electrode
- 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

2.25.3 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:

2.25.3.1 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
- Running Time Monitor (feedback message monitoring time)

2.25.4 Interlocking

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

2.25.4.1 Description

Switchgear 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 the introduction of IEC61850, V4.51; GOOSE information exchange will be accomplished via 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 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 activation of "Normal/Test"-key switch,
- For automatic commands, via command processing. by CFC and deactivated interlocking recognition,
- For local / remote commands, using an additional interlocking disable command, via Profibus.

Interlocked/Non-interlocked Switching

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

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

Interlocked switching means that all configured interlocking conditions are checked within the command processing. If a condition is not fulfilled, the command is rejected, marked with a minus sign (e.g. „CO–“), and a message to that effect is output.

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	Control	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
```

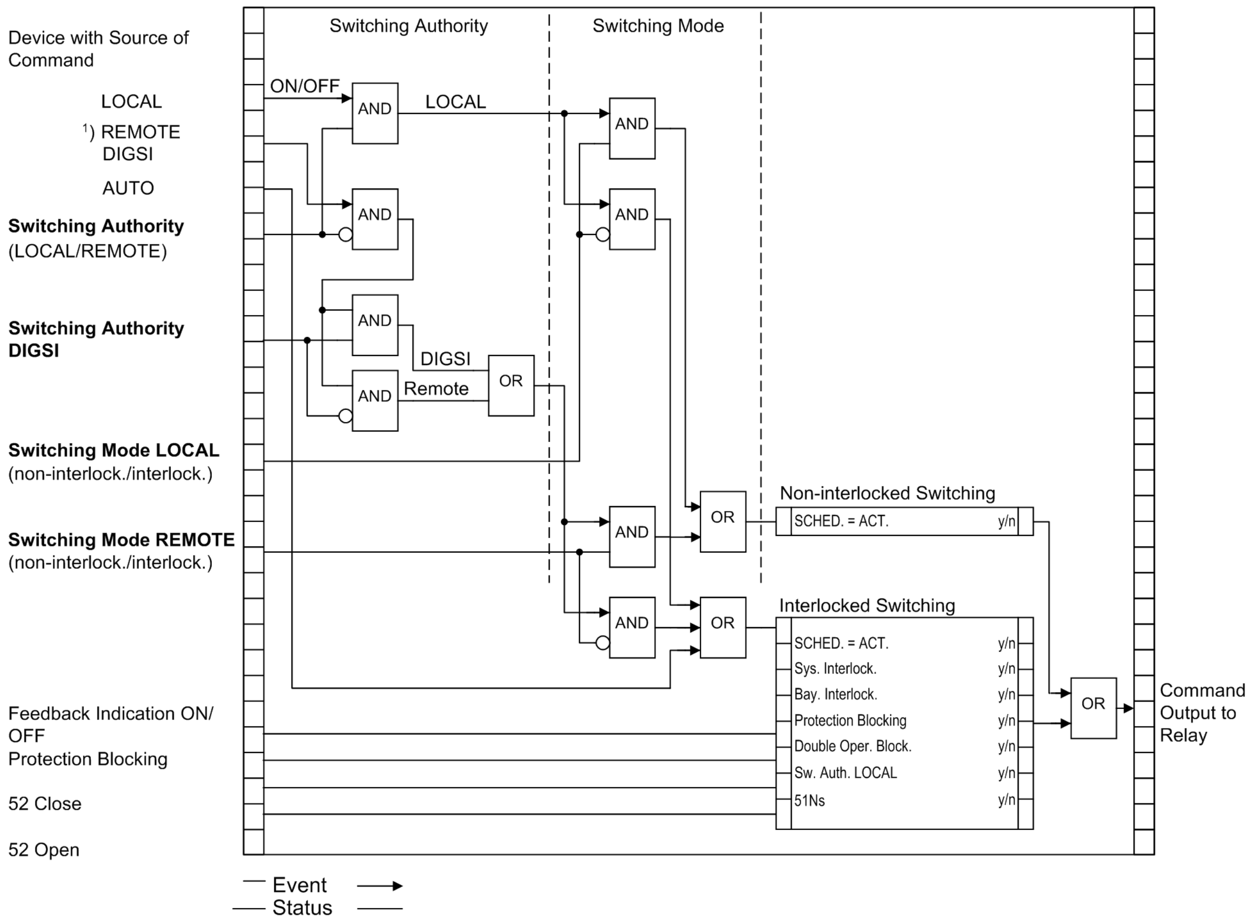
Figure 2-122 Example of an operational annunciation for switching circuit breaker 52 (Q0)

Standard Interlocking Defaults (fixed programming)

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.
- Blocked by Protection: A CLOSE-command is rejected as soon as one of the protective elements in the relay picks up. The OPEN-command, in 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. Restarting would then have to be interlocked some other way. One method would be to use a specific interlocking in the CFC logic.
- 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 2-123 Standard interlockings

The following figure shows the configuration of the interlocking conditions using DIGSI.

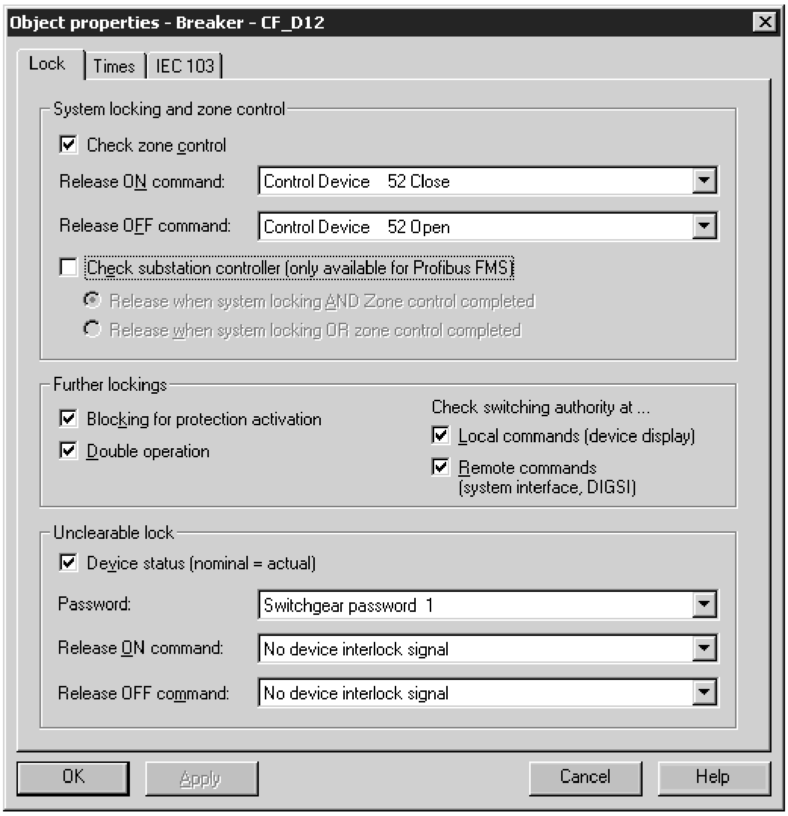


Figure 2-124 DIGSI®–dialog box for setting the interlocking conditions

For devices with operator panel the display shows the configured interlocking reasons. They are marked by letters explained in the following table.

Table 2-27 Command types and corresponding messages

Interlocking Commands	Abbrev.	Message
Switching Authority	L	L
System interlocking	S	A
Zone controlled	Z	Z
SET = ACTUAL (switch direction check)	P	P
Protection blockage	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.

```
Interlocking      01/03
-----------------------
Q0 Close/Open S - Z P B
Q1 Close/Open S - Z P B

Q8 Close/Open S - Z P B
```

Figure 2-125 Example of configured interlocking conditions

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 (for devices with operatorpanel)

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

- LOCAL
- DIGSI
- REMOTE

The object "Switching Authority" serves to interlock or enable LOCAL control against remote or DIGSI commands. The devices in housing of size $^1/_2$ or $^1/_1$ are equipped with key switches on the front panel. The top switch is reserved for switching authority. The position "LOCAL" allows local commands. The position "REMOTE" enables remote control. For devices in housing of size $^1/_3$ the switching authority can be changed between "REMOTE" and "LOCAL" in the operator panel after having entered the password or by means of CFC also via binary input and function key.

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

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

Configuration

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

Table 2-28 Interlocking logic

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

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

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

[3] SC = Source of command

SC = Auto SICAM:

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

Switching Authority (for devices without operator panel)

The dongle cable sets the switching authority of the device to "REMOTE". The specifications of the previous section apply.

Switching Mode (for devices with operatorpanel)

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

The following switching modes (local) are defined:

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

The devices in housing of size $^1/_2$ or $^1/_1$ are equipped with key switches on the front panel. The bottom switch is reserved for switching mode. The "Normal" position allows interlocked switching while the "Interlocking OFF" position allows non-interlocked switching. For devices in housing of size $^1/_3$ the switching mode can be changed between "interlocked (latched)" and "non-interlocked (unlatched)" in the operator panel after having entered the password or by means of CFC also via binary input and function key.

The following switching modes (remote) are defined:

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

Switching Mode (for devices without operator panel)

The dongle cable sets the switching mode of the device to "Normal". The specifications of the previous section apply.

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, key-switch, or internal indication (marking), or
- by means of a control logic via CFC.

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

System Interlocking

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

Double Activation Blockage

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

Blocking by Protection

The pickup of protective elements blocks switching operations. Protective elements are configured, separately for each switching component, to block specific switching commands sent in CLOSE and TRIP direction.

When enabled, "Block CLOSE commands" blocks CLOSE commands, whereas "Block TRIP commands" blocks TRIP signals. Switching operations in progress will immediately be aborted by the pickup of a protective element.

Device Status Check (set = actual)

For switching commands, a check takes place whether the selected switching device is already in the set/desired position (set/actual comparison). This means, if a circuit breaker is already in the CLOSED position and an attempt is made to issue a closing command, the command will be refused, with the operating message "set condition equals actual condition". If the circuit breaker/switchgear device is in the intermediate position, then this check is not performed.

Bypassing Interlocks

Bypassing configured interlocks 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 switching modes "interlocked (latched)" or "non-interlocked (unlatched)" can be set in housing sizes $^1/_2$ or $^1/_1$ (7SJ63, 7SJ61/2/5) via the key switch. The position "Interlocking OFF" corresponds to non-interlocked switching and serves the special purpose of unlocking the standard interlocks. For devices in housing of size $^1/_3$ the switching mode can be changed between "interlocked (latched)" and "non-interlocked (unlatched)" in the operator panel after having entered the password or by means of CFC also 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 job order must be sent for the unlocking. The unlocking applies only for one switching operation and for command caused by the same source.
  - Job order: command to object "Switching mode REMOTE", ON
  - Job order: switching command to "switching device"
- Derived command via CFC (automatic command, SC=Auto SICAM):
  - Behaviour configured in the CFC block ("BOOL to command").

2.25.5 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 centre. 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.

2.25.5.1 Description

Acknowledgement 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.

Acknowledgement of commands to Local / Remote / Digsi

The acknowledgement 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 acknowledgement 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/.

■

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 the management of power systems and with the relevant safety rules and guidelines. Hardware modifications that might be needed in certain cases are explained. The primary tests require the protected object (line, transformer, etc.) to carry load.

3.1 Mounting and Connections

General

WARNING!

Warning of improper transport, storage, installation, and application of the device.

Failure to observe these precautions can result in death, personal injury, or serious material damage.

Trouble free and safe use of this device depends on proper transport, storage, installation, and 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, ANSI, IEC, EN, DIN, or other national and international regulations). These regulations must be observed.

3.1.1 Configuration Information

Prerequisites

For installation and connections the following conditions must be met:

The rated device data has been tested as recommended in the SIPROTEC® 4 System Description and their compliance with these data is verified with the Power System Data.

General Diagrams

General diagrams for the 7SJ62/63/64 device range are shown in Appendix A.2. Connection examples for the current and voltage transformer circuits are given in the Appendix . The setting configuration of the **Power System Data 1**, Section 2.1.3, should be checked to ensure that they correspond to the connections to the device.

Connection Examples for 7SJ62

Connection examples for current and voltage transformer circuits are provided in Appendix A.3. The device can either be connected with three phase–ground voltages (connection mode **VT Connect. 3ph** = ***Van, Vbn, Vcn***), or with two phase–phase voltages and V_{delta} (also called the displacement voltage) from open delta VTs as (connection mode **VT Connect. 3ph** = ***Vab, Vbc, VGnd***). For the latter, only two phase–phase voltages or the displacement voltage V_{delta} can be connected. In the device settings the appropriate voltage connection must be entered under address 213, in **P.System Data 1**.

As the voltage inputs of the 7SJ62 device have an operating range from 0 to 170 V, this means that phase-to-phase voltages can be assessed in connection of phase-to-ground voltages up to $\sqrt{3} \cdot 170$ V = 294 V, in the latter case up to 170 V.

If there is only **one** voltage transformer on the system side, wiring is performed according to examples on single-phase connection. For this case, address 240 **VT Connect. 1ph** in the **P.System Data 1** specifies to the device which primary voltage is connected to which analog input.

Connection Examples for 7SJ63

Connection examples for current and voltage transformer circuits are provided in Appendix A.3. The device can either be connected with three phase–ground voltages (connection mode **VT Connect. 3ph** = ***Van, Vbn, Vcn***), or with two phase–phase voltages and V_{delta} (also called the displacement voltage) from open delta VTs as (connection mode **VT Connect. 3ph** = ***Vab, Vbc, VGnd***). For the latter, only two phase–phase voltages or the displacement voltage V_{delta} can be connected. In the device settings the appropriate voltage connection must be entered under address 213, in **P.System Data 1**.

As the voltage inputs of the 7SJ63 device have an operating range from 0 to 170 V, this means that phase-to-phase voltages can be assessed in connection of phase-to-ground voltages up to $\sqrt{3} \cdot 170$ V = 294 V, in the latter case up to 170 V.

If there is only **one** voltage transformer on the system side, wiring is performed according to examples on single-phase connection. For this case, address 240 **VT Connect. 1ph** in the **P.System Data 1** specifies to the device which primary voltage is connected to which analog input.

Connection Examples for 7SJ64

Connection examples for current and voltage transformer circuits are provided in Appendix A.3.

For the normal connection the 4th voltage measuring input is not used. Correspondingly the address 213 must be set to **VT Connect. 3ph** = ***Van, Vbn, Vcn***. The factor in address 206**Vph / Vdelta** must however be set to **1.73** (this factor is used internally for the conversion of measurement and fault recording values).

Also an additional connection example of an e-n-winding of the voltage transformer is shown. Here address 213 must be set to **VT Connect. 3ph** = ***Van,Vbn,Vcn,VGn***. The factor address 206 **Vph / Vdelta** depends on the transformation ratio of the e–n-winding. For additional hints, please refer to section 2.1.3.2 under „Transformation Ratio“.

Another figure shows an example of a connection of the e–n winding of a set of voltage transformers, in this case, however of a central set of transformers at a busbar. For more information refer to the previous paragraph.

Another figure shows an example of the connection of a different voltage, in this case the busbar voltage (e.g. for the synchronization function). For the synchronization function address 213 must be set to **VT Connect. 3ph** = ***Van,Vbn,Vcn,VGn***. **Balancing V1/V2**, address 6X21 is always equal to 1 unless the feeder VT and busbarside VT have a different transformation ratio. The factor in address 206**Vph / Vdelta** must however be set to 1.73 (this factor is used internally for the conversion of measurement and fault recording values).

Also two phase–phase voltages or the displacement voltage V_{delta} can be connected to the device. Here address 213 must be set to **VT Connect. 3ph** = ***Vab, Vbc, VGnd***. For the latter, only two phase–phase voltages or the displacement voltage V_{delta} can be connected.

As the voltage inputs of the 7SJ64 device have an operating range from 0 to 200 V, this means that when connecting to the device phase-to-ground voltages, the phase-to-phase voltages can be assessed up to $\sqrt{3} \cdot 200$ V = 346 V, with connection of phase-to-phase voltages up to 200 V.

If there is only **one** voltage transformer on the system side, wiring is performed according to examples on single-phase connection. For this case, address 240 **VT Connect. 1ph** in the **P.System Data 1** specifies to the device which primary voltage is connected to which analog input.

With 7SJ64 and single-phase voltage transformer connection the voltage connected to voltage input V_4 is always interpreted as the voltage which is to be synchronized.

Binary Inputs and Outputs for 7SJ62/63/64

The configuration of the binary in- and outputs, i.e. the individual adaptation to the plant conditions, is described in the SIPROTEC® 4 System Description. The connections to the plant are dependent on this actual configuration. The presettings of the device are listed in Appendix A, Section A.5. Check also whether the labelling corresponds to the allocated annunciation functions.

Changing Setting Groups

If binary inputs are used to switch setting groups, please observe the following:

- Two binary inputs must be dedicated to the purpose of changing setting groups when four groups are to be switched. One binary input must be set for „`>Set Group Bit0`“, the other input for „`>Set Group Bit1`“. If either of these input functions is not assigned, then it is considered as not controlled.
- 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 allocation of the binary inputs to the setting groups A to D and a simplified connection diagram for the two binary inputs is illustrated in the following figure. The figure illustrates an example in which both Set Group Bits 0 and 1 are configured to be controlled (actuated) when the associated binary input is energized (high).

Where:

no = not energized or not connected

yes = energized

Table 3-1 Changing setting groups using binary inputs

Binary Input		Active Group
>Set Group Bit 0	>Set Group Bit 1	
No	No	Group A
Yes	No	Group B
No	Yes	Group C
Yes	Yes	Group D

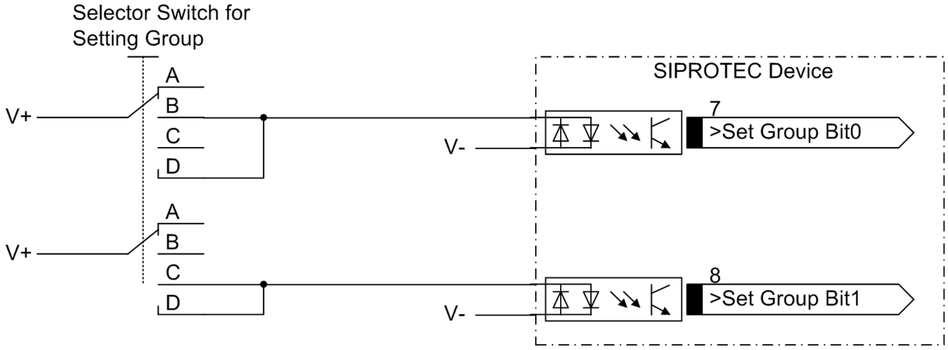


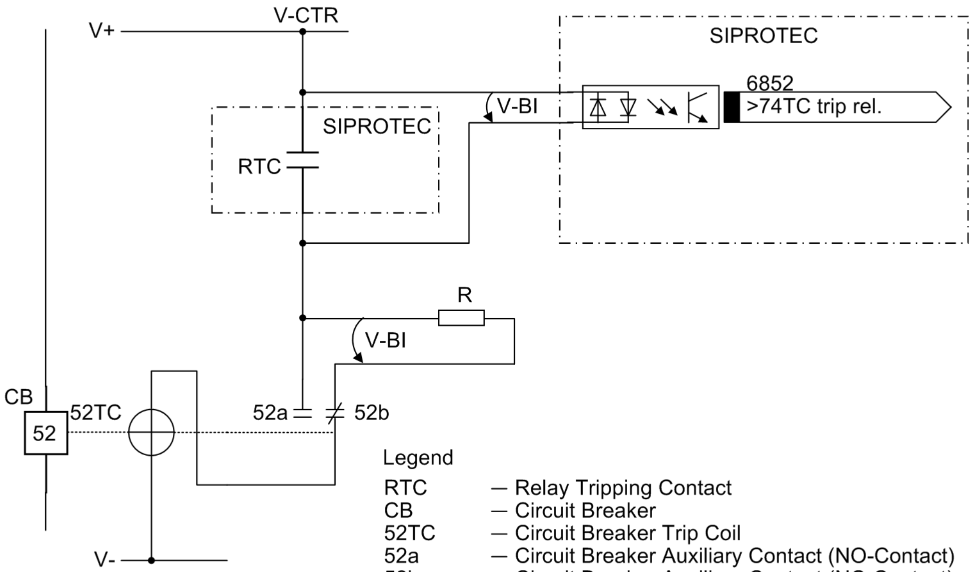
Figure 3-1 Connection diagram (example) for setting group switching using binary inputs

Trip Circuit Supervision for 7SJ62/63/64

Please note 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 volt-free i.o.w. not be commoned with each other or with another binary input.

If one binary input is used, a bypass resistor R must be employed (refer to the following figure). The resistor R is inserted into the circuit of the 52b circuit breaker auxiliary contact, to facilitate the detection of a malfunction also when the 52a circuit breaker auxiliary contact is open and the trip contact has dropped out. The value of this resistor must be such that in the circuit breaker open condition (therefore 52a is open and 52b is closed) the circuit breaker trip coil (52TC) is no longer picked up and binary input (BI1) is still picked up if the command relay contact is open.



Legend

RTC	—	Relay Tripping Contact
CB	—	Circuit Breaker
52TC	—	Circuit Breaker Trip Coil
52a	—	Circuit Breaker Auxiliary Contact (NO-Contact)
52b	—	Circuit Breaker Auxiliary Contact (NC-Contact)
V-CTR	—	Control Voltage (Trip Voltage)
V-BI	—	Input Voltage for Binary Input
R	—	Equivalent Resistance

Figure 3-2 Trip circuit supervision with one binary input

This results in an upper limit for the resistance dimension, R_{max}, and a lower limit R_{min}, from which the optimal value of the arithmetic mean R should be selected:

$$R = \frac{R_{max} + R_{min}}{2}$$

In order that the minimum voltage for controlling the binary input is ensured, R_{max} is derived as:

$$R_{max} = \left(\frac{V_{CTR} - V_{BI\ min}}{I_{BI\ (High)}}\right) - R_{CBTC}$$

So the circuit breaker trip coil does not remain energized in the above case, R_{min} is derived as:

$$R_{min} = R_{CBTC} \cdot \left(\frac{V_{CTR} - V_{CBTC\ (LOW)}}{V_{CBTC\ (LOW)}}\right)$$

$I_{BI\ (HIGH)}$	Constant current with activated BI (= 1.8 mA)
$V_{BI\ min}$	Minimum control voltage for BI (= 19 V for delivery setting for nominal voltage of 24/48/60 V; 88 V for delivery setting for nominal voltage of 110/125/220/250 V)
V_{CTR}	Control Voltage for Trip Circuit
R_{CBTC}	DC resistance of circuit breaker trip coil
$V_{CBTC\ (LOW)}$	Maximum voltage on the circuit breaker trip coil that does not lead to tripping

If the calculation results that $R_{max} < R_{min}$, then the calculation must be repeated, with the next lowest switching threshold $V_{BI\ min}$, and this threshold must be implemented in the relay using plug-in jumpers (see Section „Hardware Modifications“).

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:

$I_{BI\ (HIGH)}$	1.8 mA (SIPROTEC® 4 7SJ62/63/64)
$V_{BI\ min}$	19 V for delivery setting for nominal voltage 24/48/60 V (from 7SJ62/63/64)88 V for delivery setting for nominal voltage 110/125/220/250 V) (from 7SJ62/63/64)
V_{ST}	110 V (system / release circuit)
R_{CBTC}	500 Ω (from system / trip circuit)
$V_{CBTC\ (LOW)}$	2 V (system / release circuit)

$$R_{max} = \left(\frac{110\ V - 19\ V}{1.8\ mA}\right) - 500\ \Omega = 50.1\ k\Omega$$

$$R_{min} = 500\ \Omega \cdot \left(\frac{110\ V - 2\ V}{2\ V}\right) = 27\ k\Omega$$

$$R = \frac{R_{max} + R_{min}}{2} = 38.6\ k\Omega$$

The closest standard value of 39 kΩ is selected; the power is:

$$P_R = \left(\frac{110\ V}{39\ k\Omega + 0.5\ k\Omega}\right)^2 \cdot 39\ k\Omega \geq 0.3\ W$$

3.1.2 Hardware Modifications

3.1.2.1 General

Hardware modifications concerning, for instance, nominal currents, the control voltage for binary inputs or termination of serial interfaces might be necessary. Follow the procedure described in this section, whenever hardware modifications are done.

Since construction of modules varies from device to device, detailed information concerning hardware modifications on devices 7SJ62, 7SJ63 and 7SJ64 is specified separately.

AuxiliaryVoltage

There are different power supply voltage ranges for the auxiliary voltage (refer to the Ordering Information in Appendix A.1). The power supplies of the variants for DC 60/110/125 V and DC 110/125/220 V, AC 115/230 V are largely interchangeable by modifying the position of the jumpers. The assignment of these jumpers to the nominal voltage ranges and their spatial arrangement on the PCB for devices 7SJ62, 7SJ63 and 7SJ64 are described separately in the following sections. Location and ratings of the miniature fuse and the buffer battery are also shown. When the relays are delivered, these jumpers are set according to the name-plate sticker. Generally, they need not be altered.

LiveStatusContact

The live contacts of devices 7SJ62/63/64 are changeover contacts. With devices 7SJ63 and 7SJ64 either the NC contact or the NO contact is be connected to two device connections via a plug-in jumper (X40). The assignment of the plug-in jumper to the contact mode and the spatial arrangement of the jumper are described for devices 7SJ63 and 7SJ64 in the following sections.

NominalCurrents

The input transformers of the devices are set to a nominal current of 1 A or 5 A with jumpers. The position of the jumpers are set according to the name-plate sticker. The assignment of the plug-in jumpers to the nominal current and the spatial arrangement of the jumpers are described separately for devices 7SJ63 and 7SJ64 in the following sections.

Jumpers X61, X62 and X63 must be set for the same nominal current, i.e. there must be one jumper for each input transformer, and the common jumper X 60.

With standard 1/5 A-jumpers jumper X64 for the ground path is set to 1 A or 5 A irrespective of other jumper positions and depending on the ordered variant.

With models equipped with a sensitive ground fault current input of setting range 0.001 to 1.500 A there is no jumper X64.

Note

If nominal current ratings are changed exceptionally, then the new ratings must be registered in addresses 205 **CT SECONDARY**/218 **Ignd-CT SEC** in the Power System Data (see Subsection 2.1.3.2).

Control Voltage for BinaryInputs

When the device is delivered from the factory, the binary inputs are set to operate with a voltage that corresponds to the rated DC voltage of the power supply. In general, to optimize the operation of the inputs, the pick-up voltage of the inputs should be set to most closely match the actual control voltage being used.

A jumper position is changed to adjust the pick-up voltage of a binary input. The assignment of the jumpers to the binary inputs and their spatial arrangement are described separately for devices 7SJ63 and 7SJ64 in the following sections.

Note

If binary inputs are used for trip circuit monitoring, note that two binary inputs (or a binary input and a replacement resistor) are connected in series. The switching threshold must lie clearly below one half of the rated control voltage.

Contact Mode for BinaryOutputs

Input/output modules can have relays that are equipped with changeover contacts. Therefore it is necessary to rearrange a jumper. To which relays of which modules this applies is described separately for devices 7SJ63 and 7SJ64 in the following sections.

Replacing Interfaces

Only serial interfaces of devices for panel and cubicle flush mounting as well as of mounting devices with detached operator panel or without operator panel are replaceable. In the following section under margin heading „Exchanging Interface Modules“ it is described which interfaces can be exchanged, and how this is done.

Terminating of SerialInterfaces

If the device is equipped with a serial RS485 interface or PROFIBUS, they must be terminated with resistors at the last device on the bus to ensure reliable data transmission. For this purpose termination resistors are provided on the PCB of the CPU processor module and on the RS485 or PROFIBUS interface module which can be connected via jumpers. Here, only one option must be selected. The physical arrangement of the jumpers on p.c.b. of the corresponding processor board CPU is described in the following sections under side title „Processor Board CPU“. The arrangement of the jumpers on the interface modules is described under side title „RS485/RS232“ and „Profibus Interface (FMS/DP) DNP3.0/Modbus“. Both jumpers must always be plugged in the same way.

As delivered from the factory, the resistors are switched out.

Spare Parts

Spare parts can be the buffer battery that provides for storage of the data in the battery-buffered RAM when the supply voltage fails, and the miniature fuse of the internal power supply. Their spatial position is shown in the figures of the processor boards. The ratings of the fuse are printed on the board next to the fuse itself. When exchanging the fuse, please observe the hints given in the SIPROTEC® 4 System Description in the Chapter „Maintenance“ and „Corrective Action / Repairs“.

3.1.2.2 Disassembly

Work on the Printed Circuit Boards

Note

It is assumed for the following steps that the device is not operative.

Caution!

Caution when changing jumper settings that affect nominal values of the device

As a consequence, the ordering number (MLFB) and the ratings that are stated on the nameplate do no longer match the actual device properties.

If such changes are necessary, the changes should be clearly and fully noted on the device. Self adhesive stickers are available that can be used as replacement nameplates.

To perform work on the printed circuit boards, such as checking or moving switching elements or exchanging modules, proceed as follows:

- Prepare working area. Provide a grounded mat for protecting components subject to damage from electrostatic discharges (ESD). The following equipment is needed:
  - screwdriver with a 5 to 6 mm wide tip,
  - a Philips screwdriver size 1,
  - 5 mm socket or nut driver.
- Unfasten the screw-posts of the D-subminiature connectors on the back panel at location „A“ and „C“.(7SJ64). This is not necessary if the device is designed for surface mounting.
- If the device has more communication interfaces at locations „A“, „C“ and/or „B“ „D“ on the rear, the screws located diagonally to the interfaces must be removed. This is not necessary if the device is designed for surface mounting.

- Remove the four or six caps on the front cover and loosen the screws that become accessible.
- Carefully take off the front cover. With device versions with a detached operator panel it is possible to remove the front cover of the device right after having unscrewed all screws.

Work on the Plug Connectors

Caution!

Mind electrostatic discharges

Non–observance can result in minor personal injury or material damage.

When handling with plug connectors, electrostatic discharges may emerge by previously touching an earthed metal surface must be avoided.

Do not plug or withdraw interface connections under power!

Here, the following must be observed:

- Disconnect the ribbon cable between the front cover and the CPU board (No. 1 in Figures 3-3 and 3-8) at the front cover side. Press the top latch of the plug connector up and the bottom latch down so that the plug connector of the ribbon cable is pressed out. This action does not apply to the device version with detached operator panel. However, on the central processor unit CPU (No. 1) the 7-pole plug connector X16 behind the D-subminiture connector and the plug connector of the ribbon cable (connected to the 68-pole plug connector on the rear side) must be removed.
- Disconnect the ribbon cables between the CPU unit (No. 1) and the input/output printed circuit boards I/O (No. 2), (No. 3) and (No. 4).
- Remove the boards and set them on the grounded mat to protect them from ESD damage. In the case of the device variant for panel surface mounting please be aware of the fact a certain amount of force is required in order to remove the CPU board due to the existing plug connector.
- Check the jumpers according to figures 3-9 to 3-20 and the following information. Change or remove the jumpers if necessary.

The arrangement of modules for device types and housing sizes are shown in Figures 3-3 to 3-8.

Module Arrangement 7SJ62

The arrangement of modules for device 7SJ62 is illustrated in the following figure.

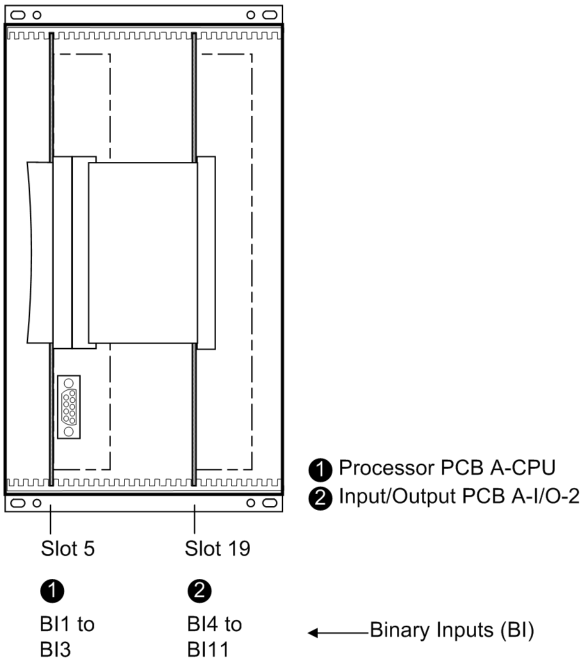


Figure 3-3 Front view of 7SJ62 after removal of the front cover (simplified and scaled down)

Module Arrangement 7SJ63

The following figure shows the arrangement of the modules for device 7SJ63 with housing size $^{1}/_{2}$. The subsequencing figure illustrates housing size $^{1}/_{1}$.

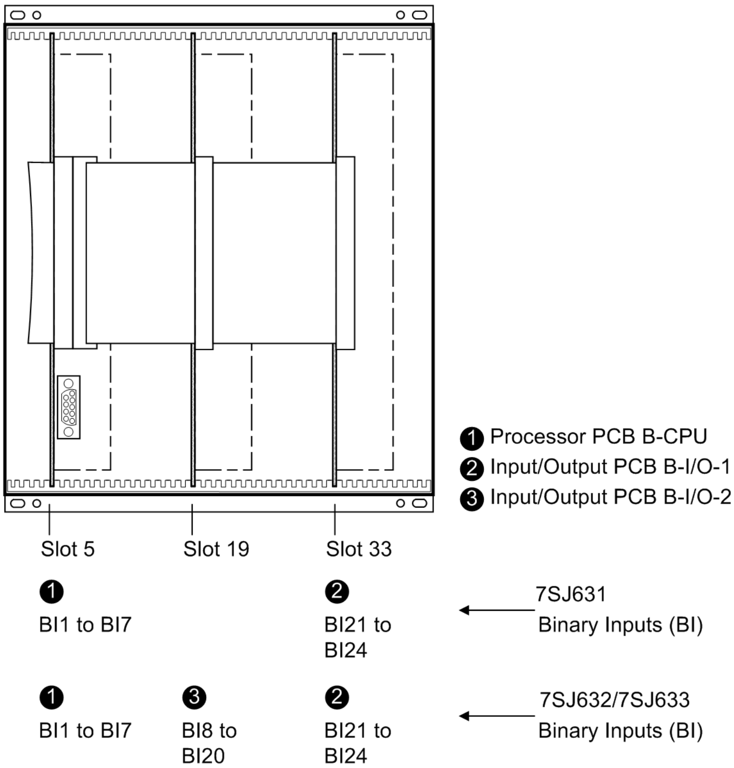


Figure 3-4 Front view of the 7SJ63 with housing size $^{1}/_{2}$ after removal of the front cover (simplified and scaled down)

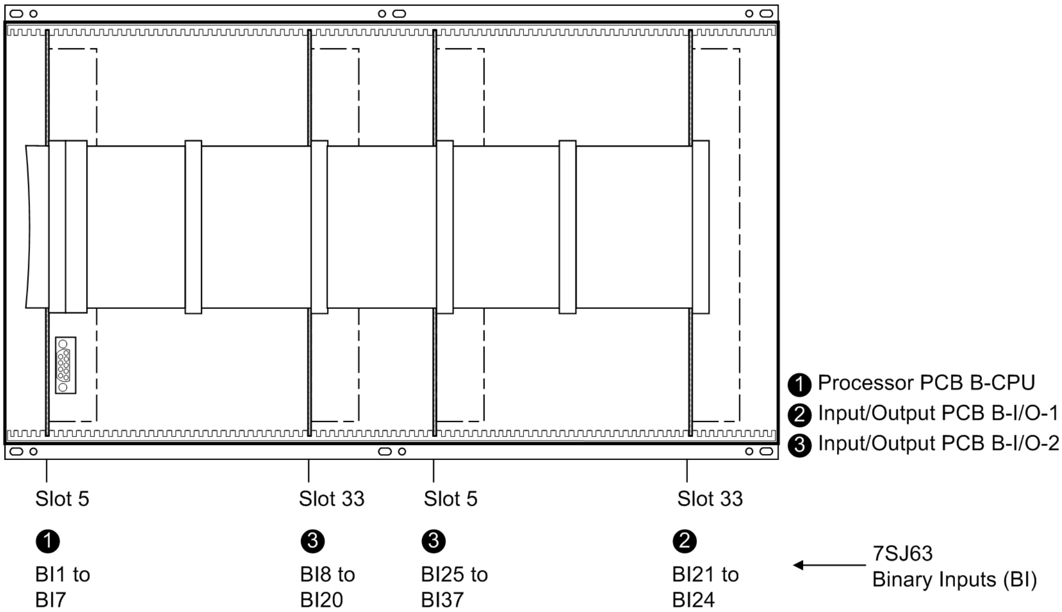


Figure 3-5 Front view of the 7SJ635 and 7SJ636 with housing size $^{1}/_{1}$ after removal of the front cover (simplified and scaled down)

Module Arrangement 7SJ64

The following figure shows the arrangement of the modules for device 7SJ64 with housing size $^1/_3$. The subsequencing figures illustrates housing size $^1/_2$ and $^1/_1$.

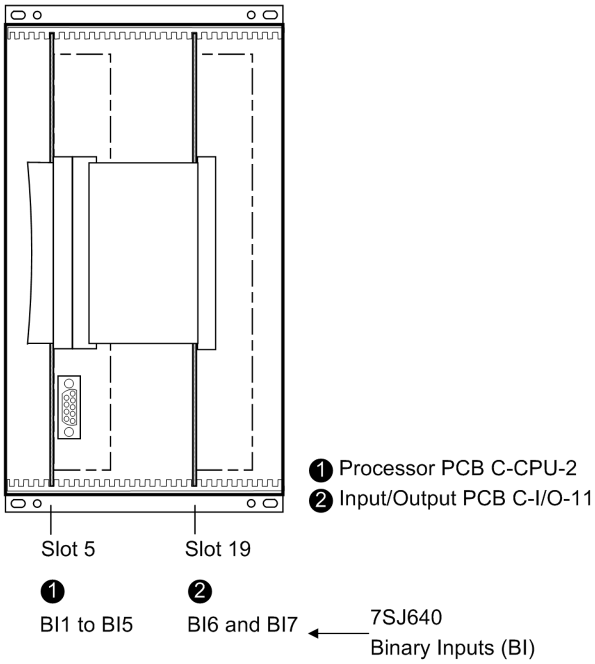


Figure 3-6 Front view with housing size $^1/_3$ after removal of the front cover (simplified and scaled down)

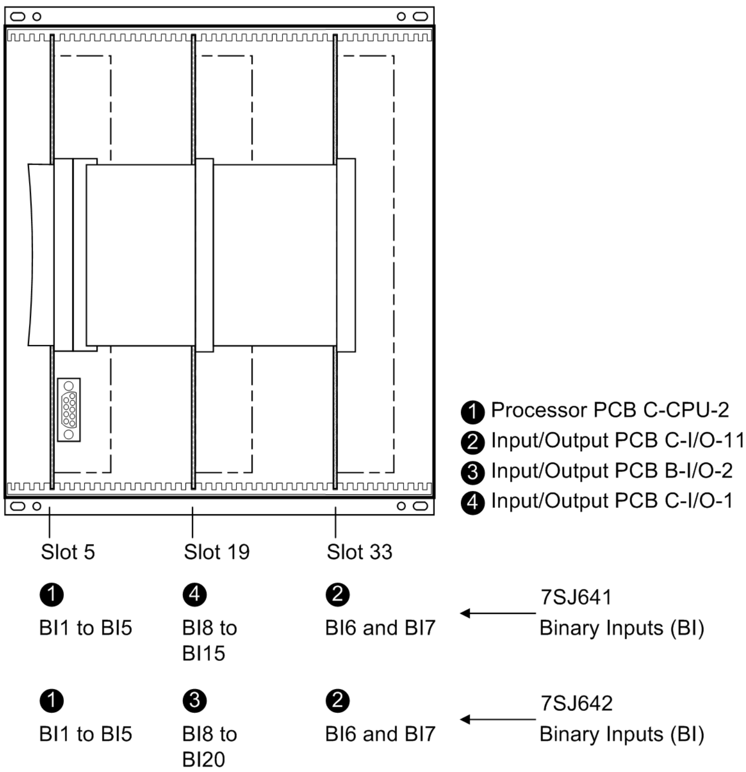


Figure 3-7 Front view of the 7SJ64 with housing size $^1/_2$ after removal of the front cover (simplified and scaled down)

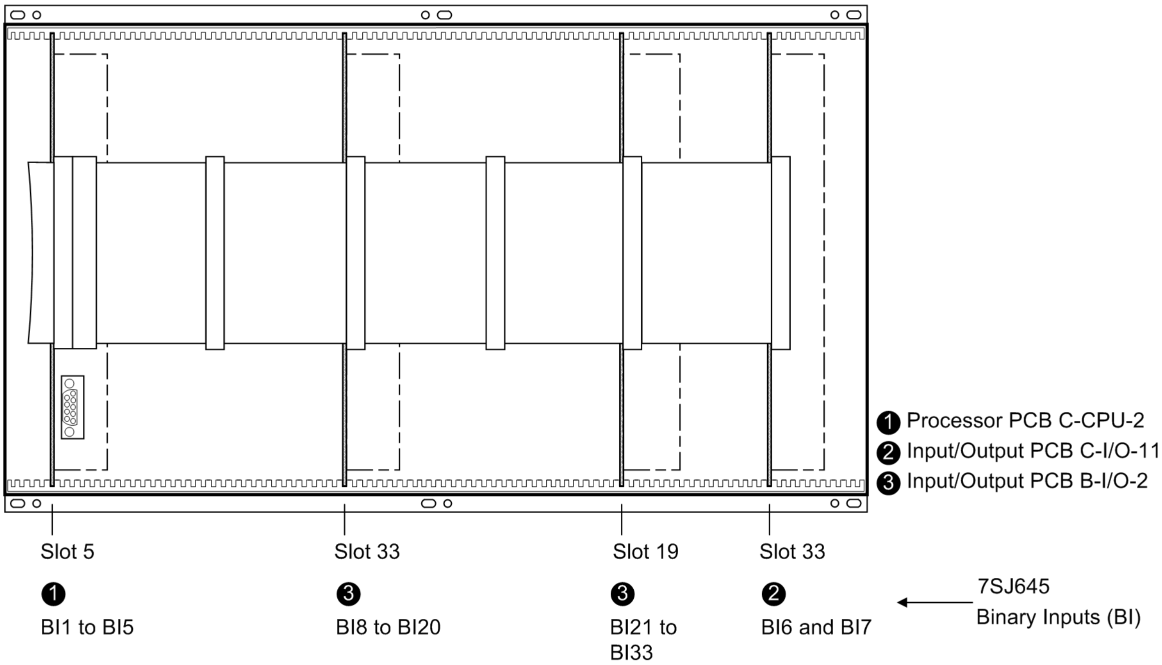


Figure 3-8 Front view of the 7SJ645 with housing size $^1/_1$ after removal of the front cover (simplified and scaled down)

3.1.2.3 Switching Elements on the Printed Circuit Boards of Device 7SJ62

Processor Board A–CPU for 7SJ62.../DD

There are two different releases available of the A–CPU board. The following figure depicts the layout of the printed circuit board for the AB-CPU board for devices up to the release 7SJ6*.../DD, the subsequencing figure for devices of release .../EE and higher. The location and ratings of the miniature fuse (F1) and of the buffer battery (G1) are shown in the following figure.

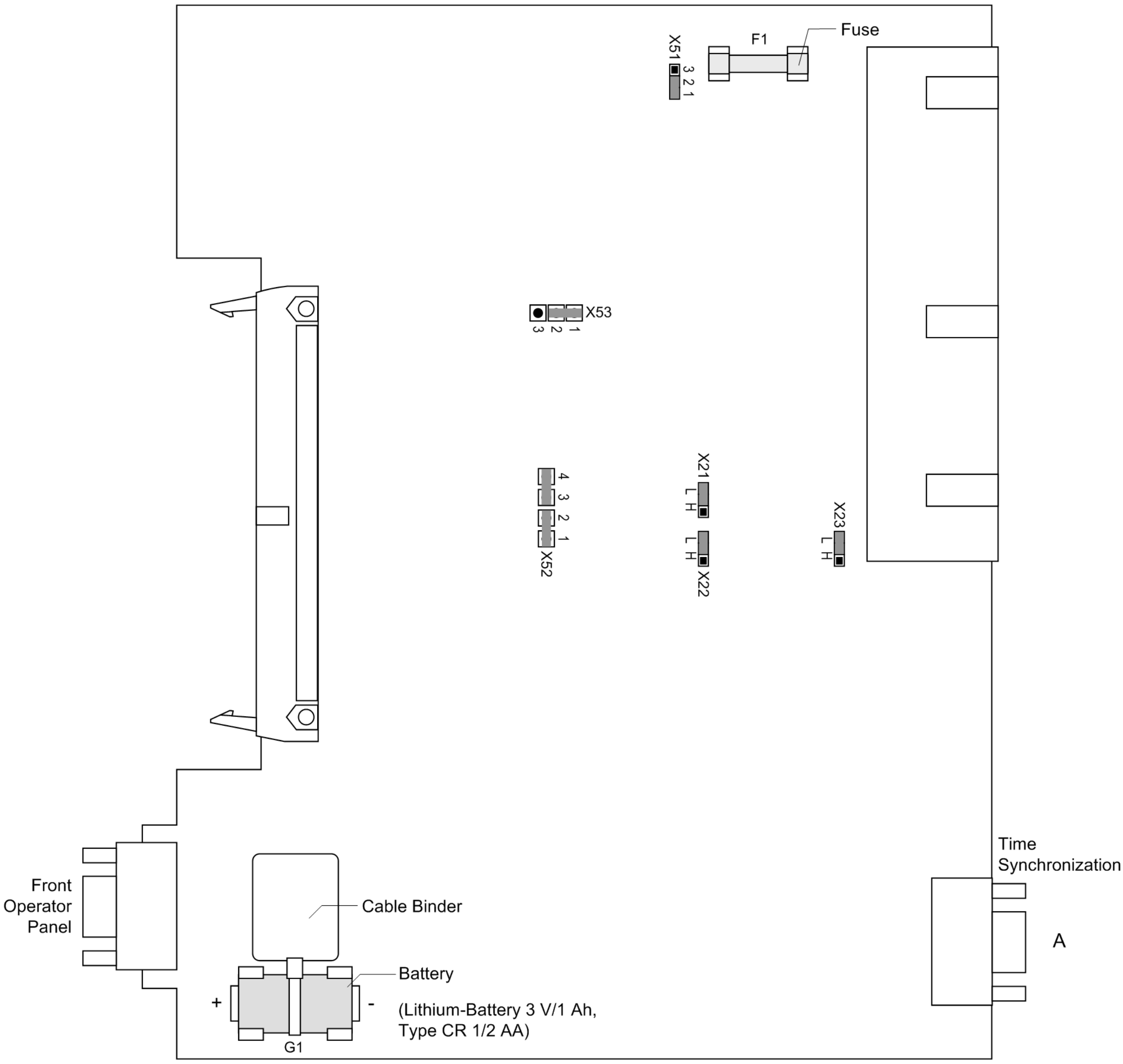


Figure 3-9 Processor printed circuit board A–CPU for devices up to release .../DD with jumpers settings required for the board configuration

The provided nominal voltage of the integrated power supply is controlled according to Table 3-2, the selected control voltages of the binary inputs BI1 to BI7 according to Table 3-3.

Power Supply

Table 3-2 Jumper settings for the nominal voltage of the integrated **power supply** on the processor board A–CPU for 7SJ62.../DD

<table>
<tr><th rowspan="2">Jumper</th><th colspan="4">Rated Voltage</th></tr>
<tr><th>60 to 125 VDC</th><th>110 to 250 VDC
115 VAC</th><th>24/48 VDC</th><th>230 VAC</th></tr>
<tr><td>X51</td><td>1-2</td><td>2-3</td><td colspan="2" rowspan="3">Jumpers X51 to X53 are not used</td></tr>
<tr><td>X52</td><td>1-2 and 3-4</td><td>2-3</td></tr>
<tr><td>X53</td><td>1-2</td><td>2-3</td></tr>
<tr><td></td><td colspan="2">interchangeable</td><td colspan="2">cannot be changed</td></tr>
</table>

Pickup Voltages of BI1 to BI3

Table 3-3 Jumper settings of **control voltages** of binary inputs BI1 to BI3 on the processor board A–CPU for 7SJ62.../DD

Binary Inputs	Jumper	19 VDC Pickup [1)]	88 VDC Pickup [2)]
BI1	X21	L	H
BI2	X22	L	H
BI3	X23	L	H

[1)] Factory settings for devices with power supply voltages of 24 VDC to 125 VDC

[2)] Factory settings for devices with power supply voltages of 110 VDC to 220 VDC and 115/230 VAC

Processor Board A–CPU for 7SJ62.../EE

The following figure depicts the layout of the printed circuit board for devices with release .../EE. The location and ratings of the miniature fuse (F1) and of the buffer battery (G1) are shown in the following figure.

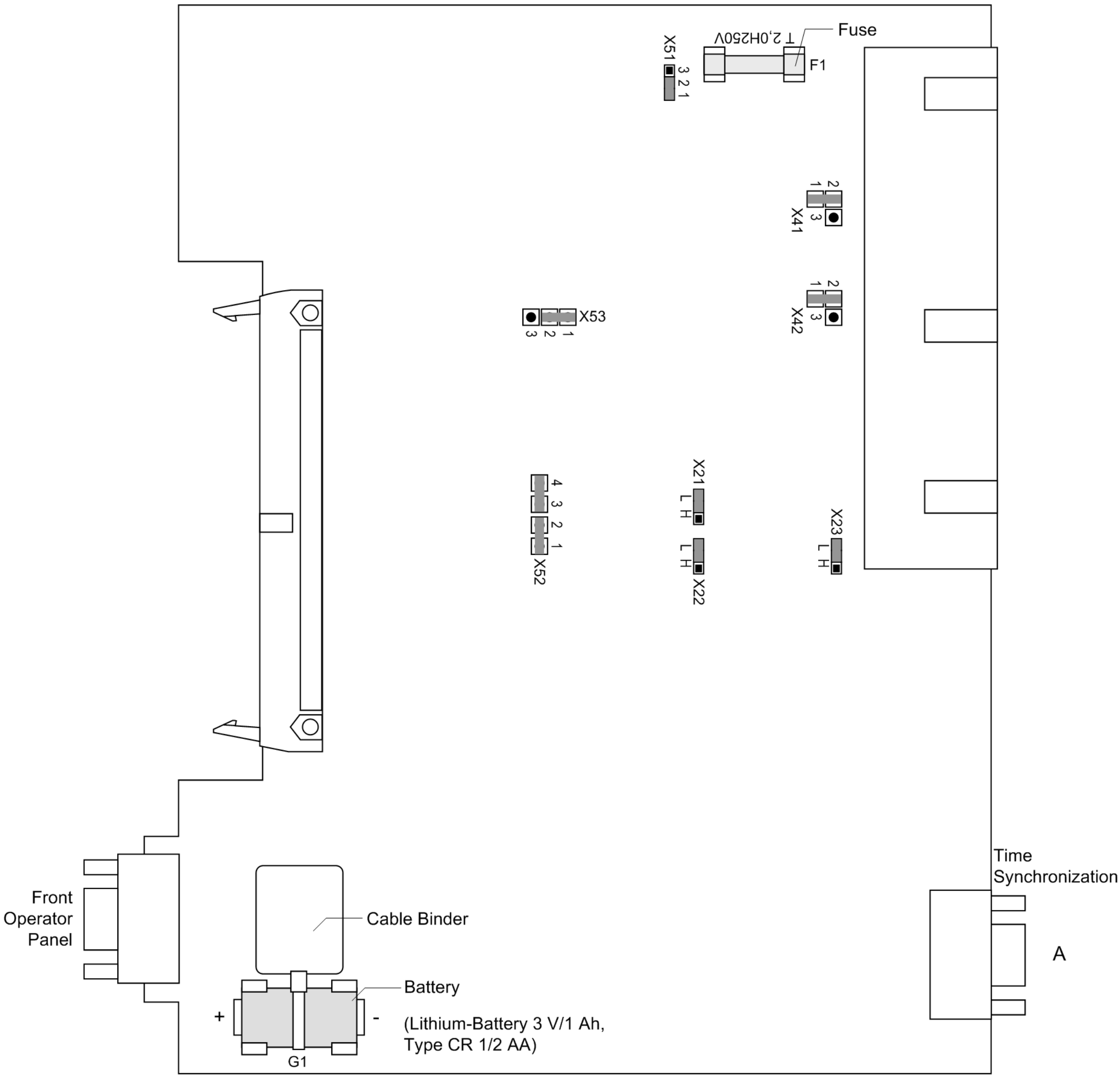


Figure 3-10 Processor printed circuit board A–CPU for devices .../EE and higher with jumpers settings required for the board configuration

The preset nominal voltage of the integrated power supply is checked according to Table 3-4, the pickup voltages of the binary inputs BI1 to BI3 are checked according to Table 3-5, and the contact mode of the binary outputs (BO1 and BO2) is checked according to Table 3-6.

Power Supply

Table 3-4 Jumper settings for the nominal voltage of the integrated **power supply** on the processor board A–CPU for 7SJ62.../EE

Jumper	Nominal Voltage		
	24/48 VDC	**60 to 125 VDC**	**110 to 250 VDC 115 to 230 VAC**
X51	Not used	1-2	2-3
X52	Not used	1-2 and 3-4	2-3
X53	Not used	1-2	2-3
	cannot be changed	interchangeable	

Pickup Voltages of BI1 to BI3

Table 3-5 Jumper settings for the **pickup voltages** of the binary inputs BI1 to BI3 on the processor printed circuit board A–CPU for 7SJ62.../EE

Binary Inputs	Jumper	19 VDC Pickup [1)]	88 VDC Pickup [2)]
BI1	X21	L	H
BI2	X22	L	H
BI3	X23	L	H

1) Factory settings for devices with power supply voltages of 24 VDC to 125 VDC

2) Factory settings for devices with power supply voltages of 110 VDC to 220 VDC and 115/230 VAC

Contact Mode for Binary Outputs BO1 and BO2

Table 3-6 Jumper settings for the **contact mode** of the binary inputs BI1 to BI3 on the processor printed circuit board A–CPU for 7SJ62.../EE

for	Jumper	Open in quiescent state (NO)	Closed in quiescent state (NC)	Presetting
BO1	X41	1-2	2-3	1-2
BO2	X42	1-2	2-3	1-2

Input/Output Board A–I/O-2 for 7SJ62

The layout of the printed circuit board for the input/output board A–I/O-2 is illustrated in the following Figure. The set nominal currents of the current input transformers and the selected operating voltage of binary inputs BI4 to BI11 are checked.

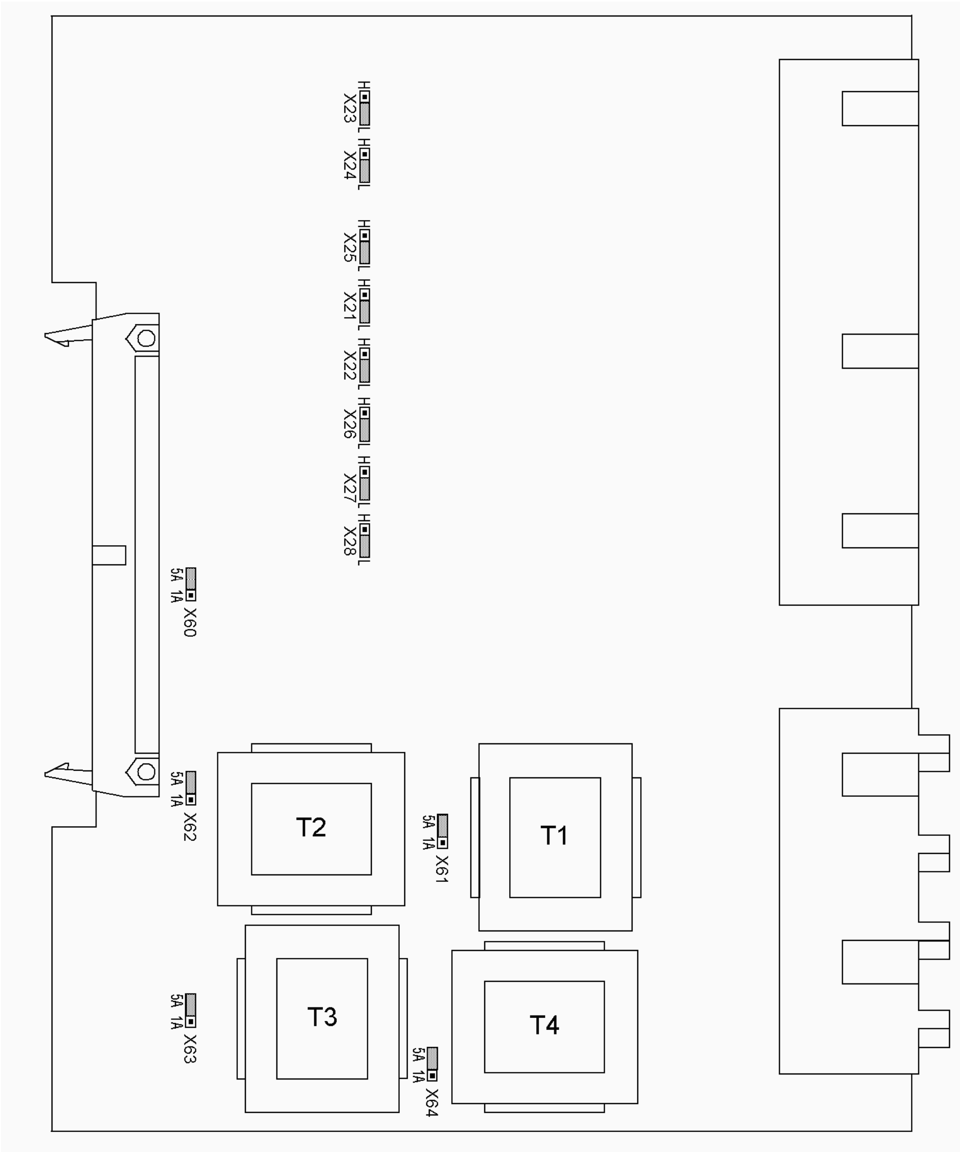


Figure 3-11 Input/output board A–I/O-2 with representation of the jumper settings required for the board configuration

The jumpers X60 to X63 must all be set to the same rated current, i.e. one jumper (X61 to X63) for each input transformer and in addition the common jumper X60. The jumper X64 determines the rated current for the input I_N and may thus have a setting that deviates from that of the phase currents. In models with sensitive ground fault current input there is no jumper X64.

Pickup Voltages of BI4 to BI11

Table 3-7 Jumper settings for **pickup voltages** of binary inputs BI4 to BI11 on the A–I/O-2 board

Binary Inputs	Jumper	19 VDC Pickup [1)]	88 VDC Pickup [2)]
BI4	X21	L	H
BI5	X22	L	H
BI6	X23	L	H
BI7	X24	L	H
BI8	X25	L	H
BI9	X26	L	H
BI10	X27	L	H
BI 11	X28	L	H

[1)] Factory settings for devices with power supply voltages of 24 VDC to 125 VDC

[2)] Factory settings for devices with power supply voltages of 110 VDC to 220 VDC and 115/230 VAC

3.1.2.4 Switching Elements on the Printed Circuit Boards of Device 7SJ63

Processor Board B–CPU for 7SJ63.../DD

There are two different releases available of the B–CPU board with a different arrangement and setting of the jumpers. The following figure depicts the layout of the printed circuit board B-CPU for devices up to release .../DD. The location and ratings of the miniature fuse (F1) and of the buffer battery (G1) are shown in the following figure.

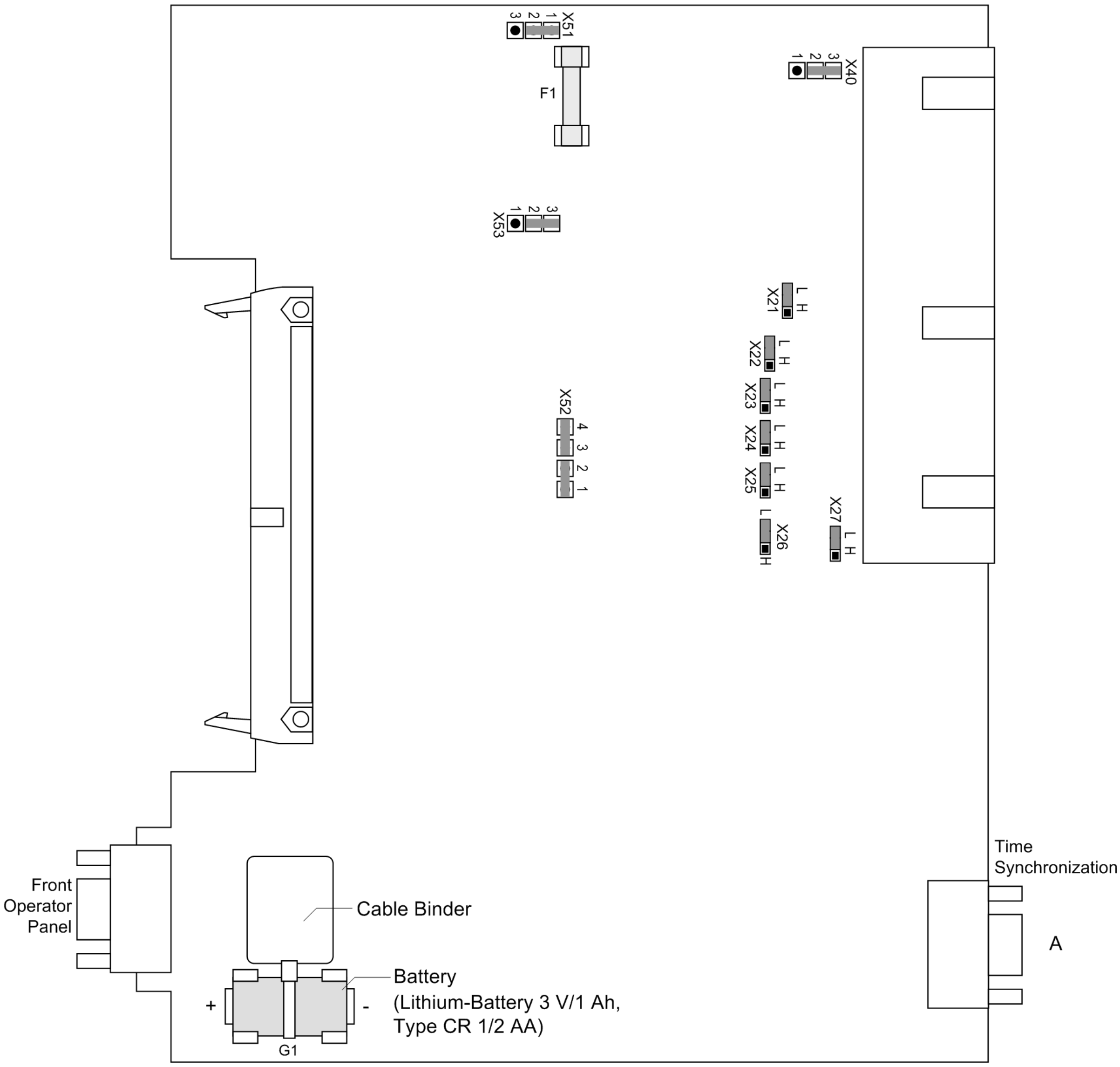


Figure 3-12 Processor printed circuit board B–CPU for devices up to release.../DD with jumpers settings required for the board configuration

For devices up to release 7SJ63.../DD check the provided nominal voltage of the integrated power supply according to Table 3-8, the quiescent state of the life contact according to Table 3-9 and the selected pickup voltages of the binary inputs BI1 through BI7 according to Table 3-10.

Power Supply

There is no 230 V AC power supply available for 7SJ63.../**DD**

Table 3-8 Jumper settings for the nominal voltage of the integrated **power supply** on the processor board B–CPU for 7SJ63.../**DD**

Jumper	Nominal Voltage		
	60 to 125 V DC	**110 to 250 VDC, 115 VAC**	**24/48 VDC**
X51	1-2	2-3	Jumpers X51 to X53 are not used
X52	1-2 and 3-4	2-3	
X53	1-2	2-3	
	interchangeable		cannot be changed

Live Status Contact

Table 3-9 Jumper setting for the quiescent state of the **life contact** on the processor printed circuit board B-CPU for devices 7SJ63.../**DD**

Jumper	Open in the quiescent state	Closed in the quiescent state	Presetting
X40	1-2	2-3	2-3

Pickup Voltages of BI1 to BI7

Table 3-10 Jumper settings for **pickup voltages** of binary inputs BI1 to BI7 on the processor printed circuit board B–CPU for 7SJ63.../**DD**

Binary Inputs	Jumper	19 VDC Pickup 1)	88 VDC Pickup 2)
BI1	X21	L	H
BI2	X22	L	H
BI3	X23	L	H
BI4	X24	L	H
BI5	X25	L	H
BI6	X26	L	H
BI7	X27	L	H

1) Factory settings for devices with power supply voltages of 24 VDC to 125 VDC

2) Factory settings for devices with power supply voltages of 110 VDC to 220 VDC and 115 VAC

Processor Board B–CPU for 7SJ63.../EE

The following figure depicts the layout of the printed circuit board for devices up to release .../EE. The location and ratings of the miniature fuse (F1) and of the buffer battery (G1) are shown in the following figure.

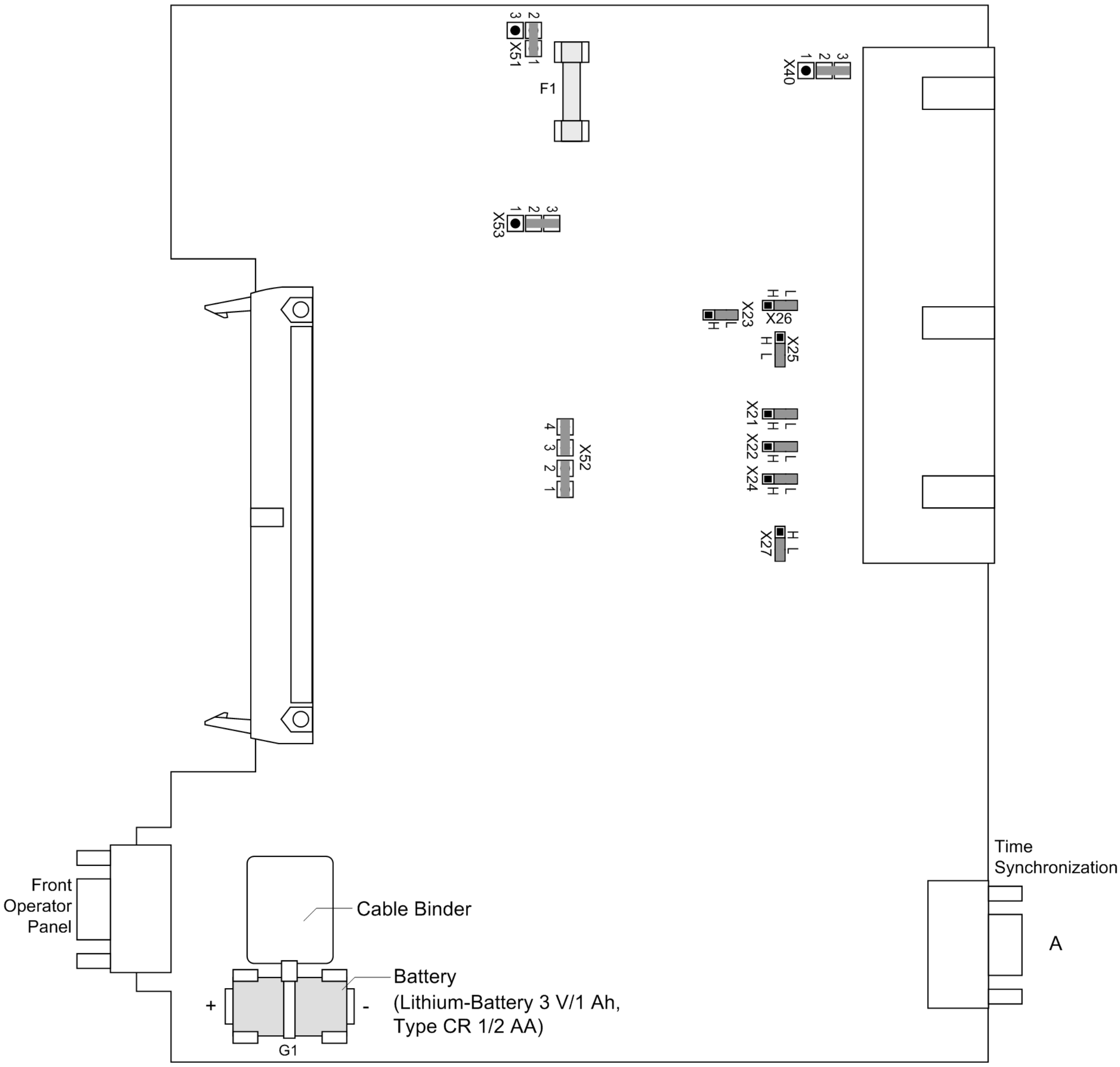


Figure 3-13 Processor printed circuit board B–CPU for devices .../EE and higher with jumpers settings required for the board configuration

For devices up to release 7SJ63.../EE check the provided nominal voltage of the integrated power supply according to Table 3-11, the quiescent state of the life contact according to Table 3-12 and the selected pickup voltages of the binary inputs BI1 through BI7 according to Table 3-13.

Power Supply

Table 3-11 Jumper settings for the nominal voltage of the integrated **power supply** on the processor board B–CPU for 7SJ63.../**EE**

Jumper	Nominal Voltage		
	60/110/125 VDC	**220/250 VDC** **115/230 VAC**	**24/48 VDC**
X51	1-2	2-3	1-2
X52	1-2 and 3-4	2-3	none
X53	1-2	2-3	none
	interchangeable		cannot be changed

Live Status Contact

Table 3-12 Jumper setting for the quiescent state of the **live status contact** on the processor printed circuit board B-CPU for devices 7SJ63.../**EE**

Jumper	Open in the quiescent state	Closed in the quiescent state	Factory Setting
X40	1-2	2-3	2-3

Pickup Voltages of BI1 to BI7

Table 3-13 Jumper settings for **pickup voltages** of binary inputs BI1 to BI7 on the processor printed circuit board B–CPU for 7SJ63.../**EE**

Binary Inputs	Jumper	19 VDC Pickup [1)]	88 VDC Pickup [2)]
BI1	X21	L	H
BI2	X22	L	H
BI3	X23	L	H
BI4	X24	L	H
BI5	X25	L	H
BI6	X26	L	H
BI7	X27	L	H

[1)] Factory settings for devices with power supply voltages of 24 VDC to 125 VDC
[2)] Factory settings for devices with power supply voltages of 220/250 VDC and 115/230 VAC

Input/Output Board B–I/O-1(7SJ63)

The layout of the printed circuit board for the input/output board B–I/O-1 is illustrated in the following figure.

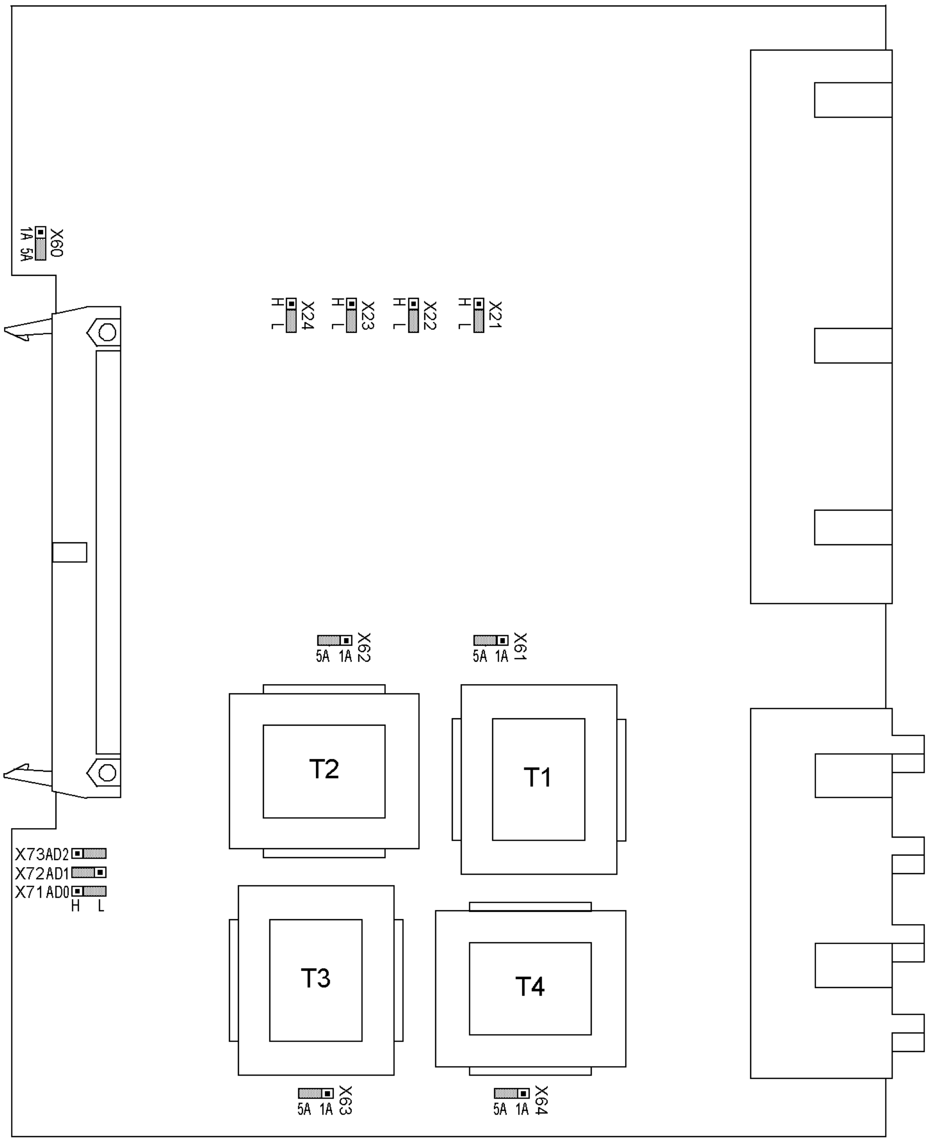


Figure 3-14 Input/output board B–I/O-1 with representation of the jumper settings required for the board configuration

The set nominal currents of the current input transformers and the selected operating voltage of binary inputs BI21 to BI24 according to Table 3-14 are checked. All jumpers must be set for one nominal current, i.e. one jumper (X61 to X64) for each input transformer and additionally the common jumper X60. The jumper X64 determines the rated current for the input I_N and may thus have a setting that deviates from that of the phase currents. In models with sensitive ground fault current input there is no jumper X64.

Pickup Voltages of BI21 to BI24

Table 3-14 Jumper settings for the **pickup voltages** of the binary inputs BI21 through BI24 on the B–I/O-1 board

Binary Inputs	Jumper	19 VDC Pickup 1)	88 VDC Pickup 2)
BI21	X21	L	H
BI22	X22	L	H
BI23	X23	L	H
BI24	X24	L	H

1) Factory settings for devices with power supply voltages of 24 VDC to 125 VDC

2) Factory settings for devices with power supply voltages of 220/250 VDC and 115/230 VAC

Bus Address

Jumpers X71, X72 and X73 on the input/output module B-I/O-1 serve to set up the **Bus Address**. The jumpers must not be changed. The following table lists the jumper presettings.

Table 3-15 Jumper Settings Input/Output Board B-I/O-1

Jumper	Housing size $^1/_2$ and $^1/_1$
X71	L
X72	H
X73	L

Input/Output Board B–I/O-2(7SJ63)

The layout of the PCB for the input/output module B–I/O–2 is illustrated in figure 3-15

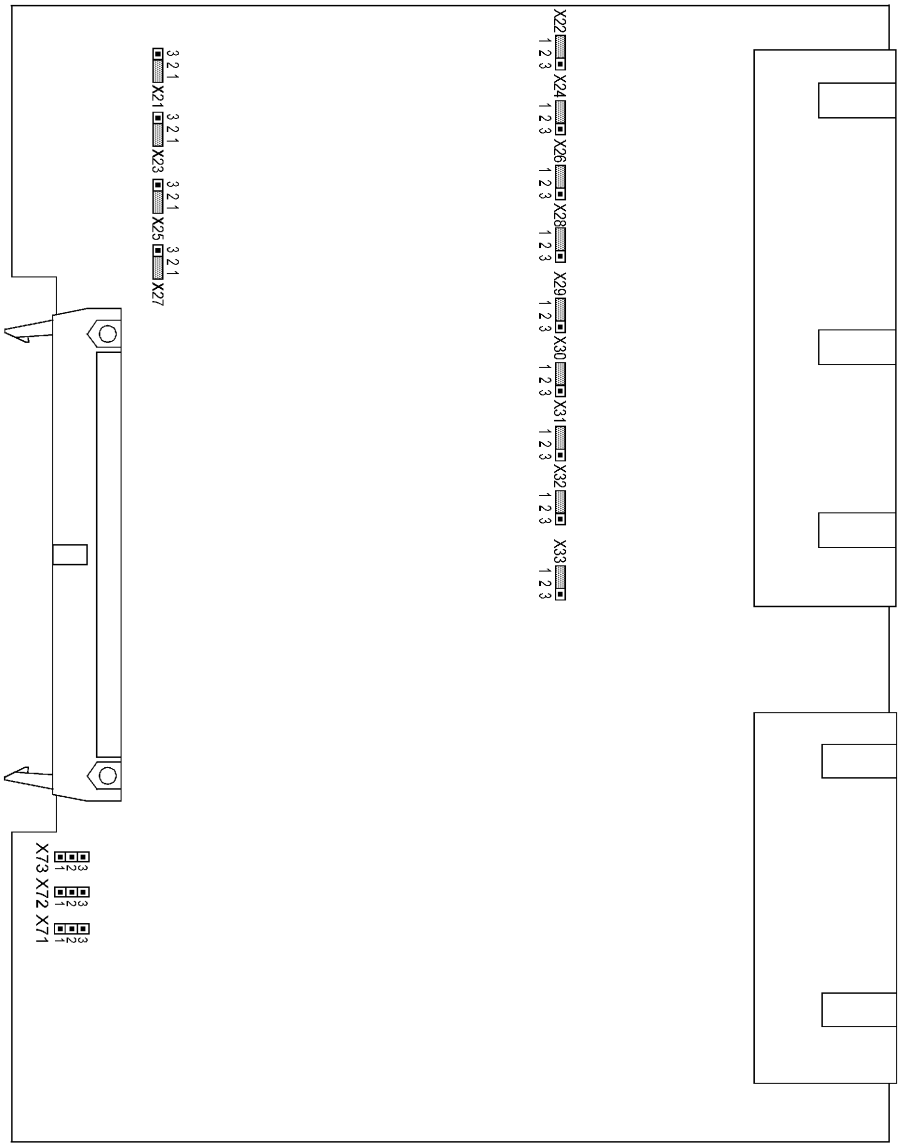


Figure 3-15 Input/output board B-I/O-2 with representation of the jumper settings required for the board configuration

The selected pickup voltages of the binary inputs BI8 to BI20, and BI25 to BI37 are checked according to Table 3-16.

Figures 3-4 and 3-5 illustrate the assignment of the binary inputs to the module slot.

Pickup Voltages of Binary Inputs BI8 to BI20, BI25 to BI37

Table 3-16 Jumper settings for **pickup voltages** of the binary inputs BI8 to BI20 and BI25 to BI37 on the input/output board B–I/O-2

Binary Input		Jumper	19 VDC Pickup [1)]	88 VDC Pickup [2)]
BI8	BI25	X21	1-2	2-3
BI9	BI26	X22	1-2	2-3
BI10	BI27	X23	1-2	2-3
BI 11	BI28	X24	1-2	2-3
BI12	BI29	X25	1-2	2-3
BI13	BI30	X26	1-2	2-3
BI14	BI31	X27	1-2	2-3
BI15	BI32	X28	1-2	2-3
BI16	BI33	X29	1-2	2-3
BI17	BI34	X30	1-2	2-3
BI18	BI35	X31	1-2	2-3
BI19	BI36	X32	1-2	2-3
BI20	BI37	X33	1-2	2-3

[1)] Factory settings for devices with power supply voltages of 24 VDC to 125 VDC

[2)] Factory settings for devices with power supply voltages of 220/250 VDC and 115/230 VAC

Bus Address

Jumpers X71, X72 and X73 on the B–I/O-2 board serve to set up the **Bus Address**. The jumpers must not be changed. The following table lists the jumper presettings.

Table 3-17 Jumper Settings Input/Output Board B-I/O-2

Jumper	Housing size $^1/_2$		Housing size $^1/_1$	
	Mounting location 19	Mounting location 33	Mounting location 33 (left)	Mounting location 19 (right)
X71	1–2	1–2	1-2	1-2
X72	2–3	1–2	2-3	1-2
X73	2–3	2–3	2-3	2-3

3.1.2.5 Switching Elements on the Printed Circuit Boards of Device 7SJ64

Processor Printed Circuit Board C–CPU-2(7SJ64)

The layout of the printed circuit board for the C–CPU–2 board is illustrated in the following figure. The location and ratings of the miniature fuse (F1) and of the buffer battery (G1) are shown in the following figure.

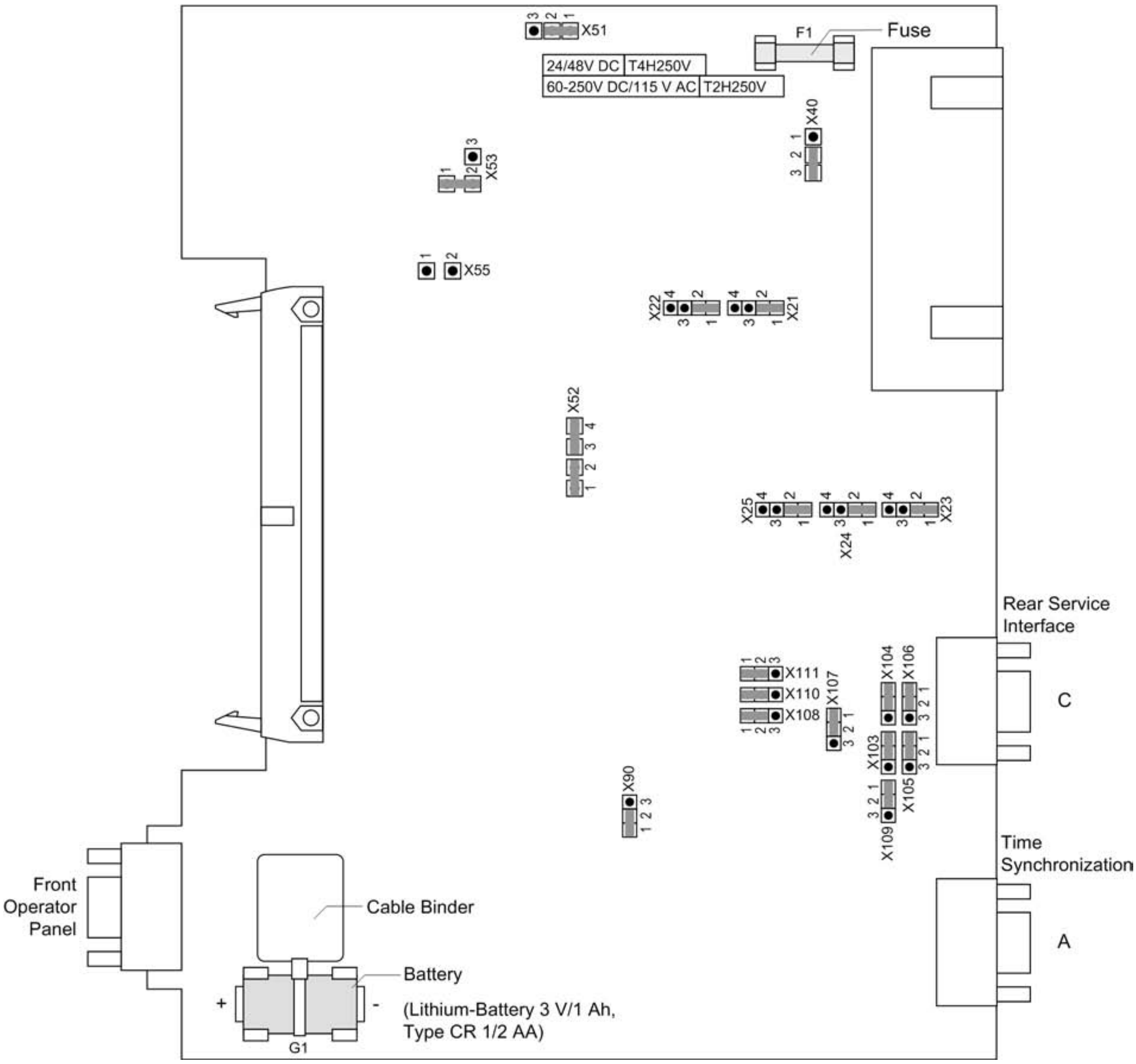


Figure 3-16 Processor printed circuit board C–CPU-2 with jumpers settings required for the board configuration

The set nominal voltage of the integrated power supply is checked according to Table 3-18, the quiescent state of the life contact according to Table 3-19 and the selected control voltages of the binary inputs BI1 to BI5 according to Table 3-20 and the integrated interface RS232 / RS485 according to Table 3-21 to 3-23.

Power Supply

Table 3-18 Jumper setting of the nominal voltage of the integrated **power supply** on the C-CPU-2 processor printed circuit board

Jumper	Nominal Voltage		
	24 to 48 VDC	**60 to 125 VDC**	**110 to 250 VDC** **115 V to 230 VAC** 1)
X51	Not used	1-2	2-3
X52	Not used	1-2 and 3-4	2-3
X53	Not used	1-2	2-3
X55	Not used	Not used	1-2
	cannot be changed	interchangeable	

1) 230 VAC only possible with release 7SJ64**-.../**CC** and higher

Live Status Contact

Table 3-19 Jumper position of the quiescent state of the **live status contact** on the C-CPU-2 processor printed circuit board

Jumper	Open in the quiescent state	Closed in the quiescent state	Presetting
X40	1-2	2-3	2-3

Pickup Voltages of BI1 to BI5

Table 3-20 Jumper settings of the **Pickup Voltages** (DC voltage) of the binary inputs BI1 to BI5 on the C-CPU-2 processor board

Binary Inputs	Jumper	19 VDC Pickup 1)	88 VDC Pickup 2)	176 VDC Pickup 3)
BI1	X21	1-2	2-3	3-4
BI2	X22	1-2	2-3	3-4
BI3	X23	1-2	2-3	3-4
BI4	X24	1-2	2-3	3-4
BI5	X25	1-2	2-3	3-4

1) Factory settings for devices with power supply voltages of 24 to 125 VDC
2) Factory settings for devices with power supply voltages of 110 to 250 VDC and 115 VAC or 115 to 230 VAC
3) Use only with pickup voltages 220 or 250 VDC

RS232/RS485

The service interface (**Port C**) can be converted into an **RS232 or RS485** interface by modifying the setting of the appropriate jumpers.

Jumpers X105 to X110 must be set to the same position !

The presetting of the jumpers corresponds to the configuration ordered.

Table 3-21 Jumper settings of the integrated **RS232/RS485 Interface** on the C–CPU-2 board

Jumper	RS232	RS485
X103 and X104	1-2	1-2
X105 to X110	1-2	2-3

With interface RS232 jumper X111 is needed to activate CTS which enables the communication with the modem.

CTS (Clear to Send)

Table 3-22 Jumper setting for **CTS** on the C-CPU-2 board

Jumper	/CTS from Interface RS232	/CTS triggered by /RTS
X111	1-2	2-3 [1)]

[1)] Presetting

Jumper setting 2-3: The connection to the modem is usually established with a star coupler or fiber-optic converter. Therefore the modem control signals according to RS232 standard DIN 66020 are not available. Modem signals are not required since the connection to the SIPROTEC® 4 devices is always operated in the half-duplex mode. Please use connection cable with order number 7XV5100-4

The jumper setting 2-3 is also necessary when using the RTD-box in half duplex operation.

Jumper setting 1-2: This setting makes the modem signals available, i.e. for a direct RS232 connection between the SIPROTEC® 4 device and the modem this setting can be selected optionally. We recommend to use a standard RS232 modem connection cable (converter 9-pin to 25-pin).

Note

For a direct connection to DIGSI with interface RS232 jumper X111 must be plugged in position 2-3.

If there are no external matching resistors in the system, the last devices on a RS485 bus must be configured using jumpers X103 and X104.

Terminating Resistors

Table 3-23 Jumper settings of the **Terminating Resistors** of interface RS485 on the C-CPU-2 processor board

Jumper	Terminating resistor closed	Terminating resistor open	Presetting
X103	2-3	1-2	1-2
X104	2-3	1-2	1-2

Note: Both jumpers must always be plugged in the same way !

Jumper X90 has currently no function. The factory setting is 1-2.

The terminating resistors can also be connected externally (e.g. to the connection module). In this case, the terminating resistors located on the RS485 or PROFIBUS interface module or directly on the PCB of the 7SJ64 processor board C-CPU-2 must be de-energized.

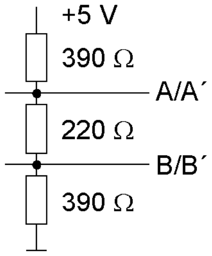


Figure 3-17 Termination of the RS485 interface (external)

Input / Output Board C–I/O-11 (7SJ64)

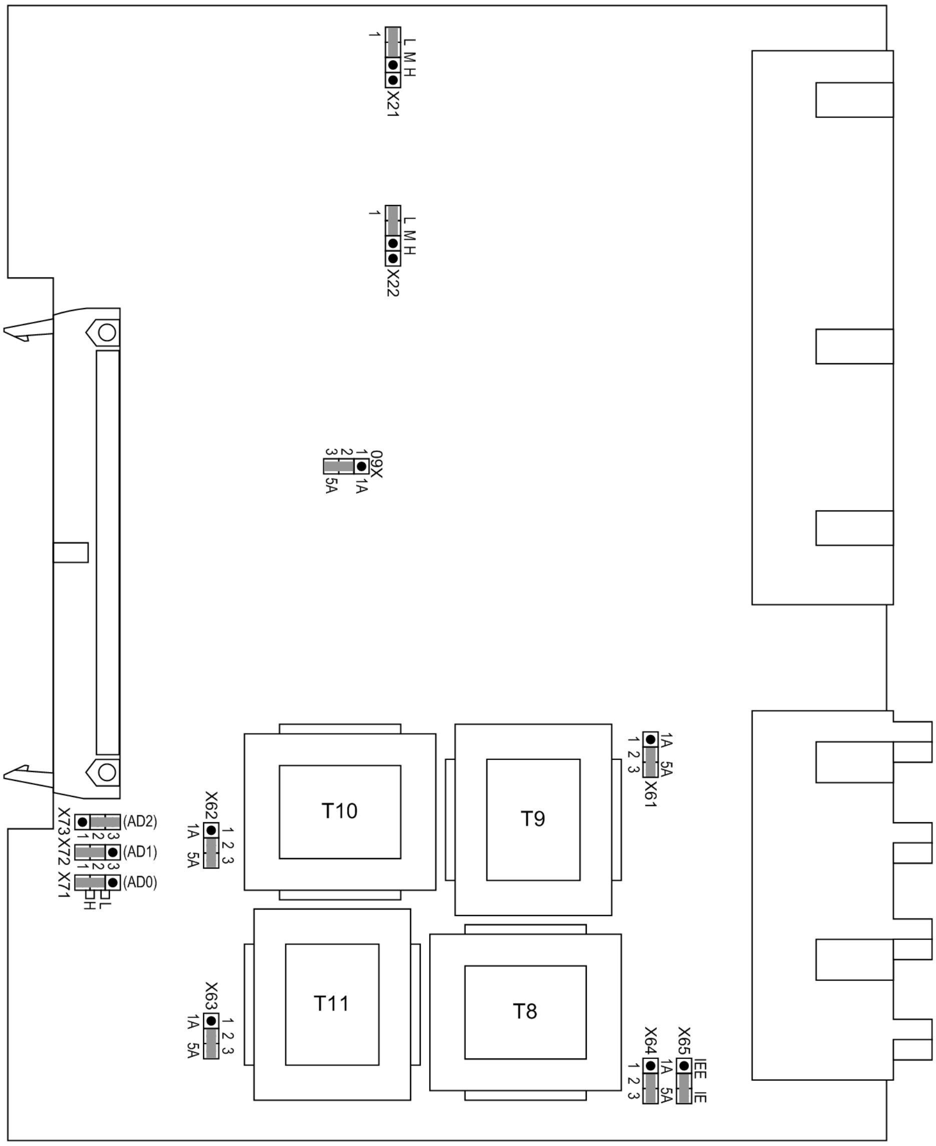


Figure 3-18 C-I/O-11 input/output board with representation of jumper settings required for checking configuration settings

The set nominal current of the current input transformers are checked on the input/output board C-I/O-11. The jumpers X60 to X63 must all be set to the same rated current, i.e. one jumper (X61 to X63) for each input transformer of the phase currents and in addition the common jumper X60. The jumper X64 determines the rated current for the input I_N and may thus have a setting that deviates from that of the phase currents. In models with sensitive ground fault current input there is no jumper X64.

For normal ground current inputs the jumper X65 is plugged in position „IE“ and for sensitive ground current inputs in position „IEE“.

Pickup Voltages of BI6 to BI7

Table 3-24 Jumper settings for **Pickup Voltages** of the binary inputs BI6 and BI7 on the input/output board C-I/O-11

Binary Input	Jumper	19 VDC Pickup [1)	88 VDC Pickup [2)	176 VDC Pickup [3)
BI6	X21	L	M	H
BI7	X22	L	M	H

1) Factory settings for devices with power supply voltages of 24 VDC to 125 VDC
2) Factory settings for devices with power supply voltages of 110 to 250 VDC and 115 VAC or 115 to 230 VAC
3) Use only with pickup voltages 220 or 250 VDC

Jumpers X71, X72 and X73 on the input/output board C-I/O-11 are used to set the bus address and must not be changed. The following table lists the jumper presettings.

Mounting location:

with housing size $^1/_3$ Serial no. 2 in Figure 3-6, slot 19

with housing size $^1/_2$ Serial no. 2 in Figure 3-7, slot 33

with housing size $^1/_1$ Serial no. 2 in Figure 3-8, slot 33 on right side

Bus Address

Table 3-25 Jumper Settings of **Bus Addresses** of Input/Output Board C–I/O-11 for 7SJ64

Jumper	Presetting
X71	1-2 (H)
X72	1-2 (H)
X73	2-3 (L)

Input/Output Board B-I/O-2 (7SJ64)

The layout of the PCB for the input/output module B–I/O–2 is illustrated in figure 3-19.

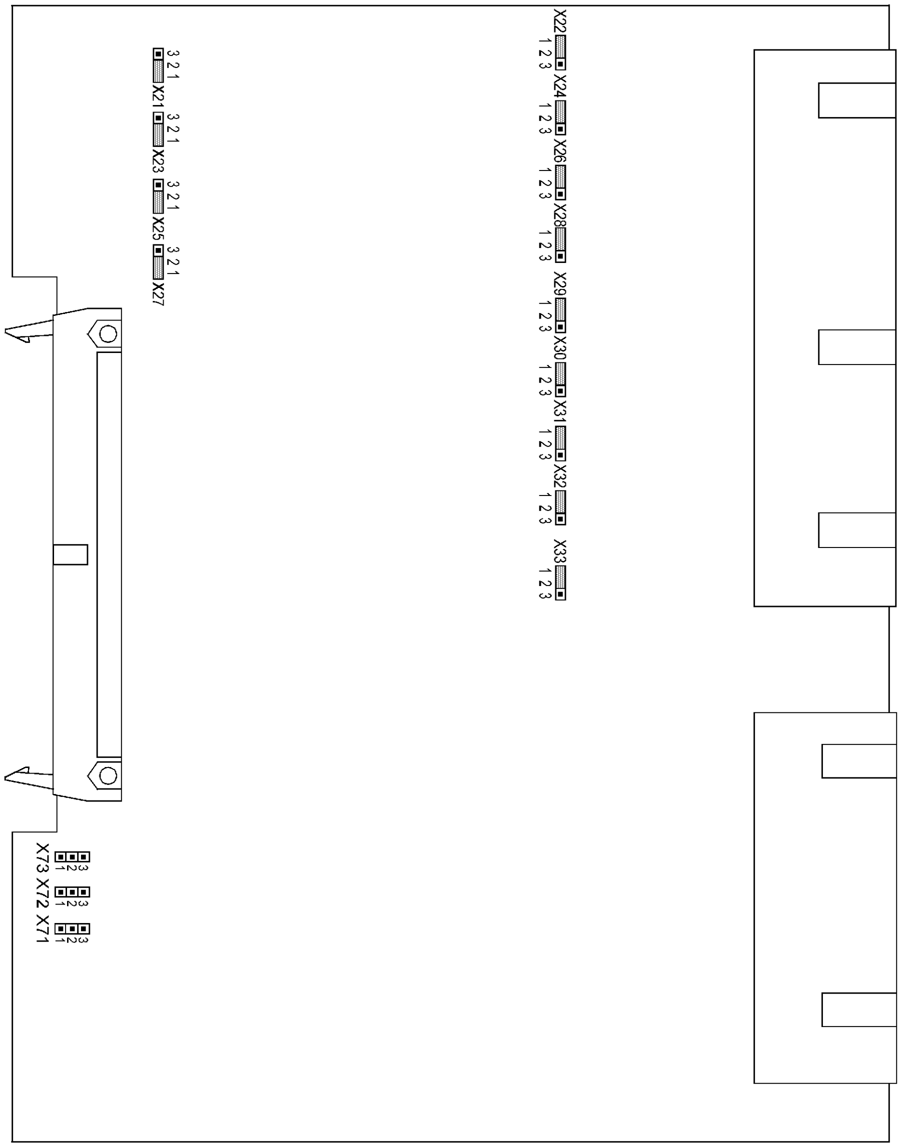


Figure 3-19 Input/output board B-I/O-2 with representation of the jumper settings required for the board configuration

The selected pickup voltages of the binary inputs BI8 to BI20 (with housing size $^1/_2$) are checked according to Table 3-26. BI8 to BI33 (with housing size $^1/_1$) are checked according to Table 3-27.

Figures 3-7 and 3-8 illustrate the assignment of the binary inputs to the module slot.

Pickup Voltages of BI8 to BI20 for 7SJ642*-

Table 3-26 Jumper settings for the **pickup voltages** of the binary inputs BI8 to BI20 on the B–I/O-2 board for model 7SJ64**2***-... (housing size $^1/_2$)

Binary Inputs	Jumper	19 VDC Pickup [1)]	88 VDC Pickup [2)]
Slot 19			
BI8	X21	1-2	2-3
BI9	X22	1-2	2-3
BI10	X23	1-2	2-3
BI 11	X24	1-2	2-3
BI12	X25	1-2	2-3
BI13	X26	1-2	2-3
BI14	X27	1-2	2-3
BI15	X28	1-2	2-3
BI16	X29	1-2	2-3
BI17	X30	1-2	2-3
BI18	X31	1-2	2-3
BI19	X32	1-2	2-3
BI20	X33	1-2	2-3

1) Factory settings for devices with power supply voltages of 24 VDC to 125 VDC

2) Factory settings for devices with power supply voltages of 110 to 220 VDC and 115 VAC or 115 to 230 VAC

Pickup Voltages of BI8 to BI33 for 7SJ645*-

Table 3-27 Jumper settings for the **pickup voltages** of the binary inputs BI8 to BI33 on the B–I/O-2 board for model 7SJ64**5***-... (housing size $^1/_1$)

Binary Inputs		Jumper	19 VDC Pickup [1)]	88 VDC Pickup [2)]
Slot 33 left side	**Slot 19 right side**			
BI8	BI21	X21	1-2	2-3
BI9	BI22	X22	1-2	2-3
BI10	BI23	X23	1-2	2-3
BI11	BI24	X24	1-2	2-3
BI12	BI25	X25	1-2	2-3
BI13	BI26	X26	1-2	2-3
BI14	BI27	X27	1-2	2-3
BI15	BI28	X28	1-2	2-3
BI16	BI29	X29	1-2	2-3
BI17	BI30	X30	1-2	2-3
BI18	BI31	X31	1-2	2-3
BI19	BI32	X32	1-2	2-3
BI20	BI33	X33	1-2	2-3

1) Factory settings for devices with power supply voltages of 24 VDC to 125 VDC

2) Factory settings for devices with power supply voltages of 110 to 220 VDC and 115 VAC or 115 to 230 VAC

Jumpers X71, X72 and X73 on the input/output module B-I/O-2 serve to set up the **Bus Address**. The jumpers must not be changed. The following two tables list the jumper presettings.

The mounting locations are shown in Figures 3-7 and 3-8.

Bus Addresses

Table 3-28 Jumper settings of the **Bus Addresses** of the input/output modules B-I/O-2 for 7SJ64 housing size $^{1}/_{2}$

Jumper	Mounting Location
	Slot 19
X71	1-2
X72	2-3
X73	1-2

Table 3-29 Jumper settings of the **Bus Addresses** of the input/output boards B-I/O-2 for 7SJ64 housing size $^{1}/_{1}$

Jumper	Mounting Location	
	Slot 19 right side	**Slot 33 left side**
X71	1-2	2-3
X72	2-3	1-2
X73	1-2	1-2

Input / Output Board C–I/O-1 (7SJ64)

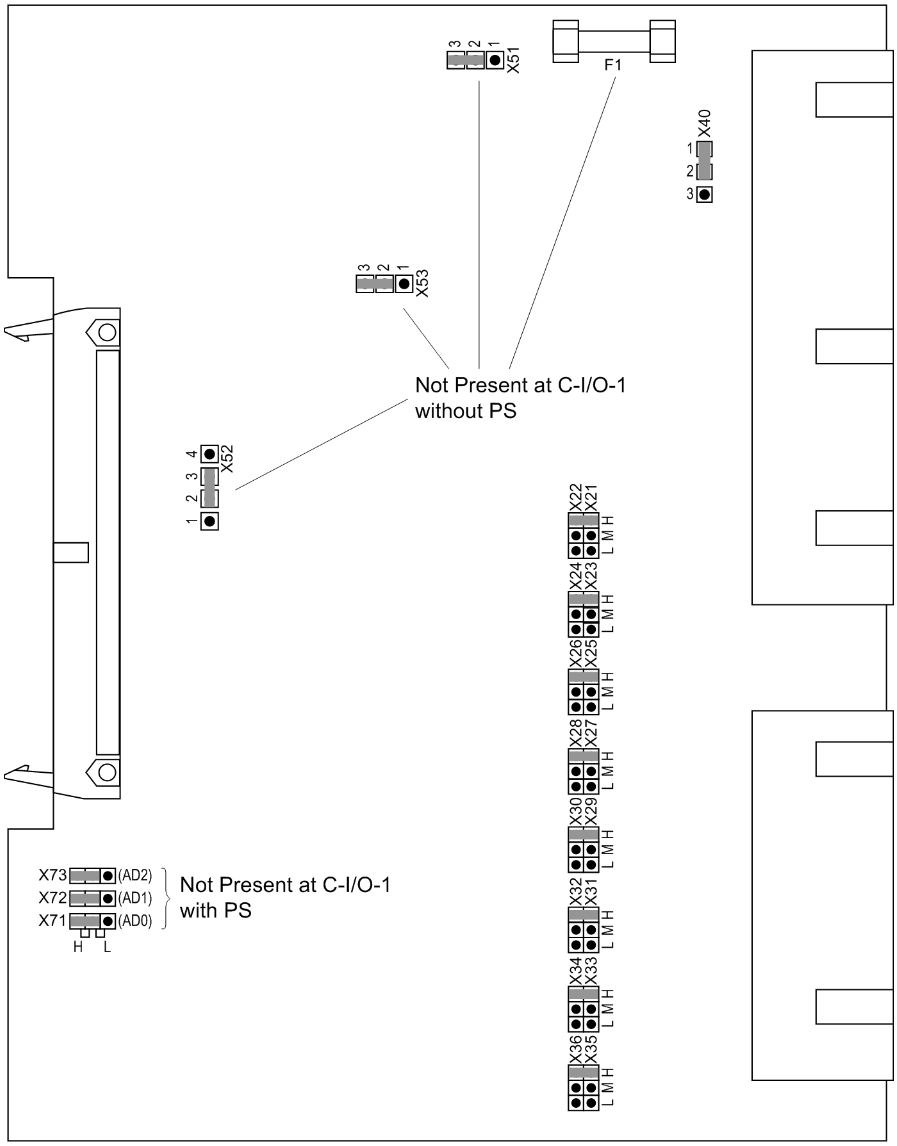


Figure 3-20 Input/output board C-I/O-1 with representation of the jumper settings required for the board configuration

The selected control voltages of binary inputs BI8 to BI15 are checked according to Table 3-30. Jumper settings for the contact mode of binary output BO6 are checked according to Table 3-31.

Figure 3-7 illustrates the assignment of the binary inputs to the mounting location.

Pickup Voltages of BI8 to BI15 for 7SJ641*-

Table 3-30 Jumper settings for the **pickup voltages** of the binary inputs BI8 to BI15 on the C–I/O-1 board for model 7SJ64**1***-

Binary Inputs	Jumper	19 VDC Pickup 1)	88 VDC Pickup 2)	176 VDC Pickup 3)
BI8	X21/X22	L	M	H
BI9	X23/X24	L	M	H
BI10	X25/X26	L	M	H
BI11	X27/X28	L	M	H
BI12	X29/X30	L	M	H
BI13	X31/X32	L	M	H
BI14	X33/X34	L	M	H
BI15	X35/X36	L	M	H

1) Factory settings for devices with power supply voltages of 24 VDC to 125 VDC
2) Factory settings for devices with power supply voltages of 110 to 220 VDC and 115 VAC or 115 to 230 VAC
3) Use only with pickup voltages 220 or 250 VDC

Contact Mode

With models 7SJ64**1** binary output BO6 can be changed from normally open to normally closed operation. The following table shows the setting of jumper X40 regarding the **contact mode**.

Table 3-31 Jumper settings for **contact mode** of the binary output BO6 on the C–I/O-1 board

Jumper	Open in quiescent state (NO)	Closed in quiescent state (NC)	Presetting
X40	1-2	2-3	1-2

PCB Addresses

Jumpers X71, X72 and X73 on the input/output board C-I/O-1 are used to set the bus address and must not be changed. The following table lists the jumper presettings.

The slots of the boards are shown in Figure 3-7.

Table 3-32 Jumper Settings of **Module Addresses** of C–I/O-1 board for 7SJ64

Jumper	Presetting
X71	H
X72	L
X73	H

3.1.2.6 Interface Modules

Exchanging Interface Modules

The following figure shows the processor board CPU and arrangement of the modules.

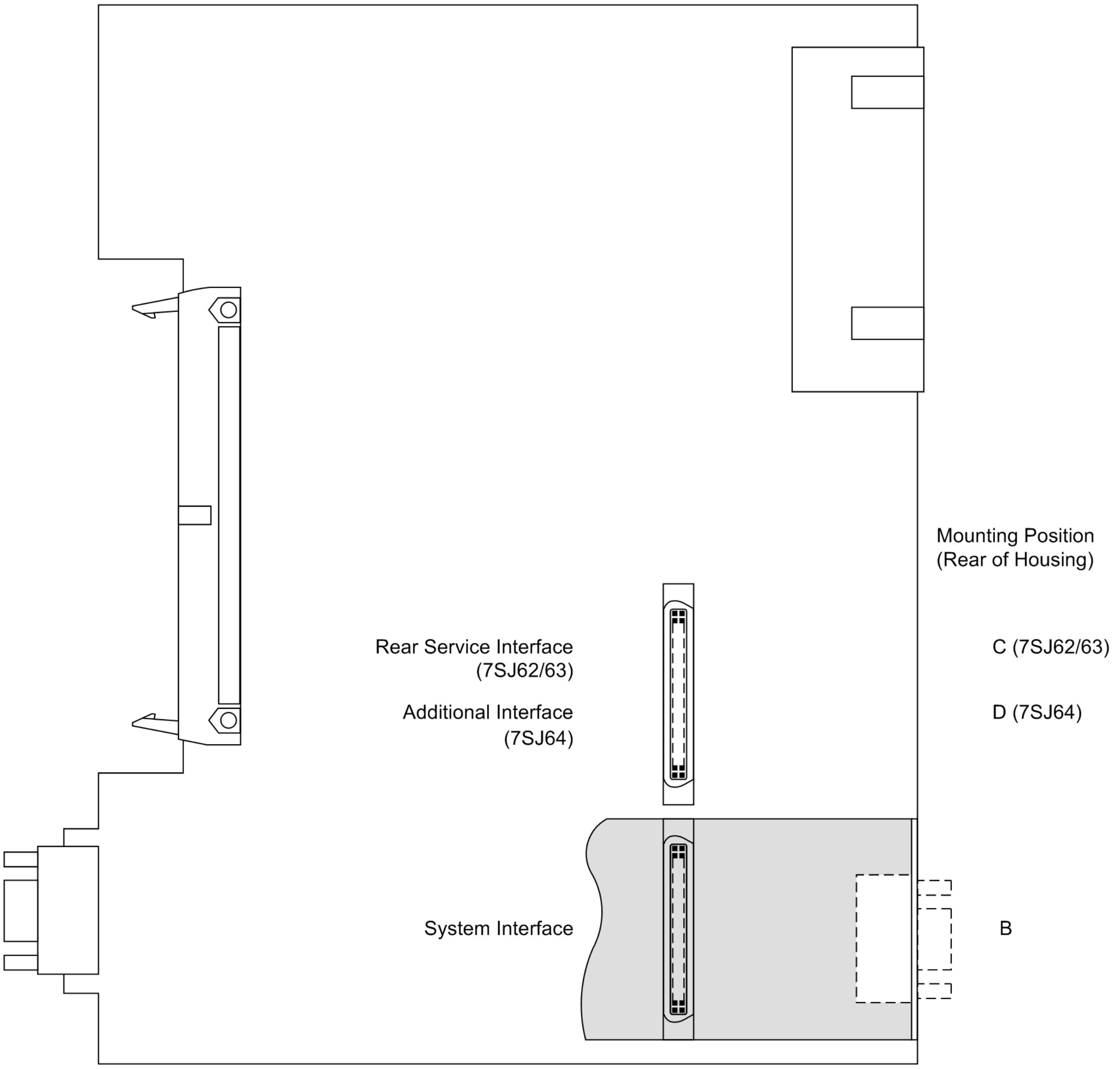


Figure 3-21 Processor board CPU with interface modules

The interface modules are located on the processor printed circuit boards CPU (No.1 in Figure 3-3 to 3-8) of the devices 7SJ62/63/64.

Please note the following:

- Only interface modules of devices for panel and cubicle flush mounting as well as of mounting devices with detached operator panel or without operator panel are replaceable. Interface modules of devices in surface mounting housings with two-tier terminals must be exchanged in our manufacturing centre.
- Use only interface modules that can be ordered in our facilities (see also Appendix A).
- For interfaces with bus capability, ensure that the bus termination is correct (if applicable); see margin heading „Termination“.

Table 3-33 Exchangeable interface modules

Interface	Mounting Location / Port	Exchange Module
System Interface (7SJ62/63/64)	B	RS232
		RS485
		FO 820 nm
		Profibus FMS RS485
		Profibus FMS double ring
		Profibus FMS single ring
		Profibus DP RS485
		Profibus DP double ring
		Modbus RS485
		Modbus 820 nm
		DNP 3.0 RS 485
		DNP 3.0 820 nm
		IEC 61850, Ethernet electrical
DIGSI® / Modem Interface / RTD-box (7SJ62/63) [1)]	C	RS232
		RS485
		FO 820 nm
Additional Interface / RTD-box (7SJ64)	D	RS485
		FO 820 nm

[1)] for 7SJ64 Port C / service port is fix, it is not a plug-in module

The order numbers of the exchange modules can be found in the Appendix in Section A.1, Accessories.

RS232 Interface

Interface RS232 can be modified to interface RS485 and vice versa (see Figures 3-22 and 3-23).

Figure 3-21 shows the printed circuit board C–CPU and the interface modules.

The following figure shows the location of the jumpers of interface RS232 on the interface module.

Devices in surface mounting housing with fiber optics connection have their fiber optics module housed in the console housing. The fiber optics module is controlled via a RS232 interface module at the associated CPU interface slot. For this application type the jumpers X12 and X13 on the RS232 module are plugged in position 2-3.

Jumper	Terminating Resistors Disconnected
X3	1-2 *)
X4	1-2 *)

*) Default Setting

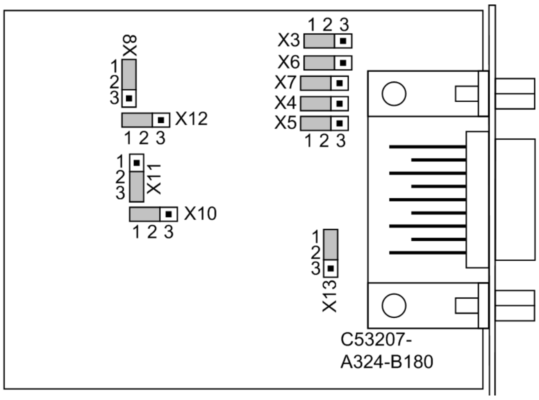


Figure 3-22 Location of the jumpers for configuration of RS232

Terminating resistors are not required. They are permanently disconnected.

Jumper X11 enables the **CTS feature (Clear to Send - flow control)**, which is important for modem communication.

Table 3-34 Jumper setting for **CTS (Clear to Send)** on the interface module

Jumper	**/CTS from interface RS232**	**/CTS controlled by /RTS**
X11	1-2	2-3[1)]

[1)] Default setting

Jumper setting 2-3: The connection to the modem is usually established with star coupler or fiber-optic converter. Therefore the modem control signals according to RS232 standard DIN 66020 are not available. Modem signals are not required since the connection to the SIPROTEC® 4 devices is always operated in the half-duplex mode. Please use connection cable with order number 7XV5100-4.

Jumper setting 2-3 is equally required when using the RTD boxes in half-duplex operation.

Jumper setting 1-2: This setting makes the modem signals available, i. e. for a direct RS232 connection between the SIPROTEC® 4 device and the modem. This setting can be selected optionally. We recommend to use a standard RS232 modem connection cable (converter 9-pin to 25-pin).

Note

For a direct connection to DIGSI with interface RS232, jumper X11 must be plugged in position 2-3.

RS485 Interface

The following figure shows the location of the jumpers of interface RS485 on the interface module.

Interface RS485 can be modified to interface RS232 and vice versa, according to Figure 3-22.

Jumper	Terminating Resistors	
	Connected	Disconnected
X3	2-3	1-2 *)
X4	2-3	1-2 *)

*) Default Setting

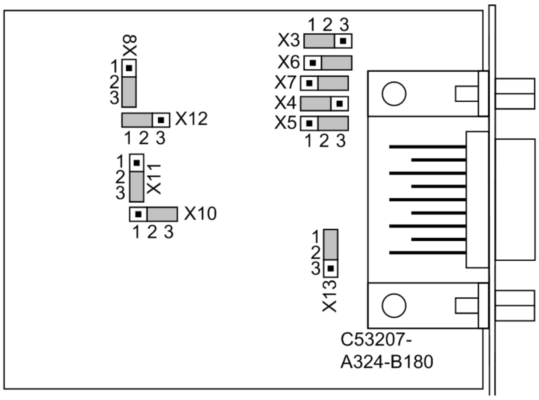


Figure 3-23 Position of terminating resistors and the plug-in jumpers for configuration of the RS485 interface

Profibus (FMS/DP)
DNP3.0/Modbus

Jumper	Terminating Resistors	
	Connected	Disconnected
X3	1-2	2-3 *)
X4	1-2	2-3 *)

*) Default Setting

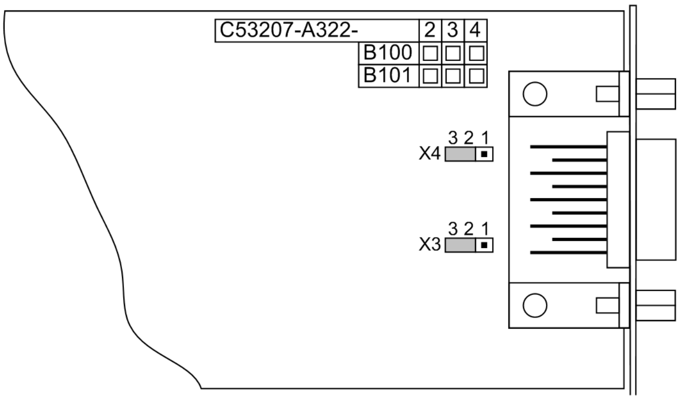


Figure 3-24 Position of the plug-in jumpers for the configuration of the terminating resistors at the Profibus (FMS and DP), DNP 3.0 and Modbus interfaces.

IEC 61850 Ethernet (EN 100)

The interface module does not feature any jumpers. Its use does not require any hardware adaptations.

Termination

For bus-capable interfaces a termination is necessary at the bus for each last device, i.e. termination resistors must be connected. With 7SJ62/63/64, this applies to variants with an RS485 or Profibus interface.

The terminating resistors are located on the RS485 or Profibus interface module that is mounted to the processor input/output board CPU (serial no. 1 in Figures 3-3 to 3-8).

With default setting the jumpers are set such that the termination resistors are disconnected. Both jumpers of a board must always be plugged in the same way.

The terminating resistors can also be connected externally (e.g. to the terminal block), see Figure 3-17. In this case, the terminating resistors located on the RS485 or PROFIBUS interface module must be switched off.

3.1.2.7 Reassembly

To reassemble the device, proceed as follows:

- Carefully insert the boards into the case. The mounting locations are shown in Figures 3-3 to 3-8. For the model of the device designed for surface mounting, use the metal lever to insert the processor circuit board CPU board. The installation is easier with the lever.
- First plug the plug connectors of the ribbon cable into the input/output boards I/O and then onto the processor module CPU. Do not bend any connector pins ! Do not use force !
- Insert the plug connector of the ribbon cable between the processor module CPU and the front cover into the socket of the front cover. This action does not apply to the device version with detached operator panel. Instead the plug connector of the ribbon cable connected to a 68-pole plug connector on the rear side of the device must be plugged into the plug connector of the processor circuit board CPU. The 7-pole X16 connector belonging to the ribbon cable must be plugged behind the D-subminiature female connector. The plugging position is not relevant in this context as the connection is protected against polarity reversal.
- Press the latches of the plug connectors together.
- Replace the front cover and secure to the housing with the screws.
- Mount the covers.
- Re-fasten the interfaces on the rear of the device housing. This activity is not necessary if the device is designed for surface mounting.

3.1.3 Installation

3.1.3.1 Panel Flush Mounting

Depending on the version, the device housing can be $^1/_3$, $^1/_2$ or $^1/_1$. For housing size $^1/_3$ or $^1/_2$ (Figure 3-25 and Figure 3-26) there are 4 covers and 4 holes for securing the device, with housing size $^1/_1$ (Figure 3-27) there are 6 covers and 6 securing holes.

- Remove the 4 covers at the corners of the front cover, for size $^1/_1$ the 2 covers located centrally at the top and bottom also have to be removed. Thus the 4 respectively 6 elongated holes in the mounting flange are revealed and can be accessed.
- Insert the device into the panel cut-out and fasten it with four or six screws. For dimensions refer to Section 4.26.
- Mount the four or six covers.
- Connect the ground on the rear plate of the device to the protective ground of the panel. Using at least one M4 screw. The cross-section of the line, here used, must correspond to the maximal connected cross-section, at least 2.5 mm^2.
- Connections use the plug plug terminals or screw terminals on the rear side of the device in accordance to the circuit diagram. When using forked lugs for direct connections or screw terminal, the screws, before having inserted the lugs and wires, must be tightened in such a way that the screw heads are even with the terminal block. A ring lug must be centered in the connection chamber, in such a way that the screw thread fits in the hole of the lug. The SIPROTEC® 4 System Description provides information on wire size, lugs, bending radii, etc. which must be observed.

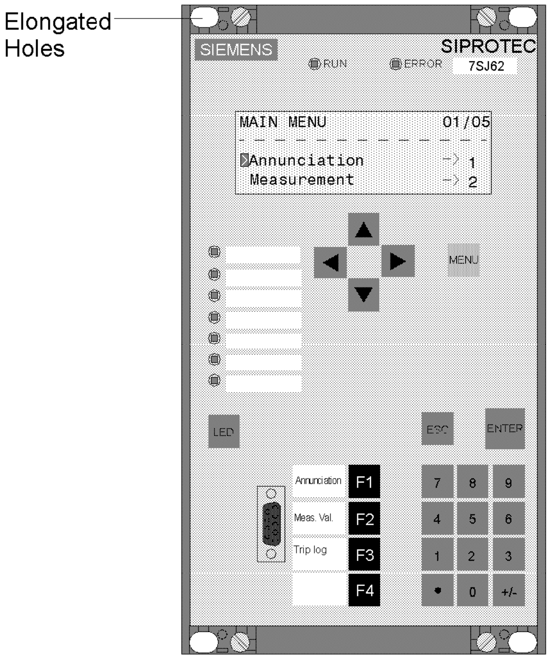


Figure 3-25 Panel flush mounting of a 7SJ62 and 7SJ640 (housing size $^{1}/_{3}$), as example

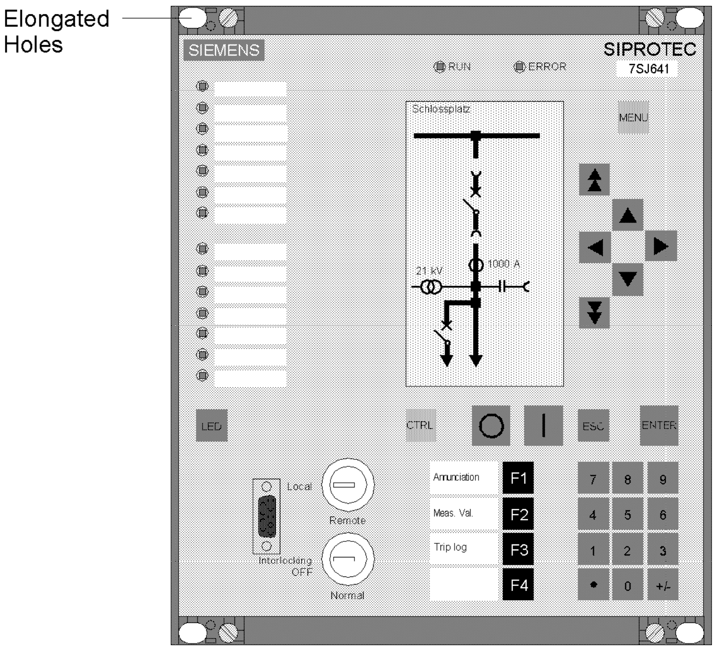


Figure 3-26 Panel flush mounting of a 7SJ632 and 7SJ641 (housing size $^{1}/_{2}$), as example

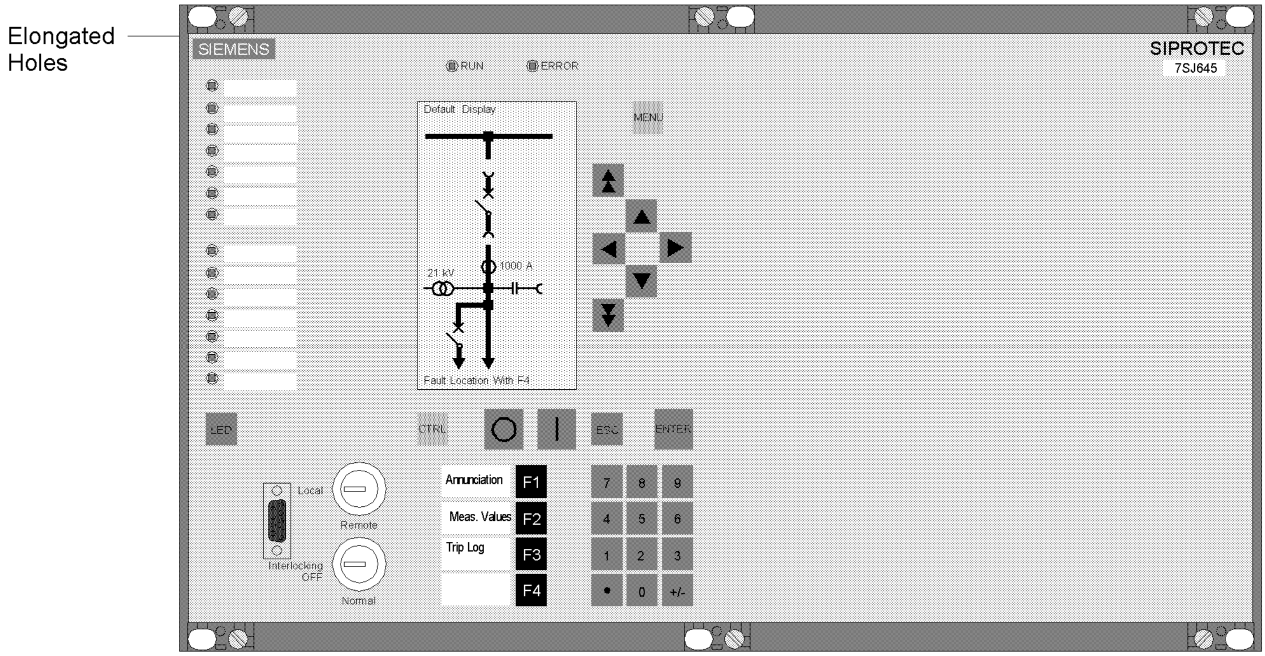


Figure 3-27 Panel flush mounting of a 7SJ635 and 7SJ645 (housing size $^1/_1$). as example

3.1.3.2 Rack Mounting and Cubicle Mounting

To install the device in a rack or cubicle, two mounting brackets are required. The ordering codes are stated in Appendix, Section A.1

For housing size $^1/_3$ (Figure 3-28) and $^1/_2$ (Figure 3-29) there are 4 covers and 4 holes for securing the device, with housing size $^1/_1$ (Figure 3-30) there are 6 covers and 6 securing holes.

- Loosely screw the two mounting brackets in the rack or cubicle with four screws.
- Remove the 4 covers at the corners of the front cover, for size $^1/_1$ the 2 covers located centrally at the top and bottom also have to be removed. Thus the 4 respectively 6 elongated holes in the mounting flange are revealed and can be accessed.
- Fasten the device to the mounting brackets with four or six screws.
- Mount the four or six covers.
- Tighten the mounting brackets to the rack or cubicle using eight screws.
- Connect the ground on the rear plate of the device to the protective ground of the panel. Using at least one M4 screw. The cross-section of the line, here used, must correspond to the maximum connected cross-section, at least 2.5 mm^2.
- Connections use the plug terminals or screw terminals on the rear side of the device in accordance to the circuit diagram. When using forked lugs for direct connections or screw terminal, the screws, before having inserted the lugs and wires, must be tightened in such a way that the screw heads are even with the terminal block. A ring lug must be centered in the connection chamber, in such a way that the screw thread fits in the hole of the lug. The SIPROTEC® 4 System Description provides information on wire size, lugs, bending radii, etc. which must be observed.

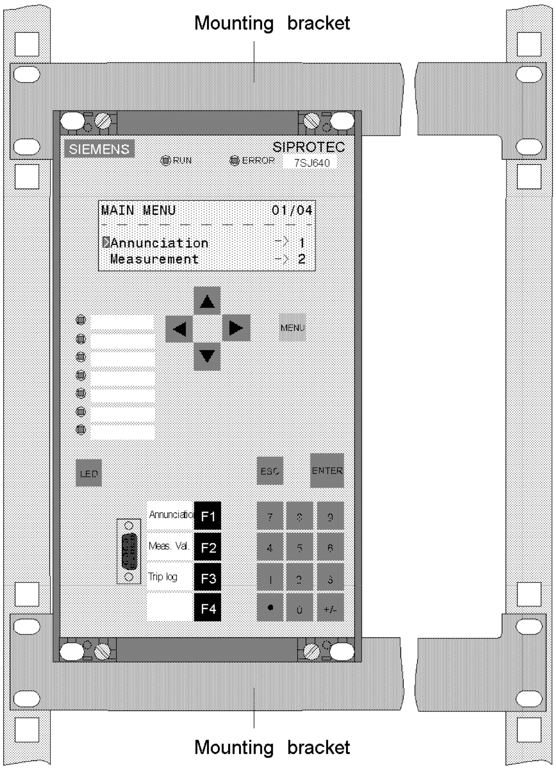


Figure 3-28 Installing a 7SJ62 and 7SJ640 in a rack or cubicle (housing size $^1/_3$), as example

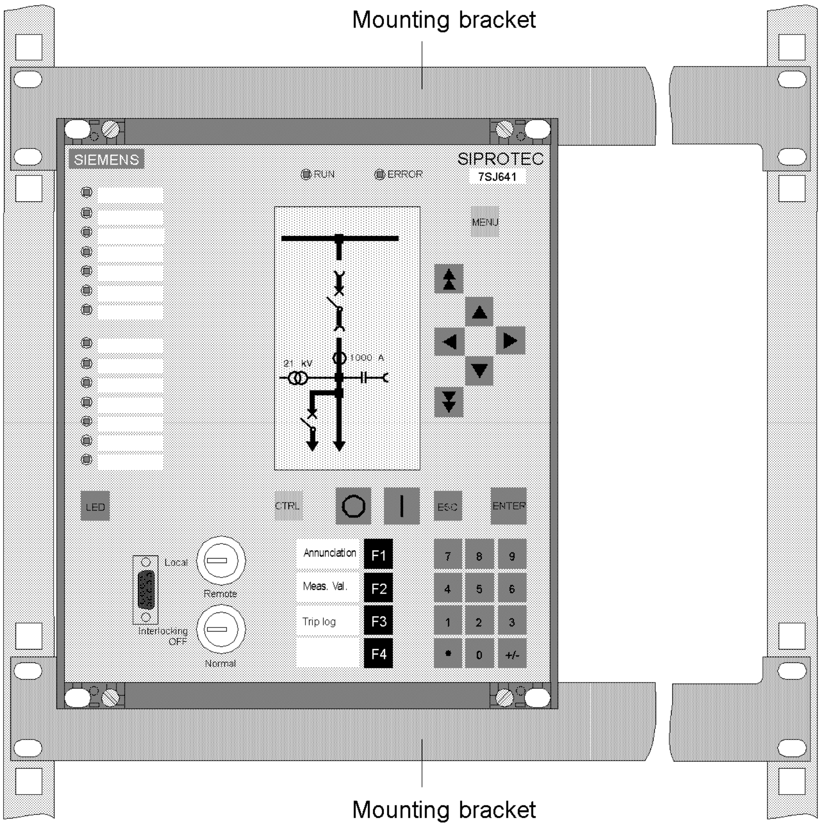


Figure 3-29 Installing a 7SJ632 and 7SJ641 in a rack or cubicle (housing size $^1/_2$), as example

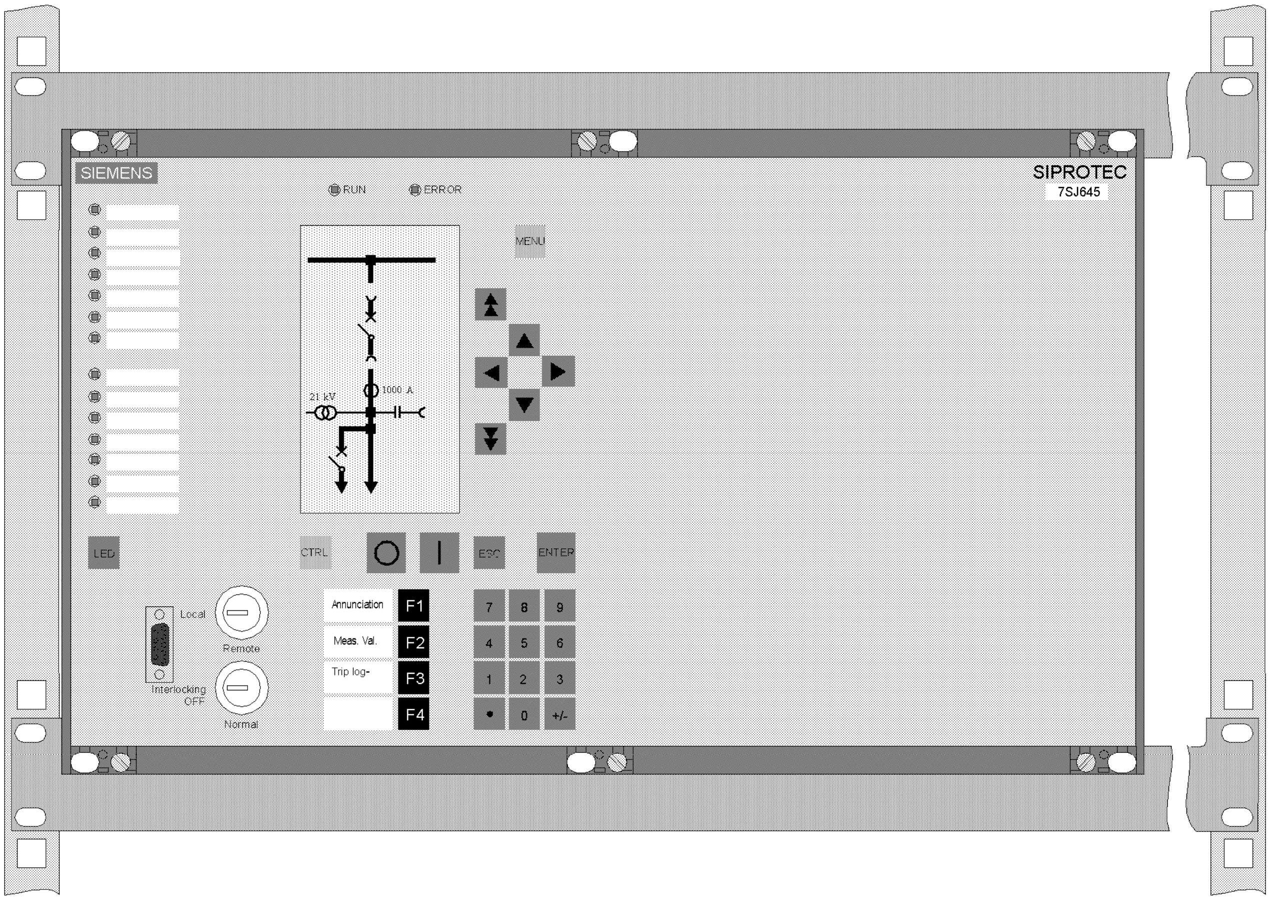


Figure 3-30 Installing a 7SJ635 and 7SJ645 in a rack or cubicle (housing size $^1/_1$), as example

3.1.3.3 Panel Surface Mounting

For installation proceed as follows:

- Screw down the device to the panel with four screws. For dimensions see for the Technical Data, Section 4.26.
- Connect the ground terminal of the device with the protective ground of the control panel. The cross-section of the line, here used, must correspond to the maximum connected cross-section, at least 0.10 in^2.
- Connect solid, low-impedance operational grounding (cross-sectional area = 0.10 in^2) to the grounding surface on the side. Use at least one M4 screw for the device ground.
- Connections according to the circuit diagram via screw terminals, connections for optical fibres and electrical communication modules via the inclined housings. The SIPROTEC® 4 System Description has pertinent information regarding wire size, lugs, bending radii, etc.

3.1.3.4 Mounting with Detached Operator Panel

Caution!

Be careful when removing or plugging the connector between device and detached operator panel

Non–observance of the following measure can result in property damage. Without the cable the device is not ready for operation!

Do never pull or plug the connector between the device and the detached operator panel during operation while the device is alive!

For mounting the **device** proceed as follows:

- Fasten device of housing size $^1/_2$ with 6 screws and device of housing size $^1/_1$ with 10 screws. For dimensions see for the Technical Data, Section 4.26.
- Connect the ground on the rear plate of the device to the protective ground of the panel. Using at least one M4 screw. The cross-section of the line, here used, must correspond to the maximum connected cross-section, at least 2.5 mm^2.
- Connections are realized via the plug terminals or screw terminals on the rear side of the device in accordance to the circuit diagram. When using forked lugs for direct connections or screw terminal, the screws, before having inserted the lugs and wires, must be tightened in such a way that the screw heads are even with the terminal block. A ring lug must be centered in the connection chamber, in such a way that the screw thread fits in the hole of the lug. The SIPROTEC® 4 System Description provides information on wire size, lugs, bending radii, etc. which must be observed.

For mounting the **operator panel** please observe the following:

- Remove the 4 covers on the corners of the front plate. Thus, 4 respectively elongated holes in the mounting bracket are revealed and can be accessed.
- Insert the operator panel into the panel cut-out and fasten with four screws. For dimensions see Technical Data.
- Replace the 4 covers.
- Connect the ground on the rear plate of the device to the protective ground of the panel. Using at least one M4 screw. The cross-section of the line, here used, must correspond to the maximum connected cross-section, at least 2.5 mm^2.
- Connect the operator panel to the device. Furthermore, plug the 68-pin connector of the cable belonging to the operator panel into the corresponding connection at the rear side of the device (see SIPROTEC® 4 System Description).

3.1.3.5 Mounting without Operator Panel

For mounting the **device** proceed as follows:

- Fasten device of housing size $^1/_2$ with 6 screws and device of housing size $^1/_1$ with 10 screws. For dimensions see for the Technical Data, Section 4.26.
- Connect the ground on the rear plate of the device to the protective ground of the panel. Using at least one M4 screw. The cross-section of the line, here used, must correspond to the maximum connected cross-section, at least 2.5 mm^2.
- Connections are realized via the plug terminals or screw terminals on the rear side of the device in accordance to the circuit diagram. When using forked lugs for direct connections or screw terminal, the screws, before having inserted the lugs and wires, must be tightened in such a way that the screw heads are even with the terminal block. A ring lug must be centered in the connection chamber, in such a way that the screw thread fits in the hole of the lug. The SIPROTEC® 4 System Description provides information on wire size, lugs, bending radii, etc. which must be observed.

For mounting the **D-subminiature connector of the dongle cable** please observe the following:

- Plug the 9-pin connector of the dongle cable with the connecting parts into the control panel or the cubicle door according to the following figure. For dimensions of the panel flush or cubicle door cutout see Technical Data, Section 4.26.
- Plug the 68-pin connector of the cable into the corresponding connection at the rear side of the device.

Caution!

Be careful with pulling or plugging the dongle cable

Non–observance of the following measures can result in minor personal injury or property damage:

Never pull or plug the dongle cable while the device is alive! Without the cable the device is not ready for operation!

The connector of the dongle cable at the device must always be plugged in during operation!

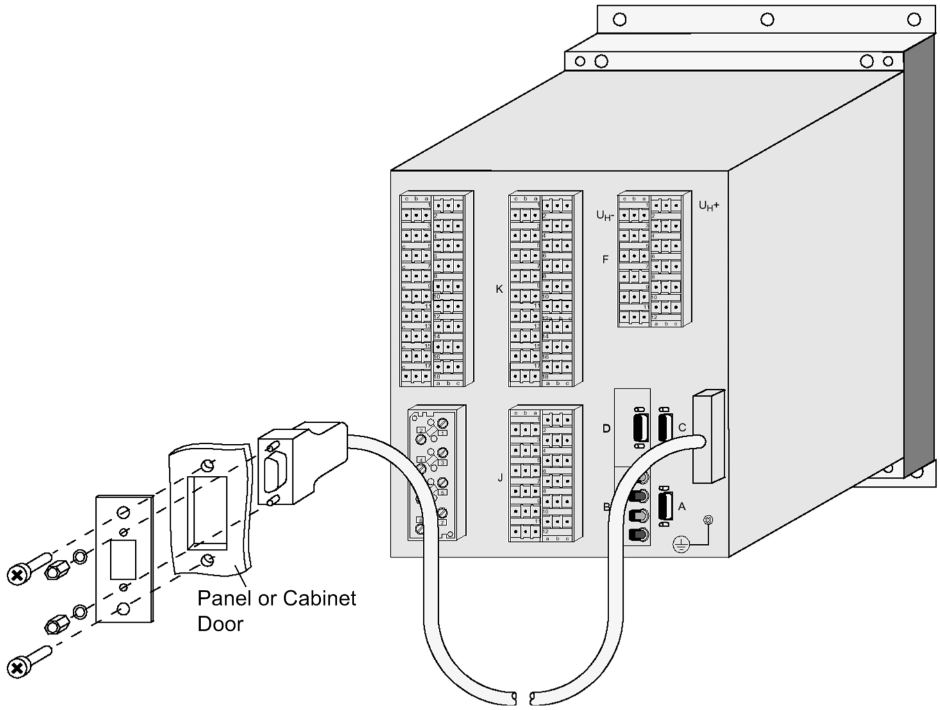


Figure 3-31 Plugging the subminiature connector of the dongle cable into the control panel or cabinet door (example housing size $^1/_2$)

3.2 Checking Connections

3.2.1 Checking Data Connections of Serial Interfaces

Pin Assignments

The following tables illustrate the pin assignments of the various serial device interfaces and of the time synchronization interface. The position of the connections can be seen in the following figure.

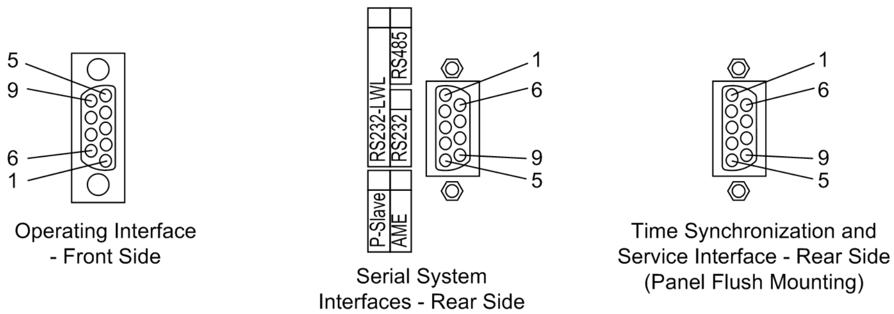


Figure 3-32 9-pin D-subminiature female connectors

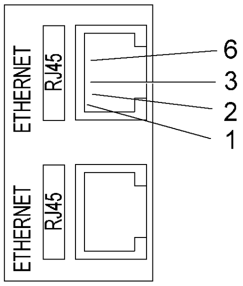


Figure 3-33 Ethernet connection

Operator Interface

When the recommended communication cable is used, correct connection between the SIPROTEC® 4 device and the PC is automatically ensured. See the Appendix for an ordering description of the cable.

Service Interface

Check the data connection if the service (port C) is used to communicate with the device via fix wiring or a modem. If the service port is used as input for one or two RTD-boxes, verify the interconnection according to one of the connection examples given in the Appendix A.3.

System Interface

When a serial interface of the device is connected to a central substation control system, the data connection must be checked. A visual check of the transmit channel and the receive channel is important. With RS232 and fiber optic interfaces, each connection is dedicated to one transmission direction. Therefore the output of one device must be connected to the input of the other device and vice versa.

With data cables, the connections are designated according to DIN 66020 and ISO 2110:

- TxD = Data output
- RxD = Data input
- $\overline{\text{RTS}}$ = Request to send
- $\overline{\text{CTS}}$ = Clear to send
- GND = Signal/Chassis Ground

The cable shield is to be grounded at **both ends**. For extremely EMC-prone environments, the GND may be connected via a separate individually shielded wire pair to improve immunity to interference.

Additional Interface (only 7SJ64)

The additional interface available only for 7SJ64 (port D) serves for signal injection of one or two RTD-boxes. The connection is performed according to one of the connection examples given in the Appendix A.3.

Table 3-35 Assignments of the connectors to the various interfaces

Pin No.	RS232	RS485	PROFIBUS FMS Slave, RS485	Modbus RS485	Ethernet EN 100
			PROFIBUS FMS Slave, RS485	**DNP3.0 RS485**	
1	Shield (with shield ends electrically connected)				Tx+
2	RxD	–	–	–	Tx–
3	TxD	A/A’ (RxD/TxD-N)	B/B’ (RxD/TxD-P)	A	Rx+
4	–	–	CNTR-A (TTL)	RTS (TTL level)	—
5	GND	C/C’ (GND)	C/C’ (GND)	GND1	—
6	–	–	+5 V (max. load < 100 mA)	VCC1	Rx–
7	$\overline{\text{RTS}}$	– [1)]	–	–	—
8	$\overline{\text{CTS}}$	B/B’ (RxD/TxD-P)	A/A’ (RxD/TxD-N)	B	—
9	–	–	–	–	not available

1) Pin 7 also carries the RTS signal with RS232 level when operated as RS485 Interface. Pin 7 must therefore not be connected!

Termination

The RS485 interface is capable of half-duplex service with the signals A/A' and B/B' with a common relative potential C/C' (GND). Verify that only the last device on the bus has the terminating resistors connected, and that the other devices on the bus do not. The jumpers for the terminating resistors are on the interface module RS485 (see Figure 3-22) or on the Profibus RS485 (see Figure 3-24) or with the 7SJ64 directly on the C–CPU-2 (see Figure 3-16 and Table 3-23). The terminating resistors can also be connected externally (e.g. to the connection module as illustrated in Figure 3-17). In this case, the terminating resistors located on the module must be disconnected.

If the bus is extended, make sure again that only the last device on the bus has the terminating resistors switched-in, and that all other devices on the bus do not.

Time Synchronization Interface

It is optionally possible to process 5 V-, 12 V- or 24 V- time synchronization signals, provided that they are carried to the inputs named in the following table.

Table 3-36 D-SUB socket assignment of the time synchronization interface

Pin No.	Description	Signal Meaning
1	P24_TSIG	Input 24 V
2	P5_TSIG	Input 5 V
3	M_TSIG	Return Line
4	– [1]	– [1]
5	SHIELD	Shield Potential
6	–	–
7	P12_TSIG	Input 12 V
8	P_TSYNC [1]	Input 24 V [1]
9	SHIELD	Shield Potential

[1] assigned, but not used

Optical Fibers

WARNING!

Laser injection!

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 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.

RTD-Box (Resistance Temperature Detector)

If one or two 7XV566 temperature meters are connected, check their connections to the port (port C or D).

Verify also the termination: The terminating resistors must be connected to 7SJ62/63/64 (see margin heading „Termination").

For further information refer to the operating manual of 7XV566. Check the transmission settings at the temperature meter. Besides the baudrate and the parity observe also the bus number.

For connection of RTD-box(es) proceed as follows:

- For connection of **1** RTD-box 7XV566: bus number = **0** (to be set at 7XV566).
- For connection of **2** RTD-boxes 7XV566: bus number = **1** for the 1st RTD-box (to be set at 7XV566 for RTD 1 to 6), bus number = **2** for the 2nd RTD-box (to be set at 7XV566 for RTD 7 to 12).

Please observe that detector input 1 (RTD1) of the first RTD-box is assigned for ambient or coolant temperature of the overload protection.

3.2.2 Checking 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).

If undervoltage protection is configured and enabled in the device and if, at the same time, the current criterion is disabled, the device picks up right after auxiliary voltage has been connected, since no measuring voltage is available. To make the device configurable, pickup is to be stopped, i.e. the measuring voltage is connected or voltage protection is blocked. This can performed by operation.

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 transformers 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 transformers correct?
  - Is the polarity for current input I_4 correct (if used)?
  - Is the polarity for voltage input V_4 correct (only with 7SJ64 and if used, e.g. for broken delta winding or busbar voltage)?

- 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.
- The short-circuit feature of the current circuits of the device are to be checked. This may be performed with an ohmmeter or other test equipment for checking continuity. Make sure that terminal continuity is not wrongly simulated in reverse direction via current transformers or their short-circuiters.
  - Remove the front panel of the device
  - Remove the ribbon cable connected to the I/O board with the measured current inputs (on the front side it is the right printed circuit board). Furthermore, remove the printed circuit board so that there is no more contact anymore with the plug-in terminal of the housing.
  - At the terminals of the device, check continuity for each pair of terminals that receives current from the CTs.
  - Firmly re-insert the I/O board. Carefully connect the ribbon cable. Do not bend any connector pins ! Do not use force !
  - At the terminals of the device, again check continuity for each pair of terminals that receives current from the CTs.
  - Attach the front panel and tighten the screws.
- 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 signalling connections.
- Close the protective switches.

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.

The device is to be grounded to the substation ground before any other connections are made.

Hazardous voltages can exist in the power supply and at the connections to current transformers, voltage transformers, 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 removing voltage from the power supply, wait a minimum of 10 seconds before re-energizing the power supply. This wait allows the initial conditions to be firmly established before the device is re-energized.

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 meant 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 **Test mode** is set ON, then a message sent by a SIPROTEC 4® device to the main system has an additional test bit. This bit allows the message to be recognized as resulting from testing and not an actual fault or power system event. Furthermore it can be determined by activating the **Transmission block** that no annunciations at all are transmitted via the system interface during test mode.

The SIPROTEC® 4 System Description describes in detail how to activate and deactivate test mode and blocked data transmission. Note that when DIGSI is being used, the program must be in the **Online** operating mode for the test features to be used.

3.3.2 Checking the System (SCADA) Interface

Prefacing Remarks

If the device features a system interface and uses it 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 service on a live system.

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 on **Generate Annunciations** shown in the list view. The dialog box **Generate Annunciations** opens (refer to the 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.

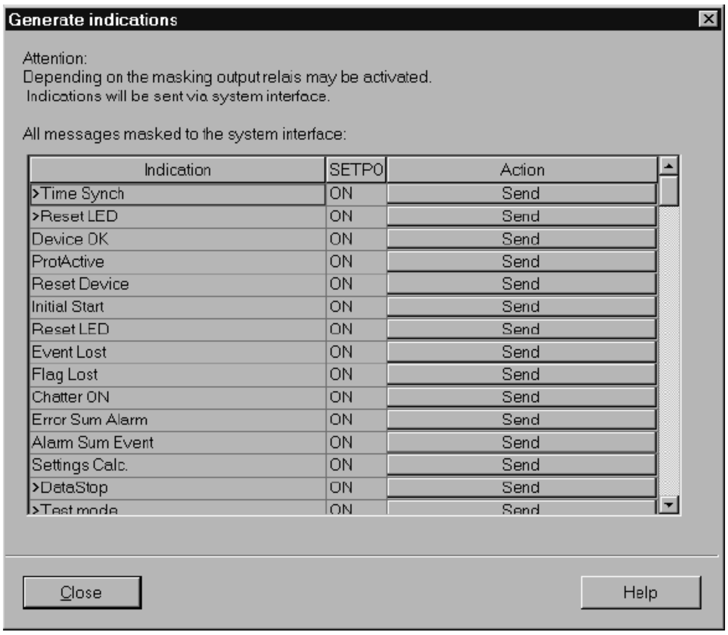


Figure 3-34 System interface test with dialog box: Generate annunciations — example

Changing the Operating State

When clicking one of the buttons in the column **Action** for the first time, you will be prompted for the password no. 6 (for hardware test menus). After correct entry of the password, individual annunciations can be initiated. To do so, click on the button **Send** on the corresponding line. The corresponding message is issued and can be read out either from the event log of the SIPROTEC® 4 device or from the substation control system.

As long as the window is open, further tests can be performed.

Test in Message Direction

For all information that is transmitted to the central station, test the options in the list which appears in **SETPOINT Status**:

- Make sure that each checking process is carried out carefully without causing any danger (see above and refer to DANGER!)
- Click on Send in the function to be tested and check whether the transmitted information reaches the central station and shows the desired reaction. Data which are normally linked via binary inputs (first character „>") are likewise indicated to the central power system with this procedure. The function of the binary inputs itself is tested separately.

Exiting the Test Mode

To end the System Interface Test, click on **Close**. The device is briefly out of service while the start-up routine is executed. The dialog box closes.

Test in Command Direction

The information transmitted in command direction must be indicated by the central station. Check whether the reaction is correct.

3.3.3 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 service on a live system.

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 test, the device will make an initial startup. Thereby, all annunciation buffers are erased. If required, these buffers should be extracted with DIGSI 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 labelled 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.

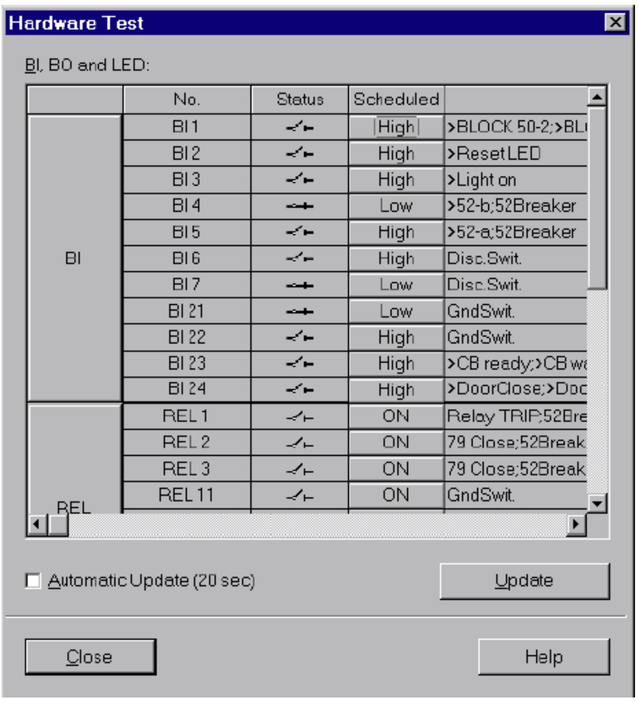


Figure 3-35 Test of the binary inputs and outputs — example

Changing the Operating State

To change the condition 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 condition change will be executed. Further condition changes remain possible while the dialog box is open.

Test of the Output Relays

Each individual output relay can be energized allowing a check of the wiring between the output relay of the 7SJ62/63/64 and the plant, without having to generate the message that is assigned to the relay. As soon as the first change of state 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 means, that e.g. a TRIP 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 7SJ62/63/64 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 again be opened 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:

- Each state in the plant which causes a binary input to pick up must be generated.
- Check the reaction in the **Status** column of the dialog box. To do this, 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

During the opening of the dialog box **Hardware Test** 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 closes. 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.

3.3.4 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 inrupting the corresponding pickup voltage supply.

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.

In order for the breaker failure protection to be started, a current must flow at least via the monitored phase. This may be a secondary injected current.

- Start by trip command of the external protection: binary input functions „>50BF ext SRC“ (FNo 1431) (in spontaneous or fault annunciations).
- After every start, the message „50BF ext Pickup“ (FNo 1457) must appear in the spontaneous or fault annunciations.
- After time expiration **TRIP-Timer** (address 7005) tripping command of the circuit breaker failure protection.

Switch off test current.

If start is possible without current flow:

- Closing the circuit breaker to be monitored to both sides with the disconnector switches open.
- Start by trip command of the external protection: Binary input functions „>50BF ext SRC“ (FNo 1431) (in spontaneous or fault annunciations).
- After every start, the message „50BF ext Pickup“ (FNo 1457) must appear in the spontaneous or fault annunciations.
- After time expiration **TRIP-Timer** (address 7005) tripping command of the circuit breaker failure protection.

Open the circuit breaker again.

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 is 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.

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.

3.3.5 Checking User-Defined Functions

CFC Logic

The device has a vast capability for allowing functions to be defined by the user, especially with the CFC logic. Any special function or logic added to the device must be checked.

A general procedure cannot in the nature of things be specified. Configuration of these functions and the set value conditions must be actually known beforehand and tested. Possible interlocking conditions of switching devices (circuit breakers, disconnectors, earth switch) are of particular importance. They must be considered and tested.

3.3.6 Current, Voltage, and Phase Rotation Testing

≥ 10 % of Load Current

The connections of the current and voltage transformers are tested using primary quantities. Secondary load current of at least 10 % of the nominal current of the device is necessary. The line is energized and will remain in this state during the measurements.

With proper connections of the measuring circuits, none of the measured-values supervision elements in the device should pick up. If an element detects a problem, the causes which provoked it may be viewed in the Event Log. If current or voltage summation errors occur, then check the matching factors.

Messages from the symmetry monitoring could occur because there actually are asymmetrical conditions in the network. If these asymmetrical conditions are normal service conditions, the corresponding monitoring functions should be made less sensitive.

Current and Voltage Values

Currents and voltages can be seen in the display field on the front of the device or the operator interface via a PC. They can be compared to the quantities measured by an independent source, as primary and secondary quantities.

If the measured values are not plausible, the connection must be checked and corrected after the line has been isolated and the current transformer circuits have been short-circuited. The measurements must then be repeated.

PhaseRotation

The phase rotation must correspond to the configured phase rotation, in general a clockwise phase rotation. If the system has an anti-clockwise phase rotation, this must have been considered when the power system data was set (address 209 **PHASE SEQ.**). If the phase rotation is incorrect, the alarm „Fail Ph. Seq.“ (FNo 171) is generated. The measured value phase allocation must be checked and corrected, if required, after the line has been isolated and current transformers have been short-circuited. The measurement must then be repeated.

Voltage Transformer Miniature Circuit Breaker(VTmcb)

The VT mcb of the feeder (if used) must be opened. The measured voltages in the operational measured values appear with a value close to zero (small measured voltages are of no consequence).

Check in the spontaneous annunciations that the VT mcb trip was entered (annunciation „>FAIL:FEEDER VT“ „ON“ in the spontaneous annunciations). Beforehand it has to be assured that the position of the VT mcb is connected to the device via a binary input.

Close the VT mcb again: The above messages appear under the spontaneous messages as „OFF“, i.e. „>FAIL:FEEDER VT“ „OFF“.

If one of the events does not appear, the connection and allocation of these signals must be checked.

If the „ON“-state and „OFF“–state are swapped, the contact type (H–active or L–active) must be checked and remedied.

Only 7SJ64

If with 7SJ64 a busbar voltage is used for input V_4 (for voltage or synchronism check) and the assigned VT mcb is connected to the device, the following function must also be checked: If the VT mcb is open the annunciation „>FAIL: BUS VT“ „ON“ appears, if it is closed the annunciation „>FAIL: BUS VT“ „OFF“ is displayed.

If the VT mcb is open the annunciation „>FAIL: BUS VT“ „ON“ appears, if it is closed the annunciation „>FAIL: BUS VT“ „OFF“ is displayed.

Switch off the protected power line.

3.3.7 Test for High Impedance Protection

Polarity of Transformers

When the device is used for high-impedance protection, the current at I_N or I_{NS} is equivalent to the fault current in the protected object. It is essential in this case that all current transformers feeding the resistor whose current is measured at $I_{N(S)}$ have the same polarity. The test currents used for this are through currents. Each CT must be included in a measurement. The current at $I_{N(S)}$ may never exceed half the pickup value of the single-phase time overcurrent protection.

3.3.8 Testing the Reverse Interlocking Scheme

(only if used)

Testing reverse interlocking is available if at least one of the binary inputs available is configured for this purpose (e.g. presetting of binary input BI1 „`>BLOCK 50-2`“ and „`>BLOCK 50N-2`“ to open circuit system). Tests can be performed with phase currents or ground current. For ground current the corresponding ground current settings apply.

Please note that the blocking function can either be configured for the pickup current connected (open circuit system) or the pickup current missing (closed circuit system). For open circuit system the following tests are to be proceeded:

The feeder protection relays of all associated feeders must be in operation. At the beginning no auxiliary voltage is fed to the reverse interlocking system.

A test current higher than the pickup values of **`50-2 PICKUP`** and **`50-1 PICKUP`** or **`51 PICKUP`** is set. As a result of the missing blocking signal, the protection function trips after (short) time delay **`50-2 DELAY`**.

Caution!

Tests with currents that exceed more than 4 times the nominal device current

cause an overload of the input circuits.

Perform test only for a short time (see Technical Data, Section 4.1). Afterwards the device has to cool off !

The auxiliary voltage for reverse interlocking is now switched to the line. The precedent test is repeated, the result will be the same.

Subsequently, at each of the protection devices of the feeders, a pickup is simulated. Meanwhile, another fault is simulated for the protection function of the infeed, as described before. Tripping is performed within time **`50-1 DELAY`** (longer time period) (with definite time overcurrent protection) or according to characteristic (with inverse time overcurrent protection).

These tests also check the proper functioning of the wiring for reverse interlocking.

3.3.9 Direction Check with Load Current

≥ 10 % of Load Current

The correct connection of the current and voltage transformers are tested via the protected line using the load current. For this purpose, connect the line. The load current the line carries must be at least $0.1 \cdot I_{Nom}$. The load current should be in-phase or lagging the voltage (resistive or resistive-inductive load). The direction of the load current must be known. If there is a doubt, network or ring loops should be opened. The line remains energized during the test.

The direction can be derived directly from the operational measured values. Initially the correlation of the measured load direction with the actual direction of load flow is checked. In this case the normal situation is assumed whereby the forward direction (measuring direction) extends from the busbar towards the line

P positive, if active power flows into the line,

P negative, if active power flows towards the busbar,

Q positive, if reactive power flows into the line,

Q negative, if reactive power flows toward the busbar.

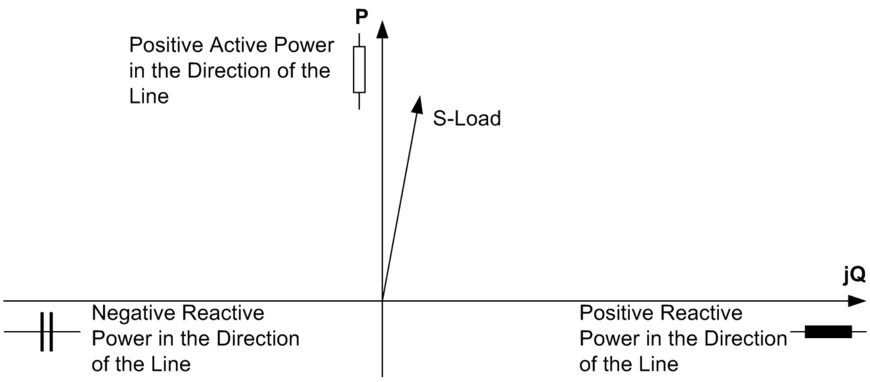


Figure 3-36 Apparent Load Power

All signs of powers may be inverted deliberately. Check whether polarity is inverted in address 1108 **`P,Q sign`** in the **`P.System Data 2`**. In that case the signs for active and reactive power are inverse as well.

The power measurement provides an initial indication as to whether the measured values have the correct polarity. If both the active power and the reactive power have the wrong sign and 1108 **`P,Q sign`** is set to ***`not reversed`***, the polarity according to address 201 **`CT Starpoint`** must be checked and corrected.

However, power measurement itself is not able to detect all connection errors. For this reason, directional messages should be generated by means of the directional overcurrent protection. Therefore, pickup thresholds must be reduced so that the available load current causes a continuous pickup of the element. The direction reported in the messages, such as „`Phase A forward`“ or „`Phase A reverse`“ must correspond to the actual power flow. Be careful that the „Forward“ direction of the protective element is in the direction of the line (or object to be protected). This is not necessarily identical with the direction of the normal the power flow. For all three phases, the directional messages to the power flow must be reported properly.

If all directions differ from each other, individual phases in current or voltage transformer connections are interchanged, not connected properly or phase assignment is incorrect. After isolation of the line and short-circuiting of the current transformers the connections must be checked and corrected. The measurements must then be repeated.

Finally, switch off the protected power line.

Important! Make sure that pickup values that have been changed for testing are set back to the valid settings!

3.3.10 Polarity Check for Voltage Input V_4 (only 7SJ64)

Only 7SJ64

Depending on the application of the voltage measuring input V_4 of a 7SJ64, a polarity check may be necessary. If no measuring voltage is connected to this input, this subsection is irrelevant.

If input V_4 is used for measuring the **Displacement Voltage U_N** (Power System Data 1 address 213 **VT Connect. 3ph** = ***Vab, Vbc, VGnd*** or ***Van,Vbn,Vcn,VGn***), the polarity is checked together with the test of current input I_4 (see further down).

Only for Synchronism and Voltage Check in 7SJ64

If the input V_4 is used for measuring a voltage for **synchronism check** (Power System Data 1, address 213 **VT Connect. 3ph** = ***Van,Vbn,Vcn,VSy***), the following is to be observed:

- The single-phase voltage V_2 needed for synchronization is to be connected to input V_4.
- The polarity must be checked as follows using the synchronism check function:

The device must be equipped with the synchronism and voltage check which is to be configured in address 16x **SYNC Funktion x** = ***SYNCHROCHECK***.

Voltage V_2 needed for synchronization is to be set correctly in address 6x23 **CONNECTIONof V2**.

If a transformer is located between the measuring points of reference voltage V_1 and the voltage to be synchronized V_2, its phase rotation must be taken into consideration. For this purpose an angle corresponding to the transformer vector group is entered in address 6x22 **ANGLE ADJUSTM.**. The angle is set in direction busbar viewed from the feeder. An example is shown in Subsection 2.19.1.

If necessary different transformation ratios of the transformers on the busbar and the feeder may have to be considered under address **Balancing V1/V2**.

The synchronism and voltage check must be switched 6x01 **Synchronizing**x = ***ON***.

An additional help for the connection control are the annunciations 170.2090 „25 V2>V1“, 170.2091 „25 V2<V1“, 170.2094 „25 α2>α1“ and 170.2095 „25 α2<α1“ in the spontaneous annunciations.

- Circuit breaker is open. The feeder is isolated (zero voltage). The VTmcb's of both voltage transformer circuits must be closed.
- For the synchrocheck the program **Direct CO** is set to ***YES*** (address 6x10A); the other programs (addresses 6x07 to 6x09) are set to ***NO***.
- Via binary input (2906 „>25 Measu. Only“) initiate the measuring request. The synchronism check must release closing (message „25 CloseRelease“, 2951). If not, check all relevant parameters again (synchrocheck configured and enabled correctly, see Sections 2.1.1 and 2.19.1).
- Set address 6x10 **Direct CO** to ***NO***.
- Then the circuit breaker is closed while the line isolator is open (see Figure 3-37). Both voltage transformers therefore measure the same voltage.
- For the synchrocheck the program **SYNC-Functional Groups X** is set to ***ASYN/SYNCHRON*** (address 016x).

- Via binary input (170.0043 „>25 Measu. Only“) initiate the measuring request. The synchronism check must release closing (message „25 CloseRelease“, 170.0049).
- If not, first check whether one of the aforenamed messages 170.2090 „25 V2>V1“ or 170.2091 „25 V2<V1“ or 170.2094 „25 α2>α1“ and 170.2095 „25 α2<α1“ is available in the spontaneous messages.

  Messages „25 V2>V1“ or „25 V2<V1“ indicate that the magnitude (ratio) adaptation is incorrect. Check address 6x21 **Balancing V1/V2** and recalculate the adaptation factor.

  The message „25 α2>α1“ or „25 α2<α1“ indicate that the phase relation of the busbar voltage does not match the setting under address **CONNECTIONof V2** (see Section2.19.1). When measuring via a transformer, address 6x22 **ANGLE ADJUSTM.** must also be checked. This must adapt the vector group. If these are correct, there is probably a reverse polarity of the voltage transformer terminals V_1.
- For the synchrocheck the program **SYNC V1>V2<** is set to ***YES*** (address 6x08) and **SYNC Funktion X** = ***ASYN/SYNCHRON*** (address 16x).
- Open the VT mcb of the busbar voltage.
- Via binary input (170.0043 „>25 Measu. Only“) initiate the measuring request. There is no close release. If there is, the VT mcb for the busbar voltage is not allocated. Check whether this is the required state, alternatively check the binary input „>FAIL: BUS VT“ (6510).
- Close the VT mcb of the busbar voltage is to be closed again.
- Open the circuit breaker.
- For the synchrocheck the program **SYNC V1<V2>** is set to ***YES*** (address 6x07) and **SYNC V1>V2<** to ***NO*** (address 6x08).
- Via binary input (170.0043 „>25 Measu. Only“) initiate the measuring request. The synchronism check must release closing (message „25 CloseRelease“, 170.0049). Otherwise check all voltage connections and the corresponding parameters again carefully as described in Section 2.19.1.
- Open the VT mcb of the feeder voltage.
- Via binary input (170.0043 „>25 Measu. Only“) initiate the measuring request. No close release is given.
- Close the VT mcb of the feeder voltage again.

Addresses 6x07 to 6x10 must be restored as they were changed for the test. If the routing of the LEDs or signal relays was changed for the test, this must also be restored.

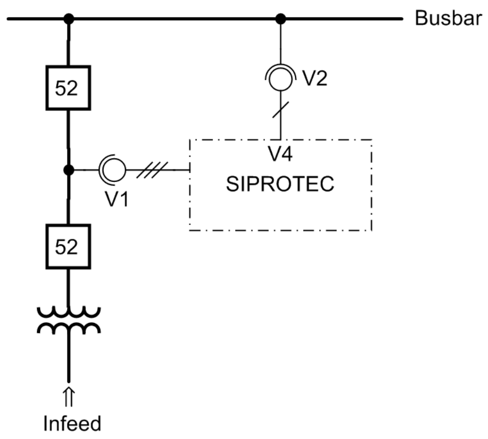


Figure 3-37 Measuring voltages for the synchro-check

3.3.11 Ground Fault Check

Ungrounded Systems

The ground fault test is only necessary if the device is connected to an isolated or resonant-grounded system and the ground fault detection is applied.

The device must thus have been preset during configuration of the device functions to **Sens. Gnd Fault** (address 131) not equal to ***Disabled***. If none of this is the case, this subsection is not relevant.

The primary check serves to find out the correct polarity of the transformer connections for the determination of the ground fault direction.

DANGER!

Energized equipment of the power system ! Capacitive coupled voltages at disconnected equipment of the power system !

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Primary measurements must only be carried out on disconnected and grounded equipment of the power system !

Using the primary ground fault method a most reliable test result is guaranteed. Therefore please proceed as follows:

- Isolate the line and ground it on both ends. During the whole testing procedure the line must be open at the remote end.
- Make a test connection between a single phase and ground. On overhead lines it can be connected anywhere, however, it must be located behind the current transformers (looking from the busbar of the feeder to be checked). Cables are grounded on the remote end (sealing end).
- Remove the protective grounding of the line.
- Connect a circuit breaker to the line end that is to be tested.
- Check the direction indication (LED if allocated)

- The faulty phase (FNo 1272 for A or 1273 for B or 1274 for C) and the direction of the line, i.e. „`SensGnd Forward`“ (FNo 1276) must be indicated in the ground fault protocol.
- The active and reactive components of the ground current are also indicated („`INs Reac`“, FNo. 702). The reactive current „`INs Real`“, FNo. 701) is the most relevant for isolated systems. If the display shows the message „`SensGnd Reverse`“ (FNo. 1277), either the current or voltage transformer terminals are swopped in the neutral path. If message „`SensGnd undef.`“ (FNo 1278) appears, the ground current may be too low.
- Deenergize and ground the line.

The test is then finished.

3.3.12 Polarity Check for Current Input I_N

General

If the standard connection of the device is used whereby current input I_N is connected in the starpoint 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, current I_N is derived from a separate summation CT (see e.g. a connection circuit diagram in the Appendix A.3), an additional direction check with this current is necessary.

If the device is provided with the sensitive current input I_N and it is connected to an isolated or resonant-grounded system, the polarity check for I_N was already carried out with the ground fault check according to the previous section. Then this section can be ignored.

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.

Directional Testing for Grounded Systems

The check can either be carried out with function „directional ground fault protection“ (address 116) or function „ground fault detection“ (address 131), which can be operated as additional fault protection.

In the following the check is described using the „directional ground fault protection“ function (address 116) as an example.

To generate a displacement voltage, the e–n winding of one phase in the voltage transformer set (e.g. A) is bypassed (refer to Figure 3-38). If no connection on the e–

n windings of the voltage transformer is foreseen, the corresponding phase is disconnected on the secondary side (see Figure 3-39). Only the current of the transformer which is not provided with voltage in its voltage path is fed into the current path. If the line carries resistive-inductive load, the protection is in principle subjected to the same conditions that exist during a ground fault in line direction.

The directional ground fault protection must be configured to enabled and activated (address `116` or `131`). Its pickup threshold must be below the load current of the line; if necessary the pickup threshold must be reduced. The parameters that have been changed, must be noted.

After switching the line on and off again, the direction indication must be checked: In the fault log the messages „`67N picked up`“ and „`Ground forward`“ must at least be present. If the directional pickup is not present, either the ground current connection or the displacement voltage connection is incorrect. If the wrong direction is indicated, either the direction of load flow is from the line toward the busbar or the ground current path has a swapped polarity. In the latter case, the connection must be rectified after the line has been isolated and the current transformers short-circuited.

If the pickup message is missing, the measured ground (residual) current or the displacement voltage emerged may be too small. This can checked via operational measured values.

Important! If parameters were changed for this test, they must be returned to their original state after completion of the test !

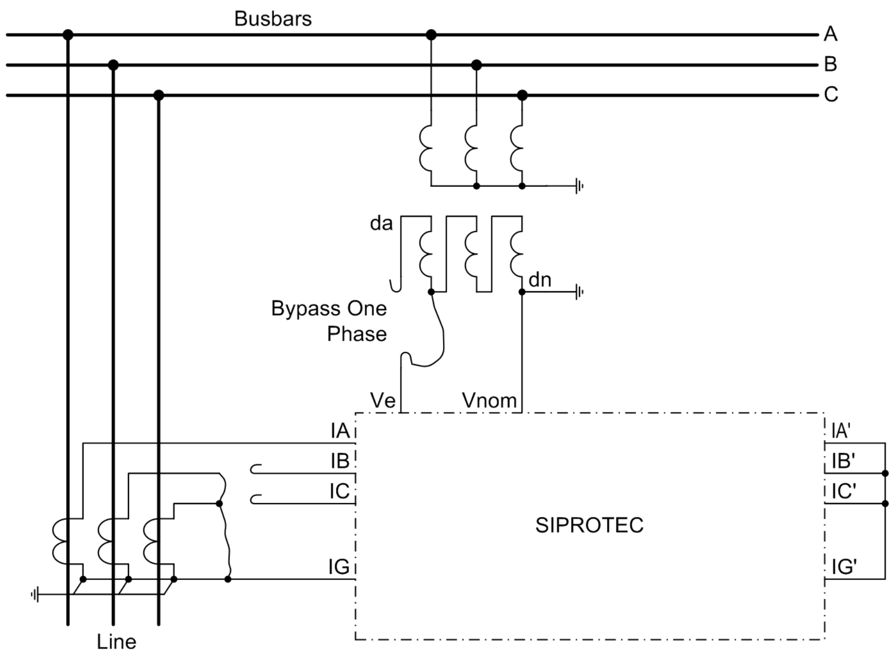


Figure 3-38 Polarity testing for I_N, example with current transformers configured in a Holmgreen-connection (VTs with broken delta connection -- e-n winding)

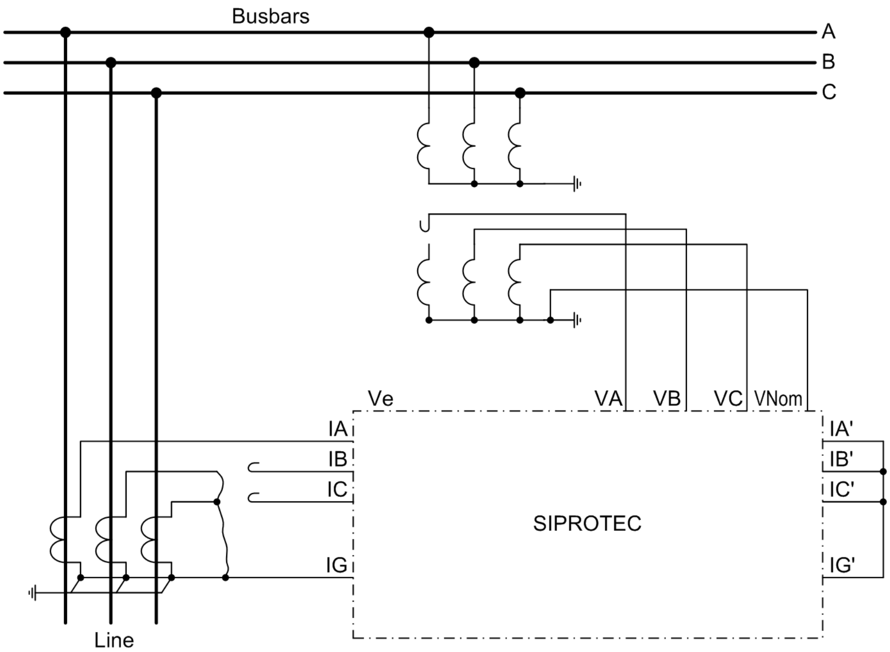


Figure 3-39 Polarity testing for I_N, example with current transformers configured in a Holmgreen-connection (VTs Wye-connected)

3.3.13 Checking the Temperature Measurement via RTD-Box

After the termination of the RS485 port and the setting of the bus address have been verified according to Section 3.2, the measured temperature values and thresholds can be checked.

If temperature sensors are used with 2-phase connection you must first determine the line resistance for the temperature detector being short-circuited. Select mode 6 at the RTD-Box and enter the resistance value you have determined for the corresponding sensor (range: 0 to 50.6 Ω).

When using the preset 3-phase connection for the temperature detectors no further entry must be made.

For checking the measured temperature values, the temperature detectors are replaced by adjustable resistors (e.g. precision resistance decade) and the correct assignment of the resistance value and the displayed temperature for 2 or 3 temperature values from the following table are verified.

Table 3-37 Assignment of the resistance value and the temperature of the sensors

Temperature in °C	Temperature in °F	Ni 100 DIN 43760	Ni 120 DIN 34760	Pt 100 IEC 60751
–50	–58	74.255	89.106	80.3062819
–40	–40	79.1311726	94.9574071	84.270652
–30	–22	84.1457706	100.974925	88.2216568
–20	–4	89.2964487	107.155738	92.1598984
–10	14	94.581528	113.497834	96.085879
0	32	100	120	100
10	50	105.551528	126.661834	103.902525
20	68	111.236449	133.483738	107.7935

Temperature in °C	Temperature in °F	Ni 100 DIN 43760	Ni 120 DIN 34760	Pt 100 IEC 60751
30	86	117.055771	140.466925	111.672925
40	104	123.011173	147.613407	115.5408
50	122	129.105	154.926	119.397125
60	140	135.340259	162.408311	123.2419
70	158	141.720613	170.064735	127.075125
80	176	148.250369	177.900442	130.8968
90	194	154.934473	185.921368	134.706925
100	212	161.7785	194.1342	138.5055
110	230	168.788637	202.546364	142.292525
120	248	175.971673	211.166007	146.068
130	266	183.334982	220.001979	149.831925
140	284	190.88651	229.063812	153.5843
150	302	198.63475	238.3617	157.325125
160	320	206.58873	247.906476	161.0544
170	338	214.757989	257.709587	164.772125
180	356	223.152552	267.783063	168.4783
190	374	231.782912	278.139495	172.172925
200	392	240.66	288.792	175.856
210	410	249.79516	299.754192	179.527525
220	428	259.200121	311.040145	183.1875
230	446	268.886968	322.664362	186.835925
240	464	278.868111	334.641733	190.4728
250	482	289.15625	346.9875	194.098125

Temperature thresholds that are configured in the protection device can be checked by slowly approaching the resistance value.

3.3.14 Measuring the Operating Time of the Circuit Breaker (only 7SJ64)

Only for Synchronism Check

If device 7SJ64 is equipped with the function for synchronism and voltage check and it is applied, it is necessary – under asynchronous system conditions – that the operating time of the circuit breaker is measured and set correctly when closing. If the synchronism check function is not used or only for closing under synchronous system conditions, this subsection is irrelevant.

For measuring the operating time a setup as shown in Figure 3-40 is recommended. The timer is set to a range of 1 s and a graduation of 1 ms.

The circuit breaker is connected manually. At the same time the timer is started. After closing the poles of the circuit breaker, the voltage V_{Line} appears and the timer is stopped. The time displayed by the timer is the real circuit breaker closing time.

If the timer is not stopped due to an unfavourable closing moment, the attempt will be repeated.

It is particularly favourable to calculate the mean value from several (3 to 5) successful switching attempts.

In address 6X20 set this time to **`T-CB close`** (under Power System Data of the synchronism check). Select the next lower settable value.

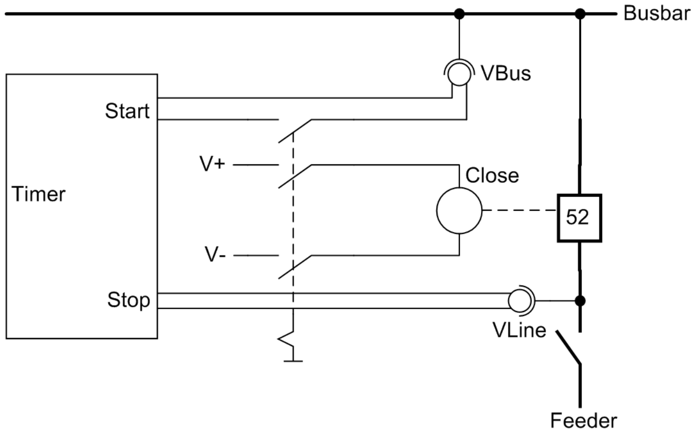


Figure 3-40 Measuring the circuit breaker closing time

3.3.15 Trip/Close Tests for the Configured Operating Devices

Control by Local Command

If the configured operating devices were not switched sufficiently in the hardware test already described, all configured switching devices must be switched on and off from the device via the integrated control element. The feedback information of the circuit breaker position injected via binary inputs is read out at the device and compared with the actual breaker position. For devices with graphic display this is easy to do with the control display.

The switching procedure is described in the SIPROTEC® 4 System Description. 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.

Control by Protective Functions

For OPEN-commands sent to the circuit breaker please take into consideration that if the internal or external automatic reclosure function is used a TRIP-CLOSE test cycle is initiated.

DANGER!

A test cycle successfully started by the automatic reclosure function can lead to the closing of the circuit breaker !

Non-observance of the following statement will result in death, severe personal injury or substantial property damage.

Be fully aware that OPEN-commands sent to the circuit breaker can result in a trip-close-trip event of the circuit breaker by an external reclosing device.

Control from a Remote Control Center

If the device is connected to a remote substation via a system interface, the corresponding switching tests may also be checked from the substation. Please also take into consideration that the switching authority is set in correspondence with the source of commands used.

3.3.16 Creating Oscillographic Recordings for Tests

General

In order to be able to test the stability of the protection during switchon procedures also, switchon trials can also be carried out at the end. Oscillographic records obtain the maximum information about the behaviour of the protection.

Requirements

To be able to trip an oscillographic recording, parameter **OSC. FAULT REC.** must be configured to ***Enabled*** in the **Functional Scope**. Along with the capability of storing fault recordings via pickup of the protection function, the 7SJ62/63/64 also has the capability of capturing the same data when commands are given to the device via the service program DIGSI, the serial interface, or a binary input. For the latter, event „>Trig.Wave.Cap.“ must be allocated to a binary input. Triggering for the oscillographic recording then occurs, for instance, via the binary input when the protection object is energized.

Those that are externally triggered (that is, without a protective element pickup) are processed by the device as a normal oscillographic record. For each oscillographic record a fault record is created which is given its individual number to ensure that assignment can be made properly. However, these recordings are not displayed in the fault indication buffer, as they are not fault events.

Triggering Oscillo-graphicRecording

To trigger test measurement recording with DIGSI, click on **Test** in the left part of the window. Double click the entry **Test Wave Form** in the list of the window.

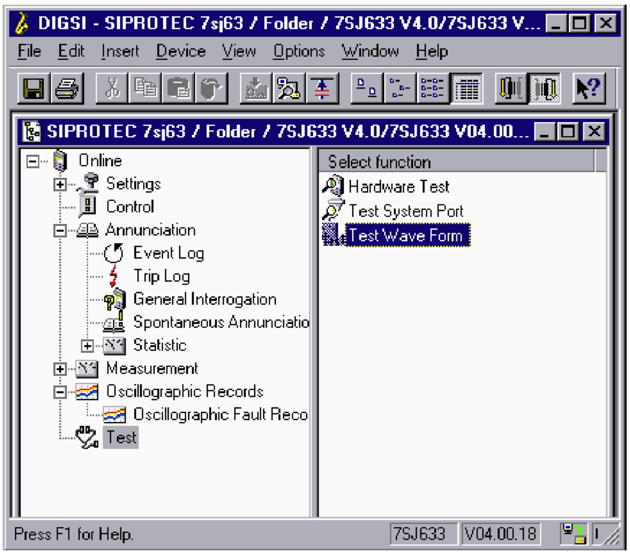


Figure 3-41 Triggering oscillographic recording with DIGSI®

Oscillographic recording is started immediately. During recording, a report is given in the left part of the status bar. Bar segments additionally indicate the progress of the procedure.

The SIGRA or the Comtrade Viewer program is required to view and analyse the oscillographic data.

3.4 Final Preparation of the Device

Firmly tighten all screws. Tighten all terminal screws, including those that are not used.

Caution!

Inadmissable Tightening Torques

Non–observance of the following measure can result in minor personal injury or property damage.

The tightening torques must not be exceeded as the threads and terminal chambers may otherwise be damaged!

The setting values should be checked again, if they were changed 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***. Keep a copy of all of the in-service settings on a PC.

Check the internal clock of the device. If necessary, set the clock or synchronize the clock if the element is not automatically synchronized. For assistance, refer to the SIPROTEC® 4 System Description.

The annunciation buffers are deleted under **MAIN MENU** → **Annunciations** → **Set/Reset**, so that future information will only apply for actual events and states (see also SIPROTEC® 4 System Description). The counters in the switching statistics should be reset to the values that were existing prior to the testing (see also SIPROTEC®4 System Description).

Reset the counters of the operational measured values (e.g. operation counter, if available) under **MAIN MENU** → **Measured Value** → **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 box (e.g. the display of operational measured values).

Clear the LEDs on the front panel of the device by pressing the LED key, so that they show only real events and states in the future. In this context, also output relays probably memorized are reset. Pressing the LED key also serves as a test for the LEDs on the front panel because they should all light when the button is pushed. Any LEDs that are lit after the clearing attempt are displaying actual conditions.

The green „RUN“ LED must light up, whereas the red „ERROR“ must not light up.

Close the protective switches. If test switches are available, then these must be in the operating position.

The device is now ready for operation.

■

Technical Data 4

This chapter provides the technical data of the device SIPROTEC® 7SJ62/63/64 and its individual functions, including the limit values that under no circumstances may be exceeded. The electrical and functional data for the maximum functional scope are followed by the mechanical specifications with dimensional diagrams.

4.1 General Device Data

4.1.1 Analog Inputs

Current Inputs

Nominal Frequency	f_{Nom}	50 Hz or 60 Hz	(adjustable)
Nominal Current	I_{Nom}	1 A or 5 A	
Ground Current, Sensitive	I_{Ns}	≤ linear range 1.6 A [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		 Approx. 0.05 VA Approx. 0.3 VA Approx. 0.05 VA	
Current overload capability - Thermal (rms) - Dynamic (peak value)		 100· I_{Nom} for 1 s 30· I_{Nom} for 10 s 4· I_{Nom} continuous 250· I_{Nom} (half-cycle)	
Current overload capability for high-sensitivity input 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		100 V to 225 V (adjustable)
Measuring Range		0 V to 170 V 0 V to 200 V (7SJ64 only)
Burden	at 100 V	Approx. 0.3 VA
AC Voltage Input Overload Capacity		
– thermal (rms)		230 V continuous

Measuring Transducer Inputs (7SJ63 only)

Input Current	0 mA DC to 20 mA DC
Input Resistance	10 Ω
Power Consumption	5.8 mW at 24 mA

4.1.2 Auxiliary Voltage

DC Voltage

Voltage Supply via Integrated Converter		
Rated auxiliary DC V_{Aux}	24/48 VDC	60/110/125 VDC
Permissible Voltage Ranges	19 to 58 VDC	48 to 150 VDC
Rated auxiliary DC V_{Aux}	110/125/220/250 VDC	
Permissible Voltage Ranges	88 to 300 VDC	
AC Ripple Voltage, Peak to Peak, IEC 60255-11	15 % of the auxiliary voltage	

Power Input	Quiescent	Energized
7SJ621, 7SJ622	Approx. 4 W	Approx. 7 W
7SJ631	Approx. 4 W	Approx. 10 W
7SJ632, 7SJ633	Approx. 5.5 W	Approx. 16 W
7SJ635, 7SJ636	Approx. 7 W	Approx. 20 W
7SJ640	Approx. 5 W	Approx. 9 W
7SJ641	Approx. 5.5 W	Approx. 13 W
7SJ642	Approx. 5.5 W	Approx. 12 W
7SJ645	Approx. 6.5 W	Approx. 15 W
Bridging Time for Failure/Short-Circuit, IEC 60255–11 (in not energized operation)	≥ 50 ms at V ≥ 110 V–	
	≥ 20 ms at V ≥ 24 V–	

AC Voltage

Voltage Supply via Integrated Converter		
Nominal Auxiliary Voltage AC V_{Aux}	115 VAC	230 VAC
Permissible Voltage Ranges	92 to 132 VAC	184 to 265 VAC

Power input (at 115 VAC / 230 VAC)	Quiescent	Energized
7SJ621, 7SJ622	Approx. 3 VA	Approx. 9 VA
7SJ631	Approx. 3 VA	Approx. 12 VA
7SJ632, 7SJ633	Approx. 5 VA	Approx. 18 VA
7SJ635, 7SJ636	Approx. 7 VA	Approx. 23 VA
7SJ640	Approx. 7 VA	Approx. 12 VA
7SJ641	Approx. 9 VA	Approx. 19.5 VA
7SJ642	Approx. 9 VA	Approx. 18.5 VA
7SJ645	Approx. 12 VA	Approx. 23 VA
Bridging Time for Failure/Short-Circuit (in not energized operation)	200 ms	

4.1.3 Binary Inputs and Outputs

Binary Inputs

Variant	Number	
7SJ621*-	8 (configurable)	
7SJ622*-	11 (configurable)	
7SJ631*-	11 (configurable)	
7SJ632*-	24 (configurable)	
7SJ633*-	20 (configurable)	
7SJ635*-	37 (configurable)	
7SJ636*-	33 (configurable)	
7SJ640*-	7 (configurable)	
7SJ641*-	15 (configurable)	
7SJ642*-	20 (configurable)	
7SJ645*-	33 (configurable)	
Rated Voltage Range	24 VDC to 250 VDC, bipolar	
7SJ62	– – –	BI1 ... BI 11
7SJ63	BI1....6; BI8....19; BI25....36	BI7; BI20 ... 24; BI37
7SJ640	– – –	BI1 ... 7
7SJ641	– – –	BI1 ... 15
7SJ642	BI8... 19	BI1 ... BI7; BI20
7SJ645	BI8... 19; BI21...32	BI1...7; BI20; BI33
Current Consumption (independent of the control voltage)	approx. 0.9 mA	approx. 1.8 mA
Pickup Times	approx. 9 ms	approx. 4 ms
Secured switching threshold	Switching Thresholds, adjustable voltage range with jumpers	
for Nominal Voltages	24/48/60/110/125 VDC	V high ≥ 19 VDC V low ≤ 10 VDC
for Nominal Voltages	110/125/220/250 VDC	V high ≥ 88 VDC V low ≤ 44 VDC
for Nominal Voltages (only for modules with 3 switching thresh-olds)	220/250 VDC and 115/230 VAC	V high ≥ 176 VDC V low ≤ 88 VDC
Maximum Permissible Voltage	300 V DC	
Impulse Filter on Input	220 nF at 220 V with recovery time > 60 ms	

Output Relays

Output Relay for Commands/Annunciations, Alarm Relay *) High-duty Relay **) 2)			
Number and Information	According to the order variant (allocatable); Values in (): up to release .../DD		
Order Variant	NO contact*)	NO/NC, switch selectable*)	High-duty Relay **) 2)
7SJ621*-	6 (8)	3 (1)	—
7SJ622*-	4 (6)	3 (1)	—
7SJ631*-	8	1	—
7SJ632*-	11	1	4
7SJ633*-	11	1	4
7SJ635*-	14	1	8
7SJ636*-	14	1	8
7SJ640*-	5	1	–
7SJ641*-	12	2	–
7SJ642*-	8	1	4
7SJ645*-	11	1	8
Switching Capability MAKE	1000 W/VA		–
Switching Capability MAKE	30 VA 40 W resistive 25 W at L/R ≤ 50 ms		–
Switching Voltage	250 VDC / VAC		250 VDC / VAC
admissible current per contact (continuous)	5 A		–
admissible current per contact (close and hold)	30 A for 0.5 s (Closer)		
Permissible Total Current on common path	5 A continuous, 30 A for 0.5 s		–
max. switching capability for 30 s At 48 V to 250 V At 24 V	–		 1000 W 500 W
Permissible relative closing time	–		1 %
AC Load (it has to be taken into consideration for the dimensions of external circuits)			
Value of the ANSI capacitor: 4,70· 10^{-9} F ± 20%	Frequency	Impedance	
	50 Hz	6,77· 10^5 Ω ± 20%	
	60 Hz	5,64· 10^5 Ω ± 20%	
*) UL–listed with the Following Nominal Values:			
	120 VAC	Pilot duty, B300	
	240 VAC	Pilot duty, B300	
	240 VAC	5 A General Purpose	
	24 VDC	5 A General Purpose	
	48 VDC	0.8 A General Purpose	
	240 VDC	0.1 A General Purpose	
	120 VAC	1/6 hp (4.4 FLA1))	
	240 VAC	1/2 hp (4.9 FLA1))	
**) UL–listed with the Following Nominal Values:			

	240 VDC	1.6 FLA[1)]
	120 VDC	3.2 FLA[1)]
	60 VDC	5.5 FLA[1)]

1) FLA = “Full Load Ampere”

2) High-duty relays are used for the direct activation of motor-driven switches. The high-duty relays operate in an interlocked mode, i.e. only one binary output of each pair of switches is activated, thus avoiding a short-circuit of the power supply. When used as a standard relay, only one binary output of a pair can be used. Permanent operation is not specified.

4.1.4 Communication Interfaces

Operator Interface

Connection	Front side, non-isolated, RS232, 9-pin DSUB port for connecting a personal computer
Operation	With DIGSI
Transmission Speed	min. 4,800 Baud; max. 38,400 Baud; for 7SJ63/64: max. 11,200 Baud; Factory Setting: 38,400 Baud; Parity: 8E1
Maximum Distance of Transmission	49.2 feet (15 m)

Service / Modem Interface

	Connection	isolated interface for data transfer
	Operation	With DIGSI
	Transmission Speed	min. 4,800 Baud; max. 38,400 Baud; for 7SJ63/64: max. 115,200 Baud; Factory setting 38,400 Baud
RS232/RS485		RS232/RS485 according to the ordering variant
	Connection for flush mounting housing	Rear panel, mounting location „C“, 9-pin D-SUB miniature connector
	Connection for surface mounting housing	at the housing mounted case on the case bottom; shielded data cable
	Test Voltage	500 VAC
RS232		
	Maximum Distance of Transmission	49.2 feet (15 m)
RS485		
	Maximum Distance of Transmission	3,280 feet (1,000 m)
Fiber Optical Link (FO) [1]		
	FO connector type	ST connector
	Connection for flush-mounted case	Rear panel, mounting location „C“
	Connection for surface mounting housing	at the housing mounted case on the case bottom
	Optical Wavelength	λ = 820 nm
	Laser Class 1 according to EN 60825-1/-2	using glass fiber 50/125 μm or using glass fiber 62.5/125 μm
	Permissible Optical Link Signal Attenuation	max. 8 dB, with glass fiber 62.5/125 μm
	Maximum Distance of Transmission	max. 0.93 miles (1.5 km)
	Character Idle State	Configurable: factory setting „Light off“

[1] not for 7SJ64

Additional Interface (only 7SJ64)

	Connection	isolated interface for data transfer with RTD-boxes
	Transmission Speed	min. 4,800 Baud; max. 115,200 Baud; Factory setting 38,400 Baud
RS485		
	Connection for flush mounting case	Rear panel, mounting location „D“ 9-pin D-SUB miniature connection
	Connection for surface mounting housing	at the housing bottom; shielded data cable
	Test Voltage	500 VAC
	Maximum Distance of Transmission	3,280 feet (1,000 m)
Fiber Optical Link (FO)		
	FO connector type	ST connector
	Connection for flush-mounted case	Rear panel, mounting location „D“
	Connection for surface mounting housing	at the housing mounted case on the case bottom
	Optical Wavelength	λ = 820 nm
	Laser Class 1 according to EN 60825-1/-2	using glass fiber 50/125 μm or using glass fiber 62.5/125 μm
	Permissible Optical Link Signal Attenuation	max. 8 dB, with glass fiber 62.5/125 μm
	Maximum Distance of Transmission	max. 0.93 miles (1.5 km)
	Character Idle State	Configurable: factory setting „Light off“

System Interface

IEC 60870-5-103		
	RS232/RS485/FO according to the ordering variant	isolated interface for data transfer to a master terminal
RS232		
	Connection for flush-mounted case	Rear panel, mounting location „B“, 9-pin D-SUB miniature connector
	Connection for surface mounting housing	at the housing mounted case on the case bottom
	Test Voltage	500 VAC
	Transmission Speed	min. 4,800 Baud; max. 38,400 Baud; Factory setting 9600 Baud
	Maximum Distance of Transmission	49.2 feet (15 m)
RS485		
	Connection for flush-mounted case	Rear panel, mounting location „B“, 9-pin D-SUB miniature connector
	Connection for surface mounting housing	at the housing mounted case on the case bottom
	Test Voltage	500 VAC
	Transmission Speed	min. 4,800 Baud; max. 38,400 Baud; Factory setting 9600 Baud
	Maximum Distance of Transmission	max. 0.62 miles (1 km)
Fiber Optical Link (FO)		
	FO connector type	ST connector
	Connection for flush-mounted case	Rear panel, mounting location „B“
	Connection for surface mounting housing	at the housing mounted case on the case bottom
	Optical Wavelength	λ = 820 nm
	Laser Class 1 according to EN 60825-1/-2	using glass fiber 50/12 μm or using glass fiber 62.5/125 μm
	Permissible Optical Link Signal Attenuation	max. 8 dB, with glass fiber 62.5/125 μm
	Maximum Distance of Transmission	max. 0.93 miles (1.5 km)
	Character Idle State	Configurable: factory setting „Light off“
PROFIBUS RS485 (FMS and DP)		
	Connection for flush-mounted case	Rear panel, mounting location „B“ 9-pin D-SUB miniature connector
	Connection for surface mounting housing	at the housing mounted case on the case bottom
	Test Voltage	500 VAC
	Transmission Speed	up to 1.5 MBd
	Maximum Distance of Transmission	3,280 ft or 1,000 m at ≤ 93.75 kBd 500 m or 1,640 ft at ≤ 187.5 kBd 200 m or 330 ft at ≤ 1.5 MBd

PROFIBUS FO (FMS and DP)		
	FO connector type	ST connector Single ring / double ring according to the order for FMS; for DP only double ring available
	Connection for flush-mounted case	Rear panel, mounting location „B“
	Connection for surface mounting housing	in console housing on the case bottom via RS485 and external RS485/optical converter
	Transmission Speed	up to 1.5 MBd
	recommended:	> 500 kBd with normal casing ≤ 57 600 Bd at detached operator panel
	Optical Wavelength	λ = 820 nm
	Laser Class 1 according to EN 60825-1/-2	using glass fiber 50/125 µm or using glass fiber 62.5/125 µm
	Permissible Optical Link Signal Attenuation	max. 8 dB, with glass fiber 62.5/125 µm
	Maximum Distance of Transmission	max. 0.93 miles (1.5 km)
DNP3.0 / MODBUS RS485		
	Connection for flush-mounted case	Rear panel, mounting location „B“, 9-pin D-SUB miniature connector
	Connection for surface mounting housing	at the housing mounted case on the case bottom
	Test Voltage	500 VAC
	Transmission Speed	up to 19,200 Bd
	Maximum Distance of Transmission	max. 0.62 miles (1 km)
DNP3.0 / MODBUS Fiber Optical Link		
	FO connector type	ST–Connector Receiver/Transmitter
	Connection for flush-mounted case	Rear panel, mounting location „B“
	Connection for surface mounting housing	not available
	Transmission Speed	up to 19,200 Bd
	Optical Wavelength	λ = 820 nm
	Laser Class 1 according to EN 60825-1/-2	using glass fiber 50/125 µm or using glass fiber 62.5/125 µm
	Permissible Optical Link Signal Attenuation	max. 8 dB, with glass fiber 62.5/125 µm
	Maximum Distance of Transmission	max. 0.93 miles (1.5 km)

Ethernet electrical (EN 100) for IEC61850 and DIGSI		
	Connection for flush-mounted case	rear side, mounting location „B“ 2 x RJ45 socket contact 100BaseT acc. to IEEE802.3
	Connection for panel surface-mounted housing	available expected as of 02/2005
	Test voltage (reg. socket)	500 V; 50 Hz
	Transmission speed	100 MBit/s
	Bridgeable distance	65.62 feet (20 m)

Time Synchronization Interface

Time Synchronization	DCF 77 / IRIG B Signal (Telegram Format IRIG-B000)
Connection for flush-mounted case	Rear panel, mounting location „A“ 9-pin D-subminiature female connector
Connection for surface mounting housing	at the double-deck terminal on the case bottom
Signal Nominal Voltages	selectable 5 V, 12 V or 24 V
Test Voltage	500 V; 50 Hz

Signal Levels and Burdens			
	Nominal Signal Voltage		
	5 V	12 V	24 V
V_{IHigh}	6.0 V	15.8 V	31 V
V_{ILow}	1.0 V at I_{ILow} = 0.25 mA	1.4 V at I_{ILow} = 0.25 mA	1.9 V at I_{ILow} = 0.25 mA
I_{IHigh}	4.5 mA to 9.4 mA	4.5 mA to 9.3 mA	4.5 mA to 8.7 mA
R_I	890 at V_I = 4 V	1930 at V_I = 8.7 V	3780 at V_I = 17 V
	640 at V_I = 6 V	1700 at V_I = 15.8 V	3560 at V_I = 31 V

4.1.5 Electrical Tests

Specifications

Standards:	IEC 60255 (product standards) ANSI/IEEE Std C37.90.0/.1/.2 UL 508 DIN 57435 Part 303 for more standards see also individual functions

Insulation Test

Standards:	IEC 60255-5 and IEC 60870-2-1
High Voltage Test (routine test) All circuits except power supply, Binary Inputs, Communication Interface and Time Synchronization Interfaces	2.5 kV (rms), 50 Hz
High voltage test (routine test). Auxiliary voltage and binary inputs	3.5 kV–
High Voltage Test (routine test). Only Isolated Communication and Time Synchronization Interfaces	500 V (rms), 50 Hz
Impulse Voltage Test (type test). All Circuits Except Communication and Time Synchronization Interfaces, Class III	5 kV (peak value); 1.2/50 µs; 0.5 J; 3 positive and 3 negative impulses at intervals of 1 s

EMC Tests for Immunity (Type Tests)

Standards:		IEC 60255-6 and -22 (product standards), EN 50082-2 (Generic standard) DIN 57435 Part 303
High Frequency Test IEC 60255-22-1, Class III and VDE 0435 Part 303, Class III		2.5 kV (Peak); 1 MHz; τ = 15 µs; 400 surges per s; test duration 2 s; R_i = 200 Ω
Electrostatic Discharge IEC 60255-22-2, Class IV and IEC 61000-4-2, Class IV		8 kV contact discharge; 15 kV air discharge, both polarities; 150 pF; R_i = 330 Ω
Irradiation with HF field, pulse modulated IEC 60255-22-3 (report), Class III		10 V/m; 27 MHz to 500 MHz
Irradiation with HF field, amplitude modulated IEC 61000-4-3, Class III		10 V/m; 80 MHz to 1000 MHz; 80 % AM; 1 kHz
Irradiation with HF field, pulse modulated IEC 61000-4-3/ENV 50204, Class III		10 V/m; 900 MHz: repetition frequency 200 Hz: duty cycle of 50 %
Fast Transient Disturbance Variables / Burst IEC 60255-22-4 and IEC 61000-4-4, Class IV		4 kV; 5/50 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 (SURGE), IEC 61000-4-5 Installation Class 3		Impulse: 1.2/50 µs
	Auxiliary voltage	common mode: 2 kV; 12 Ω; 9 µF diff. mode:1 kV; 2 Ω; 18 µF
	Measuring Inputs, Binary Inputs, Relay Outputs	common mode: 2 kV; 42 Ω; 0.5 µF diff. mode: 1 kV; 42 Ω; 0.5 µF

HF on lines, amplitude-modulated IEC 61000-4-6, Class III	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
Power System Frequency Magnetic Field IEC 61000-4-8; class IV IEC 60255-6	30 A/m continuous; 300 A/m for 3 s; 50 Hz 0.5 mT; 50 Hz
Oscillatory Surge Withstand Capability IEEE Std C37.90.1	2.5 kV (peak value); 1 MHz; τ = 15 μs; 400 surges per s; Test Duration 2 s; R_i = 200 Ω
Fast Transient Surge Withstand Cap. IEEE Std C37.90.1	4 kV; 5/50 ns; repetition rate 300 ms; both polarities; Test Duration 1 min; R_i = 50 Ω
Radiated Electromagnetic Interference IEEE Std C37.90.2	35 V/m; 25 MHz to 1000 MHz
Damped Oscillations IEC 60694, IEC 61000-4-12	2.5 kV (Peak Value), polarity alternating 100 kHz, 1 MHz, 10 MHz and 50 MHz, R_i = 200 Ω

EMC Tests For Noise Emission (Type Test)

Standard:	EN 50081-* (technical generic standard)
Radio noise voltage to lines, only auxiliary voltage IEC-CISPR 22	150 kHz to 30 MHz Limit Class B
Interference field strength IEC-CISPR 22	30 MHz to 1000 MHz Limit Class B
Harmonic Currents on the Network Lead at 230 VAC IEC 61000-3-2	Device is to be assigned Class D (applies only for devices with > 50 VA power consumption)
Voltage fluctuations and flicker on the network incoming feeder at 230 VAC IEC 61000-3-3	Limits are observed

4.1.6 Mechanical Stress Tests

Vibration and Shock Stress During 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: 1 g 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 I; IEC 60068-3-3	Sinusoidal 1 Hz to 8 Hz: ± 3.5 mm amplitude (horizontal vectors) 1 Hz to 8 Hz: ± 1.5 mm Amplitude (vertical axis) 8 Hz to 35 Hz: 1 g acceleration (horizontal axis) 8 Hz to 35 Hz: 0.5 g acceleration (vertical axis) frequency sweep rate 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 II; 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 I; 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 I; 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[1])

Standards:	IEC 60255-6
Type tested (acc. IEC 60086-2-1 and -2, Test Bd, for 16 h)	–13 °F to +185 °F or -25.00 °C to +85 °C
Permissible temporary operating temperature (tested for 96 h)	– 4.00 °F to +158 °F or –20 °C to +70 °C (legibility of display may be restricted from +131 °F or +55 °C)
Recommended for permanent operation (according to IEC 60255-6)	+23 °F to +131 °F or -5 °C to +55 °C
Limiting Temperatures for Storage	–13 °F to +131 °F or -25 °C to +55 °C
Limiting temperatures for transport	–13 °F to +158 °F or -25 °C to +70 °C
STORE AND TRANSPORT THE DEVICE WITH FACTORY PACKAGING.	
[1]) UL–certified according to Standard 508 (Industrial Control Equipment):	
Limiting temperatures for normal operation (i.e. output relays not energized)	–4 °F to +158 °F or -20 °C to +70 °C
Limiting temperatures with maximum load (max. cont. permissible energization of inputs and outputs)	+23 °F to +131 °F or –5 °C to +55 °C for 7SJ62 +23 °F to +104 °F or –5 °C to +40 °C for 7SJ63/64

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 Certifications

UL Listing		**UL recognition**	
7SJ62**-*B***-****	Models with threaded terminals	7SJ62**-*D***-****	Models with plug–in terminals
7SJ62**-*E***-****			
7SJ63**-*B***-****		7SJ63**-*A***-****	
7SJ63**-*C***-****		7SJ63**-*D***-****	
7SJ63**-*E***-****			
7SJ64**-*B***-****		7SJ64**-*A***-****	
7SJ64**-*C***-****		7SJ64**-*D***-****	
7SJ64**-*E***-****		7SJ64**-*G***-****	
7SJ64**-*F***-****			

4.1.10 Design

Case	7XP20
Dimensions	see dimensional drawings, Section 4.26

Variant	**Case**	**Size**	**Weight (mass)**
7SJ62**-*B	in surface mounting housing	$^1/_3$	8.8 lb or 4.5 kg
7SJ62**-*D/E	in flush mounting housing	$^1/_3$	8.8 lb or 4 kg
7SJ631/2/3*-*B	in surface mounting housing	$^1/_2$	15.4 lb or 7.5 kg
7SJ635/6*-*B	in surface mounting housing	$^1/_1$	33.07 lb or 15 kg
7SJ631/2/3*-*D/E	in flush mounting housing	$^1/_2$	13.22 lb or 6.5 kg

Variant	Case	Size	Weight (mass)
7SJ63/5/6*-*D/E	in flush mounting housing	$^1/_1$	28.66 lb or 13 kg
7SJ631/2/3*-*A/C	in housing for detached operator panel	$^1/_2$	17.4 lb or 8 kg
7SJ63/5/6*-*A/C	in housing for detached operator panel	$^1/_1$	33.07 lb or 15 kg
7SJ631/2/3*-*F/G	in housing without operator panel	$^1/_2$	17.4 lb or 8 kg
7SJ63/5/6*-*F/G	in housing without operator panel	$^1/_1$	33.07 lb or 15 kg
7SJ640*-*B	in surface mounting housing	$^1/_3$	17.4 lb or 8 kg
7SJ641/2*-*B	in surface mounting housing	$^1/_2$	24.25 lb or 11 kg
7SJ645*-*B	in surface mounting housing	$^1/_1$	33.07 lb or 15 kg
7SJ641/2*-*A/C	in housing for detached operator panel	$^1/_2$	17.4 lb or 8 kg
7SJ645*-*A/C	in housing for detached operator panel	$^1/_1$	26.45 lb or 12 kg
7SJ641/2*-*F/G	in housing without operator panel	$^1/_2$	17.4 lb or 8 kg
7SJ645*-*F/G	in housing without operator panel	$^1/_1$	26.45 lb or 12 kg
7SJ640*-*D/E	in flush mounting housing	$^1/_3$	11.02 lb or 5 kg
7SJ641/2*-*D/E	in flush mounting housing	$^1/_2$	13.23 lb or 6 kg
7SJ645*-*D/E	in flush mounting housing	$^1/_1$	22.05 lb or 10 kg
Detached operator panel			5.51 lb or 2.5 kg

International Protection Under IEC 60529		
for equipment of the surface mounting housing		IP 51
in flush mounted case and in model with detached operator panel		
	Front	IP 51
	Rear	IP 50
For personal protection		IP 2x with cover cap
UL-certification conditions		„For use on a Flat Surface of a Type 1 Enclosure“

4.2 Definite Time Overcurrent Protection 50, 50N

Operating Modes

Three-phase	Standard
Two-phase	Phases A and C

Setting Ranges / Increments

Pickup current 50–1, 50–2 (phases)	for I_{Nom} = 1 A	0.10 A to 35.00 A or ∞ (disabled)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 175.00 A or ∞ (disabled)	
Pickup current 50N–1, 50N–2 (ground)	for I_{Nom} = 1 A	0.05 A to 35.00 A or ∞ (disabled)	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 175.00 A or ∞ (disabled)	
Delay times T		0.00 s to 60.00 s or ∞ (disabled)	Increments 0.01 s
Dropout delay times 50 T DROP-OUT, 50N T DROP-OUT		0.00 s to 60.00 s	Increments 0.01 s

Times

Pickup times (without inrush restraint, with restraint add 10 ms)	
50-1, 50-2, 50N-1, 50N-2 – Current = 2 x Pickup Value – Current = 10 x Pickup Value	 approx. 30 ms approx. 20 ms
Dropout Times 50-1, 50-2, 50N-1, 50N-2	 approx. 40 ms

Dropout Ratio

Dropout ratio	approx. 0.95 for $I/I_{Nom} \geq 0.3$

Tolerances

Pickup current	2 % of set value or 10 mA with I_{Nom} = 1 A or 50 mA with I_{Nom} = 5 A
Delay times T	1 % or 10 ms

Influencing Variables for Pickup and Dropout

Power supply direct voltage in range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$	1 %
Temperature in range $-5\ °C \leq \Theta_{amb} \leq 55\ °C$	0.5 %/10 K
Frequency in range $0.95 \leq f/f_{Nom} \leq 1.05$	1 %

Harmonics Up to 10 % 3rd harmonic Up to 10 % 5th harmonic	 1 % 1 %
Transient overreach for τ > 100 ms (with complete asymmetry)	<5 %

4.3 Inverse Time Overcurrent Protection 51, 51N

Operating Modes

Three-phase	Standard
Two-phase	Phases A and C

Setting Ranges / Increments

Pickup current 51 (phases)	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	
Pickup current 51N	for I_{Nom} = 1 A	0.05 A to 4.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 20.00 A	
Time multipliers T for 51, 51N IEC curves		0.05 s to 3.20 s or ∞ (disabled) (disabled)	Increments 0.01 s
Time multipliers D for 51, 51N ANSI curves		0.50 s to 15.00 s or ∞ (disabled)	Increments 0.01 s

Trip Time Curves acc. to IEC

Acc. to IEC 60255-3 or BS 142, Section 3.5.2 (see also Figure 4-1 and 4-2)

NORMAL INVERSE (Type A)

$$t = \frac{0.14}{(I/I_p)^{0.02} - 1} \cdot T_p \ [s]$$

VERY INVERESE (Type B)

$$t = \frac{13.5}{(I/I_p)^{1} - 1} \cdot T_p \ [s]$$

EXTREMELY INV. (Type C)

$$t = \frac{80}{(I/I_p)^{2} - 1} \cdot T_p \ [s]$$

LONG INVERSE (Type B)

$$t = \frac{120}{(I/I_p)^{1} - 1} \cdot T_p \ [s]$$

For All Characteristics

t	trip time in seconds
T_p	setting value of the time multiplier
I	fault current
I_p	setting value of the pickup current

The tripping times for $I/I_p \geq 20$ are identical with those for $I/I_p = 20$.	
For zero-sequence current read 3I0p instead of I_p and T_{3I0p} instead of T_p; for ground fault read I_{Ep} instead of I_p and T_{IEp} instead of T_p	
Pickup Threshold	approx. $1.10 \cdot I_p$

Dropout Time Characteristics with Disk Emulation acc. to IEC

Ass. to IEC 60255-3 or BS 142, Section 3.5.2 (see also Figures 4-1 and 4-2)

NORMAL INVERSE (Type A)

$$t_{Reset} = \frac{9.7}{(I/I_p)^2 - 1} \cdot T_p \quad [s]$$

VERY INVERSE (Type B)

$$t_{Reset} = \frac{43.2}{(I/I_p)^2 - 1} \cdot T_p \quad [s]$$

EXTREMELY INV. (Type C)

$$t_{Reset} = \frac{58.2}{(I/I_p)^2 - 1} \cdot T_p \quad [s]$$

LONG INVERSE (Type B)

$$t_{Reset} = \frac{80}{(I/I_p)^2 - 1} \cdot T_p \quad [s]$$

For all Characteristics

t_{RESET} = Reset time
T_p = Setting value of the time multipli
I = Fault Current
I_p = Setting value of the pickup curre

The dropout time curves apply for the range $0.05 \le (I/Ip) \le 0.90$

For zero-sequence current read 3I0p instead of I_p and T_{3I0p} instead of T_p;
for ground fault read I_{Ep} instead of I_p and T_{IEp} instead of T_p

Dropout Setting

IEC without Disk Emulation	approx. 1.05 · set value I_p for $I_p/I_{Nom} \ge 0.3$, corresponds to approx. 0.95 · pickup threshold
IEC with Disk Emulation	approx. 0.90 · set value I_p

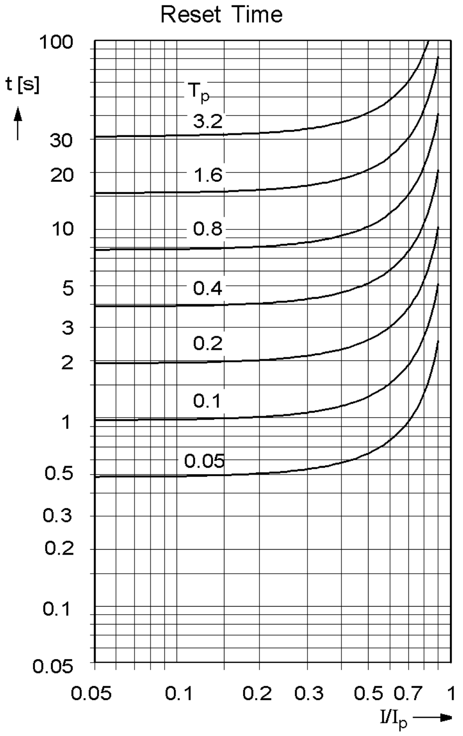
Tolerances

Pickup/dropout thresholds I_p, I_{Ep}	2 % of set value or 10 mA for I_{Nom} = 1 A or 50 mA for I_{Nom} = 5 A
Pickup time for $2 \le I/I_p \le 20$	5 % of reference (calculated) value + 2 % current tolerance, respectively 30 ms
Dropout ratio for $I/I_p \le 0.90$	5 % of reference (calculated) value + 2 % current tolerance, respectively 30 ms

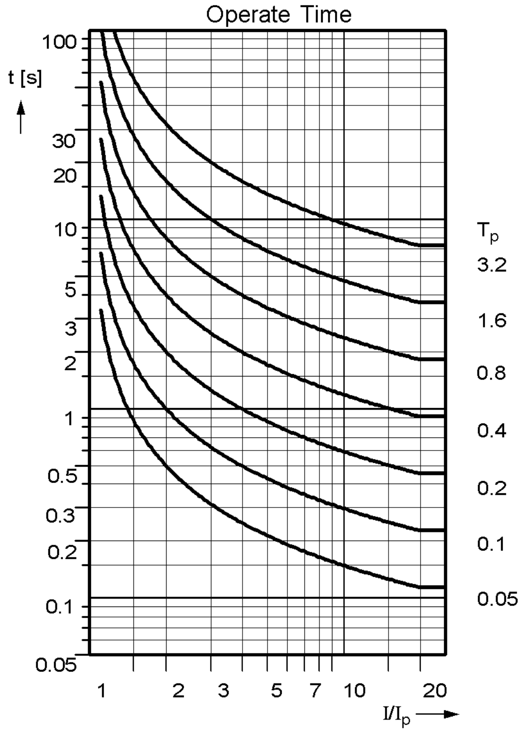
Influencing Variables for Pickup and Dropout

Power supply direct voltage in range $0.8 \le V_{PS}/V_{PSNom} \le 1.15$	1 %
Temperature in range 23.00 °F (–5 °C) $\le \Theta_{amb} \le$ 131.00 °F (55 °C)	0.5 %/10 K
Frequency in range $0.95 \le f/f_{Nom} \le 1.05$	1 %

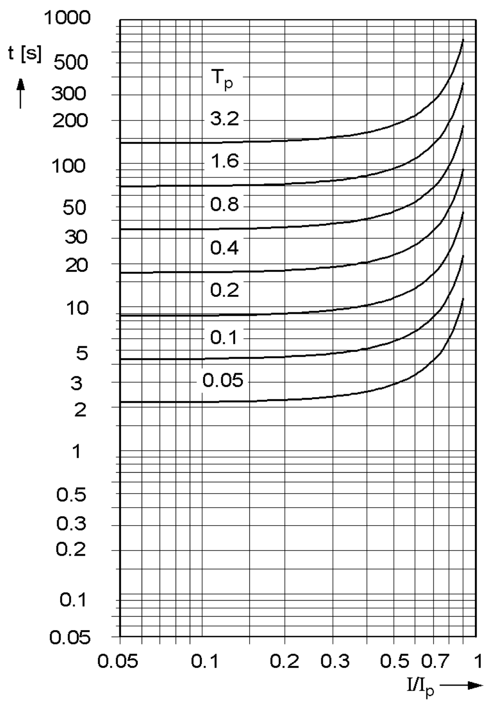
Harmonics Up to 10 % 3rd harmonic Up to 10 % 5th harmonic	 1 % 1 %
Transient overreach for τ > 100 ms (with complete asymmetry)	<5 %



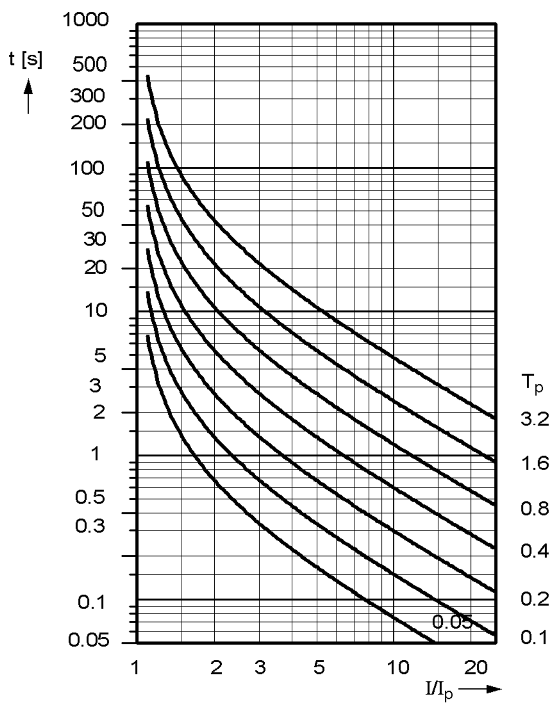
Reset Normal inverse: (Type A) $t = \frac{9.7}{(I/I_p)^2 - 1} \cdot T_p$ [s]



Normal inverse: (Type A) $t = \frac{0.14}{(I/I_p)^{0.02} - 1} \cdot T_p$ [s]

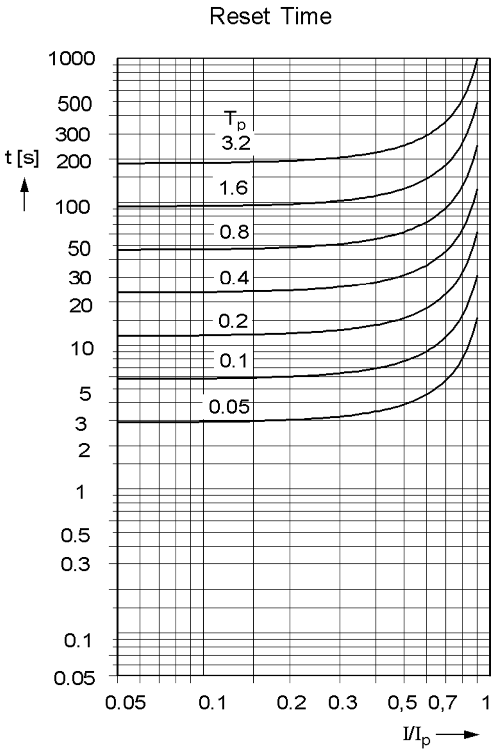


Reset Very inverse: (Type B) $t = \frac{43.2}{(I/I_p)^2 - 1} \cdot T_p$ [s]



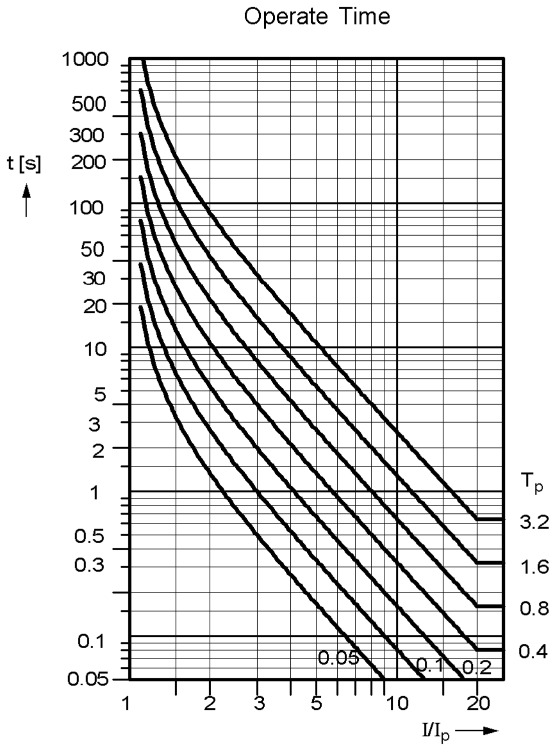
Very inverse: (Type B) $t = \frac{13.5}{(I/I_p)^1 - 1} \cdot T_p$ [s]

Figure 4-1 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to IEC



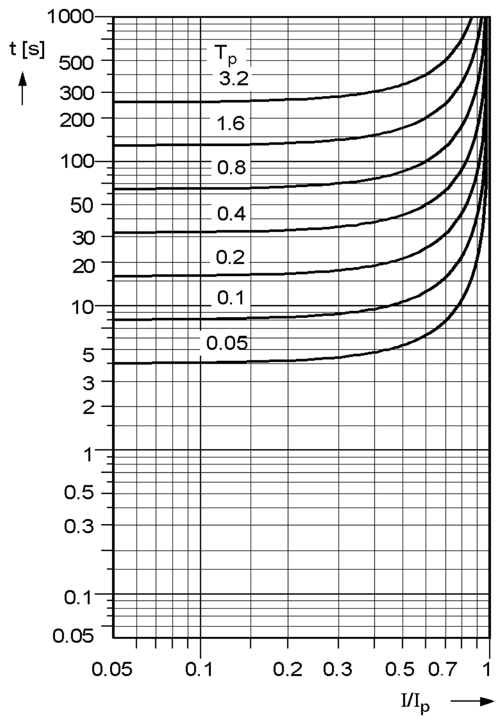
Reset Extremely inverse:
(Type C)

$$t = \frac{58.2}{(I/I_p)^2 - 1} \cdot T_p \quad [s]$$



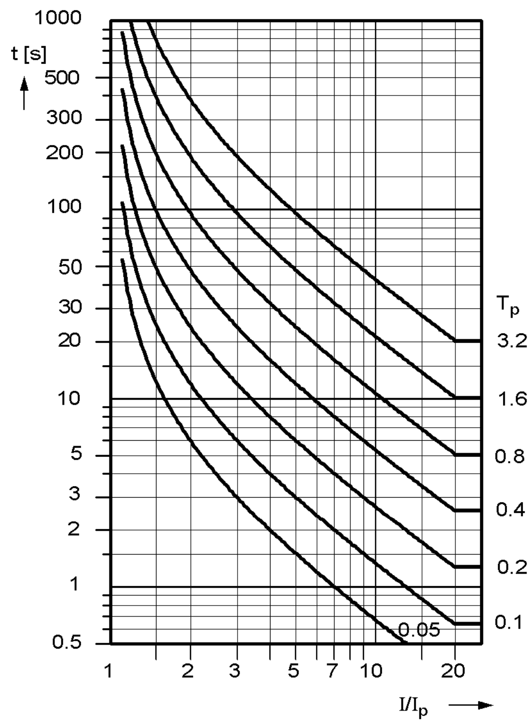
Extremely inverse:
(Type C)

$$t = \frac{80}{(I/I_p)^2 - 1} \cdot T_p \quad [s]$$



Reset Long inverse:
(Type B)

$$t = \frac{80}{(I/I_p)^2 - 1} \cdot T_p \quad [s]$$



Long inverse:
(Type B)

$$t = \frac{120}{(I/I_p)^1 - 1} \cdot T_p \quad [s]$$

Figure 4-2 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to IEC

Trip Time Curves acc. to ANSI

<table>
<tr><td colspan="2">Acc. to ANSI/IEEE (see also Figures 4-3 to 4-6)</td></tr>
<tr><td colspan="2">

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 INV. $$t = \left(\frac{0.0103}{(I/I_p)^{0.02} - 1} + 0.0228\right) \cdot D \ [s]$$

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 $$t = \left(\frac{0.4797}{(I/I_p)^{1.5625} - 1} + 0.21359\right) \cdot D \ [s]$$

For all Characteristics

t = Trip time in seconds
D = Setting value of the time multiplier
I = Fault Current
I_p = Setting value of the pickup current

</td></tr>
<tr><td colspan="2">The tripping times for $I/I_p \geq 20$ are identical with those for $I/I_p = 20$.</td></tr>
<tr><td colspan="2">For zero-sequence current read 3I0p instead of I_p and T_{3I0p} instead of T_p;
for ground fault read I_{Ep} instead of I_p and T_{IEp} instead of T_p</td></tr>
<tr><td>Pickup Threshold</td><td>approx. $1.10 \cdot I_p$</td></tr>
</table>

Dropout Time Characteristics with Disk Emulation acc. to ANSI/IEEE

Acc. to ANSI/IEEE (see also Figures 4-3 to 4-6)	
ANSI INVERSE	$t_{Reset} = \left(\frac{8.8}{(I/I_p)^{2.0938} - 1}\right) \cdot D \quad [s]$
ANSI SHORT INVERSE	$t_{Reset} = \left(\frac{0.831}{(I/I_p)^{1.2969} - 1}\right) \cdot D \quad [s]$
ANSI LONG INVERSE	$t_{Reset} = \left(\frac{12.9}{(I/I_p)^{1} - 1}\right) \cdot D \quad [s]$
ANSI MODERATELY INV.	$t_{Reset} = \left(\frac{0.97}{(I/I_p)^{2} - 1}\right) \cdot D \quad [s]$
ANSI VERY INVERSE	$t_{Reset} = \left(\frac{4.32}{(I/I_p)^{2} - 1}\right) \cdot D \quad [s]$
ANSI EXTREMELY INV.	$t_{Reset} = \left(\frac{5.82}{(I/I_p)^{2} - 1}\right) \cdot D \quad [s]$
ANSI DEFINITE INV.	$t_{Reset} = \left(\frac{1.03940}{(I/I_p)^{1.5625} - 1}\right) \cdot D \quad [s]$
for $0.05 < (I/I_p) \leq 0.90$	For all Characteristics t_{RESET} = Reset time D = Setting value of the time multiplier I = Fault Current I_p = Setting value of the pickup current
The dropout time curves apply for the range $(I/Ip) \leq 0.90$	
For zero-sequence current read 3I0p instead of I_p and T_{3I0p} instead of T_p; for ground fault read I_{Ep} instead of I_p and T_{IEp} instead of T_p	

Dropout Setting

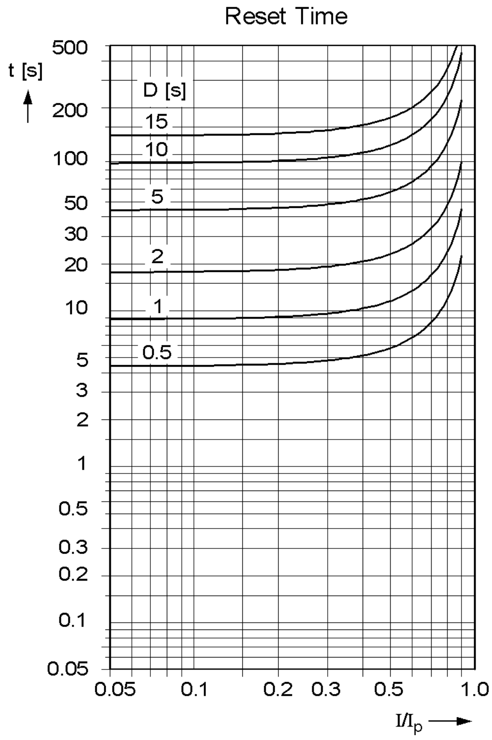
IEC without Disk Emulation	approx. 1.05 · set value I_p for $I_p/I_{Nom} \geq 0.3$; corresponds to approx. 0.95 · pickup threshold
ANSI with Disk Emulation	approx. 0.90 · set value I_p

Tolerances

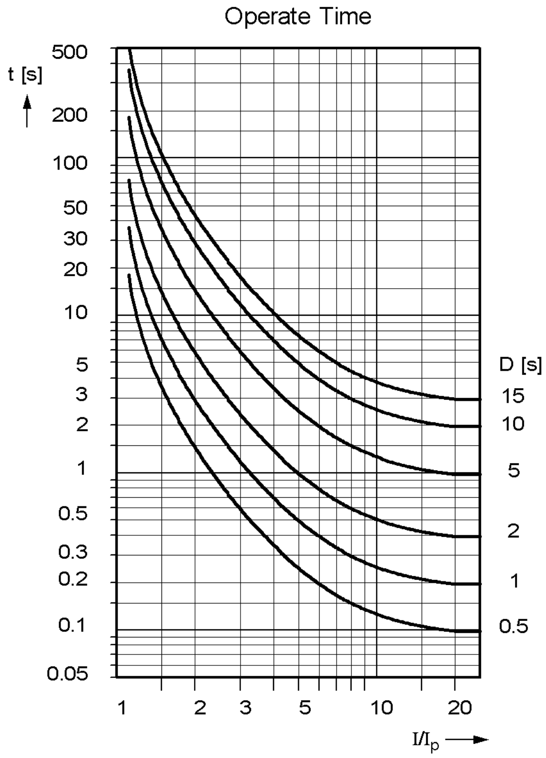
Pickup/dropout thresholds I_p, I_{Ep}	2 % of set value or 10 mA for I_{Nom} = 1 A or 50 mA for I_{Nom} = 5 A
Pickup tme for $2 \leq I/I_p \leq 20$	5 % of reference (calculated) value + 2 % current tolerance, respectively 30 ms
Dropout time for $I/Ip \leq 0.90$	5 % of reference (calculated) value + 2 %, respectively 30 ms

Influencing Variables for Pickup and Dropout

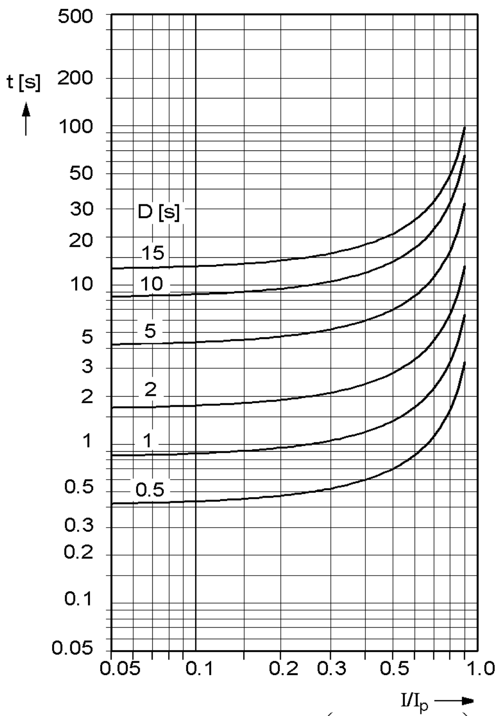
Power supply direct voltage in range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$	1 %
Temperature in range 23.00 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131.00 °F (55 °C)	0.5 %/10 K
Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$	1 %
Harmonics - up to 10 % 3rd harmonic - up to 10 % 5th harmonic	 1% 1%
Transient overreach for τ > 100 ms (with complete asymmetry)	<5 %



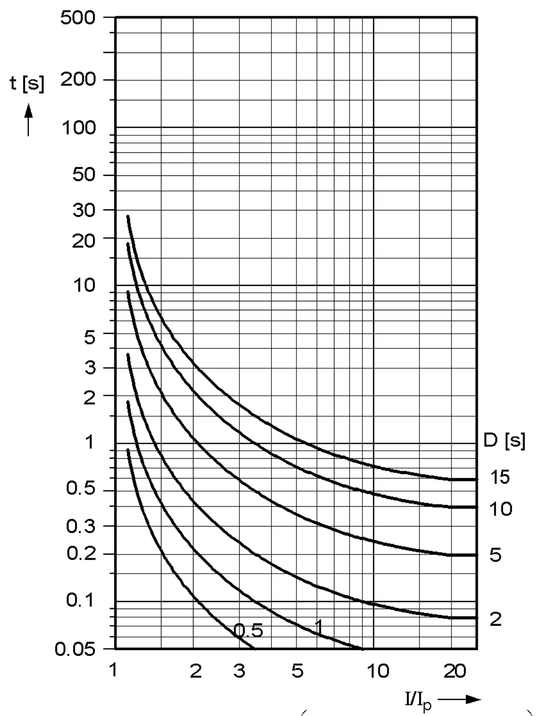
RESET INVERSE $t = \left(\dfrac{8.8}{(I/I_p)^{2.0938} - 1}\right) \cdot D$ [s]



INVERSE $t = \left(\dfrac{8.9341}{(I/I_p)^{2.0938} - 1} + 0.17966\right) \cdot D$ [s]

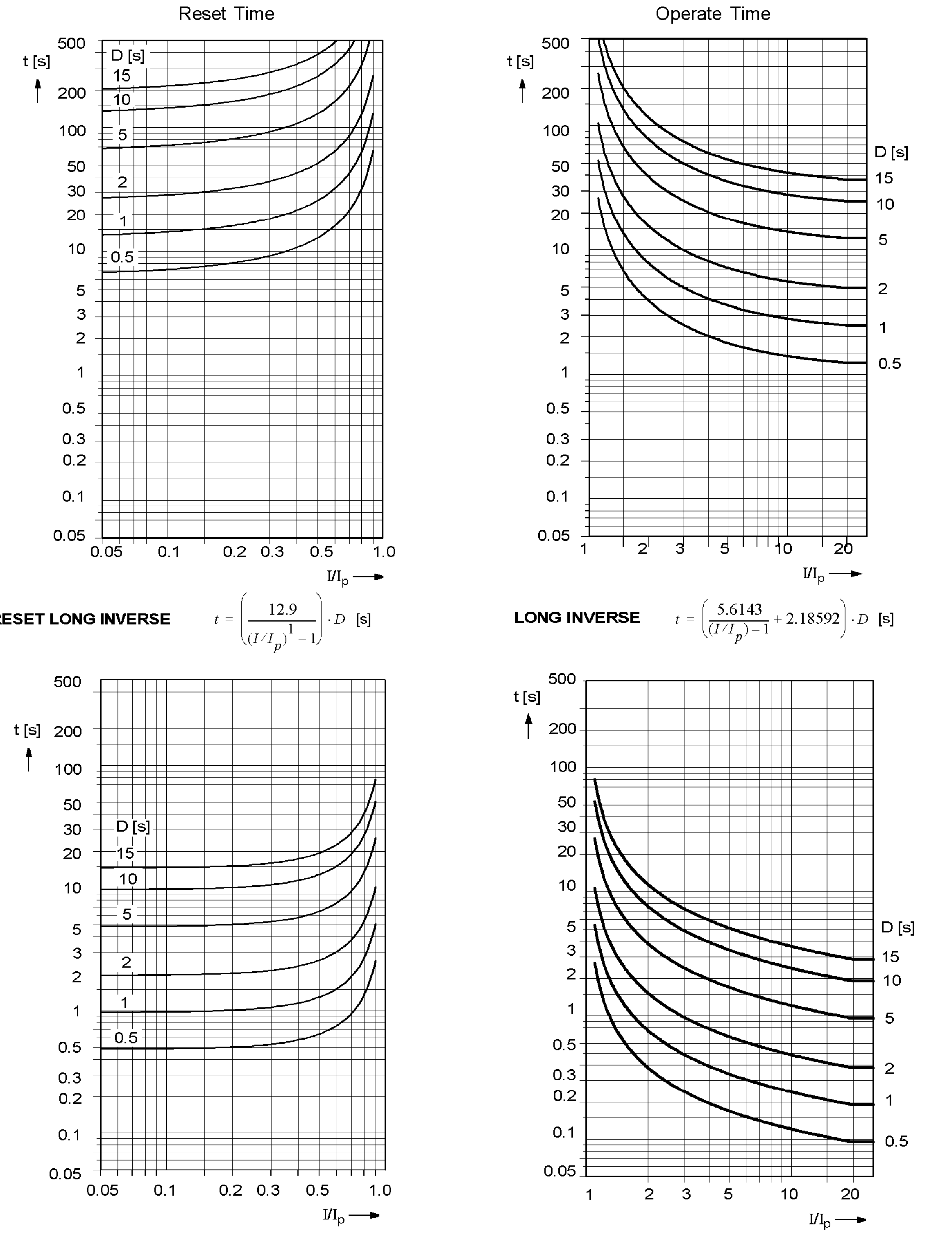


RESET SHORT INVERSE $t = \left(\dfrac{0.831}{(I/I_p)^{1.2969} - 1}\right) \cdot D$ [s]



SHORT INVERSE $t = \left(\dfrac{0.2663}{(I/I_p)^{1.2969} - 1} + 0.03393\right) \cdot D$ [s]

Figure 4-3 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to ANSI/IEEE



RESET LONG INVERSE

$$t = \left(\frac{12.9}{(I/I_p)^1 - 1}\right) \cdot D \quad [s]$$

LONG INVERSE

$$t = \left(\frac{5.6143}{(I/I_p) - 1} + 2.18592\right) \cdot D \quad [s]$$

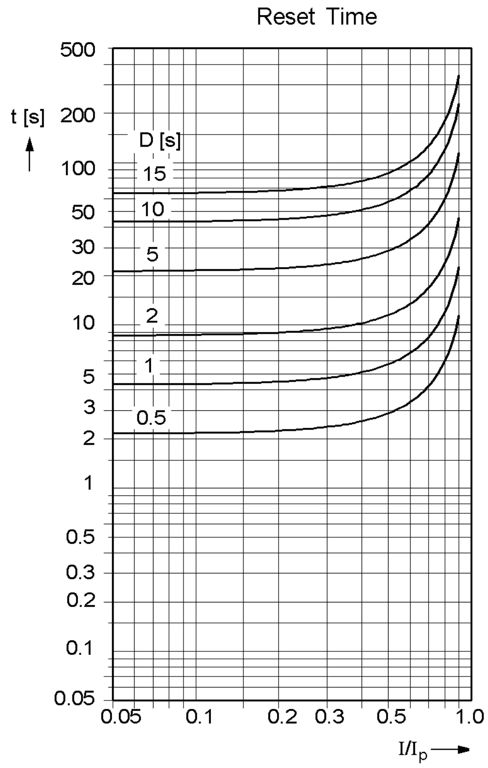
RESET MODERATELY INVERSE

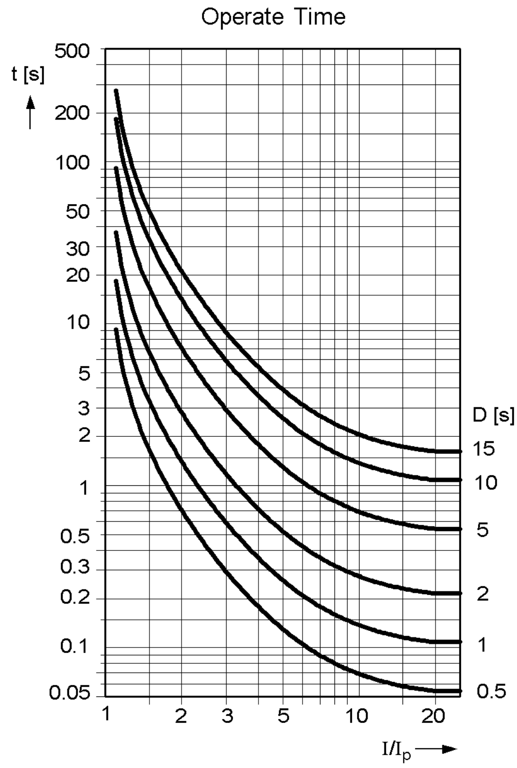
$$t = \left(\frac{0.97}{(I/I_p)^2 - 1}\right) \cdot D \quad [s]$$

MODERATELY INVERSE

$$t = \left(\frac{0.0103}{(I/I_p)^{0.02} - 1} + 0.0228\right) \cdot D \quad [s]$$

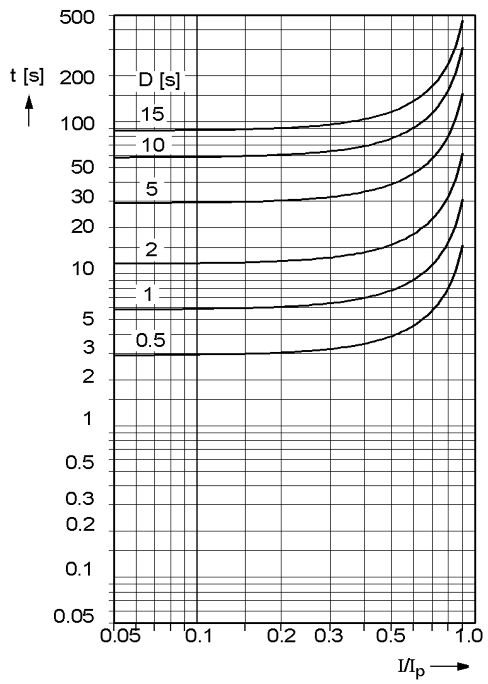
Figure 4-4 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to ANSI/IEEE

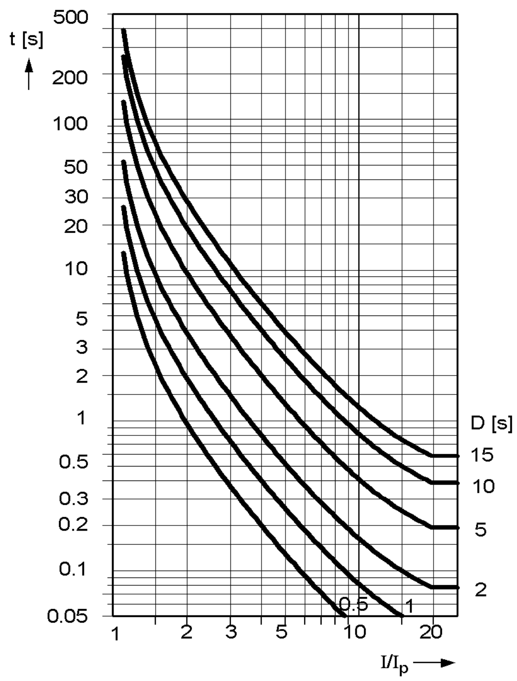




RESET VERY INVERSE $t = \left(\frac{4.32}{(I/I_p)^2 - 1}\right) \cdot D$ [s]

VERY INVERSE $t = \left(\frac{3.922}{(I/I_p)^2 - 1} + 0.0982\right) \cdot D$ [s]

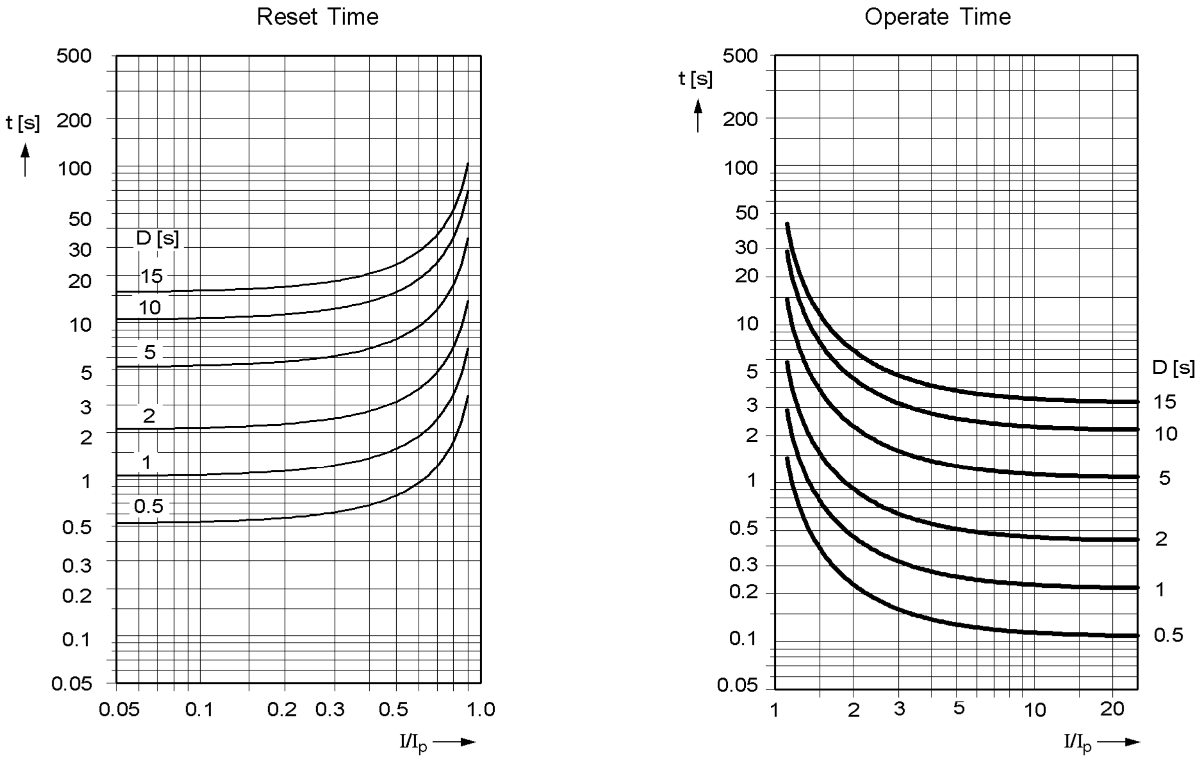




RESET EXTREMELY INVERSE $t = \left(\frac{5.82}{(I/I_p)^2 - 1}\right) \cdot D$ [s]

EXTREMELY INVERSE $t = \left(\frac{5.64}{(I/I_p)^2 - 1} + 0.02434\right) \cdot D$ [s]

Figure 4-5 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to ANSI/IEEE



RESET DEFINITE INVERSE $t = \left(\frac{1.0394}{(I/I_p)^{1.5625} - 1}\right) \cdot D$ [s]

DEFINITE INVERSE $t = \left(\frac{0.4797}{(I/I_p)^{1.5625} - 1} + 0.21359\right) \cdot D$ [s]

Figure 4-6 Dropout time and trip time curve of the inverse time overcurrent protection, acc. to ANSI/IEEE

4.4 Directional Time Overcurrent Protection 67, 67N

Time Overcurrent Elements

The same specifications and characteristics apply as for non-directional time overcurrent protection (see previous Sections).

Determination of Direction

Moreover, the following data apply for determining the fault direction:

For Phase Faults

Polarization	With cross-polarized voltages; With voltage memory (memory duration is 2 cycles) for measurement voltages that are too low
Forward Range	$V_{ref,rot} \pm 86°$
Rotation of the reference voltage $V_{ref,rot}$	–180° to +180° Increments 1°
Dropout difference	2°
Directional sensitivity	Unlimited for single and two phase faults For three phase faults, dynamically unlimited, steady-state approx. 7 V phase-to-phase.

For Ground Faults

Polarization	with zero sequence quantities $3V_0$, $3I_0$
Forward Range	$V_{ref,rot} \pm 86°$
Rotation of the reference voltage $V_{ref,rot}$	–180° to +180° Increments 1°
Dropout difference	2°
Directional Sensitivity	$V_0 \approx 2.5$ V zero voltage, measured $3V_0 \approx 5$ V zero voltage, calculated

Polarization	with negative sequence quantities $3V_2$, $3I_2$
Forward Range	$V_{ref,rot} \pm 86°$
Rotation of the reference voltage $V_{ref,rot}$	–180° to +180° Increments 1°
Dropout difference	2°
Directional Sensitivity	$3V_2 \approx 5$ V negative sequence voltage $3I_2 \approx 45$ mA negative sequence current with $I_{Nom} = 1$ A $3I_2 \approx 225$ mA negative sequence current with $I_{Nom} = 5$ A

Times

Pickup times (without inrush restraint, with restraint add 10 ms)

50-1, 50-2, 50N-1, 50N-2 – Current = 2 times pickup value – Current = 10 times pickup value	 approx. 45 ms approx. 40 ms
Dropout Times 50-1, 50-2, 50N-1, 50N-2	 approx. 40 ms

Tolerances

Angle faults for phase and ground faults	±3° electrical

Influencing Variables

Frequency Influence – With no memory voltage	 approx.1° in range $0.95 < f/f_{Nom} < 1.05$

4.5 Inrush Restraint

Controlled Elements

Time Overcurrent Elements	50-1, 50N-1, 51, 51N, 67-1, 67N-1

Setting Ranges / Increments

Stabilization factor I_{2f}/I	10 % to 45 %	Increments 1 %

Functional Limits

lower function limit phases		at least one phase current ≥ 0,25 * I_N
lower function limit ground		Earth current ≥ 0,25 * I_N
upper function limit, configurable	for I_{Nom} = 1 A	0.30 A to 25.00 A (increment 0.01 A)
	for I_{Nom} = 5 A	1.50 A to 125.00 A (increment 0.01 A)

Crossblock

Crossblock I_A, I_B, I_C	ON/OFF

4.6 Dynamic Cold Load Pickup Function

Timed Changeover of Settings

Controlled Elements	Directional and non-directional time overcurrent protection elements (segregated into phase and ground settings)
Initiation Criteria	Current Criteria „BkrClosed I MIN“
	Interrogation on the circuit breaker position
	Automatic reclosing function ready
	Binary Input
Timing	3 time levels ($T_{CB\ Open}$, T_{Active}, T_{Stop})
Current Control	Current threshold „BkrClosed I MIN“ (reset on current falling below threshold: monitoring with timer)

Setting Ranges / Increments

Current Control „BkrClosed I MIN“	for I_{Nom} = 1 A	0.04 A to 1.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.20 A to 5.00 A	
Time Until Changeover To Dynamic Settings $T_{CB\ OPEN}$		0 s to 21600 s (= 6 h)	Increments 1 s
Period Dynamic Settings are Effective After a Reclosure T_{Active}		1 s to 21600 s (= 6 h)	Increments 1 s
Fast Reset Time T_{Stop}		1 s to 600 s (= 10 min) or ∞ (fast reset inactive)	Increments 1 s
Dynamic Settings of Pickup Currents and Time Delays or Time Multipliers		Adjustable within the same ranges and with the same increments as the directional and non-directional time overcurrent protection	

4.7 Single-Phase Overcurrent Protection 50

Current Elements

High-set current elements	50-2	0.05 A to 35.00 A [1)] 0.003 A to 1.500 A [2)] or ∞ (element disabled)	Increments 0.01 A Increments 0.001 A
	T_{50-2}	0.00 s to 60.00 s or ∞ (no trip)	Increments 0.01 s
Definite-Time Current Element	50-1	0.05 A to 35.00 A [1)] 0.003 A to 1.500 A [2)] or ∞ (element disabled)	Increments 0.01 A Increments 0.001 A
	T_{50-1}	0.00 s to 60.00 s or ∞ (no trip)	Increments 0.01 s

The set times are pure delay times.
[1)] Secondary values for I_{Nom} = 1 A; with I_{Nom} = 5 A multiply currents by 5
[2)] Secondary values for „sensitive“ measuring input, independent of nominal device current

Operating Times

Pickup/Dropout Times		
Frequency Pickup Time	50 Hz	60 Hz
minimum	14 ms	13 ms
maximum	≤ 35 ms	≤ 35 ms
Dropout time approx.	25 ms	22 ms

Dropout Ratios

Current Elements	approx. 0.95 for $I/I_{Nom} \geq 0.5$

Tolerances

Currents	3 % of setting value or 1 % of nominal current at I_{Nom} = 1 A or 5 A 5 % of setting value or 3 % of nominal current at I_{Nom} = 0.1 A
Times	1 % of setting value or 10 ms

Influencing Variables for Pickup Values

Power supply direct voltage in range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$	1 %
Temperature in Range 23.00 °F (–5 °C) ≤ Θ_{amb} ≤ 131.00 °F (55 °C)	0.5 %/10 K
Frequency in range $0.95 \leq f/f_{Nom} \leq 1.05$	1 %
Harmonics - up to 10 % 3rd harmonic - up to 10 % 5th harmonic	 1 % 1 %

4.8 Voltage Protection 27, 59

Setting Ranges / Increments

Undervoltage 27-1, 27-2	Measured quantity used	
	With three-phase connection:	Positive sequence component of phase-to-phase voltages
	With three-phase connection	Smallest of the phase-to-phase voltages or positive sequence component
	with single-phase connection	Single-phase phase-ground or phase-phase voltage connected
- Connection: Phase–to–Ground Voltages	10 V to 210 V	Increments 1V
- Connection: Phase–to–Phase Voltages	10 V to 120 V	Increments 1V
- Connection: Single-phase for 27-1, 27-2	10 V to 120 V	Increments 1V
Dropout ratio r for 27-1, 27-2	1.01 to 3.00	Increments 0.01
Dropout Threshold for (r ·27-1 pickup) or (r · 27-2 pickup)	max. 120 V for phase–to–phase voltage max. 210 V for phase–to–ground voltage Minimum hysteresis 0.6 V	
Time Delays 27-Delay	0.00 s to 100.00 s or ∞ (disabled)	Increments 0.01 s
Current Criteria „Bkr Closed I MIN“ for I_{Nom} = 1 A	0.04 A to 1.00 A	Increments 0.01 A
Current Criteria „Bkr Closed I MIN“ for I_{Nom} = 5 A	0.20 A to 5.00 A	
Overvoltage 59-1, 59-2	Measured quantity used	
	With three-phase connection	Largest voltage of the three phase-to-phase voltages
	With three-phase connection	Negative sequence voltage component or largest voltage of the three phase-to-phase voltages
	with single-phase connection	Single-phase phase-ground or phase-phase voltage connected
- Connection: Phase-to-ground voltages and evaluation of the largest voltage	40 V to 260 V	Increments 1V
- Connection: Phase-to-phase voltages and evaluation of the largest voltage	40 V to 150 V	Increments 1V
- Connection: Single-phase for 59-1, 59-2	40 V to 150 V	Increments 1V
- with evaluation of the negative sequence components	2 V to 150 V	Increments 1 V
Dropout ratio r for 59-1, 59-2 [1)]	0.90 to 0.99	Increments 0.01 V
Dropout threshold for (r · 59-1 pickup) or (r · 59-2 pickup)	max. 150 V for phase–to–phase voltage max. 260 V for phase–to–ground voltage Minimum hysteresis 0.6 V	
Time delay 59-Delay	0.00 s to 100.00 s	Increments 0.01 s

[1)] $r = V_{dropout}/V_{pickup}$

Times

Pickup Times	
- Undervoltage 27-1, 27-2, 27-1 V_1, 27-2 V_1 - Overvoltage 59-1, 59-2 - Overvoltage 59-1 V_2, 59-2 V_2	Approx. 50 ms Approx. 50 ms Approx. 60 ms
Dropout Times	
- Undervoltage 27-1, 27-2, 27-1 V_1, 27-2 V_1 - Overvoltage 59-1, 59-2 - Overvoltage 59-1 V_2, 59-2 V_2	Approx. 50 ms Approx. 50 ms Approx. 60 ms

Tolerances

Pickup Voltage Limits	3 % of setting value or 1 V
Delay times T	1 % of setting value or 10 ms

Influencing Variables

Power Supply DC Voltage in Range $0.8 \leq V_H/V_{PSNom} \leq 1.15$	1 %
Temperature in Range 23.00 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131.00 °F (55 °C)	0.5 %/10 K
Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$	1 %
Frequency out of Range $f_{Nom} \pm 5$ Hz	Increased tolerances, tending to overfunction with undervoltage protection
Harmonics - Up to 10 % 3rd harmonic - Up to 10 % 5th harmonic	 1 % 1 %

4.9 Negative Sequence Protection 46-1, 46-2

Setting Ranges / Increments

Unbalanced load tripping element 46-1,46-2	for I_{Nom} = 1 A	0.10 A to 3.00 A or ∞ (disabled)	Increments 0.01 A
	for I_{Nom} = 5 A	0.50 A to 15.00 A or ∞ (disabled)	
Delay Times 46-1, 46-2		0.00 s to 60.00 s or ∞ (disabled)	Increments 0.01 s
Dropout Delay Times 46 T DROP-OUT		0.00 s to 60.00 s	Increments 0.01 s

Functional Limit

Functional Limit	for I_{Nom} = 1 A	All phase currents ≤ 4 A
	for I_{Nom} = 5 A	All phase currents ≤ 20 A

Times

Pickup Times Dropout Times	Approx. 35 ms Approx. 35 ms

Dropout Ratio

Characteristic 46-1, 46-2	Approx. 0.95 for $I_2/I_{Nom} \geq 0.3$

Tolerances

Pickup values 46-1, 46-2	3 % of set value or 10 mA for I_{Nom} = 1 A or 50 mA for I_{Nom} = 5 A
Time Delays	1 % or 10 ms

Influencing Variables for Pickup Values

Power Supply DC Voltage in Range $0{,}8 \leq V_{PS}/V_{PSNom} \leq 1.15$	1 %
Temperature in Range 23 °F (–5 °C) ≤ Θ_{amb} ≤ 131 °F (55 °C)	0.5 %/10 K
Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$	1 %
Harmonics - Up to 10 % 3rd harmonic - Up to 10 % 5th harmonic	 1 % 1 %
Transient overreach for τ > 100 ms (with complete asymmetry)	<5 %

4.10 Negative Sequence Protection 46-TOC

Setting Ranges / Increments

Pickup value 46-TOC	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	
Time Multiplier T $_{I2p}$ (IEC)		0.05 s to 3.20 s or ∞ (disabled)	Increments 0.01 s
Time Multiplier D $_{I2p}$ (ANSI)		0.50 s to 15.00 s or ∞ (disabled)	Increments 0.01 s

Functional Limit

Functional Limit	for I_{Nom} = 1 A	All phase currents ≤ 4 A
	for I_{Nom} = 5 A	All phase currents ≤ 20 A

Trip Time Curves acc. to IEC

See also Figure 4-7

NORMAL INVERSE
$$t = \frac{0.14}{(I_2/I_{2p})^{0.02} - 1} \cdot T_{I2p} \quad [s]$$

VERY INVERSE
$$t = \frac{13.5}{(I_2/I_{2p})^{1} - 1} \cdot T_{I2p} \quad [s]$$

EXTREMELY INVERSE
$$t = \frac{80}{(I_2/I_{2p})^{2} - 1} \cdot T_{I2p} \quad [s]$$

Where:

t	trip time in seconds
T_{I2p}	setting value of the time multiplier
I_2	negative sequence currents
I_{2p}	setting value of the pickup current

The trip times for $I_2/I_{2p} \geq 20$ are identical to those for $I_2/I_{2p} = 20$.

Pickup Threshold	Approx. $1.10 \cdot I_{2p}$

Trip Time Curves acc. to ANSI

It can be selected one of the represented trip time characteristic curves in the figures 4-8 and 4-9 each on the right side of the figure.	
INVERSE	$t = \left(\frac{8.9341}{(I_2/I_{2p})^{2.0938}-1} + 0.17966\right) \cdot D_{I2p}$ [s]
MODERATELY INVERSE	$t = \left(\frac{0.0103}{(I_2/I_{2p})^{0.02}-1} + 0.0228\right) \cdot D_{I2p}$ [s]
VERY INVERSE	$t = \left(\frac{3.922}{(I_2/I_{2p})^{2}-1} + 0.0982\right) \cdot D_{I2p}$ [s]
EXTREMELY INVERSE	$t = \left(\frac{5.64}{(I_2/I_{2p})^{2}-1} + 0.02434\right) \cdot D_{I2p}$ [s]
	Where: t trip time in seconds D_{I2p} setting value of the time multiplier I_2 negative sequence currents I_{2p} setting value of the pickup current
The trip times for $I_2/I_{2p} \geq 20$ are identical to those for $I_2/I_{2p} = 20$.	
Pickup Threshold	Approx. $1.10 \cdot I_{2p}$

Tolerances

Pickup Threshold I_{2p}	3 % of setting value or 10 mA for I_{Nom} = 1 A or 50 mA with I_{Nom} = 5 A
Time for $2 \leq I/I_{2p} \leq 20$	5 % of reference (calculated) value + 2 % current tolerance, respectively 30 ms

Dropout Time Curves with Disk Emulation acc. to ANSI

Representation of the possible dropout time curves, see figure 4-8 and 4-9 each on the left side of the figure	
ANSI INVERSE	$t_{Reset} = \left(\frac{8.8}{(I_2/I_{2p})^{2.0938}-1}\right) \cdot D_{I2p}$ [s]
ANSI MODERATELY INVERSE	$t_{Reset} = \left(\frac{0.97}{(I_2/I_{2p})^{2}-1}\right) \cdot D_{I2p}$ [s]
ANSI VERY INVERSE	$t_{Reset} = \left(\frac{4.32}{(I_2/I_{2p})^{2}-1}\right) \cdot D_{I2p}$ [s]
ANSI EXTREMELY INVERSE	$t_{Reset} = \left(\frac{5.82}{(I_2/I_{2p})^{2}-1}\right) \cdot D_{I2p}$ [s]
for $0.05 < (I_2/I_{2p}) \leq 0.90$	Where: t_{Reset} trip time D_{I2p} setting value of the time multiplier I_2 negative sequence currents I_{2p} setting value of the pickup current
The dropout time constants apply for the range $(I_2/I_{2p}) \leq 0.90$	

Dropout Value

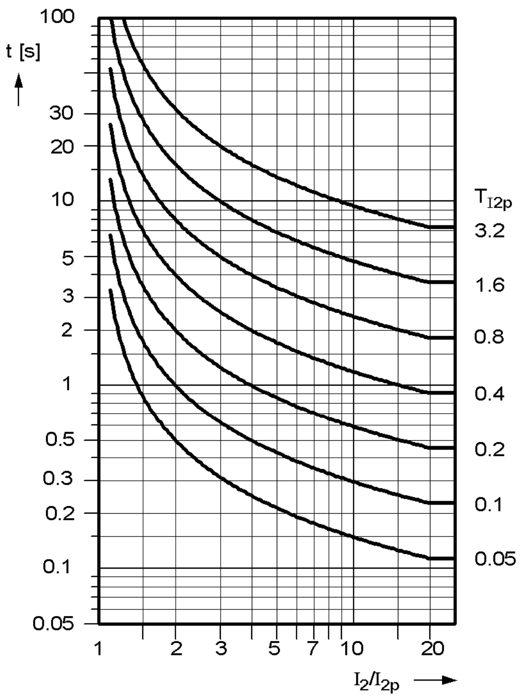
IEC and ANSI (without Disk Emulation)	Approx. $1.05 \cdot I_{2p}$ setting value, which is approx. $0.95 \cdot$ pickup threshold I_2
ANSI with Disk Emulation	Approx. $0.90 \cdot I_{2p}$ setting value

Tolerances

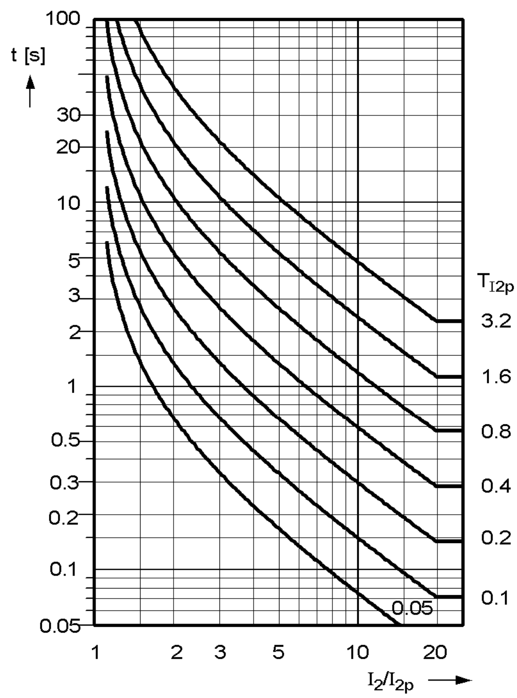
Pickup threshold I_{2p}	2 % of set value or 10 mA for I_{Nom} = 1 A or 50 mA for I_{Nom} = 5 A
Time for $I_2/I_{2p} \leq 0.90$	5 % of reference (calculated) value + 2 % current tolerance, respectively 30 ms

Influencing Variables for Pickup Values

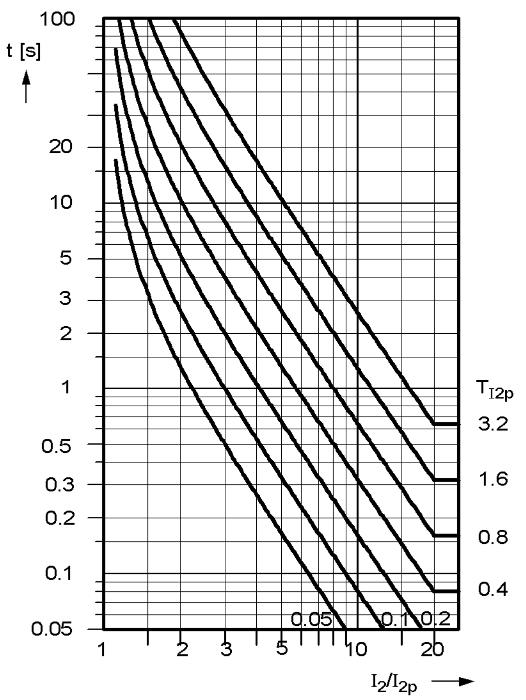
Power Supply DC Voltage in Range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$	1 %
Temperature in range 23 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131 °F (55 °C)	0.5 %/10 K
Frequency in range $0.95 \leq f/f_{Nom} \leq 1.05$	1 %
Harmonics - Up to 10 % 3rd harmonic - Up to 10 % 5th harmonic	 1 % 1 %
Transient overreach for τ > 100 ms (with complete asymmetry)	<5 %



IEC NORMAL INVERSE: $t = \frac{0.14}{(I_2/I_{2p})^{0.02} - 1} \cdot T_{I2p}$ [s]



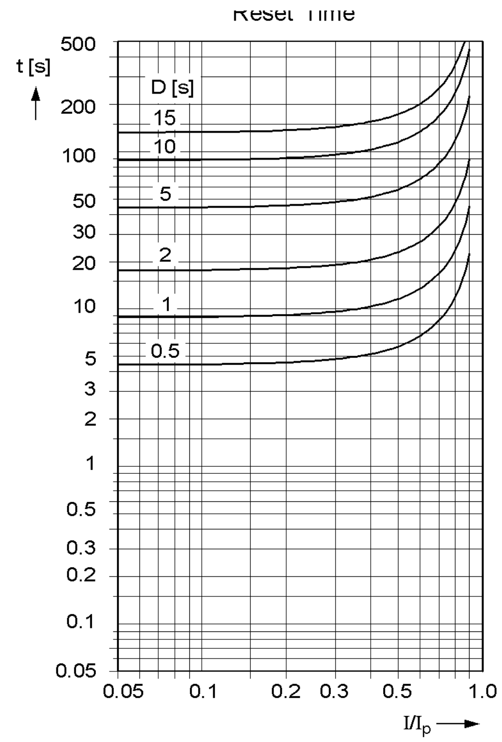
IEC VERY INVERSE: $t = \frac{13.5}{(I_2/I_{2p})^{1} - 1} \cdot T_{I2p}$ [s]

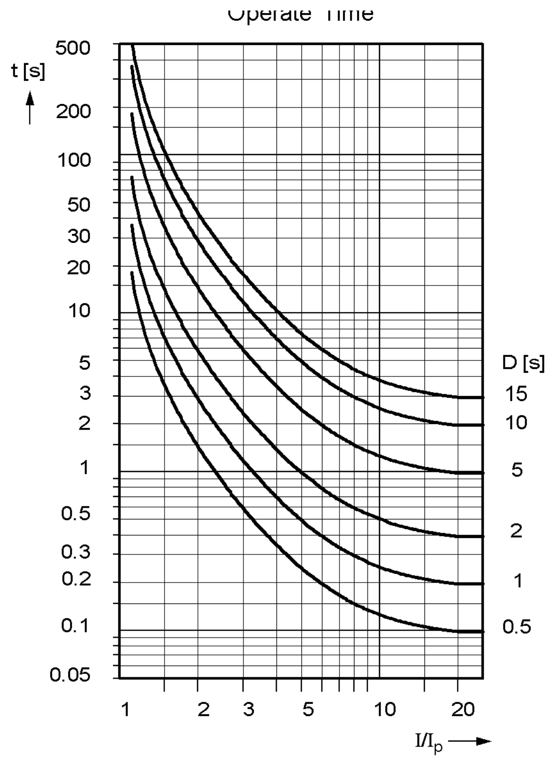


IEC EXTREMELY INVERSE: $t = \frac{80}{(I_2/I_{2p})^{2} - 1} \cdot T_{I2p}$ [s]

t = Trip time in seconds
T_{I2p} = Setting value of the time multiplier
I_2 = Negative Sequence Current
I_{2p} = Setting value of the pickup current

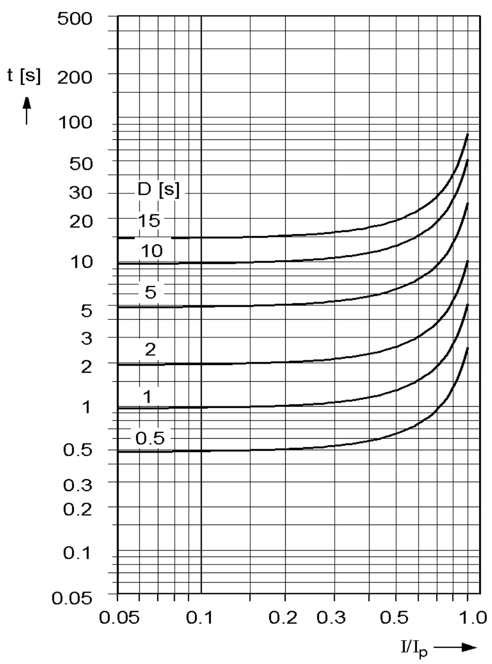
Figure 4-7 Trip time characteristics of the inverse time negative sequence element 46-TOC, acc. to IEC

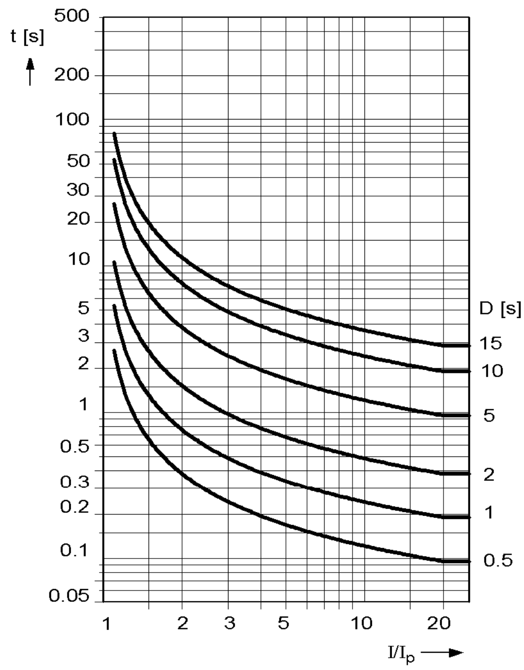




RESET INVERSE $t = \left(\frac{8.8}{(I/I_p)^{2.0938} - 1}\right) \cdot D$ [s]

INVERSE $t = \left(\frac{8.9341}{(I/I_p)^{2.0938} - 1} + 0.17966\right) \cdot D$ [s]

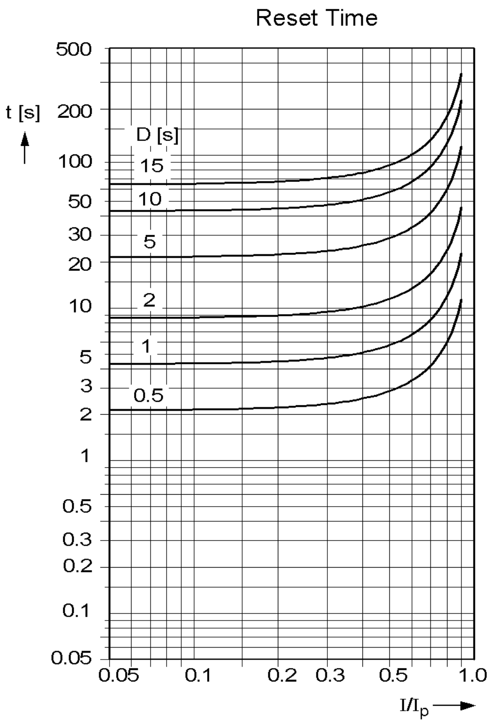


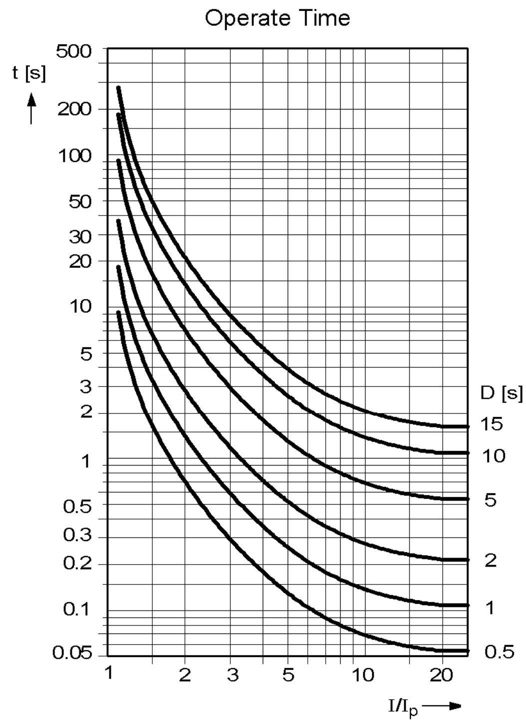


RESET MODERATELY INVERSE $t = \left(\frac{0.97}{(I/I_p)^{2} - 1}\right) \cdot D$ [s]

MODERATELY INVERSE $t = \left(\frac{0.0103}{(I/I_p)^{0.02} - 1} + 0.0228\right) \cdot D$ [s]

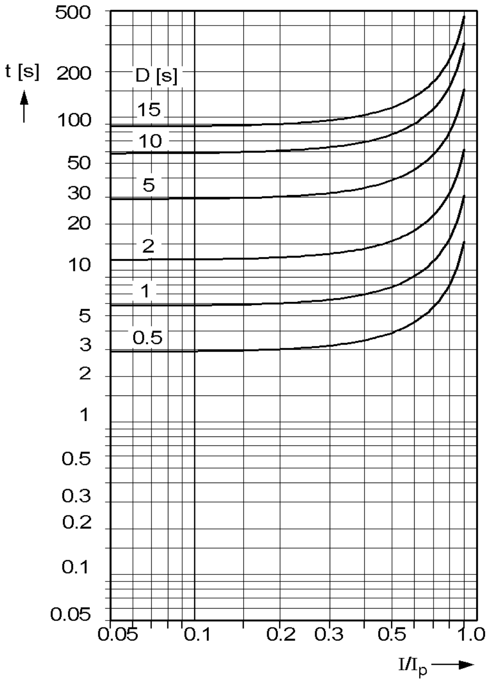
Figure 4-8 Dropout time and trip time characteristics of the inverse time unbalanced load stage, acc. to ANSI

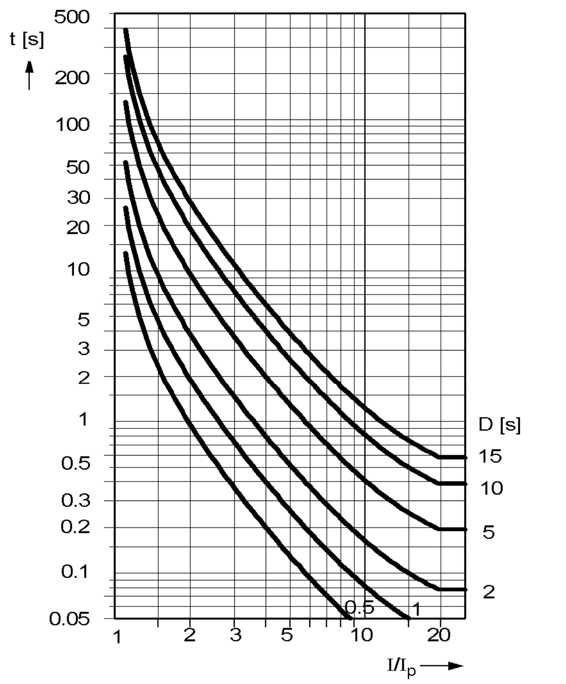




RESET VERY INVERSE $t = \left(\frac{4,32}{(I/I_p)^2 - 1}\right) \cdot D$ [s]

VERY INVERSE $t = \left(\frac{3,922}{(I/I_p)^2 - 1} + 0,0982\right) \cdot D$ [s]





RESET EXTREMELY INVERSE $t = \left(\frac{5,82}{(I/I_p)^2 - 1}\right) \cdot D$ [s]

EXTREMELY INVERSE $t = \left(\frac{5,64}{(I/I_p)^2 - 1} + 0,02434\right) \cdot D$ [s]

Figure 4-9 Dropout time and trip time characteristics of the inverse time unbalanced load stage, acc. to ANSI

4.11 Motor Starting Protection 48

Setting Ranges / Increments

Motor Starting Current $I_{STARTUP}$	for I_{Nom} = 1 A	0.50 A to 16.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	2.50 A to 80.00 A	
Pickup Threshold $I_{MOTOR\ START}$	for I_{Nom} = 1 A	0.40 A to 10.0 A	Increments 0.01 A
	for I_{Nom} = 5 A	2.00 A to 50.00 A	
Permissible Starting Time $T_{STARTUP}$		1.0 s to 180.0 s	Increments 0.1 s
Permissible Blocked Rotor Time $T_{BLOCKED\text{-}ROTOR}$		0.5 s to 120.0 s or ∞ (disabled)	Increments 0.1 s

Trip Curve

Trip Time Characteristics
for $I_{rms} > I_{MOTOR\ START}$

$$t = \left(\frac{I_{STARTUP}}{I_{rms}}\right)^2 \cdot T_{STARTUP}$$

Where:

$I_{STARTUP}$	Motor starting current setting.
I_{rms}	Actual current flowing.
$I_{MOTOR\ START}$	Pickup threshold setting, used to detect motor startup.
t	Trip time in seconds.

Dropout Ratio

Dropout ratio	Approx. 0.95

Tolerances

Pickup Threshold	2 % of set value or 10 mA for I_{Nom} = 1 A or 50 mA for I_{Nom} = 5 A
Time Delay	5 % or 30 ms

Influencing Variables

Power Supply DC Voltage in Range $0{,}8 \le V_{PS}/V_{PSNom} \le 1.15$	1 %
Temperature in range 23.00 °F (–5 °C) ≤ Θ_{amb} ≤ 131.00 °F (55 °C)	0.5 %/10 K
Frequency in Range $0.95 \le f/f_{Nom} \le 1.05$	1 %
Harmonics - Up to 10 % 3rd harmonic - Up to 10 % 5th harmonic	 1 % 1 %

4.12 Motor Restart Inhibit 66

Setting Ranges / Increments

Motor starting current relative to Nominal Motor Current $I_{START}/I_{Motor\ Nom}$		1.1 to 10.0	Increments 0.1
Nominal Motor Current $I_{Motor\ Nom}$	for I_{Nom} = 1 A	0.20 A to 1.20 A	Increments 0.01 A
	for I_{Nom} = 5A	1.00 A to 6.00 A	
Max. Permissible Starting Time $T_{Start\ Max}$		3 s to 320 s	Increments 1 s
Equilibrium Time T_{Equal}		0.0 min to 320.0 min	Increments 0.1 min
Minimum Inhibit Time $T_{MIN.\ INHIBIT\ TIME}$		0.2 min to 120.0 min	Increments 0.1 min
Maximum Permissible Number of Warm Starts n_{WARM}		1 to 4	Increments 1
Difference between Cold and Warm Starts $n_{Cold} - n_{Warm}$		1 to 2	Increments 1
Extension K-Factor for Cooling Simulations of Rotor at Rest $k_{\tau\ at\ STOP}$		0.2 to 100.0	Increments 0.1
Extension Factor for Cooling Time Constant with Motor Running $k_{\tau RUNNING}$		0.2 to 100.0	Increments 0.1

Restart Threshold

$$\Theta_{Restart} = \left(\frac{I_{Start}}{I_B \cdot k_R}\right)^2 \cdot \left(1 - e^{-\frac{(n_{cold} - 1) \cdot T_m}{\tau_R}}\right)$$

Where:	$\Theta_{Restart}$ = Temperature limit below which restarting is possible k_R = k-factor for rotor I_{Start} = Startup current I_B = Basic current $T_{start\ max}$ = Max. startup time τ_R = Thermal rotor time constant n_{cold} = Max. number of cold starts

Influencing Variables

Power Supply DC Voltage in Range $0{,}8 \le V_{PS}/V_{PSNom} \le 1.15$	1 %
Temperature in Range 23 °F (–5 °C) $\le \Theta_{amb} \le$ 131 °F (55 °C)	0.5 %/10 K
Frequency in Range fN ± 5 Hz	1 %
Frequency out of Range $f_{Nom} \pm 5$ Hz	Increased Tolerances

4.13 Frequency Protection 81 O/U

Setting Ranges / Increments

Number of Frequency Elements	4; each can be set f> or f<	
Pickup Frequency f> or f< with f_{Nom} = 50 Hz	45.50 Hz to 54.50 Hz	Increments 0.01 Hz
Pickup Frequency f> or f< with f_{Nom} = 60 Hz	55.50 Hz to 64.50 Hz	Increments 0.01 Hz
Delay times T	0.00 s to 100.00 s or ∞	Increments 0.01 s
Undervoltage Blocking with Three-phase Connection: Positive Sequence Component V_1 with Single-phase Connection: single-phase phase-ground or phase-phase voltage	10 V to 150 V	Increments 1V

Times

Pickup times f>, f<	approx. 150 ms (7SJ62/63) approx. 80 ms (7SJ64)
Dropout times f>, f<	approx. 150 ms (7SJ62/63) approx. 80 ms (7SJ64)

Dropout Frequency

Δf = I Pickup value - Dropout value I	approx. 20 mHz

Dropout Ratio

Dropout Ratio for Undervoltage Blocking	approx. 1.05

Tolerances

Pickup Frequencies 81/O or 81U Undervoltage Blocking Time Delays 81/O or 81/U	10 mHz (with $V = V_{Nom}$, $f = f_{Nom}$) 3 % of setting value or 1 V 1 % of setting value or 10 ms

Influencing Variables

Power Supply DC Voltage in Range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$	1 %
Temperature in Range 23.00 °F (–5 °C) ≤ Θ_{amb} ≤ 131.00 °F (55 °C)	0.5 %/10 K
Harmonics Up to 10 % 3rd harmonic Up to 10 % 5th harmonic	 1 % 1 %

4.14 Thermal Overload Protection 49

Setting Ranges / Increments

K-Factor per 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 excessive temperature	Increments 1 %
Current Overload 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	
Extension $k\tau$ Factor when Machine Stopped		1.0 to 10.0 relative to the time constant for the machine running	Increments 0.1
Emergency Time $T_{Emergency}$		10 s to 15000 s	Increments 1 s
Nominal Overtemperature (for I_{Nom})		40 °C to 200 °C = –13 °F to +185 °F	Increments 1 °C

Trip Characteristic

Trip Characteristic Curve
for $(I/k \cdot I_{Nom}) \le 8$

$$t = \tau \cdot \ln \frac{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - \left(\frac{I_{pre}}{k \cdot I_{Nom}}\right)^2}{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - 1} \quad \text{[min]}$$

Where:

t	Trip time in minutes
τ	Temperature rise time constant
I	Load current
I_{pre}	Preload current
k	Setting factor per VDE 0435 Part 3011 and IEC 60255–8, (see also Figure 4-10)
I_{Nom}	Nominal current of the device

Dropout Ratios

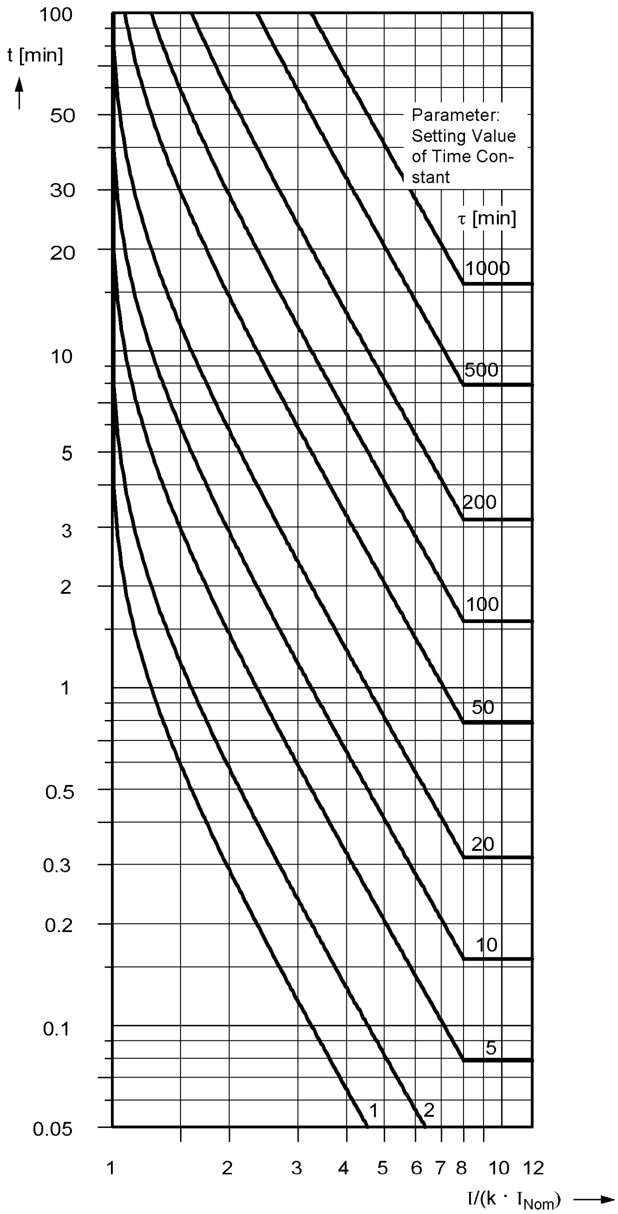
Θ/Θ_{Trip}	Drops out with Θ_{Alarm}
Θ/Θ_{Alarm}	Approx. 0.99
I/I_{Alarm}	Approx. 0.97

Tolerances

Referring to $k \cdot I_{Nom}$	2 % or 10 mA for I_{Nom} = 1 A, or 50 mA for I_{Nom} = 5 A,
Referring to Trip Time	2 % class according to IEC 60255-8 3 % or 1 s for $I/(k \cdot I_{Nom}) > 1.25$; 3 % class according to IEC 60255-8

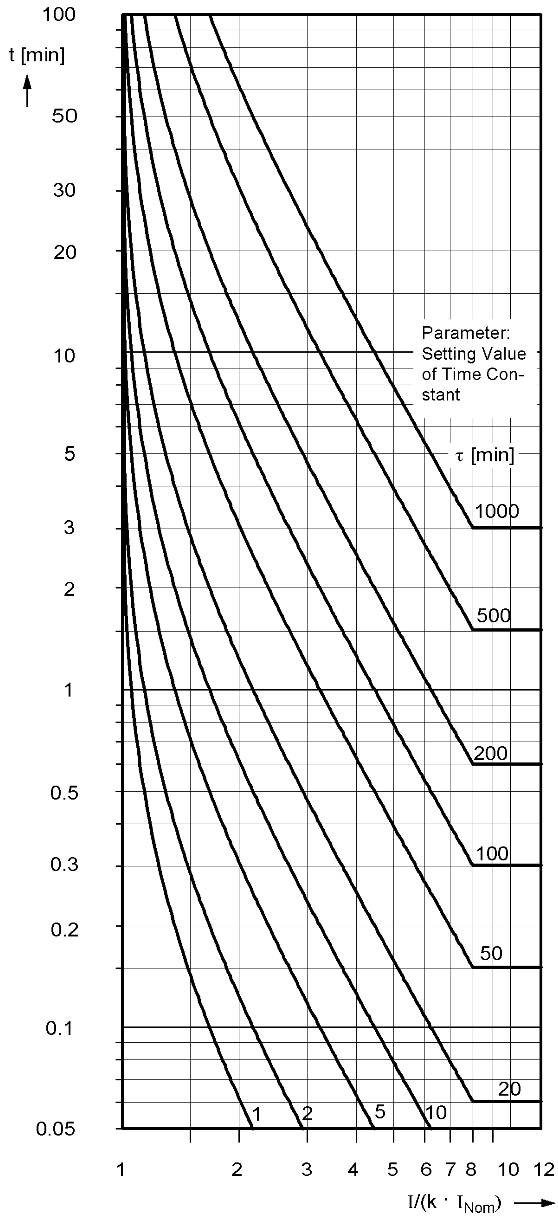
Influencing Variables Referring to k · I_{Nom}

Power Supply DC Voltage in Range $0.8 \le V_{PS}/V_{PSNom} \le 1.15$	1 %
Temperature in Range 23 °F (–5 °C) $\le \Theta_{amb} \le$ 131 °F (55 °C)	0.5 %/10 K
Frequency in Range fN ± 5 Hz	1 %
Frequency out of Range f_{Nom} ± 5 Hz	Increased Tolerances



<u>without</u> pre-load:

$$t = \tau \cdot \ln \frac{\left(\frac{I}{k \cdot I_{Nom}}\right)^2}{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - 1} \quad [\text{min}]$$



<u>with</u> 90 % pre-load:

$$t = \tau \cdot \ln \frac{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - \left(\frac{I_{pre}}{k \cdot I_{Nom}}\right)^2}{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - 1} \quad [\text{min}]$$

Figure 4-10 Trip time curves for the thermal overload protection (49)

4.15 Ground Fault Detection 64, 50Ns, 51Ns, 67Ns

Displacement Voltage Element Characteristics - For all Types of Ground Faults

Displacement Voltage, Measured	VN> 1.8 V to 170.0 V (7SJ62/63) VN> 1.8 V to 200.0 V (7SJ64)	Increments 0.1V
Displacement Voltage, Calculated	$3V_0$> 10.0 V to 225.0 V	Increments 0.1V
Pickup delay T-DELAY Pickup	0.04 s to 320.00 s or ∞	Increments 0.01 s
Additional pickup delay 64-1 DELAY	0.10 s to 40000.00 s or ∞ (disabled)	Increments 0.01 s
Operating Time	Approx. 60 ms	
Dropout Value	0.95 or (pickup value – 0.6 V)	
Measurement Tolerance V_N> (measured) 3V0> (calculated)	 3 % of setting value or 0.3 V 3 % of setting value or 3 V	
Operating Time Tolerances	1 % of setting value or 10 ms	

Phase Detection for Ground Faults on an Ungrounded System

Measuring Principle	voltage measurement (phase-to-ground)	
$V_{PHASE\ MIN}$ (Ground Fault Phase)	10 V to 100 V	Increments 1V
$V_{PHASE\ MAX}$ (Healthy Phase)	10 V to 100 V	Increments 1V
Measurement Tolerance acc. to VDE 0435, Part 303	3 % of setting value or 1 V	

Ground Fault Pickup for All Types of Ground Faults (Definite Time Characteristic)

Pickup current 50Ns-2 PICKUP for sensitive transformer for normal 1-A transformer for normal 5-A transformer	 0.001 A to 1.500 A 0.05 A to 35.00 A 0.25 A to 175.00 A	 Increments 0.001 A Increments 0.01 A Increments 0.05 A
Time Delay 50Ns-2 DELAY	0.00 s to 320.00 s or ∞ (disabled)	Increments 0.01 s
Pickup current 50Ns-1 PICKUP for sensitive transformer for normal 1-A transformer for normal 5-A transformer	 0.001 A to 1.500 A 0.05 A to 35.00 A 0.25 A to 175.00 A	 Increments 0.001 A Increments 0.01 A Increments 0.05 A
Time Delay 50Ns-1 DELAY	0.00 s to 320.00 s or ∞ (disabled)	Increments 0.01 s
Dropout Time Delay 50Ns T DROP-OUT	0.00 s to 60.00 s	Increments 0.01 s
Operating Time	≤ 60 ms (non-directional) ≤ 80 ms (directional)	
Dropout Ratio	Approx. 0.95 for 50Ns >50 mA	
Measurement Tolerance	2 % of setting value or 1 mA	
Operating Time Tolerance	1 % of setting value or 10 ms	

Ground Fault Pickup for All Types of Ground Faults (Inverse Time Characteristic)

User-defined Curve (defined by a maximum of 20 value pairs of current and time delay)		
Pickup Current 51Ns for sensitive transformer for normal 1-A transformer for normal 5-A transformer	 0.001 A to 1.400 A 0.05 A to 4.00 A 0.25 A to 20.00 A	 Increments 0.001 A Increments 0.01 A Increments 0.05 A
Time multiplier T_{51Ns}	0.10 s to 4.00 s or ∞ (disabled)	Increments 0.01 s
Pickup Threshold	Approx. $1.10 \cdot I_{51Ns}$	
Dropout ratio	Approx. $1.05 \cdot I_{51Nsp}$ for $I_{51Ns} > 50$ mA	
Measurement Tolerance	2 % of setting value or 1 mA	
Operating Time Tolerance in Linear Range	7 % of reference value for $2 \leq I/I_{51Ns} \leq 20$ + 2 % current tolerance, or 70 ms	

Ground Fault Pickup for All Types of Ground Faults (Inverse Time Characteristic Logarithmic inverse)

Pickup Current 50Ns For sensitive transformer For normal 1-A transformer For normal 5-A transformer		 0.001 A to 1.400 A 0.05 A to 4.00 A 0.25 A to 20.00 A	 Increments 0.001 A Increments 0.01 A Increments 0.05 A
Starting current factor 51Ns Startpoint		1.0 to 4.0	Increments 0.1
Time factor 51Ns TIME DIAL		0.05 s to 15.00 s; ∞	Increments 0.01 s
Maximum time 51Ns Tmax		0.00 s to 30.00 s	Increments 0.01 s
Minimum time 51Ns Tmin		0.00 s to 30.00 s	Increments 0.01 s
Characteristics		see Figure 4-11	
Tolerances Times	inv.	5 % ± 15 ms for $2 \leq I/I_{51Ns} \leq 20$ and 51Ns TIME DIAL ≥ 1 s	
	def.	1 % of setting value or 10 ms	

Ground Fault Pickup for All Types of Ground Faults (Inverse Time Characteristic Logarithmic Inverse with Knee Point)

Pickup Current 50Ns for sensitive transformer for normal 1-A transformer for normal 5-A transformer		 0.003 A to 0.500 A 0.05 A to 4.00 A 0.25 A to 20.00 A	 Increments 0.001 A Increments 0.01 A Increments 0.05 A
Minimum time 51Ns T min		0.10 s to 30.00 s	Increments 0.01 s
Current threshold 51Ns I T min for sensitive transformer for normal 1-A transformer for normal 5-A transformer		 0.003 A to 1.400 A 0.05 A to 20.00 A 0.25 A to 100.00 A	 Increments 0.001 A Increments 0.01 A Increments 0.05 A
Knee-point time 51Ns T knee		0.20 s to 100.00 s	Increments 0.01 s
Current threshold 51Ns I T knee for sensitive transformer for normal 1-A transformer for normal 5-A transformer		 0.003 A to 0.650 A 0.05 A to 17.00 A 0.25 A to 85.00 A	 Increments 0.001 A Increments 0.01 A Increments 0.05 A
Maximum time 51Ns T max		0.00 s to 30.00 s	Increments 0.01 s
Time factor 51Ns TD		0.05 s to 1.50 s	Increments 0.01 s
Characteristics		see Figure 4-12	
Tolerances Times	inv.	5 % ± 15 ms	
	def.	1 % of setting value or 10 ms	

Influencing Variables

Power Supply DC Voltage in Range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$	1 %
Temperature in Range 23.00 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131.00 °F (55 °C)	0.5 %/10 K
Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$	1 %
Harmonics - Up to 10 % 3rd harmonic - Up to 10 % 5th harmonic	 1 % 1 %
Note: When using the sensitive transformer, the linear range of the measuring input for the sensitive ground fault detection is from 0.001 A to 1.6 A. The function is however still preserved for greater currents.	

Direction Determination for All Types of Ground Faults

Direction Measurement	– I_N and V_N measured – $3 \cdot I_0$ and $3 \cdot V_0$ calculated	
Measuring Principle	Real/reactive power measurement	
Measuring release $I_{RELEASE\ DIR.}$ (current component perpendicular (90°) to direction phasor) for sensitive transformer for normal 1-A transformer for normal 5-A transformer	 0.001 A to 1.200 A 0.05 A to 30.00 A 0.25 A to 150.00 A	 Increments 0.001 A Increments 0.01 A Increments 0.05 A
Dropout ratio	approx. 0.80	
Measurement method	cos φ and sin φ	
Direction Phasor $\varphi_{Correction}$	–45.0° to +45.0°	Increments 0.1°
Dropout Delay $T_{Reset\ Delay}$	1 s to 60 s	Increments 1 s

Angle Correction

Angle correction for cable converter in two operating points F1/I1 and F2/I2:		
Angle correction F1, F2 (for resonant-grounded system)	0.0° to 5.0°	Increments 0.1°
Current value I1, I2 for the angle correction for sensitive transformer for normal 1-A transformer for normal 5-A transformer	 0.001 A to 1.600 A 0.05 A to 35.00 A 0.25 A to 175.00 A	 Increments 0.001 A Increments 0.01 A Increments 0.05 A
Measurement Tolerance	2 % of setting value or 1 mA	
Angle Tolerance	3°	
Note: Due to the high sensitivity the linear range of the measuring input I_N with integrated sensitive input transformer is from 0.001A to 1.6 A. For currents greater than 1.6 A, correct directionality can no longer be guaranteed.		

Logarithmic inverse trip time characteristic

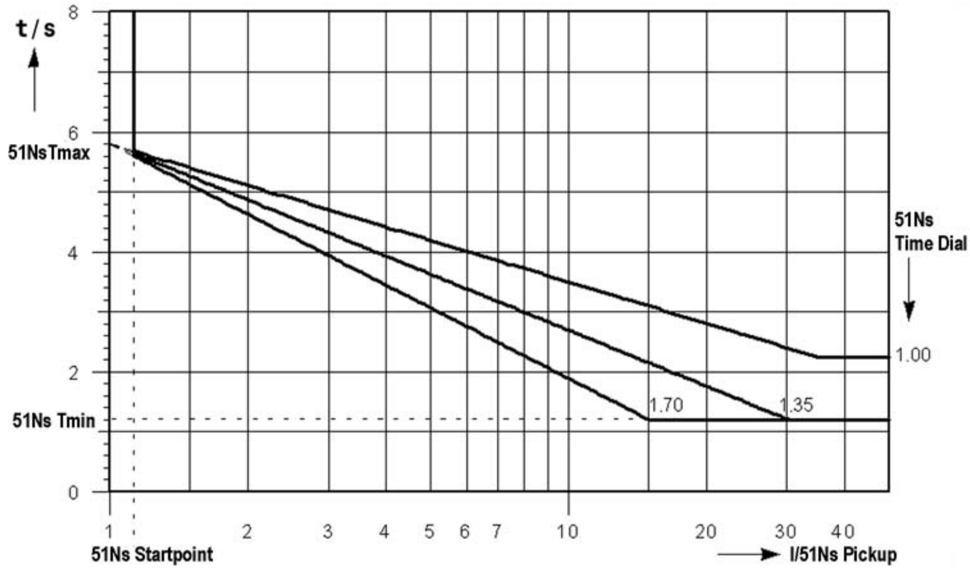


Figure 4-11 Trip time characteristics of inverse time ground fault protection with logarithmic inverse characteristic

Logarithmic inverse t = **51Ns Tmax** – **51Ns TIME DIAL** ·ln(I/**51Ns PICKUP**)

Note: For I/**51Ns PICKUP** > 35 the time applies for I/**51Ns PICKUP** = 35; for t < **51Ns Tmin** the time **51Ns Tmin** applies.

Logarithmic inverse trip time characteristic with knee point

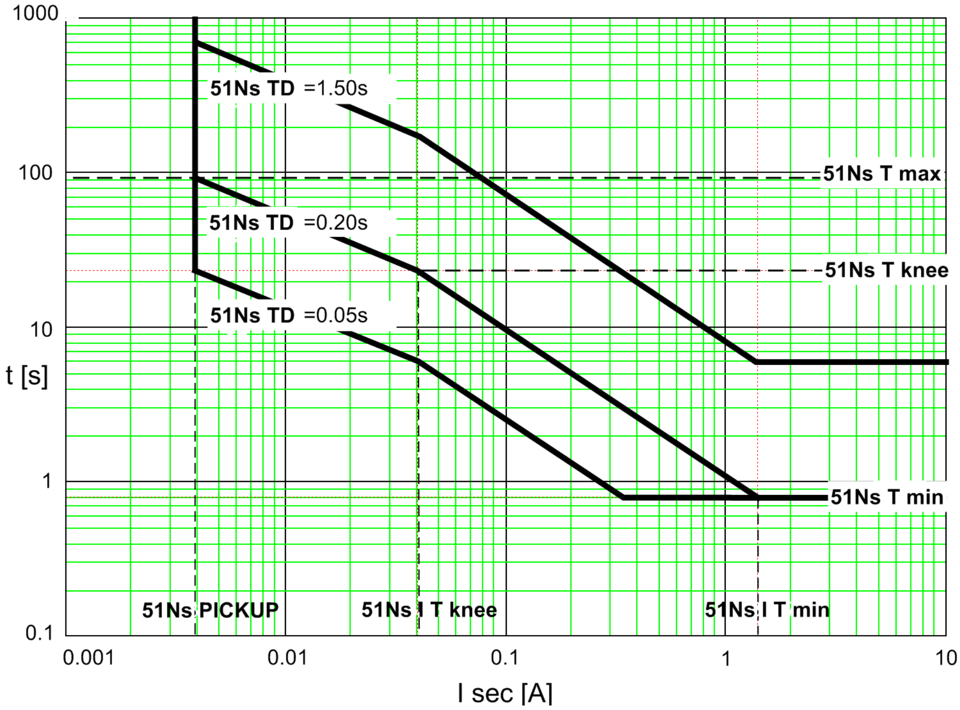


Figure 4-12 Trip-time characteristics of the inverse-time ground fault protection 51Ns with logarithmic inverse characteristic with knee point (example for 51Ns = 0.004 A)

4.16 Intermittent Ground Fault Protection

Setting Ranges / Increments

Pickup Threshold			
with IN	for I_{Nom} = 1 A	0.05 A to 35.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 175.00 A	Increments 0.01 A
with 3I0	for I_{Nom} = 1 A	0.05 A to 35.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.25 A to 175.00 A	Increments 0.01 A
with INs		0.005 A to 1.500 A	Increments 0.001 A
Pickup extension time T_v		0.00 s to 10.00 s	Increments 0.01 s
Ground Fault Accumulation Time T_{sum}		0.00 s to 100.00 s	Increments 0.01 s
Reset Time for Accumulation T_{res}		1 s to 600 s	Increments 1 s
Number of Pickups for Intermittent Ground Fault		2 to 10	Increments 1

Times

Pickup Times	
– Current = 1.25 x Pickup Value	Approx. 30 ms
– for ≥ 2 · Pickup Value	Approx. 22 ms
Dropout Time (without extension time)	Approx. 22 ms

Tolerances

Pickup threshold I	3 % of set value or 10 mA for I_{Nom} = 1 A or 50 mA for I_{Nom} = 5 A
Times T_V, T_{sum}, T_{res}	1 % of setting value or 10 ms

Influencing Variables

Power Supply DC Voltage in Range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$	<1 %
Temperature in Range 0 °C $\leq \Theta_{amb} \leq$ 40 °C	<0.5 %/ K
Frequency in range $0.98 \leq f/f_N \leq 1.02$	<5% relating to the set time

4.17 Automatic Reclosing System 79

Number of Reclosures	0 to 9 (segregated into phase and ground settings) Cycles 1 to 4 can be adjusted individually	
The following Protective Functions initiate the AR 79 (no 79 start / 79 start / 79 blocked)	50-1, 50-2, 51, 67-1, 67-2, 67-TOC, 50N-1, 50N-2, 51N, 67N-1, 67N-2, 67N-TOC, sensitive ground fault detection, unbalanced load 46-1, 46-2, 46-TOC, binary inputs	
Blocking of 79 by	Pick up of protective elements for which 79 blocking is set (see above)	
	three phase pickup (optional)	
	Binary input	
	Last trip command after the reclosing cycle is complete (unsuccessful reclosing)	
	Trip command from the breaker failure	
	Opening the circuit breaker without 79	
	External CLOSE Command	
	Breaker failure monitoring	
Dead Time T_{Dead} (separate for phase and ground and individual for shots 1 to 4)	0.01 s to 320.00 s	Increments 0.01 s
Extension of Dead Time	Using binary input with time monitoring	
Blocking Duration for Manual-CLOSE Detection $T_{Blk\ Manual\ Close}$	0.50 s to 320.00 s or ∞	Increments 0.01 s
Blocking Duration after Manual Close $T_{Blocking\ Time}$	0.50 s to 320.00 s	Increments 0.01 s
Blocking Duration after Dynamic Blocking $T_{Blk\ Dyn}$	0.01 s to 320.00 s	Increments 0.01 s
Start Signal Monitoring Time $T_{Start\ Monitor}$	0.01 s to 320.00 s or ∞	Increments 0.01 s
Circuit Breaker Monitoring Time $T_{CB\ Monitor}$	0.10 s to 320.00 s	Increments 0.01 s
Maximum Dead Time Extension $T_{Dead\ Exten}$	0.50 s to 320.00 s or ∞	Increments 0.01 s
Start delay of dead time	using binary input with time monitoring	
Max. start delay of dead time $T_{Dead\ delay}$	0.0 s to 1800.0 s or ∞	Increments 1.0 s
Operating time T_{Operat}	0.01 s to 320.00 s or ∞	Increments 0.01 s
The following protection functions can be influenced by the automatic reclosing function individually for the cycles 1 to 4 (setting value T=T/ instantaneous T=0/ blocked T=infinite):	50-1, 50-2, 51, 67-1, 67-2, 67-TOC, 50N-1, 50N-2, 51N, 67N-1, 67N-2, 67N-TOC	
Additional Functions	Lockout (Final Trip) Circuit breaker monitoring using breaker auxiliary contacts, Synchronous closing (optionally with integrated or external synchrocheck, 7SJ64 only)	

4.18 Fault Location

Units of Distance Measurement		secondary in Ω in km or miles line [1]	
Trigger		trip command, Dropout of an Element, or External command via binary input	
Reactance Setting (secondary)	for I_{Nom} = 1 A	0.0050 to 9.5000 Ω/km	Increments 0.0001
		0.0050 to 15.0000 Ω/mile	Increments 0.0001
	for I_{Nom} = 5 A	0.0010 to 1.9000 Ω/km	Increments 0.0001
		0.0010 to 3.0000 Ω/mile	Increments 0.0001
Measurement Tolerance acc. to VDE 0435, Part 303 for Sinusoidal Measurement Quantities		2.5% fault location (without intermediate infeed) $30° \leq \varphi_K \leq 90°$ and $V_K/V_{Nom} \geq 0.1$ and $I_K/I_{Nom} \geq 1.0$	

[1] Homogeneous lines are assumed when the fault distance is given in miles or km !

4.19 Circuit Breaker Failure Protection 50BF

Setting Ranges / Increments

Pickup of Element 50, „BkrClosed I MIN“	for I_{Nom} = 1 A	0.04 A to 1.00 A	Increments 0.01 A
	for I_{Nom} = 5 A	0.20 A to 5.00 A	
Time Delay TRIP-Timer		0.06 s to 60.00 s or ∞	Increments 0.01 s

Times

Pickup Times – On Internal Start – Using Controls – For external Start	 included in time delay included in time delay included in time delay
Dropout Time	Approx. 25 ms [1)]

Tolerances

Pickup of Element 50, „BkrClosed I MIN“	2 % of setting value; or 10 mA for I_{Nom} = 1 A or 50 mA for I_{Nom} = 5 A
Time Delay TRIP-Timer	1 % or 20 ms

Influencing Variables for Pickup Values

Power supply direct voltage in range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$	1 %
Temperature in Range 23 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131 °F (55 °C)	0.5 %/10 K
Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$	1 %
Harmonics - Up to 10 % 3rd harmonic - Up to 10 % 5th harmonic	 1 % 1 %

[1)] A further delay for the current may be caused by compensation in the CT secondary circuit.

4.20 Flexible Protection Functions (7SJ64 only)

Measured Quantities / Operating Modes

Three-phase	I, I_N, I_{Ns}, $3I_0$, I1, I2, V, V_N, $3V_0$, V1, V2, P, Q, cosφ
Single-phase	I, I_N, I_{Ns}, V, V_N, P, Q, cosφ
Without fixed phase reference	f, df/dt, binary input
Measuring procedure for I, V	Fundamental wave, r.m.s. value (true rms), positive sequence system, negative sequence system
Pickup on	exceeding threshold or falling below threshold value

Setting Ranges / Increments

Pickup Thresholds:			
Current I, I_1, I_2, $3I_0$, I_N	I_{Nom} = 1 A	0.05 to 35.00 A	Increments 0.01 A
	I_{Nom} = 5 A	0.25 to 175.00 A	
Sensitive ground current I_{Ns}		0.001 to 1.500 A	Increments 0.001 A
Voltage V, V_1, V_2, $3V_0$		2.0 to 260.0 V	Increments 0.1V
Displacement voltage V_N		2.0 to 200.0 V	Increments 0.1V
Power P, Q	for I_{Nom} = 1 A	0.5 to 10000 W	Increments 0.1 W
	for I_{Nom} = 5 A	2.5 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	45.5 to 54.5 Hz 55.5 to 64.5 Hz	Increments 0.1 Hz Increments 0.1 Hz
Frequency Change df/dt		0.10 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		0.03 Hz	
Dropout difference df/dt		0.1 Hz/s	
Pickup delay		0.00 to 60.00 s	Increments 0.01 s
Command delay time		0.00 to 3600.00 s	Increments 0.01 s
Dropout delay		0.00 to 60.00 s	Increments 0.01 s

Functional Limits

Power measurement 3-phase	for I_{Nom} = 1 A	With current system > 0.03 A
	for I_{Nom} = 5 A	With current system > 0.15 A
Power measurement 1-phase	for I_{Nom} = 1 A	Phase current > 0.03 A
	for I_{Nom} = 5 A	Phase current > 0.15 A

Times

Pickup times:	
Current, voltage (phase quantities) = 2 times pickup value = 10 times pickup value	 approx. 30 ms approx. 20 ms

Current, voltage (symmetrical components) = 2 times pickup value = 10 times pickup value	 approx. 40 ms approx. 30 ms
Power typical maximum (small signals and thresholds)	 approx. 120 ms approx. 350 ms
Power Factor	300 to 600 ms
Frequency	approx. 100 ms
Frequency Change for 1.25 times pickup 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	I_{Nom} = 1 A	1% of setting value or 10 mA
	I_{Nom} = 5 A	1% of setting value or 50 mA
Current (symmetrical components)	I_{Nom} = 1 A	2% of setting value or 20 mA
	I_{Nom} = 5 A	2% of setting value or 100 mA
Voltage		1% of setting value or 0.1 V
Voltage (symmetrical components)		2% of setting value or 0.2 V
Power		1% of setting value or 0.3 W (for nominal values)
Power Factor		2°
Frequency		10 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

Power supply direct voltage in range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$	1 %
Temperature in Range 23.00 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131.00 °F (55 °C)	0.5 %/10 K
Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$	1 %
Harmonics – Up to 10 % 3rd harmonic – Up to 10 % 5th harmonic	 1 % 1 %

4.21 Synchronism and Voltage Check 25 (7SJ64 only)

Operating Modes

- Synchrocheck - Asynchronous / Synchronous

Additional Release Conditions

- Live bus / dead line, - Dead bus / live line, - Dead bus and dead line - Bypassing

Voltages

Maximum operating voltage V_{max}	20 V to 140 V (phase-to-phase)	Increments 1 V
Minimum operating voltage V_{min}	20 V to 125 V (phase-to-phase)	Increments 1 V
V< for dead line / dead bus check V< V> for live line V>	1 V to 60 V (phase-to-phase) 20 V to 140 V (phase-to-phase)	Increments 1 V Increments 1 V
Primary transformer rated voltage V2N	0.10 kV to 800.00 kV	Increments 0.01 kV
Tolerances	2 % of pickup value or 2 V	
Dropout Ratios	approx. 0.9 (V>) or 1.1 (V<)	

Permissible Difference

Voltages differences V2>V1; V2<V1 Tolerance	0.5 V to 50.0 V (phase-to-phase) 1 V	Increments 0.1 V
Frequency Difference f2>f1; f2<f1 Tolerance	0.01 Hz to 2.00 Hz 15 mHz	Increments 0.01 Hz
Angle Difference $\alpha2 > \alpha1$; $\alpha2 < \alpha1$	2° to 80°	Increments 1°
Tolerance	2°	
Max. angle error	5° for $\Delta f \leq 1$ Hz 10° for $\Delta f > 1$ Hz	

Circuit breaker

Circuit breaker operating time	0.01 s to 0.60 s	Increments 0.01 s

Threshold ASYN / SYN

Frequency Difference $F_{Synchronous}$	0.01 Hz to 0.04 Hz	Increments 0.01 Hz

Matching

Vector group matching via angle	0° to 360°	Increments 1°
Different voltage transformer V1/V2	0.50 to 2.00	Increments 0.01

Times

Minimum Measuring Time	Approx. 80 ms	
Maximum Duration $T_{SYN\ DURATION}$	0.01 s to 1200.00 s or ∞	Increments 0.01 s
Monitoring Time $T_{SUP\ VOLTAGE}$	0.00 s to 60.00 s	Increments 0.01 s
Closing time of CB $T_{CB\ close}$	0.00 s to 60.00 s	Increments 0.01 s
Tolerance of All Timers	1 % of setting value or 10 ms	

Measured Values of the Synchronism and Voltage Check

Reference voltage V1 - Range - Tolerance [1)]	in kV primary, in V secondary or in % of V_{Nom} 10 % to 120 % of V_{Nom} ≤ 1 % of measured value, or 0.5 % of V_{Nom}
Voltage to be synchronized V2 - Range - Tolerance [1)]	in kV primary, in V secondary or in % of V_{Nom} 10 % to 120 % of V_{Nom} ≤ 1 % of measured value, or 0.5 % of V_{Nom}
Frequency of voltage V1 - Range - Tolerance [1)]	f1 in Hz f_{Nom} ± 5 Hz 20 mHz
Frequency of voltage V2 - Range - Tolerance [1)]	f2 in Hz f_{Nom} ± 5 Hz 20 mHz
Voltage differences V2-V1 - Range - Tolerance [1)]	in kV primary, in V secondary or in % of V_{Nom} 10 % to 120 % of V_{Nom} ≤ 1 % of measured value, or 0.5 % of V_{Nom}
Frequency difference f2-f1 - Range - Tolerance [1)]	in mHz f_{Nom} ± 5 Hz 20 mHz
Angle difference λ2-λ1 - Range - Tolerance [1)]	in ° 0 to 180° 0.5°

[1)] at nominal frequency

4.22 RTD Boxes for Temperature Detection

Temperature Detectors

Connectable RTD-boxes	1 or 2
Number of temperature detectors per RTD-box	Max. 6
Measuring method	Pt 100 Ω or Ni 100 Ω or Ni 120 Ω selectable 2 or 3 phase connection
Mounting identification	„Oil“ or „Ambient“ or „Stator“ or „Bearing“ or „Other“

Operational Measured Values

Number of measuring points		Maximal of 12 temperature measuring points
	Temperature Unit	°C or °F, adjustable
	Measuring Range – for Pt 100 – for Ni 100 – for Ni 120	 –199 °C to 800 °C (–326 °F to 1472 °F) –54 °C to 278 °C (–65 °F to 532 °F) –52 °C to 263 °C (–62 °F to 505 °F)
	Resolution	1 °C or 1 °F
	Tolerance	± 0.5 % of measured value ± 1 digit

Thresholds for Indications

For each measuring point		
Stage 1	–58°F to 482°F –58 °F to 482 °F or ∞ (no indication)	(in increments of 1° F) (in increments of 1°C)
Stage 2	–58°F to 482°F or – 50 °C to 250 °C –58°F to 482 °F or –50 °C to 250 °C or ∞ (no indication)	(in increments of 1°F) (in increments of 1°C)

4.23 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 clock	X	X	X	X
AND	AND - Gate	X	X	X	X
FLASH	Blink block	X	X	X	X
BOOL_TO_CO	Boolean to Control (conversion)	—	X	X	—
BOOL_TO_DL	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	Command cancelled	X	X	X	X
CMD_CHAIN	Switching Sequence	—	X	X	—
CMD_INF	Command Information	—	—	—	X
COMPARE	Metered value comparison	X	X	X	X
CONNECT	Connection	—	X	X	X
COUNTER	Counter	X	X	X	X
D_FF	D- Flipflop	—	X	X	X
D_FF_MEMO	Status Memory for Restart	X	X	X	X
DI_TO_BOOL	Double Point to Boolean (conversion)	—	X	X	X
DINT_TO_REAL	Adapter	X	X	X	X
DIV	Division	X	X	X	X
DM_DECODE	Decode Double Point	X	X	X	X
DYN_OR	Dynamic OR	X	X	X	X
INT_TO_REAL	Conversion	X	X	X	X
LIVE_ZERO	Live-zero, non-linear Curve	X	—	—	—
LONG_TIMER	Timer (max.1193h)	X	X	X	X
LOOP	Feedback Loop	X	X	—	X
LOWER_SETPOINT	Lower Limit	X	—	—	—
MUL	Multiplication	X	X	X	X
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	Adapter	X	X	X	X
REAL_TO_INT	Conversion	X	X	X	X

Function Module	Explanation	Task Level			
		MW_ BEARB	PLC1_ BEARB	PLC_ BEARB	SFS_ BEARB
RISE_DETECT	Rise detector	X	X	X	X
RS_FF	RS- Flipflop	—	X	X	X
SQUARE_ROOT	Root Extractor	X	X	X	X
SR_FF	SR- Flipflop	—	X	X	X
SUB	Substraction	X	X	X	X
TIMER	Timer	—	X	X	—
TIMER_SHORT	Simple timer	—	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 (record in device fault log, 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 reset-resistant flipflops D_FF_MEMO	350	When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.

Device-specific Limits

Description	Limit	Comments
Maximum number of synchronous changes of chart inputs per task level	50	When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.
Maximum number of chart outputs per task level	150	

Additional Limits

Additional limits [1] for the following 4 CFC blocks:			
Task Level	**Maximum Number of Modules in the Task Levels**		
	TIMER[2) 3)]	TIMER_SHORT[2) 3)]	CMD_CHAIN
MW_BEARB	—	—	—
PLC1_BEARB	15	30	20
PLC_BEARB			
SFS_BEARB	—	—	—

1) When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.

2) The following condition applies for the maximum number of timers: (2 · number of TIMER + number of TIMER_SHORT) < 30. TIMER and TIMER_SHORT hence share the available timer resources within the frame of this inequation. The limit does not apply to the LONG_TIMER.

3) The time values for the blocks TIMER and TIMER_SHORT must not be selected shorter than the time resolution of the device, 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]		
	7SJ62	**7SJ63**	**7SJ64**
MW_BEARB (Measured Value Processing)	2536	2536	10000
PLC1_BEARB (Slow PLC Processing)	255	300	2000
PLC_BEARB (Fast PLC Processing)	130	130	400
SFS_BEARB (Interlocking)	2173	2173	10000

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
Arithmetic	ABS_VALUE	5
	ADD	26
	SUB	26
	MUL	26
	DIV	54
	SQUARE_ROOT	83

Individual Element		Number of TICKS
Basic logic	AND	5
	CONNECT	4
	DYN_OR	6
	NAND	5
	NEG	4
	NOR	5
	OR	5
	RISE_DETECT	4
	X_OR	5
Information status	SI_GET_STATUS	5
	CV_GET_STATUS	5
	DI_GET_STATUS	5
	MV_GET_STATUS	5
	SI_SET_STATUS	5
	MV_SET_STATUS	5
	ST_AND	5
	ST_OR	5
	ST_NOT	5
Memory	D_FF	5
	D_FF_MEMO	6
	RS_FF	4
	RS_FF_MEMO	4
	SR_FF	4
	SR_FF_MEMO	4
Control commands	BOOL_TO_CO	5
	BOOL_TO_IC	5
	CMD_INF	4
	CMD_CHAIN	34
	CMD_CANCEL	3
	LOOP	8
Type converter	BOOL_TO_DI	5
	BUILD_DI	5
	DI_TO_BOOL	5
	DM_DECODE	8
	DINT_TO_REAL	5
	UINT_TO_REAL	5
	REAL_TO_DINT	10
	REAL_TO_UINT	10
Comparison	COMPARE	12
	LOWER_SETPOINT	5
	UPPER_SETPOINT	5
	LIVE_ZERO	5
	ZERO_POINT	5
Metered value	COUNTER	6

Individual Element		Number of TICKS
Time and clock pulse	TIMER	5
	TIMER_LONG	5
	TIMER_SHORT	8
	ALARM	21
	FLASH	11

Configurable in Matrix

In addition to the defined preassignments, indications and measured values can be freely configured to buffers, preconfigurations can be removed.

CFC-Debugging

For the device 7SJ64 a CFC-Debugging is possible via a Browser connection. For more detailed information refer to the SIPROTEC System Description.

4.24 Additional Functions

Operational Measured Values

Currents I_A; I_B; I_C Positive sequence component I_1 Negative sequence component I_2 I_N or 3I0	in A (kA) primary and in A secondary or in % I_{Nom}
Range Tolerance [1]	10 % to 200 % I_{Nom} 1 % of measured value, or 0.5 % I_{Nom}
Phase-to-ground voltages V_{A-N}, V_{B-N}, V_{C-N} Phase-to-phase voltages V_{A-B}, V_{B-C}, V_{C-A}, V_{SYN} V_N or V_0 Positive Sequence Component V_1 Negative Sequence Component V_2	in kV primary, in V secondary or in % of V_{Nom}
Range Tolerance [1]	10 % to 120 % of V_{Nom} 1 % of measured value, or 0.5 % of V_{Nom}
S, apparent power	in kVAr (MVAr or GVAr) primary and in % of S_{Nom}
Range Tolerance [1]	0 % to 120 % S_{Nom} 1 % of S_{Nom} for V/V_{Nom} and I/I_{Nom} = 50 to 120 %
P, active power	with sign, total and phase-segregated in kW (MW or GW) primary and in % S_{Nom}
Range Tolerance [1] for 7SJ62/63 for 7SJ64	0 % to 120 % S_{Nom} 2 % of S_{Nom} for V/V_{Nom} and I/I_{Nom} = 50 to 120 % and $\lvert \cos \varphi \rvert$ = 0.707 to 1 with $S_{Nom} = \sqrt{3} \cdot V_{Nom} \cdot I_{Nom}$ 1% of S_{Nom} For V/V_N and I/I_N = 50 to 120 % With $S_{Nom} = \sqrt{3} \cdot V_{Nom} \cdot I_{Nom}$
Q, reactive power	with sign, total and phase-segregated in kVAr (MVAr or GVAr) primary and in % S_{Nom}
Range Tolerance [1] for 7SJ62/63 for 7SJ64	0 % to 120 % S_{Nom} 2 % of S_{Nom} for V/V_{Nom} and I/I_{Nom} = 50 to 120 % and $\lvert \sin \varphi \rvert$ = 0.707 to 1 with $S_{Nom} = \sqrt{3} \cdot V_{Nom} \cdot I_{Nom}$ 1 % of S_{Nom} For V/V_N and I/I_N = 50 to 120 % With $S_{Nom} = \sqrt{3} \cdot V_{Nom} \cdot I_{Nom}$
cos φ, power factor[2]	total and phase-segregated
Range Tolerance [1] for 7SJ62/63 for 7SJ64	–1 to +1 3 % for $\lvert \cos \varphi \rvert \geq 0.707$ 2 % for $\lvert \cos \varphi \rvert \geq 0.707$
Frequency f	in Hz
Range Tolerance [1]	$f_{Nom} \pm 5$ Hz 20 mHz

Temperature Overload Protection Θ/Θ_{Trip}		in %.
	Range Tolerance [1]	0 % to 400 % 5% class accuracy per IEC 60255-8
Temperature Restart Inhibit $\Theta_L/\Theta_{L\ Trip}$		in %.
	Range Tolerance [1]	0 % to 400 % 5% class accuracy per IEC 60255-8
Restart Threshold $\Theta_{Restart}/\Theta_{L\ Trip}$		in %.
Reclose Time $T_{Reclose}$		in min
Currents of Sensitive Ground Fault Detection (total, real, and reactive current) I_{Ns}, $I_{Ns\ real}$; $I_{NS\ reactive}$		in A (kA) primary and in mA secondary
	Range Tolerance [1]	0 mA to 1600 mA 2 % of measured value or 1 mA
Measuring transducer (7SJ63 only)		
	Operating Range Accuracy Range Tolerance [1]	0 mA to 24 mA 1 mA to 20 mA 1.5%, relative to nominal value of 20 mA
	For Standard Usage of the Measurement Transducer for Pressure and Temperature Monitoring:	
	Operating Measured Value Pressure	Pressure in hPa
	Operating Range (Presetting)	0 hPa to 1200 hPa
	Operating Measured Value Temperature	Temp in °F / °C
	Operating Range (Presetting)	32 °F to 464 °F or 0 °C to 240 °C
	Operating Range (Presetting)	32 °F to 464 °F or 0 °C to 240 °C
RTD-Box		See Section (RTD-Boxes for Temperature Detection)
Synchronization Function and Voltage Check (25)		see Section (Synchronization Function and Voltage Check)

[1] At nominal frequency

[2] Display of cos φ in case I/I_{Nom} and V/V_{Nom} greater than 10%

Long-term Averages

Time Window		5, 15, 30 or 60 minutes
Frequency of Updates		adjustable
Long-Term Averages		
	of Currents of Real Power of Reactive Power of Apparent Power	I_{Admd}; I_{Bdmd}; I_{Cdmd}; I_{1dmd} in A (kA) P_{dmd} in W (kW, MW) Q_{dmd} in VAr (kVAr, MVAr) S_{dmd} in VAr (kVAr, MVAr)

Min / Max Report

Storage of Measured Values	with date and time
Reset automatic	Time of day adjustable (in minutes, 0 to 1439 min) Time frame and starting time adjustable (in days, 1 to 365 days, and ∞)
Manual Reset	Using binary input Using keypad Via communication
Min/Max Values for Current	I_A; I_B; I_C; I_1 (positive sequence component)
Min/Max Values for Voltages	V_{A-N}; V_{B-N}; V_{C-N}; V_1 (Positive Sequence Component); V_{A-B}; V_{B-C}; V_{C-A}
Min/Max Values for Power	S, P; Q, cos φ; frequency
Min/Max Values for Overload Protection	Θ/Θ_{Trip}
Min/Max Values for Mean Values	I_{Admd}; I_{Bdmd}; I_{Cdmd}; I_1 (positive sequence component); S_{dmd}; P_{dmd}; Q_{dmd}

Fuse Failure Monitor

Setting range of displacement voltage 3V0 above which voltage failure is detected	10 - 100 V
Setting range of ground current above which voltage failure is assumed	0.1 - 1 A
Operation of the fuse failure monitor	Depending on the settings and the MLFB, the FFM operates with the measured or the calculated values V_N and I_N.

Local Measured Values Monitoring

Current Asymmetry	I_{max}/I_{min} > balance factor, for $I > I_{balance\ limit}$
Voltage Asymmetry	V_{max}/V_{min} > balance factor, for $V > V_{lim}$
Current Sum	$\mid i_A + i_B + i_C + k_I \cdot i_N \mid$ > limit value, with 1 % $k_I = \frac{\text{Ignd-CT PRIM} / \text{Ignd-CT SEC}}{\text{CT PRIMARY} / \text{CT SECONDARY}}$
Current Phase Sequence	Clockwise (ABC) / counter-clockwise (ACB)
Voltage Phase Sequence	Clockwise (ABC) / counter-clockwise (ACB)
Limit Value Monitoring	I_A > limit value I_{Admd}> I_B > limit value I_{Bdmd}> I_C > limit value I_{Cdmd}> I_1 > limit value I_{1dmd}> I_L< limit value I_L< cos φ < lower limit value |cos φ |< P > limit value of real power |P_{dmd} | > Q > limit value of reactive power | Q_{dmd} | > S > limit value of apparent power S_{dmd} > Pressure < lower limit value Press< Temperature > limit value Temp>

Fault Recording

Recording of indications of the last 8 power system faults
Recording of indications of the last 3 power system ground faults

Time Stamping

Resolution for Event Log (Operational Annunciations)	1 ms
Resolution for Trip Log (Fault Annunciations)	1 ms
Maximum Time Deviation (Internal Clock)	0.01 %
Battery	Lithium battery 3 V/1 Ah, type CR 1/2 AA Message „Battery Fault“ for insufficient battery charge

Fault Recording

Maximum 8 fault records saved, Memory maintained by buffer battery in case of loss of power supply	
Recording Time - 7SJ62/63 - 7SJ64	 Total 5 s Total 20 s Pre-event and post-event recording and memory time adjustable
Sampling Rate for 50 Hz Sampling Rate for 60 Hz	1 sample/1.25 ms (16 sam/cyc) 1 sample/1.04 ms (16 sam/cyc)

Energy

Meter Values for Energy Wp, Wq (real and reactive energy)	in kWh (MWh or GWh) and in kVARh (MVARh or GVARh)
Range	28 bit or 0 to 2 68 435 455 decimal for IEC 60870-5-103 (VDEW protocol) 31 bit or 0 to 2 147 483 647 decimal for other protocols (other than VDEW)
Tolerance [1)]	$\leq$ 5% for $I > 0.5\ I_{Nom}$, $V > 0.5\ V_{Nom}$ and $\mid \cos \varphi \mid \geq 0.707$

1) At nominal frequency

Statistics

Saved Number of Trips	Up to 9 digits
Number of Automatic Reclosing Commands (segregated according to 1st and ≥ 2nd cycle)	Up to 9 digits
Accumulated Interrupted Current (segregated according to pole)	Up to 4 digits

Operating Hours Counter

Display Range	Up to 7 digits
Criterion	Overshoot of an adjustable current threshold (element 50-1, BkrClosed I MIN)

Circuit-Breaker Maintenance

Calculation methods	with rms values: ΣI, ΣI^x, 2P; with instantaneous values: I^2t (only 7SJ64)
Acquisition/conditioning of measured values	phase-selective
Evaluation	one threshold per subfunction
Number of saved statistic values	up to 13 digits

Trip Circuit Monitoring

With one or two binary inputs.

Commissioning Aids

Phase Rotation Field Check Operational Measured Values Circuit Breaker / Switching Device Test Creation of a Test Measurement Report

Clock

Time Synchronization		DCF 77/IRIG B-Signal (telegram format IRIG-B000) Binary Input Communication
Operating Modes for Time Tracking		
No.	Operating Mode	Explanations
1	Internal	Internal synchronization using RTC (presetting)
2	IEC 60870-5-103	External synchronization using system interface (IEC 60870-5-103)
3	PROFIBUS FMS	External synchronization using PROFIBUS interface
4	Time signal IRIG B	External synchronization using IRIG B
5	Time signal DCF77	External synchronization using DCF 77
6	Time signal Sync. Box	External synchronization via the time signal SIMEAS-Synch.Box
7	Pulse via binary input	External synchronization with pulse via binary input
8	Field bus (DNP, Modbus)	External synchronization using field bus
9	NTP (IEC 61850)	External synchronization using system interface (IEC 61850)

Setting Group Switchover of the Function Parameters

Number of Available Setting Groups	4 (parameter group A, B, C and D)
Switchover Performed	Using the keypad DIGSI using the front PC port with protocol via system (SCADA) interface Binary Input

IEC 61850 GOOSE (inter-relay communication)

7SJ62/63: The communication service GOOSE of IEC 61850 is qualified for switchgear interlocking. Since the transmission time of GOOSE messages in the 7SJ62/63 V4.6 relays depends on both the number of IEC 61850 clients and the relay's pickup condition, GOOSE is not generally qualified for protection-relevant applications. The protective application must be checked with regard to the required operating times and coordinated with the manufacturer.
7SJ64: The communication service GOOSE of IEC 61850 is qualified for switchgear interlocking. The transmission time of GOOSE messages in the 7SJ64 relay that has picked up depends on the number of the connected IEC 61850 clients. For relay version V4.6, applications with protective functions must be checked as to their required operating time. The requirements must be coordinated with the manufacturer in each case to ensure a safe application.

4.25 Breaker Control

Number of Controlled Switching Devices	Depends on the number of binary inputs and outputs available
Interlocking	Freely programmable interlocking
Messages	Feedback messages; closed, open, intermediate position
Control Commands	Single command / double command
Switching Command to Circuit Breaker	1-, $1^1/_2$ - and 2-pole
Programmable Logic Controller	PLC logic, graphic input tool
Local Control	Control via menu control assignment of function keys
Remote Control	Using Communication Interfaces Using a substation automation and control system (e.g. SICAM) Using DIGSI (e.g. via Modem)

4.26 Dimensions

4.26.1 Panel Flush and Cubicle Mounting (Housing Size $^1/_3$)

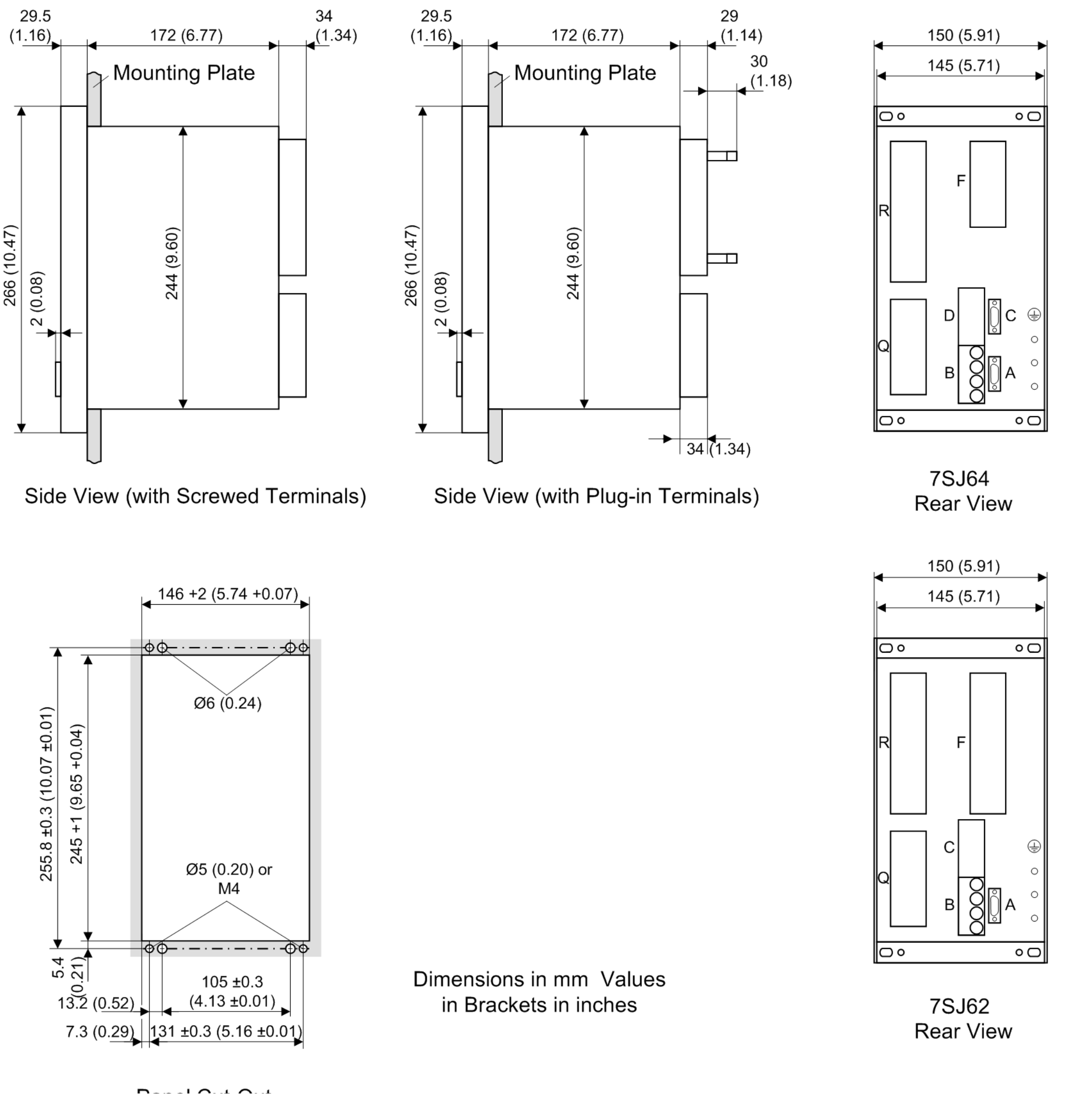


Figure 4-13 Dimensional drawing of a 7SJ62 or 7SJ64 for panel flush and cubicle mounting (housing size $^1/_3$)

4.26.2 Panel Flush and Cubicle Mounting (Housing Size $^1/_2$)

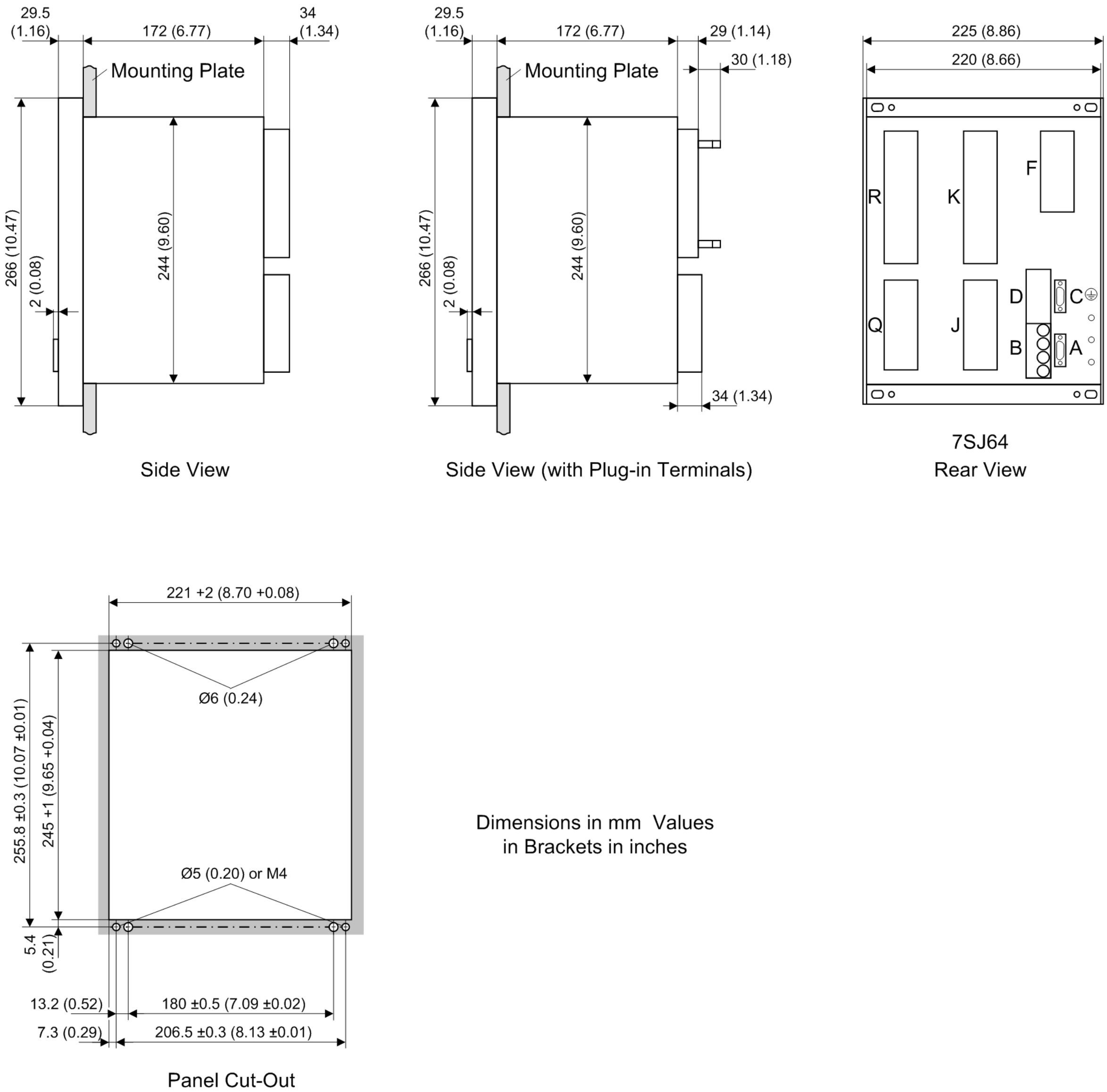


Figure 4-14 Dimensional drawing of a 7SJ63 or 7SJ64 for panel flush and cubicle mounting (housing size $^1/_2$)

4.26.3 Panel Flush and Cubicle Mounting (Housing Size $^{1}/_{1}$)

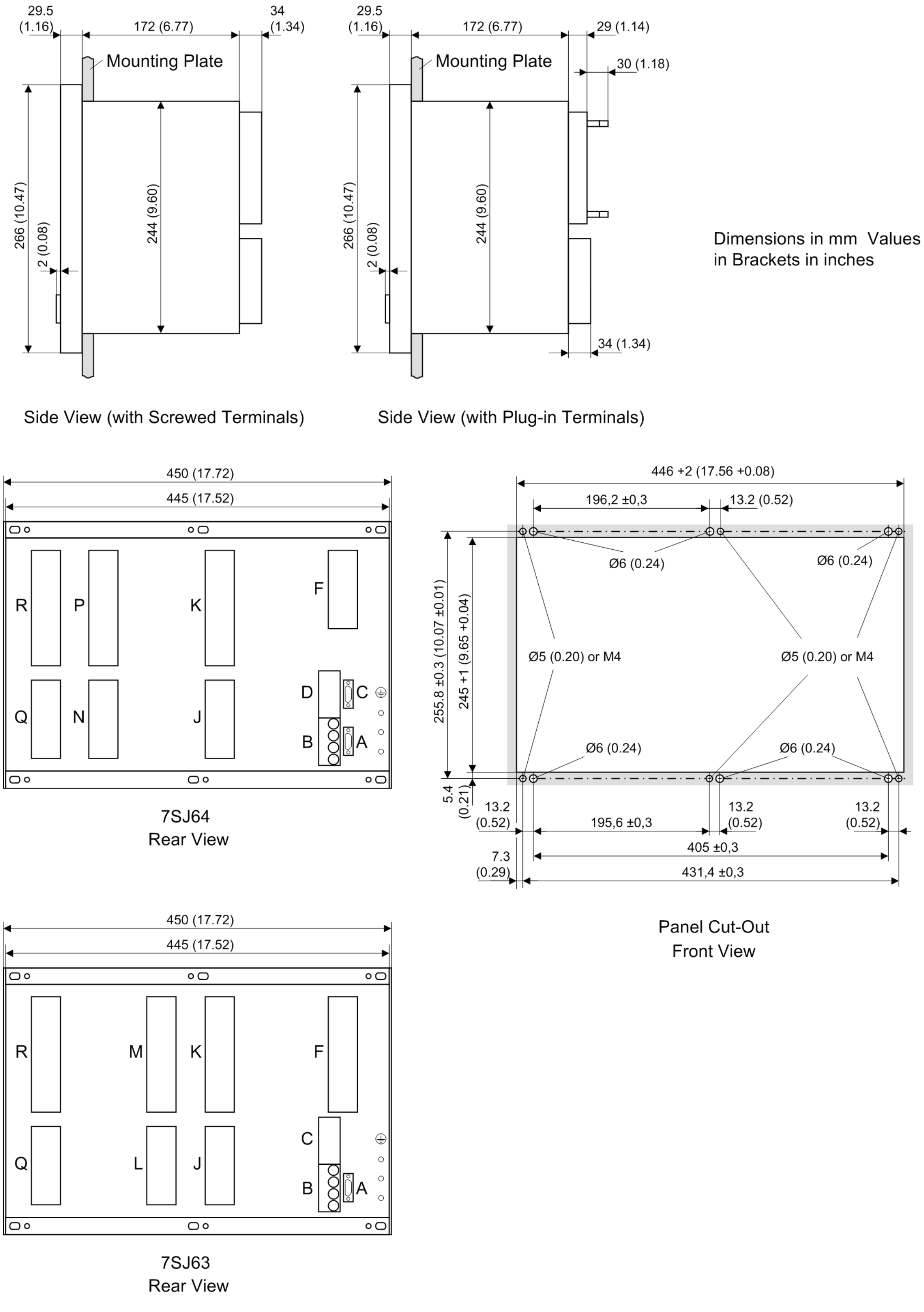


Figure 4-15 Dimensional drawing of a 7SJ63 or 7SJ64 for panel flush and cubicle mounting (housing size $^{1}/_{1}$)

4.26.4 Panel Surface Mounting (Housing Size $^1/_3$)

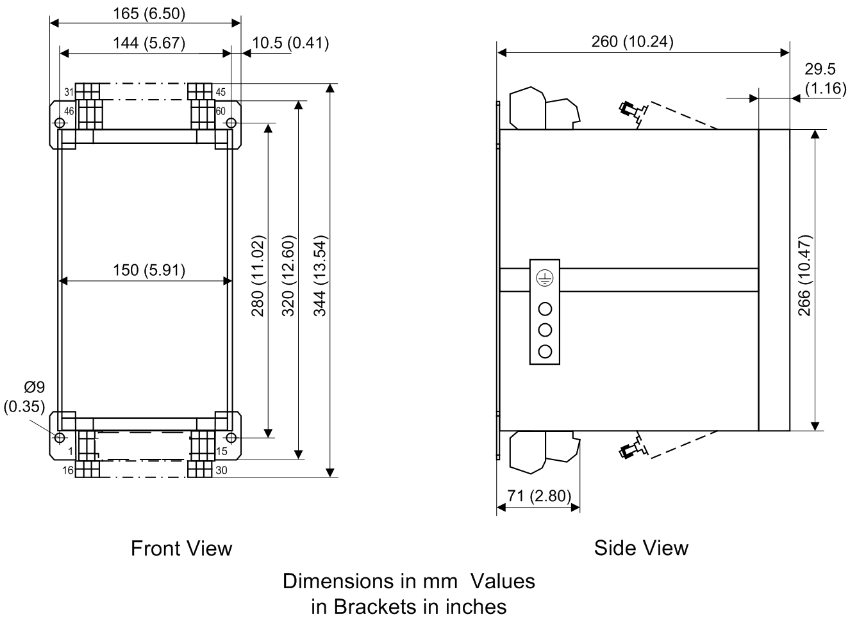


Figure 4-16 Dimensional drawing of a 7SJ62 or 7SJ64 for panel flush mounting (housing size $^1/_3$)

4.26.5 Panel Surface Mounting (Housing Size $^1/_2$)

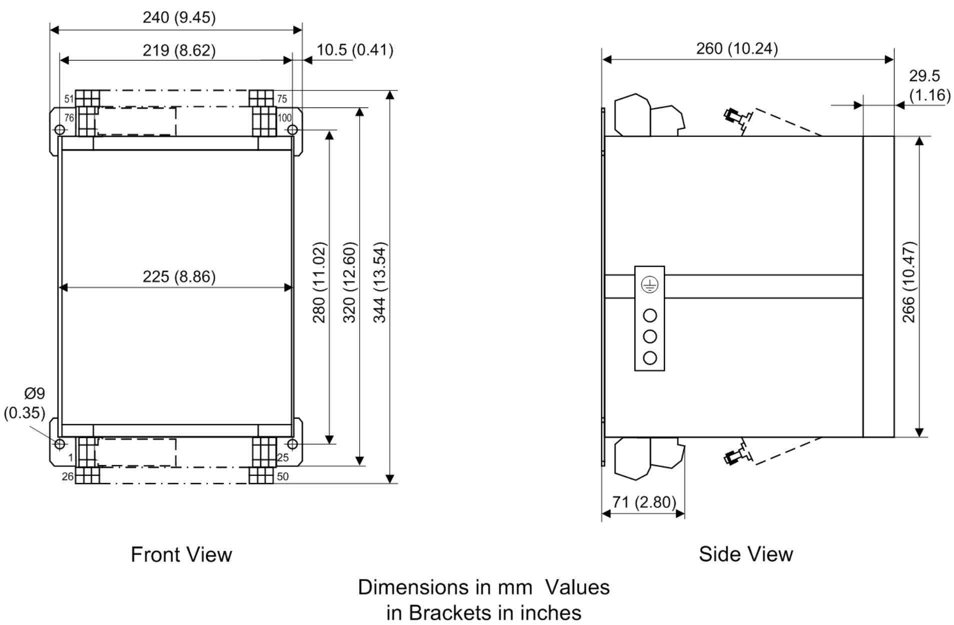


Figure 4-17 Dimensional drawing of a 7SJ63 or 7SJ64 for panel flush mounting (housing size $^1/_2$)

4.26.6 Panel Surface Mounting (Housing Size $^1/_1$)

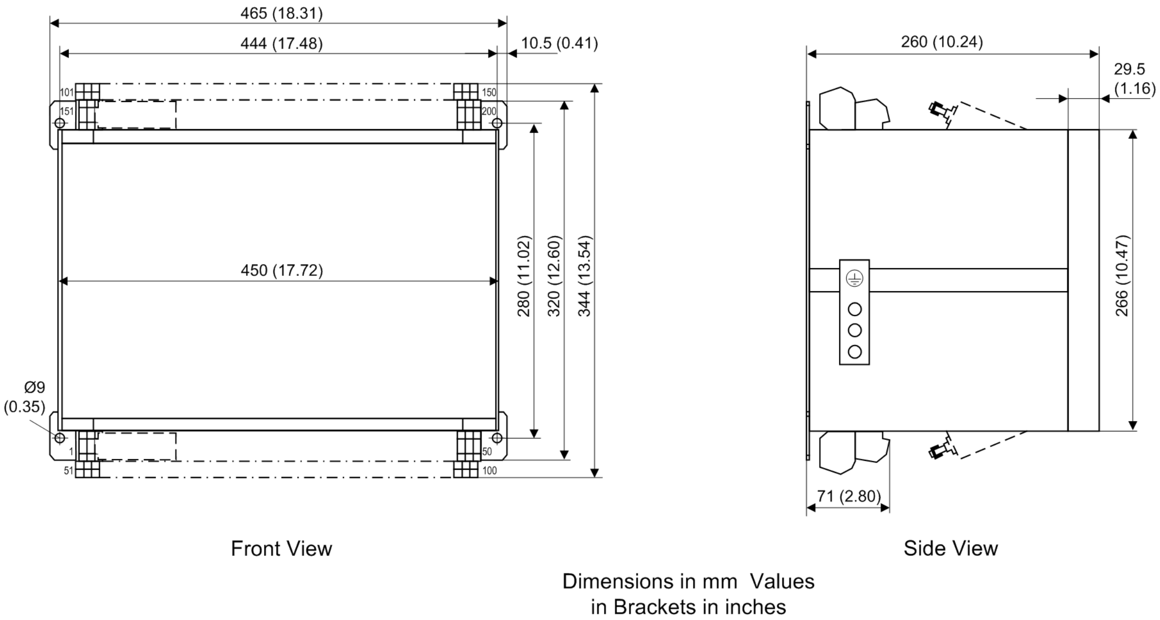


Figure 4-18 Dimensional drawing of a 7SJ63 or 7SJ64 for panel flush mounting (housing size $^1/_1$)

4.26.7 Surface-mounted Housing with Detached Operator Panel or without Operator Panel (Housing Size $^1/_2$)

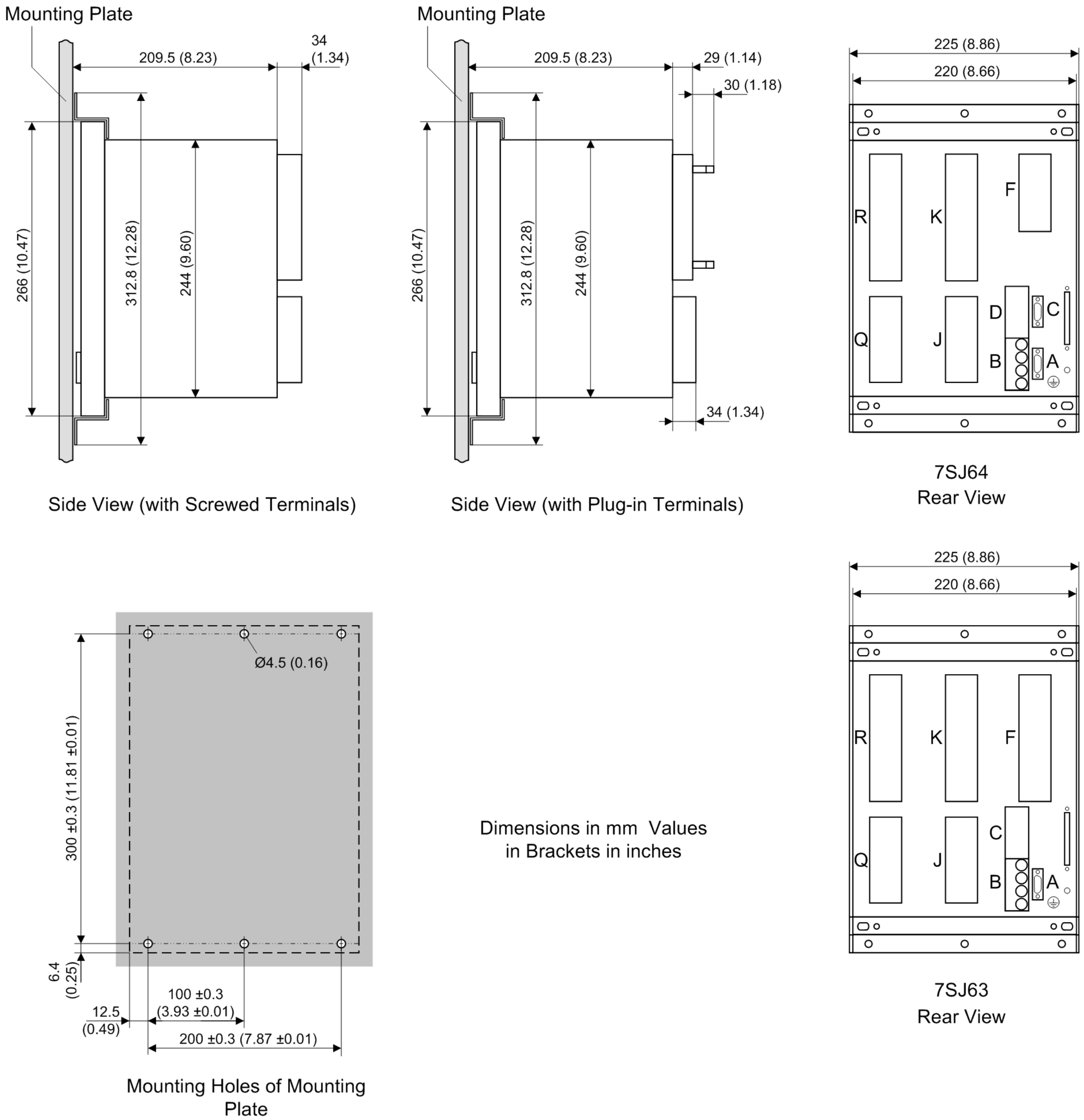


Figure 4-19 Dimensional drawing of a 7SJ63 or 7SJ64 (housing size $^1/_2$)) for mounting with detached operator panel or without operator panel

4.26.8 Housing for Mounting with Detached Operator Panel or without Operator Panel (Housing Size $^{1}/_{1}$)

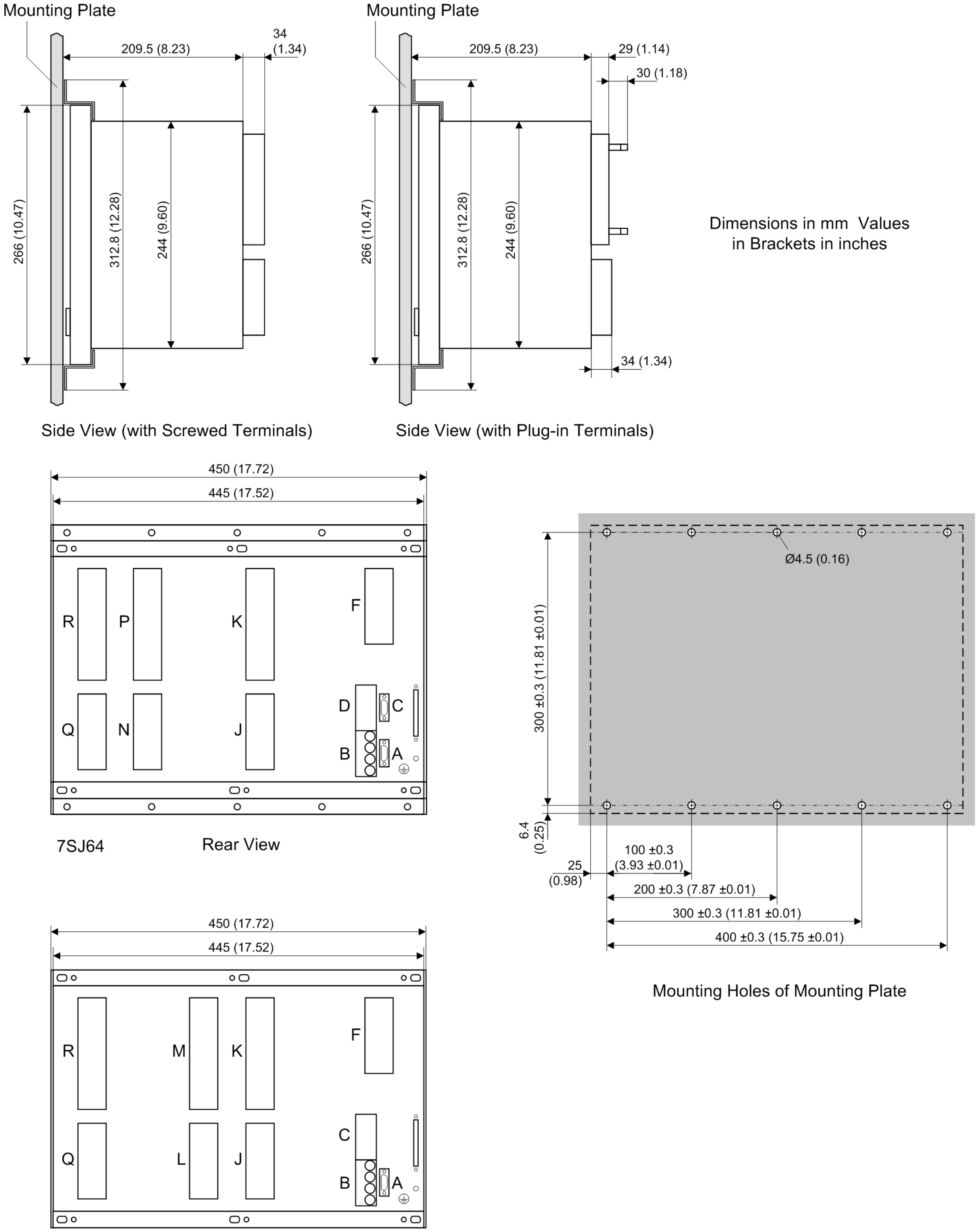


Figure 4-20 Dimensions 7SJ63 or 7SJ64 for mounting with detached operator panel or without operator panel (housing size $^{1}/_{1}$)

4.26.9 Detached Operator Panel

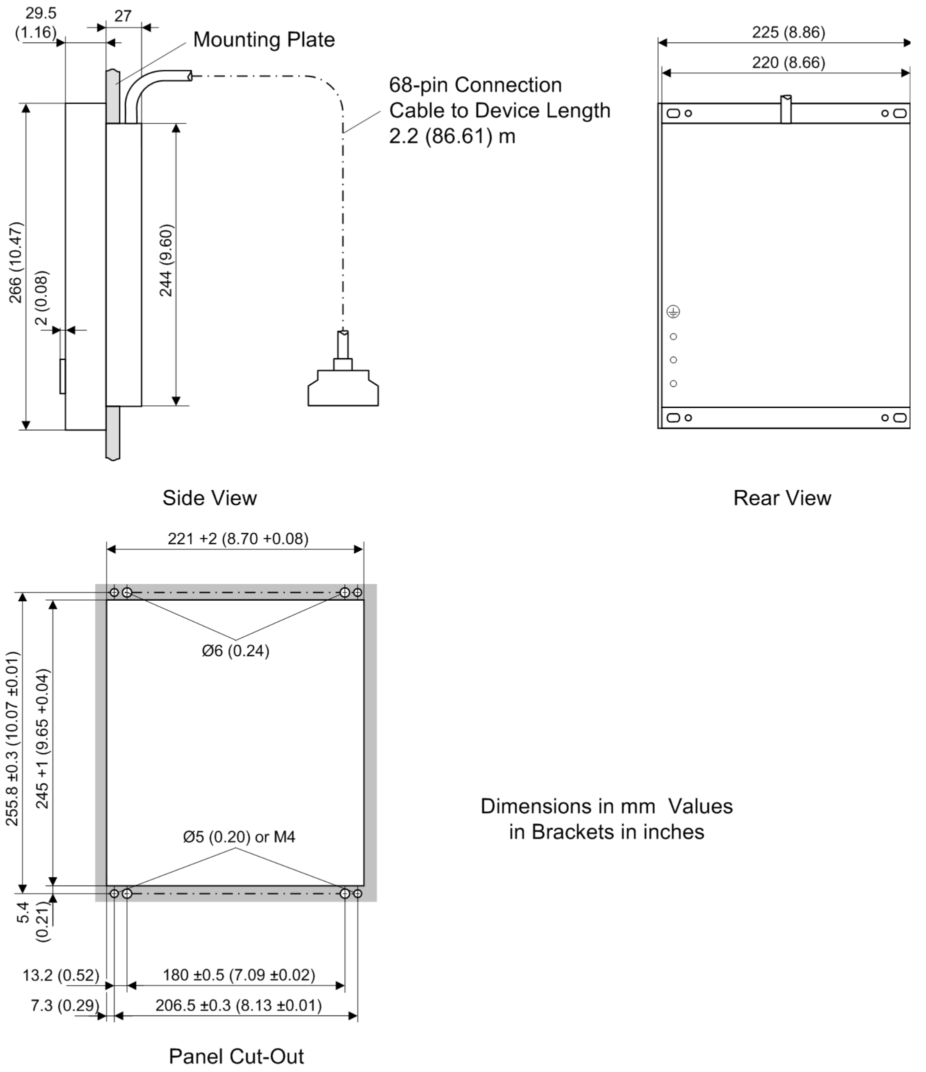
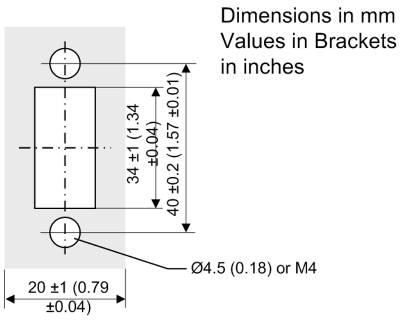


Figure 4-21 Dimensions of a detached operator panel for a 7SJ63 or a 7SJ64 device

4.26.10 D-Subminiature Connector of Dongle Cable (Panel Flush or Cubicle Door Cutout)



Panel or Cabinet Door

Figure 4-22 Dimensions of panel flush or cubicle door cutout of D-subminiature connector of dongle cable for a 7SJ63 or a 7SJ64 device without integrated operator panel

■

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.

A.1 Ordering Information and Accessories

A.1.1 Ordering Information

A.1.1.1 7SJ62 V4.6

Multi-Functional Protective Relay with Local Control						6	7		8	9	10	11	12		13	14	15	16		Supplementary		
	7	S	J	6	2			–						–					+			

Number of Binary Inputs and Outputs	Pos. (=Position) 6
8 Binary Inputs, 8 Binary Outputs, 1 Live Status Contact	1
11 Binary Inputs, 6 Binary Outputs, 1 Live Status Contact	2

Measuring Inputs (3 x V, 4 x I)	Pos. 7
I_{Ph} = 1 A, I_N = 1 A (min. = 0.05 A); 15th position only with C, E, G	1
I_{Ph} = 1 A, I_N = sensitive (min. = 0.001 A); 15th position only with B, D, F, H	2
I_{Ph} = 5 A, I_N = 5 A (min. = 0.25 A); 15th position only with C, E, G	5
I_{Ph} = 5 A, I_N = sensitive (min. = 0.001 A); 15th position only with B, D, F, H	6
I_{Ph} = 5 A, I_N = 1 A (min. = 0.05 A); 15th position only with C, E, G	7

Power Supply, Binary Input Pickup Threshold Setting	Pos. 8
24 to 48 VDC, Binary Input Threshold 19 VDC	2
60 to 125 VDC, Binary Input Threshold 19 VDC	4
110 to 250 VDC, 115 to 230 VAC, Binary Input Threshold 88 VDC	5

Construction	Pos. 9
Surface-mounting case for panel, 2 tier terminals top/bottom	B
Flush mounting case with plug-in terminals (2/3 pin connector)	D
Flush mounting case, screw-type terminals (direct connection / ring and spade lugs)	E

Region-specific Default / Language Settings and Function Versions	Pos. 10
Region DE, 50 Hz, IEC, Language German (Language can be changed)	A
Region World, 50/60 Hz, IEC/ANSI, Language English (Language can be changed)	B
Region US, 60 Hz, ANSI, Language American English (Language can be changed)	C
Region FR, 50/60 Hz, IEC/ANSI, Language French (Language can be changed)	D
Region World, 50/60 Hz, IEC/ANSI, Language Spanish (Language can be changed)	E

System Interface (Rear Side, Port B)	Pos. 11
No system interface	0
IEC-Protocol, electrical RS232	1
IEC-Protocol, electrical RS485	2
IEC-Protocol, optical, 820 nm, ST-Connector	3

System Interface (Rear Side, Port B)	Pos. 11
Profibus FMS Slave, electrical RS485	4
Profibus FMS Slave, optical, Single Ring, ST-Connector [1]	5 [1]
Profibus FMS Slave, optical, Double Ring, ST-Connector [1]	6 [1]
For further interface options see Additional Information in the following	9

Additional information to further system interfaces (device rear, port B)	Supplementary
Profibus DP Slave, RS485	+ L 0 A
Profibus DP Slave, 820 nm, optical Double Ring, ST–Connector [1]	+ L 0 B [1]
Modbus RS485	+ L 0 D
Modbus, 820 nm, optical, ST–Connector [2]	+ L 0 E [2]
DNP3.0, RS485	+ L 0 G
DNP3.0, 820 nm, optical, ST–Connector [2]	+ L 0 H [2]
IEC 61850, Ethernet electrical (EN 100)[3],	+ L 0 R, [3]
IEC 61850, Ethernet optical, double, ST-connector (EN 100)[2], [4]	+ L 0 S[2], [4]

1) Cannot be delivered in connection with 9th digit = "B". If the optical interface is required you must order the following: 11th digit = 4 (RS485) and in addition, the associated converter
2) Cannot be delivered in connection with 9th digit = "B".
3) In the surface mounting case with 2 tier terminals as of January 2005
4) Deliverable as of April 2005

Converter	Order No.	Use
SIEMENS OLM[1]	6GK1502–2CB10	For single ring
SIEMENS OLM[1]	6GK1502–3CB10	For double ring

1) The converter requires an operating voltage of 24 VDC. If the available operating voltage is > 24 VDC the additional power supply 7XV5810–0BA00 is required.

DIGSI/Modem Interface (Rear Side, Port C)	Pos. 12
No DIGSI interface at the back	0
DIGSI/Modem, electrical RS232	1
DIGSI/Modem/RTD box [1], electrical RS485	2
DIGSI/Modem/RTD box [1], optical 820 nm, ST connector [2]	3

1) RTD-box 7XV5662–*AD10
2) If you want to run the RTD-Box at an optical interface, you need also the RS485–FO–converter 7XV5650–0*A00.

Measuring/Fault Recording	Pos. 13
With fault recording	1
With fault recording, average values, min/max values	3

Functions			Pos. 14 and 15
Designation	ANSI no.	Description	
Basic Elements (included in all versions)	—	Control	
	50/51	Time overcurrent protection phase 50-1, 50-2, 51, reverse interlocking	
	50N/51N	Time overcurrent protection ground 50N-1, 50N-2, 51N	
	50N/51N	Insensitive time overcurrent protection ground via the insensitive DGFD function: 50Ns-1, 50Ns-2, 51Ns [2]	
	49	Overload protection (with 2 time constants)	
	46	Negative Sequence Protection	
	37	Undercurrent monitoring	
	47	Phase Rotation	
	59N/64	Displacement Voltage	
	50BF	Circuit breaker failure protection	
	74TC	Trip Circuit Monitoring	
	—	Cold-load pickup (dynamic setting changes) 50c, 51c, 50Nc, 51Nc, 67c, 67Nc	
	—	Inrush restraint	
	86	Lock out	
V, f	27/59 81O/U	Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency	F E
IEF V, f	27/59 81O/U —	Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency Intermittent ground fault	P E
Dir	67/67N	Directional overcurrent protection	F C
Dir V, f	67/67N 27/59 81O/U	Directional overcurrent protection Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency	F G
Dir IEF	67/67N —	Directional overcurrent protection Intermittent ground fault	P C
DGFD Dir	67/67N 67Ns 87N	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection	F D [1]
DGFD Dir IEF	67/67N 67Ns 87N —	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection Intermittent ground fault	P D [1]
DGFD	67Ns 87N	Directional sensitive ground fault detection High-impedance ground fault differential protection	F B [1]
DGFD Motor V, f	67Ns 87N 48/14 66/86 27/59 81O/U	Directional sensitive ground fault detection High-impedance ground fault differential protection Motor starting supervision, locked rotor Restart Inhibit for Motors Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency	H F [1]

Functions							Pos. 14 and 15
DGFD	Motor	Dir		V, f	67/67N 67Ns 87N 48/14 66/86 27/59 81O/U	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection Motor starting supervision, locked rotor Restart Inhibit for Motors Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency	H H [1)]
DGFD	Motor	Dir	IEF	V, f	67/67N 67Ns 87N 48/14 66/86 27/59 81O/U —	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection Motor starting supervision, locked rotor Restart Inhibit for Motors Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency Intermittent ground fault	R H [1)]
	Motor	Dir		V, f	67/67N 48/14 66/86 27/59 81O/U	Directional overcurrent protection Motor starting supervision, locked rotor Restart Inhibit for Motors Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency	H G
DGFD = Directional ground fault detection IEF = Intermittent ground (earth) fault protection Dir = Directional Time Overcurrent Protection (67 and 67N Elements) V, f = Voltage protection, frequency protection							

[1)] for isolated/compensated networks, only for sensitive ground current transformer if 7th digit = 2, 6

[2)] only for non-sensitive ground current transformer if 7th digit = 1, 5, 7

Automatic Reclosing (79) / Fault Locator			Pos. 16
		No 79, no fault locator	0
	79	With 79	1
	21FL	With fault locator	2
	79, 21FL	With 79 and fault locator	3

Special model	Supplementary
with ATEX 100 approval (for the protection of explosion-protected motors of protection type increased safety "e"	+Z X 9 9

A.1.1.2 7SJ63 V4.6

Multi-Functional Protective Relay with Local Control						6	7		8	9	10	11	12		13	14	15	16		Supplementary		
	7	**S**	**J**	**6**	**3**			–						–					+			

Housing, Binary Inputs and Outputs, Measuring Transducer	Pos. 6
Housing $^{1}/_{2}$ 19", 11 BI, 8 BO, 1 Live Status Contact	1
Housing $^{1}/_{2}$ 19", 24 BI, 11 BO, 2 High-duty relays (4 Contacts), 1 Live Status Contact	2
Housing $^{1}/_{2}$ 19", 20 BI, 11 BO, 2 TD, 2 High-duty relays (4 Contacts), 1 Live Status Contact	3
Housing $^{1}/_{1}$ 19", 37 BI, 14 BO, 4 High-duty relays (8 Contacts), 1 Live Status Contact	5
Housing $^{1}/_{1}$ 19", 33 BI, 14 BO, 2 TD, 4 High-duty relays (8 Contacts), 1 Live Status Contact	6

Measuring Inputs (3 x V, 4 x I)	Pos. 7
I_{Ph} = 1 A, I_N = 1 A (min. = 0.05 A); 15th position only with A, C, E, G	1
I_{Ph} = 1 A, I_N = sensitive (min. = 0.001 A); 15th position only with B, D, F, H	2
I_{Ph} = 5 A, I_N = 5 A (min. = 0.25 A); 15th position only with A, C, E, G	5
I_{Ph} = 5 A, I_N = sensitive (min. = 0.001 A); 15th position only with B, D, F, H	6
I_{Ph} = 5 A, I_N = 1 A (min. = 0.05 A); 15th position only with A, C, E, G	7

Power Supply, Binary Input Pickup Threshold Setting	Pos. 8
24 to 48 VDC, Binary Input Threshold 19 VDC	2
60 to 125 VDC, Binary Input Threshold 19 VDC	4
110 to 250 VDC, 115 to 230 VAC, Binary Input Threshold 88 VDC	5

Construction	Pos. 9
Surface-mounting case, plug-in terminals, detached operator panel Installation in a low-voltage compartment	A
Surface-mounting case for panel, 2 tier terminals top/bottom	B
Surface-mounting case, screw-type terminals (direct connection / ring and spade lugs), detached operator panel, installation in a low-voltage	C
Flush mounting case with plug-in terminals (2/3 pin connector)	D
Flush mounting case, screw-type terminals (direct connection / ring and spade lugs)	E
Surface-mounting case, screw-type terminals (direct connection / ring and spade lugs), without operator panel, installation in a low-voltage	F
Surface-mounting case, plug-in terminals, without operator panel Installation in a low-voltage compartment	G

Region-specific Default / Language Settings and Function Versions	Pos. 10
Region DE, 50 Hz, IEC, Language German (Language can be changed)	A
Region World, 50/60 Hz, IEC/ANSI, language English (language can be changed)	B
Region US, 60 Hz, ANSI, Language American English (Language can be changed)	C
Region FR, 50/60 Hz, IEC/ANSI, Language French (Language can be changed)	D
Region World, 50/60 Hz, IEC/ANSI, Language Spanish (Language can be changed)	E

System Interface (Rear Side, Port B)	Pos. 11
No system interface	0
IEC-Protocol, electrical RS232	1
IEC-Protocol, electrical RS485	2

System Interface (Rear Side, Port B)	Pos. 11
IEC-Protocol, optical, 820 nm, ST-Connector	3
Profibus FMS Slave, electrical RS485	4
Profibus FMS Slave, optical, Single Ring, ST-Connector [1)]	5 [1)]
Profibus FMS Slave, optical, Double Ring, ST-Connector [1)]	6 [1)]
For further interface options see Additional Information in the following	9

Additional information to further system interfaces (device rear, port B)	Supple-mentary
Profibus DP Slave, RS485	+ L 0 A
Profibus DP Slave, 820 nm, optical Double Ring, ST–Connector [1)]	+ L 0 B [1)]
Modbus RS485	+ L 0 D
Modbus, 820 nm, optical, ST–Connector [2)]	+ L 0 E [2)]
DNP3.0, RS485	+ L 0 G
DNP3.0, 820 nm, optical, ST–Connector [2)]	+ L 0 H [2)]
IEC 61850, Ethernet electrical (EN 100)[3)],	+ L 0 R, [3)]
IEC 61850, Ethernet optical, double, ST-connector (EN 100)[2), 4)]	+ L 0 S[2), 4)]

1) Cannot be delivered in connection with 9th digit = "B". If the optical interface is required you must order the following: 11th digit = 4 (RS485) and in addition, the associated converter

2) Cannot be delivered in connection with 9th digit = "B".

3) In the surface mounting case with 2 tier terminals as of January 2005

4) Deliverable as of April 2005

Converter	Order No.	Use
SIEMENS OLM[1)]	6GK1502–2CB10	For single ring
SIEMENS OLM[1)]	6GK1502–3CB10	For double ring

1) The converter requires an operating voltage of 24 VDC. If the available operating voltage is > 24 VDC the additional power supply 7XV5810–0BA00 is required.

DIGSI/Modem Interface (Rear Side, Port C)	Pos. 12
No DIGSI interface at the back	0
DIGSI/Modem, electrical RS232	1
DIGSI/Modem/RTD box [1)], electrical RS485	2
DIGSI/Modem/RTD box [1)], optical 820 nm, ST connector [2)]	3

1) RTD-box 7XV5662–*AD10

2) If you want to run the RTD-Box at an optical interface, you need also the RS485–FO–converter 7XV5650–0*A00.

Measuring/Fault Recording	Pos. 13
With fault recording, average values, min/max values	3

Functions			Pos. 14 and 15
Designation	ANSI no.	Description	F A
Basic Elements (included in all versions)	—	Control	
	50/51	Time overcurrent protection phase 50-1, 50-2, 51, reverse interlocking	
	50N/51N	Time overcurrent protection ground 50N-1, 50N-2, 51N	
	50N/51N	Insensitive time overcurrent protection ground via the insensitive DGFD function: 50Ns-1, 50Ns-2, 51Ns [2)]	
	49	Overload protection (with 2 time constants)	
	46	Negative Sequence Protection 46-1, 46-2, 46-TOC	
	37	Undercurrent monitoring	
	47	Phase Rotation	
	59N/64	Displacement voltage	
	50BF	Circuit breaker failure protection	
	74TC	Trip Circuit Monitoring	
	—	Cold-load pickup (dynamic setting changes) 50C-1, 50C-2, 50NC-1, 50NC-2, 51NC	
	—	Inrush restraint	
	86	Lock out	
V, f	27/59 81O/U	Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency	F E
IEF V, f	27/59 81O/U —	Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency Intermittent ground fault	P E
Dir	67/67N	Directional overcurrent protection	F C
Dir V, f	67/67N 27/59 81O/U	Directional overcurrent protection Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency	F G
Dir IEF	67/67N —	Directional overcurrent protection Intermittent ground fault	P C
DGFD Dir	67/67N 67Ns 87N	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection	F D [1)]
DGFD Dir IEF	67/67N 67Ns 87N —	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection Intermittent ground fault	P D [1)]
DGFD	67Ns 87N	Directional sensitive ground fault detection High-impedance ground fault differential protection	F B [1)]
DGFD Motor V, f	67Ns 87N 48/14 66/86 27/59 81O/U	Directional sensitive ground fault detection High-impedance ground fault differential protection Motor starting supervision, locked rotor Restart Inhibit for Motors Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency	H F [1)]
DGFD Motor Dir V, f	67/67N 67Ns 87N 48/14 66/86 27/59 81O/U	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection Motor starting supervision, locked rotor Restart Inhibit for Motors Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency	H H [1)]

Functions							Pos. 14 and 15
DGFD	Motor	Dir	IEF	V, f	67/67N 67Ns 87N 48/14 66/86 27/59 81O/U —	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection Motor starting supervision, locked rotor Restart Inhibit for Motors Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency Intermittent ground fault	R H [1]
	motor	Dir		V, f	67/67N 48/14 66/86 27/59 81O/U	Directional overcurrent protection Motor starting supervision, locked rotor Restart Inhibit Under/Overvoltage Under/Overfrequency	H G
	motor				48/14 66/86	Motor starting supervision, locked rotor Restart Inhibit for Motors	H A
DGFD = Directional ground fault detection IEF = Intermittent ground (earth) fault protection Dir = Directional Time Overcurrent Protection (67 and 67N Elements) V, f = Voltage protection, frequency protection							

[1] for isolated/compensated networks, only for sensitive ground current transformer if 7th digit = 2, 6

[2] only for non-sensitive ground current transformer if 7th digit = 1, 5, 7

Automatic Reclosing (79) / Fault Locator			Pos. 16
		No 79, no fault locator	0
	79	With 79	1
	21FL	With fault locator	2
	79, 21FL	With 79 and fault locator	3

Special model	Supplementary
with ATEX 100 approval (for the protection of explosion-protected motors of protection type increased safety "e"	+Z X 9 9

A.1.1.3 7SJ64 V4.6

Multi-Functional Protective Relay with Local Control						6	7		8	9	10	11	12		13	14	15	16		Supplementary		
	7	**S**	**J**	**6**	**4**			–						–					+			

Housing, Binary Inputs and Outputs, Measuring Transducer	**Pos. 6**
Housing $^1/_3$ 19'', 4-line Display, 7 BI, 5 BO, 1 Live Status Contact; 9th position only with: B, D, E	0
Housing $^1/_2$ 19'', Graphic Display, 15 BI, 13 BO, 1 Live Status Contact	1
Housing $^1/_2$ 19'', Graphic Display, 20 BI, 8 BO, 2 High-duty relays (4 Contacts), 1 Live Status Contact	2
Housing $^1/_1$ 19'', Graphic Display, 33 BI, 11 BO, 4 High-duty relays (8 Contacts), 1 Live Status Contact	5

Measuring Inputs (4 x V, 4 x I)	**Pos. 7**
I_{Ph} = 1 A, I_N = 1 A (min. = 0.05 A); 15th position only with A, C, E, G	1
I_{Ph} = 1 A, I_N = sensitive (min. = 0.001 A); 15th position only with B, D, F, H	2
I_{Ph} = 5 A, I_N = 5 A (min. = 0.25 A); 15th position only with A, C, E, G	5
I_{Ph} = 5 A, I_N = sensitive (min. = 0.001 A); 15th position only with B, D, F, H	6
I_{Ph} = 5 A, I_N = 1 A (min. = 0.05 A); 15th position only with A, C, E, G	7

Power Supply, Binary Input Pickup Threshold Setting	**Pos. 8**
24 to 48 VDC, Binary Input Threshold 19 VDC	2
60 to 125 VDC, Binary Input Threshold 19 VDC	4
110 to 250 VDC, 115 to 230 VAC [1)], Binary Input Threshold 88 VDC	5

[1)] 230 VAC only possible with release 7SJ64**...../**CC** and higher

Construction	**Pos. 9**
Surface-mounting case, plug-in terminals, detached operator panel Installation in a low-voltage compartment	A
Surface-mounting case for panel, 2 tier terminals top/bottom	B
Surface-mounting case, screw-type terminals (direct connection / ring and spade lugs), detached operator panel, installation in a low-voltage	C
Flush mounting case with plug-in terminals (2/3 pin connector)	D
Flush mounting case, screw-type terminals (direct connection / ring and spade lugs)	E
Surface-mounting case, screw-type terminals (direct connection / ring and spade lugs), without operator panel, installation in a low-voltage	F
Surface-mounting case, plug-in terminals, without operator panel Installation in a low-voltage compartment	G

Region-specific Default / Language Settings and Function Versions	**Pos. 10**
Region DE, 50 Hz, IEC, Language German (Language can be changed)	A
Region World, 50/60 Hz, IEC/ANSI, language English (language can be changed)	B
Region US, 60 Hz, ANSI, Language American English (Language can be changed)	C
Region FR, 50/60 Hz, IEC/ANSI, Language French (Language can be changed)	D
Region World, 50/60 Hz, IEC/ANSI, Language Spanish (Language can be changed)	E

System Interface (Rear Side, Port B)	**Pos. 11**
No system interface	0
IEC-Protocol, electrical RS232	1

System Interface (Rear Side, Port B)	Pos. 11
IEC-Protocol, electrical RS485	2
IEC-Protocol, optical, 820 nm, ST-Connector	3
Profibus FMS Slave, electrical RS485	4
Profibus FMS Slave, optical, Single Ring, ST-Connector [1]	5 [1]
Profibus FMS Slave, optical, Double Ring, ST-Connector [1]	6 [1]
For further interface options see Additional Information in the following **L**	9

Additional information L to further system interfaces (device rear, port B)	Supple-mentary
Profibus DP Slave, RS485	+ L 0 A
Profibus DP Slave, 820 nm, optical Double Ring, ST–Connector [1]	+ L 0 B [1]
Modbus RS485	+ L 0 D
Modbus, 820 nm, optical, ST–Connector [2]	+ L 0 E [2]
DNP3.0, RS485	+ L 0 G
DNP3.0, 820 nm, optical, ST–Connector [2]	+ L 0 H [2]
IEC 61850, Ethernet electrical (EN 100)[3],	+ L 0 R[3]
IEC 61850, Ethernet optical, double, ST-connector (EN 100)[2], [4]	+ L 0 S[2], [4]

[1] Cannot be delivered in connection with 9th digit = "B". If the optical interface is required you must order the following: 11th digit = 4 (RS485) and in addition, the associated converter

[2] Cannot be delivered in connection with 9th digit = "B".

[3] In the surface mounting case with 2 tier terminals as of January 2005

[4] Deliverable as of April 2005

Converter	Order No.	Use
SIEMENS OLM[1]	6GK1502–2CB10	For single ring
SIEMENS OLM[1]	6GK1502–3CB10	For double ring

[1] The converter requires an operating voltage of 24 VDC. If the available operating voltage is > 24 VDC the additional power supply 7XV5810–0BA00 is required.

DIGSI/Modem Interface (Rear Side, Port C)	Pos. 12
DIGSI/Modem, electrical RS232	1
DIGSI/Modem/RTD box [1], electrical RS485	2
For further interface options see Additional Information **M**	9

[1] RTD-box 7XV5662–*AD10

Additional Information M, Service and Additional Interface (Port C and Port D)	
Port C: DIGSI/Modem, electrical RS232	M 1 *
Port C: DIGSI/Modem/RTD box [1], electrical RS485	M 2 *
Port D: RTD box [1], optical 820 nm, [2], ST connector	M * A
Port D: RTD-Box [1], electrical RS485	M * F

[1] RTD-box 7XV5662–*AD10

[2] If you want to run the RTD box on an optical port, you will also need the RS485 optical converter 7XV5650–0*A00.

Measuring/Fault Recording	Pos. 13
With fault recording	1
With fault recording, average values, min/max values	3

Functions			Pos. 14 and 15
Designation	ANSI no.	Description	F A
Basic Elements (included in all versions)	—	Control	
	50/51	Time overcurrent protection phase 50-1, 50-2, 51, reverse interlocking, independent of phase sequence	
	50N/51N	Time overcurrent protection ground 50N-1, 50N-2, 51N	
	50N/51N	Insensitive time overcurrent protection ground via the insensitive DGFD function: 50Ns-1, 50Ns-2, 51Ns [2)]	
	50/50N	Flexible Protection Functions (current parameters): Additive overcurrent time protection 50-3, 50-4	
	49	Overload protection (with 2 time constants)	
	46	Negative Sequence Protection 46-1, 46-2, 46-TOC	
	37	Undercurrent monitoring	
	47	Phase Rotation	
	64/59N	Displacement voltage	
	50BF	Circuit breaker failure protection	
	74TC	Trip Circuit Monitoring	
	—	Cold-load pickup (dynamic setting changes) 50C-1, 50C-2, 50NC-1, 50NC-2, 51NC	
	—	Inrush restraint	
	86	Lock out	
V, f, P	27/59 81O/U 27/47/59(N)/ 32/55/81R	Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency Flexible Protection Functions (current and voltage parameters): Protective function for voltage, power, power factor, frequency change	F E
IEF V, f, P	27/59 81O/U 27/47/59(N)/ 32/55/81R —	Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency Flexible Protection Functions (current and voltage parameters): Protective function for voltage, power, power factor, frequency change Intermittent ground fault	P E
Dir	67/67N	Directional overcurrent protection	F C
Dir V, f, P	67/67N 27/59 81O/U 27/47/59(N)/ 32/55/81R	Directional overcurrent protection Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency Flexible Protection Functions (current and voltage parameters): Protective function for voltage, power, power factor, frequency change	F G
Dir IEF	67/67N —	Directional overcurrent protection Intermittent ground fault	P C
DGFD Dir	67/67N 67Ns 87N	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection	F D [1)]
DGFD Dir IEF	67/67N 67Ns 87N —	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection Intermittent ground fault	P D [1)]

Functions			Pos. 14 and 15
DGFD	67Ns 87N	Directional sensitive ground fault detection High-impedance ground fault differential protection	F B [1]
DGFD Motor V, f, P	67Ns 87N 48/14 66/86 27/59 81O/U 27/47/59(N)/ 32/55/81R	Directional sensitive ground fault detection High-impedance ground fault differential protection Motor starting supervision, locked rotor Restart Inhibit for Motors Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency Flexible Protection Functions (current and voltage parameters): Protective function for voltage, power, power factor, frequency change	H F [1]
DGFD Motor Dir V, f, P	67/67N 67Ns 87N 48/14 66/86 27/59 81O/U 27/47/59(N)/ 32/55/81R	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection Motor starting supervision, locked rotor Restart Inhibit for Motors Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency Flexible Protection Functions (current and voltage parameters): Protective function for voltage, power, power factor, frequency change	H H [1]
DGFD Motor Dir IEF V, f, P	67/67N 67Ns 87N 48/14 66/86 27/59 81O/U 27/47/59(N)/ 32/55/81R —	Directional overcurrent protection Directional sensitive ground fault detection High-impedance ground fault differential protection Motor starting supervision, locked rotor Restart Inhibit for Motors Under/Overvoltage 59-1, 59-2, 27-1, 27-2 Under/Overfrequency Flexible Protection Functions (current and voltage parameters): Protective function for voltage, power, power factor, frequency change Intermittent ground fault	R H [1]
Motor Dir V, f, P	67/67N 48/14 66/86 27/59 81O/U 27/47/59(N)/ 32/55/81R	Directional overcurrent protection Motor starting supervision, locked rotor Restart Inhibit Under/Overvoltage Under/Overfrequency Flexible Protection Functions (current and voltage parameters): Protective function for voltage, power, power factor, frequency change	H G
DGFD = Directional ground fault detection IEF = Intermittent ground (earth) fault protection Dir = Directional Time Overcurrent Protection (67 and 67N Elements) V, f, P = Voltage protection, frequency protection, power protection			

[1] for isolated/compensated networks, only for sensitive ground current transformer if 7th digit = 2, 6

[2] only for non-sensitive ground current transformer if 7th digit = 1, 5, 7

Automatic Reclosing (79) / Fault Locator / Synchronization			Pos. 16
		Without	0
	79	With 79	1
	21FL	With fault locator	2
	79, 21FL	With 79 and fault locator	3

Automatic Reclosing (79) / Fault Locator / Synchronization			Pos. 16
	25	With Synchronization	4
	25, 79, 21FL	With synchronization, 79 and fault locator	7

Special model	Supple-ment
with ATEX 100 approval (for the protection of explosion-protected motors of protection type increased safety “e”	+Z X 9 9[1]

[1] with V4.6 in 01/2005

A.1.2 Accessories

Exchangeable interface modules

Name	Order No.
RS232	C53207-A351-D641-1
RS485	C73207-A351-D642-1
FO 820 nm	C73207-A351-D643-1
Profibus FMS RS485	C53207-A351-D603-1
Profibus FMS double ring	C53207-A351-D606-1
Profibus FMS single ring	C53207-A351-D609-1
Profibus DP RS485	C53207-A351-D611-1
Profibus DP double ring	C53207-A351-D613-1
Modbus RS485	C53207-A351-D621-1
Modbus 820 nm	C53207-A351-D623-1
DNP 3.0 RS 485	C53207-A351-D631-1
DNP 3.0 820 nm	C53207-A351-D633-1
Ethernet electrical (EN 100)	C53207–A351–D675–1

RTD-Box (Resistance Temperature Detector)

Name	Order No.
RTD-box, Vaux = 24 to 60 V AC/DC	7XV5662–2AD10–0000
RTD-box, Vaux = 90 to 240 V AC/DC	7XV5662–5AD10–0000

RS485/Fibre Optic Converter

RS485/Fibre Optic Converter	Order No.
820 nm; FC–Connector	7XV5650–0AA00
820 nm, with ST–Connector	7XV5650–0BA00

Terminal Block Covering Caps

Covering cap for terminal block type	Order No.
18-pin voltage terminal, 12-pin current terminal	C73334-A1-C31-1
12-terminal voltage, 8-terminal current block	C73334-A1-C32-1

Short Circuit Links

Short circuit links for terminal type	Order No.
Voltage terminal, 18-terminal, or 12-terminal	C73334-A1-C34-1
Current terminal,12-terminal, or 8-terminal	C73334-A1-C33-1

Female Plugs

Connector Type	Order No.
2-pin	C73334-A1-C35-1
3-pin	C73334-A1-C36-1

Mounting Rail for 19"-Racks

Name	Order No.
Angle Strip (Mounting Rail)	C73165-A63-C200-3

Battery

Lithium battery 3 V/1 Ah, type CR 1/2 AA	Order No.
VARTA	6127 101 501

Interface Cable

Interface cable between PC or SIPROTEC device	Order No.
Cable with 9-pin male/female connections	7XV5100–4

DIGSI® operating software

DIGSI® protection operation and configuration software	Order No.
DIGSI®, basic version with licenses for 10 PCs	7XS5400-0AA00
DIGSI®, complete version with all option packages	7XS5402-0AA0

Graphical analysis program SIGRA

Software for graphical visualization, analysis, and evaluation of fault data. Option package of the complete version of DIGSI®	Order No.
Full version with license for 10 PCs	7XS5410–0AA0

Display Editor

Software for creating basic and power system control pictures (option package of the complete version of DIGSI®)	Order No.
Display Editor 4; Full version with license for 10 PCs	7XS5420-0AA0

Graphic Tools

Graphical Software to aid in the setting of characteristic curves and provide zone diagrams for overcurrent and dis-

tance protective devices. Option package of the complete version of DIGSI®.	Order No.
Full version with license for 10 PCs	7XS5430–0AA0

DIGSI REMOTE 4

Software for remotely operating protective devices via a modem (and possibly a star connector) using DIGSI® (option package of the complete version of DIGSI®)	Order No.
DIGSI REMOTE 4; Full version with license for 10 PCs; Language: German	7XS5440-1AA0

SIMATIC CFC 4

Graphical software for setting interlocking (latching) control conditions and creating additional functions (option package of the complete version of DIGSI®)	Order No.
SIMATIC CFC 4; Full version with license for 10 PCs	7XS5450-0AA0

Varistor

Voltage-limiting resistor for high-impedance differential protection

Name	Order number
125 Veff, 600 A, 1S/S256	C53207-A401-D76-1
240 Veff, 600 A, 1S/S1088	C53207-A401-D77-1

Dongle cable

Cable for the operation of the device without operator panel and for leading the PC interface out	Order number
	C73195-A100-B65-1

A.2 Terminal Assignments

A.2.1 7SJ62 — Housing for panel flush mounting or cubicle installation

7SJ621*-*D/E

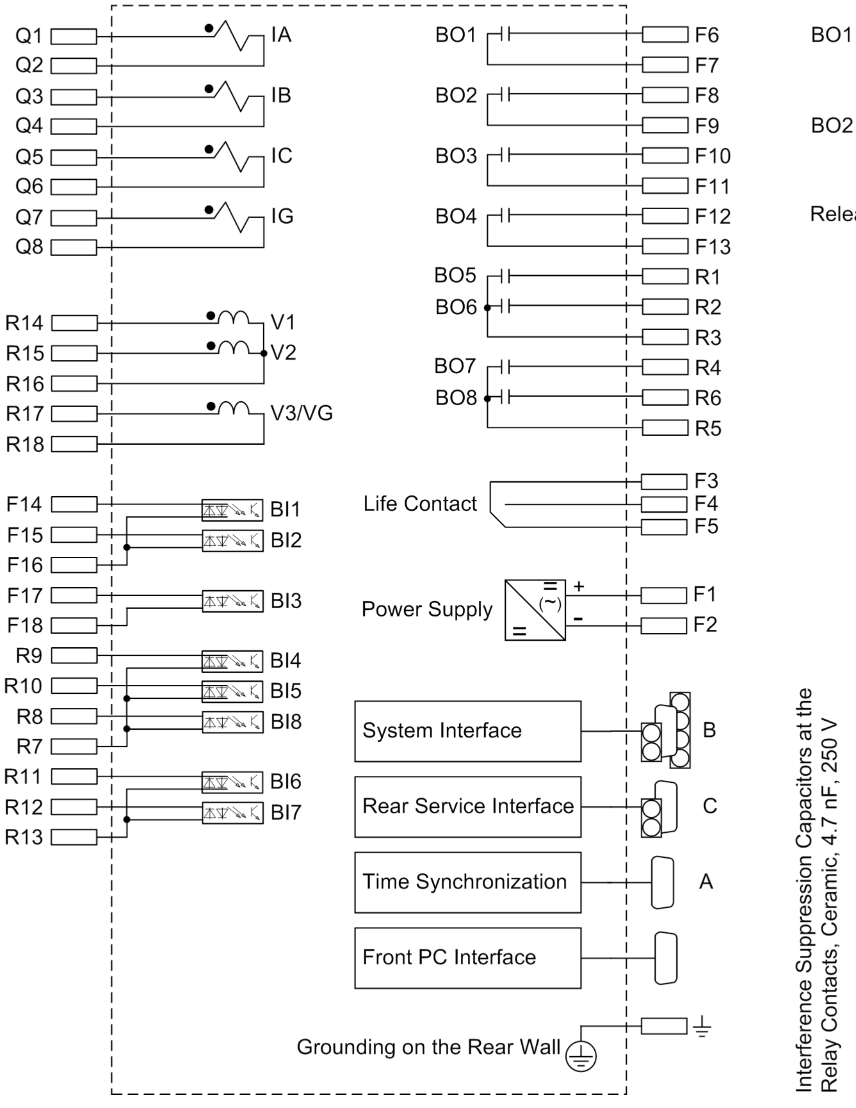


Figure A-1 General diagram for 7SJ621*–*D/E (panel flush mounting or cubicle mounting)

7SJ622*-*D/E

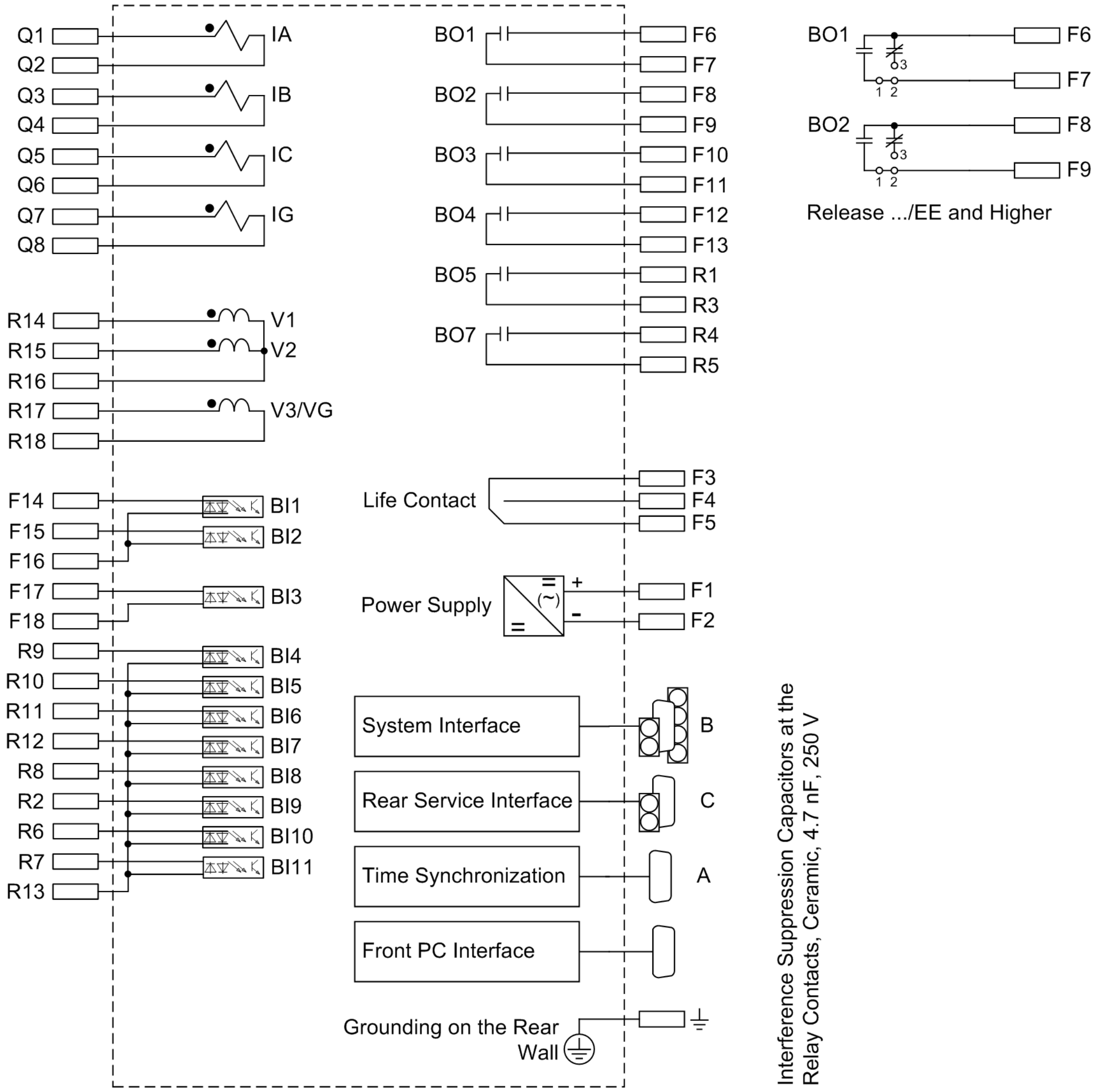


Figure A-2 General diagram for 7SJ622*–*D/E (panel flush mounted or cubicle mounted)

A.2.2 7SJ62 — Housing for Panel Surface Mounting

7SJ621*-*B

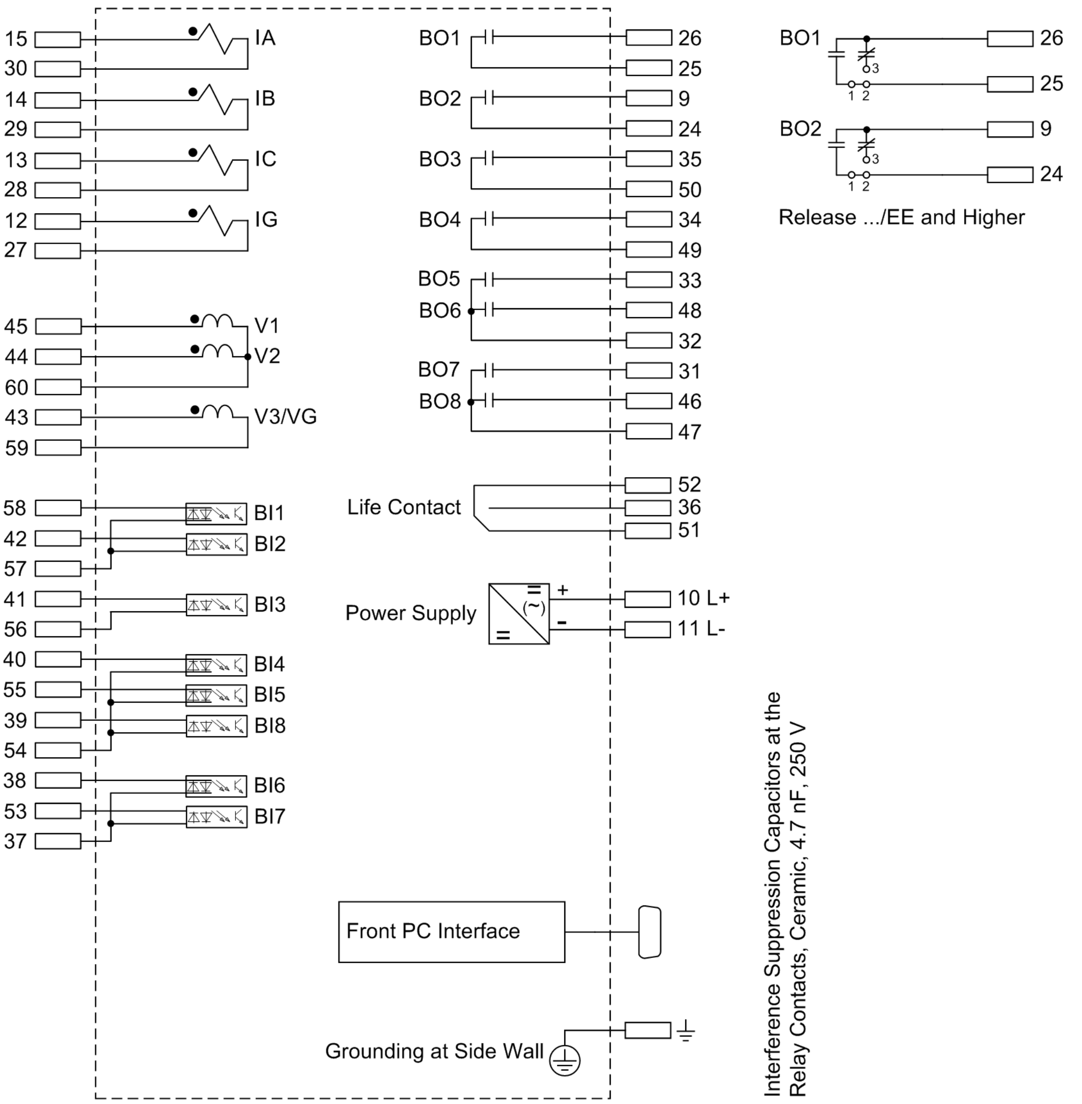


Figure A-3 General diagram for 7SJ621*–*B (panel surface mounted)

7SJ622*-*B

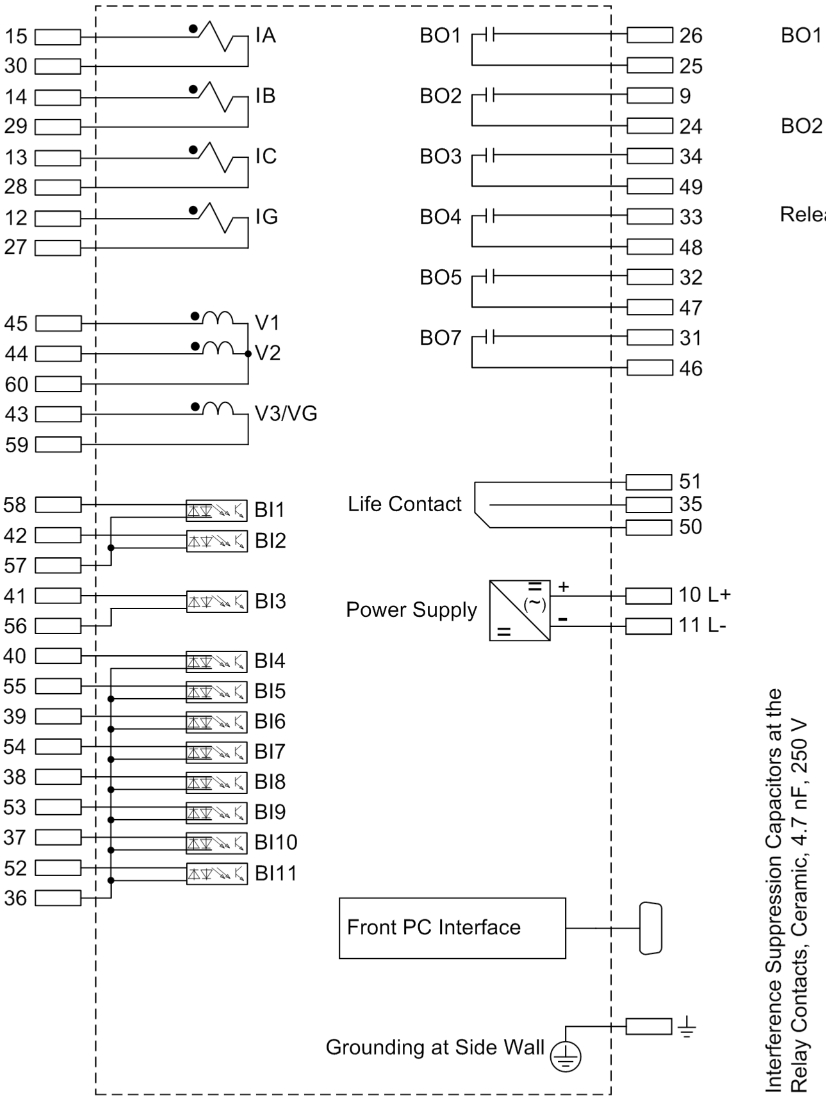


Figure A-4 General diagram for 7SJ622*–*B (panel surface mounted)

A.2.3 7SJ62 — Interface assignment on housing for panel surface mounting

7SJ621/2*-*B (up to release ... /CC)

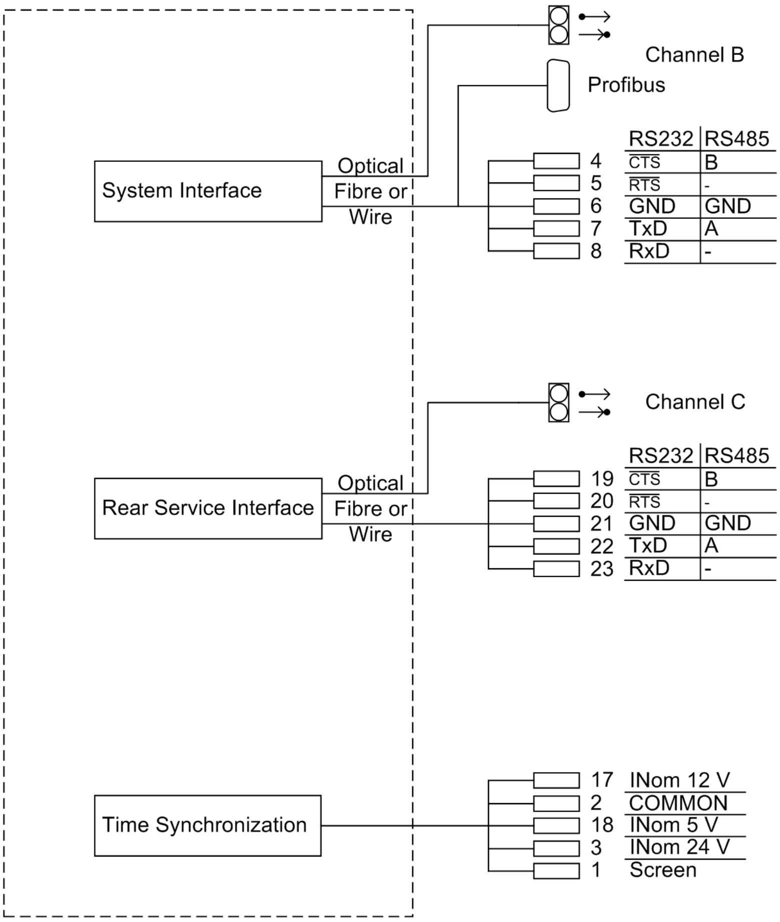


Figure A-5 General diagram for 7SJ621/2*–*B up to release ... /CC (panel surface mounted)

7SJ621/2*-*B (release ... /DD and higher)

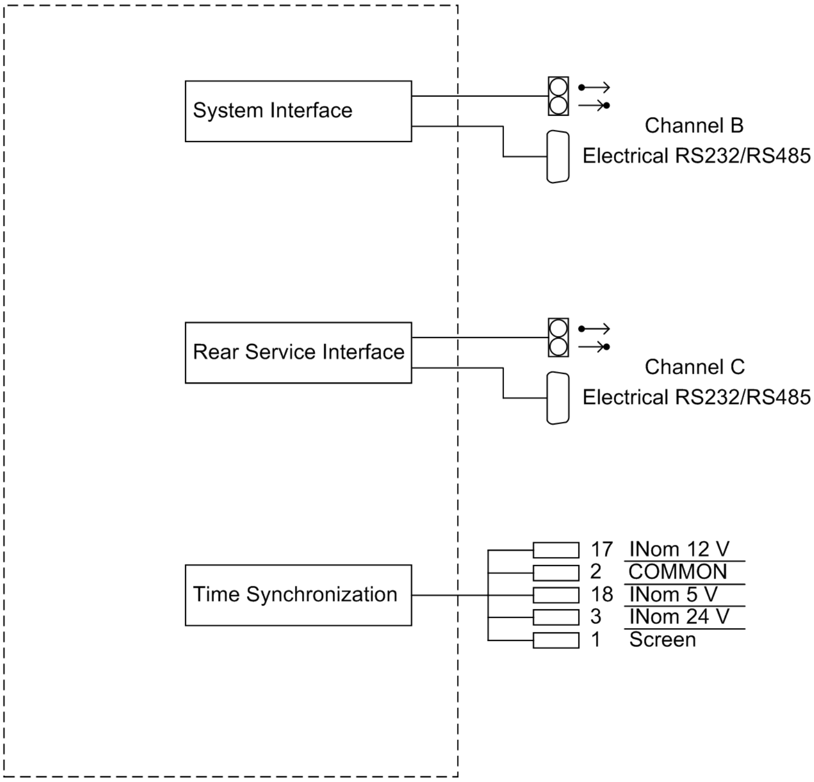


Figure A-6 General diagram for 7SJ621/2*–*B, release ... /DD and higher (panel surface mounted)

A.2.4 7SJ63 — Housing for panel flush mounting or cubicle installation

7SJ631*-*D/E

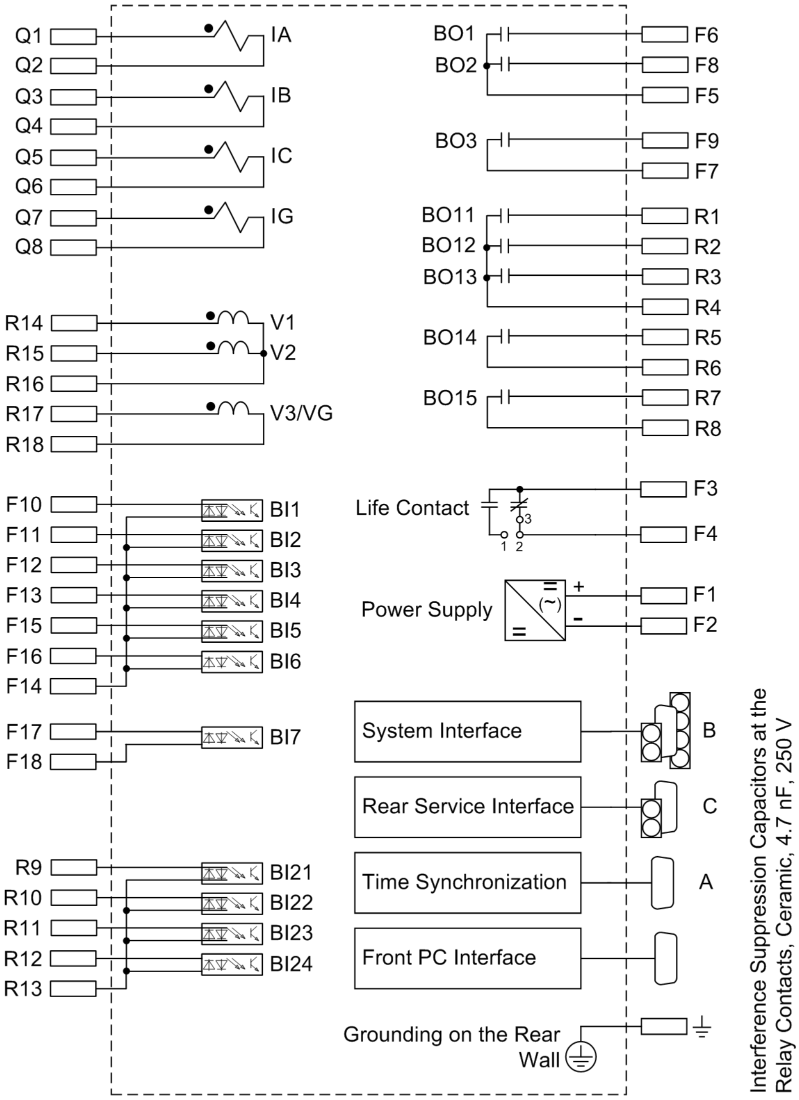


Figure A-7 General diagram for 7SJ631*–*D/E (panel flush mounted or cubicle mounted)

7SJ632*-*D/E

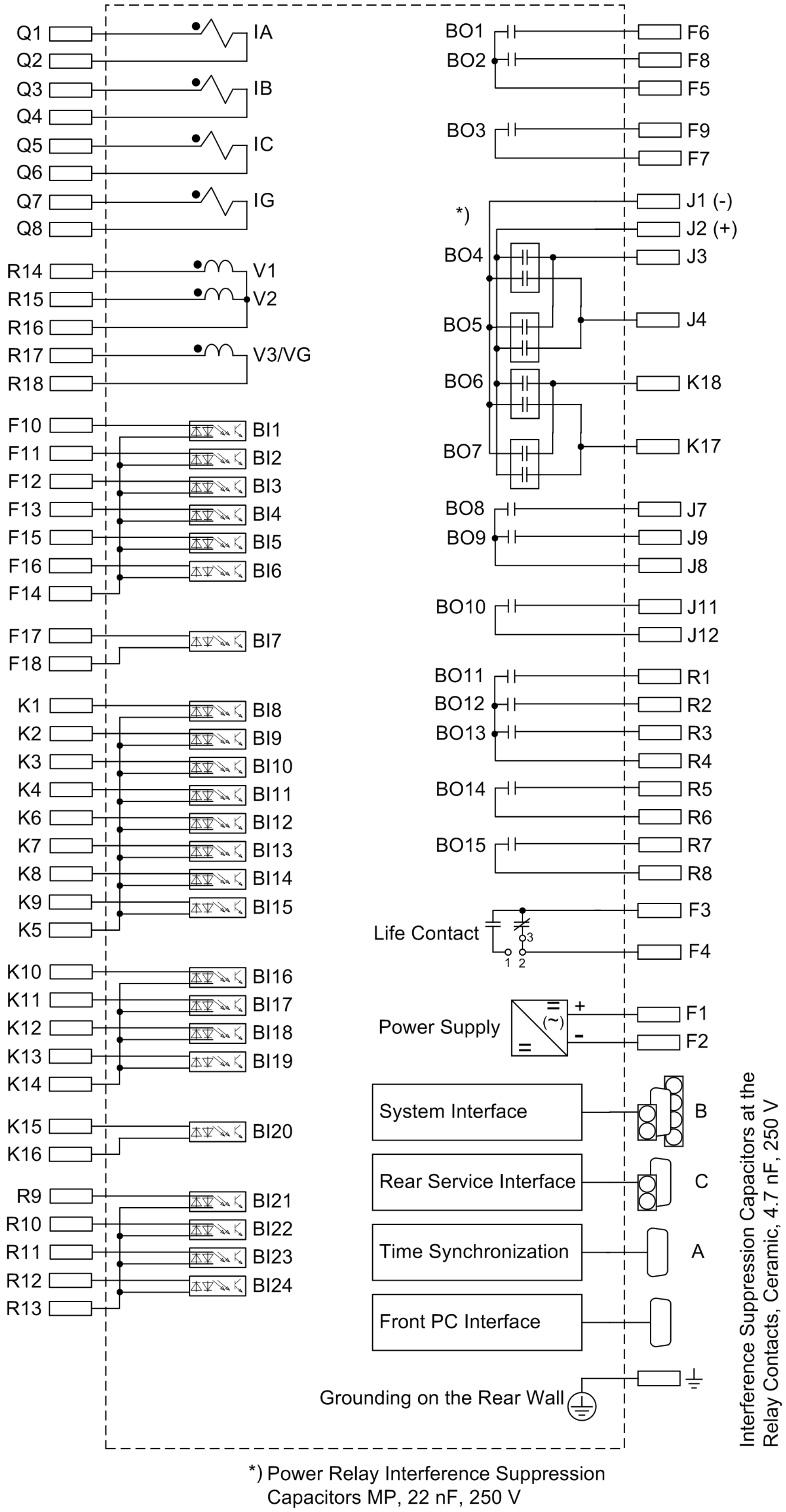


Figure A-8 General diagram for 7SJ632*–*D/E (panel flush mounting or cubicle mounting)

7SJ633*-*D/E

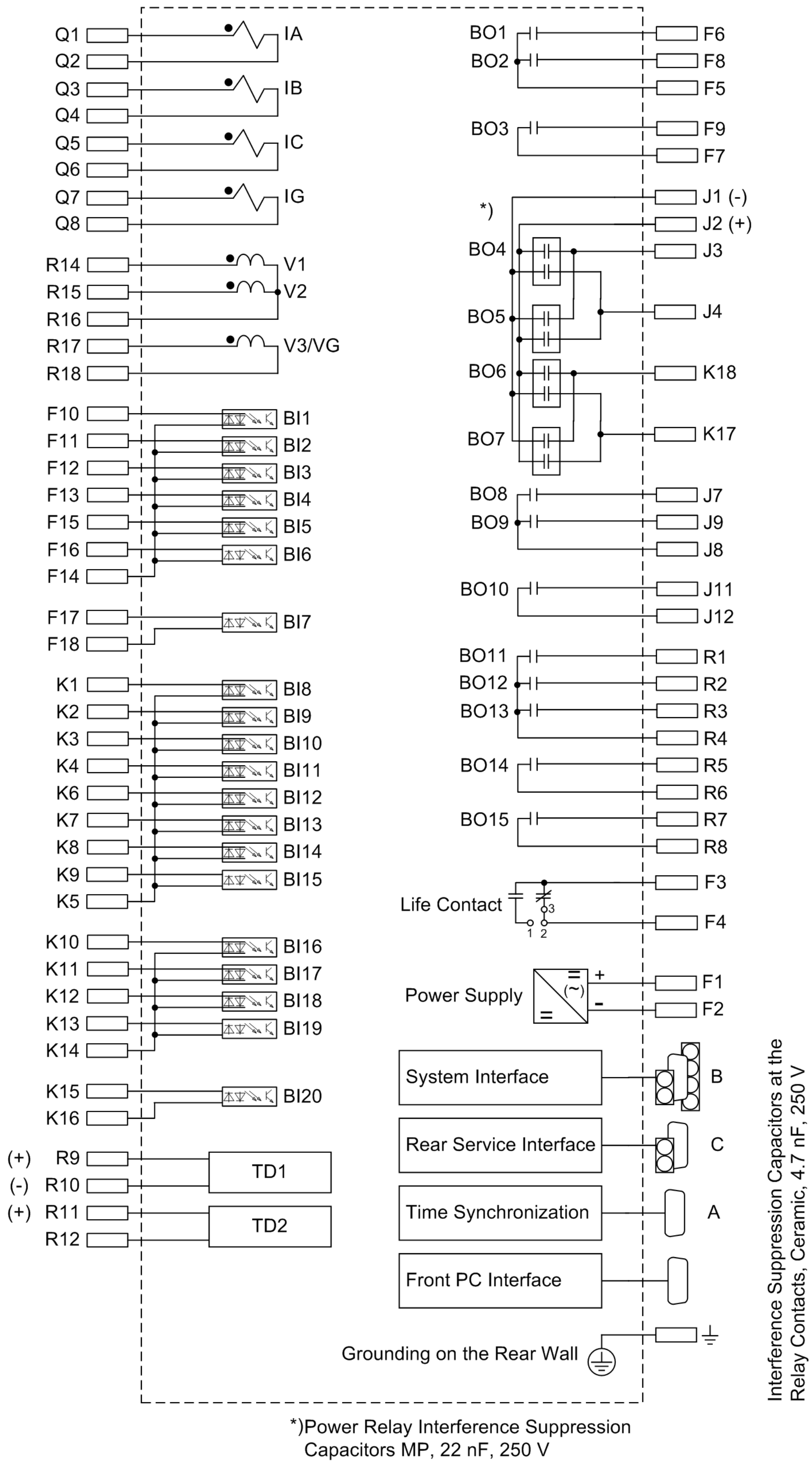


Figure A-9 General diagram for 7SJ633*–*D/E (panel flush mounting or cubicle mounting)

7SJ635*-*D/E

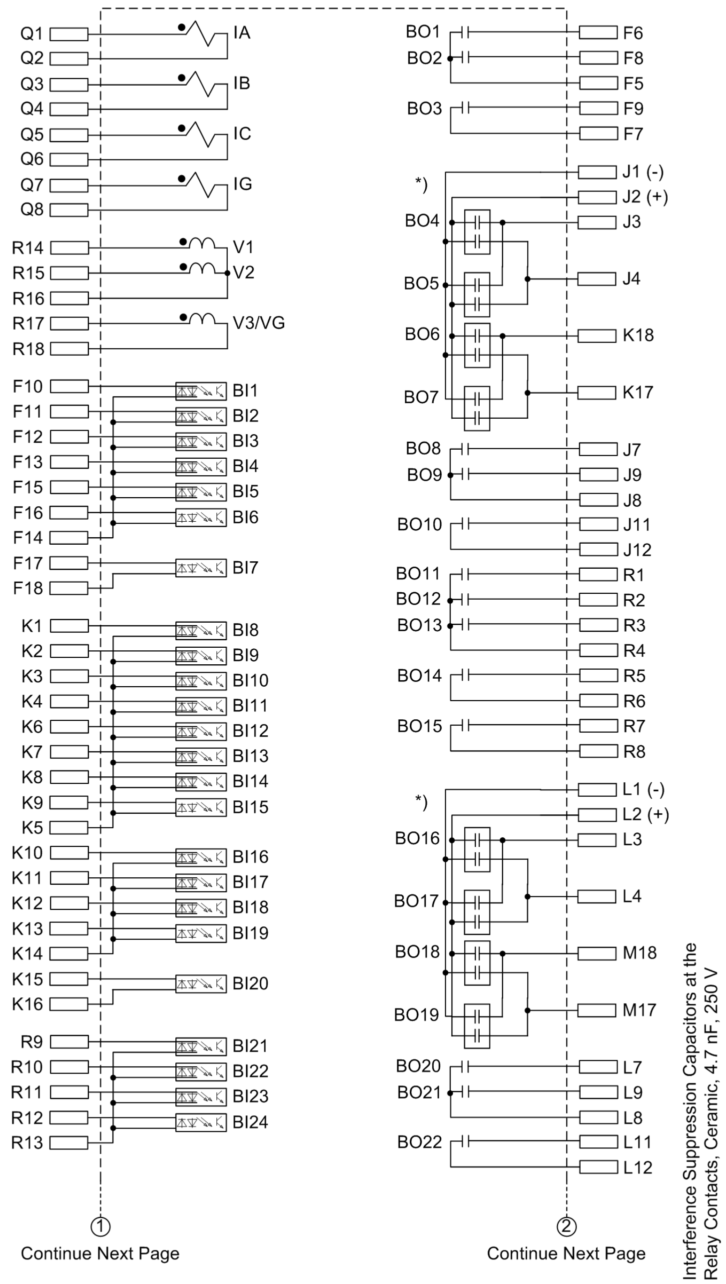


Figure A-10 General diagram for 7SJ635*–*D/E (panel flush mounting or cubicle mounting), part 1

7SJ635*-*D/E

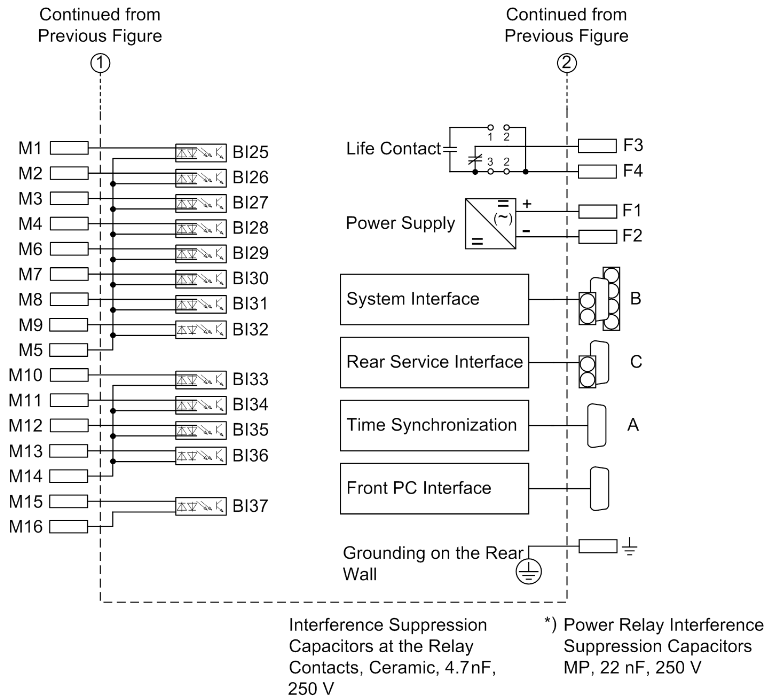


Figure A-11 General diagram for 7SJ635*–*D/E (panel flush mounting or cubicle mounting), part 2

7SJ636*-*D/E

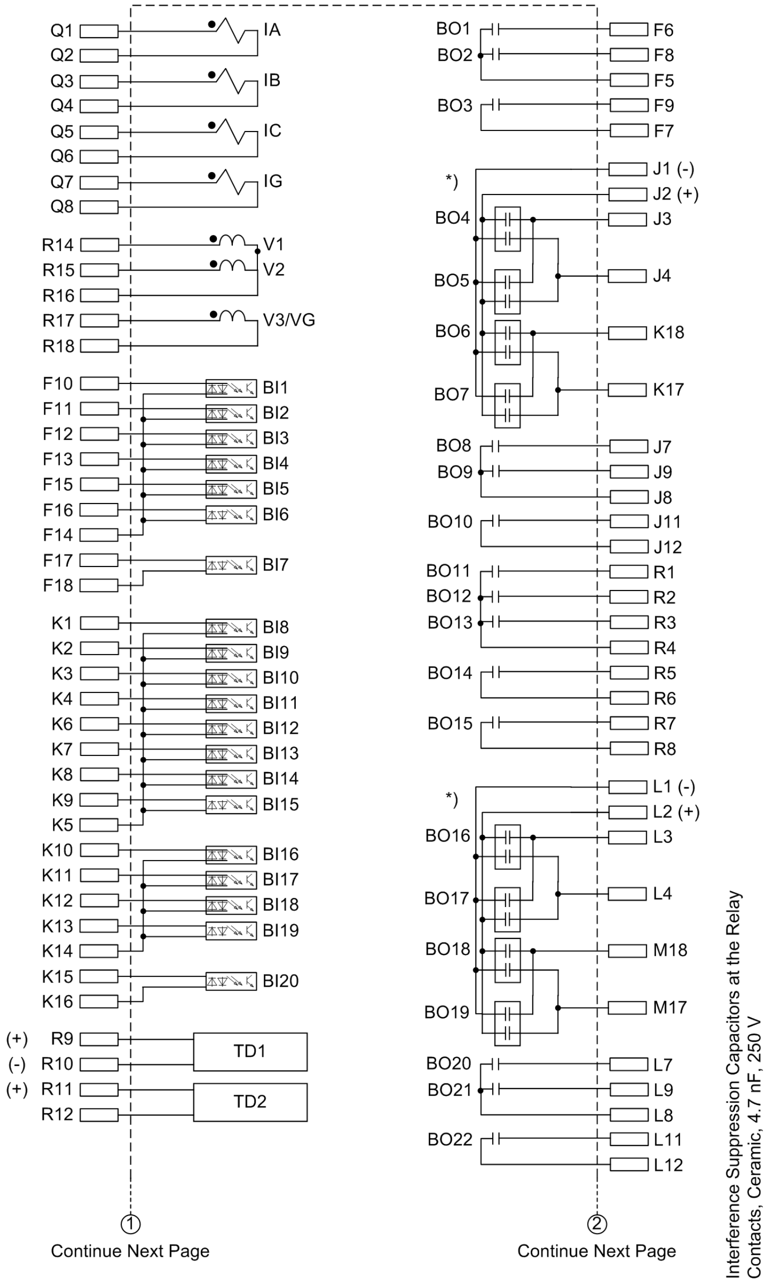


Figure A-12 General diagram for 7SJ636*–*D/E (panel flush mounting or cubicle mounting), part 1

7SJ636*-*D/E

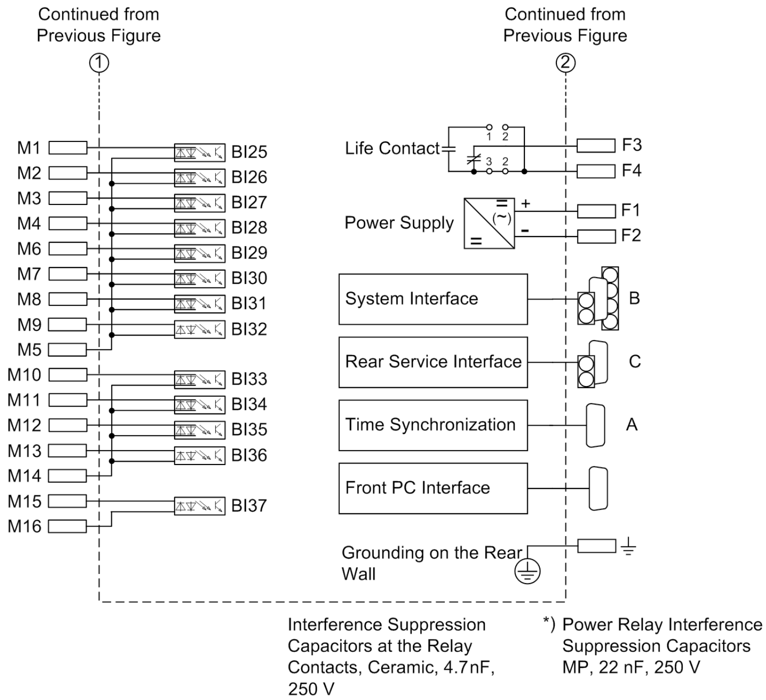


Figure A-13 General diagram for 7SJ636*–*D/E (panel flush mounting or cubicle mounting), part 2

A.2.5 7SJ631/2/3 — Housing for panel surface mounting

7SJ631*-*B

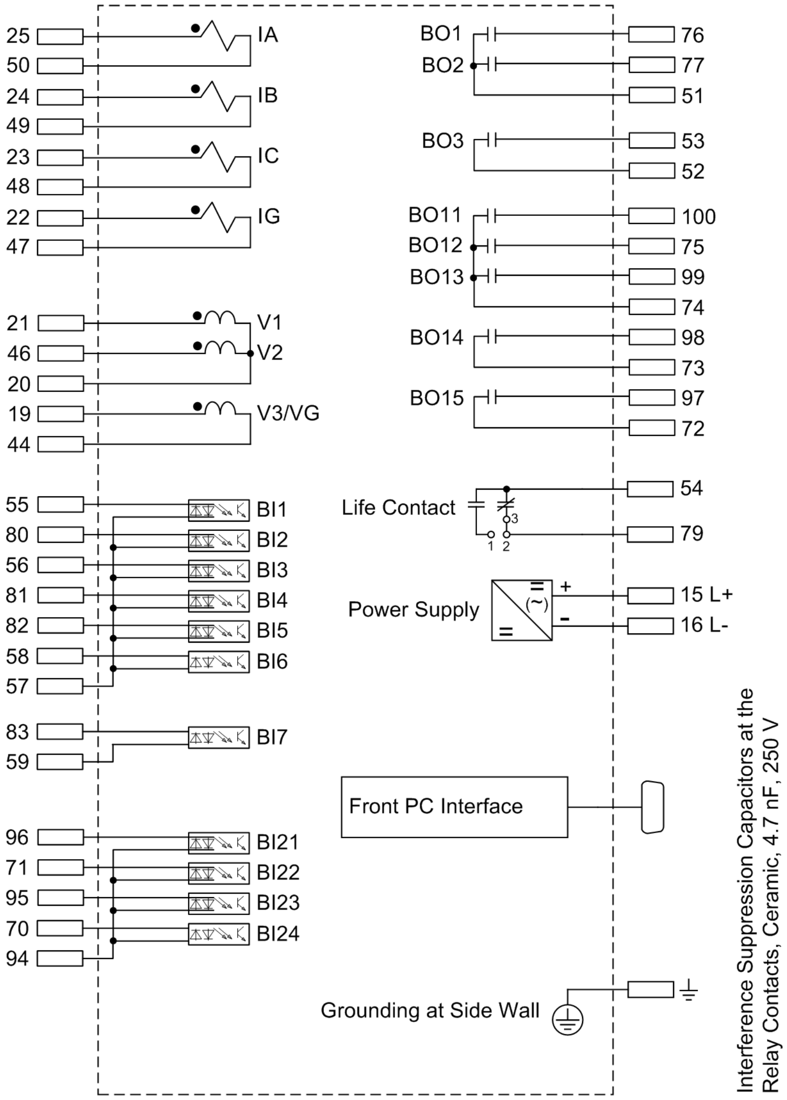


Figure A-14 General diagram for 7SJ631*-*B (panel surface mounting)

7SJ632*-*B

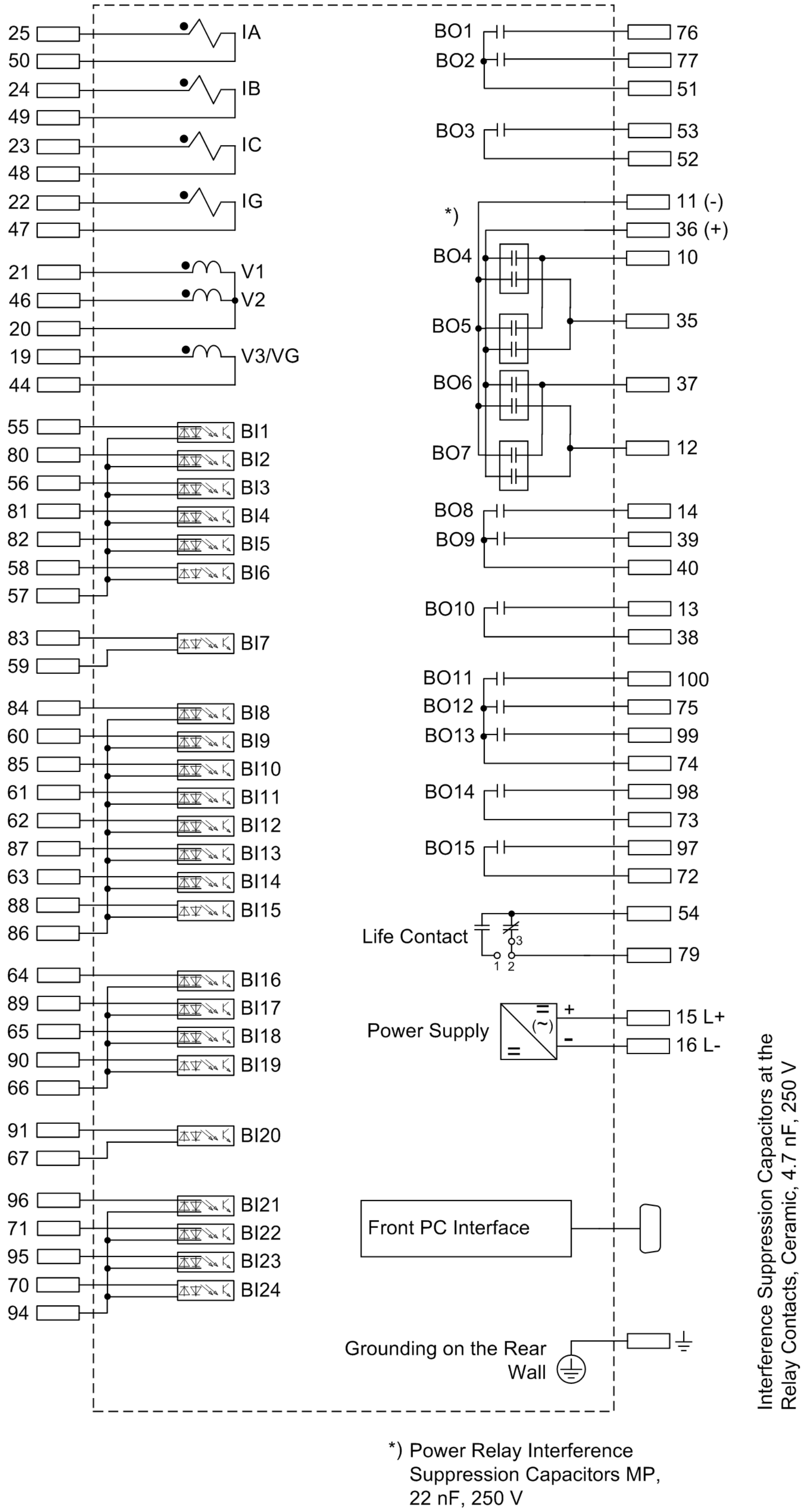


Figure A-15 General diagram for 7SJ632*-*B (panel surface mounted)

7SJ633*-*B

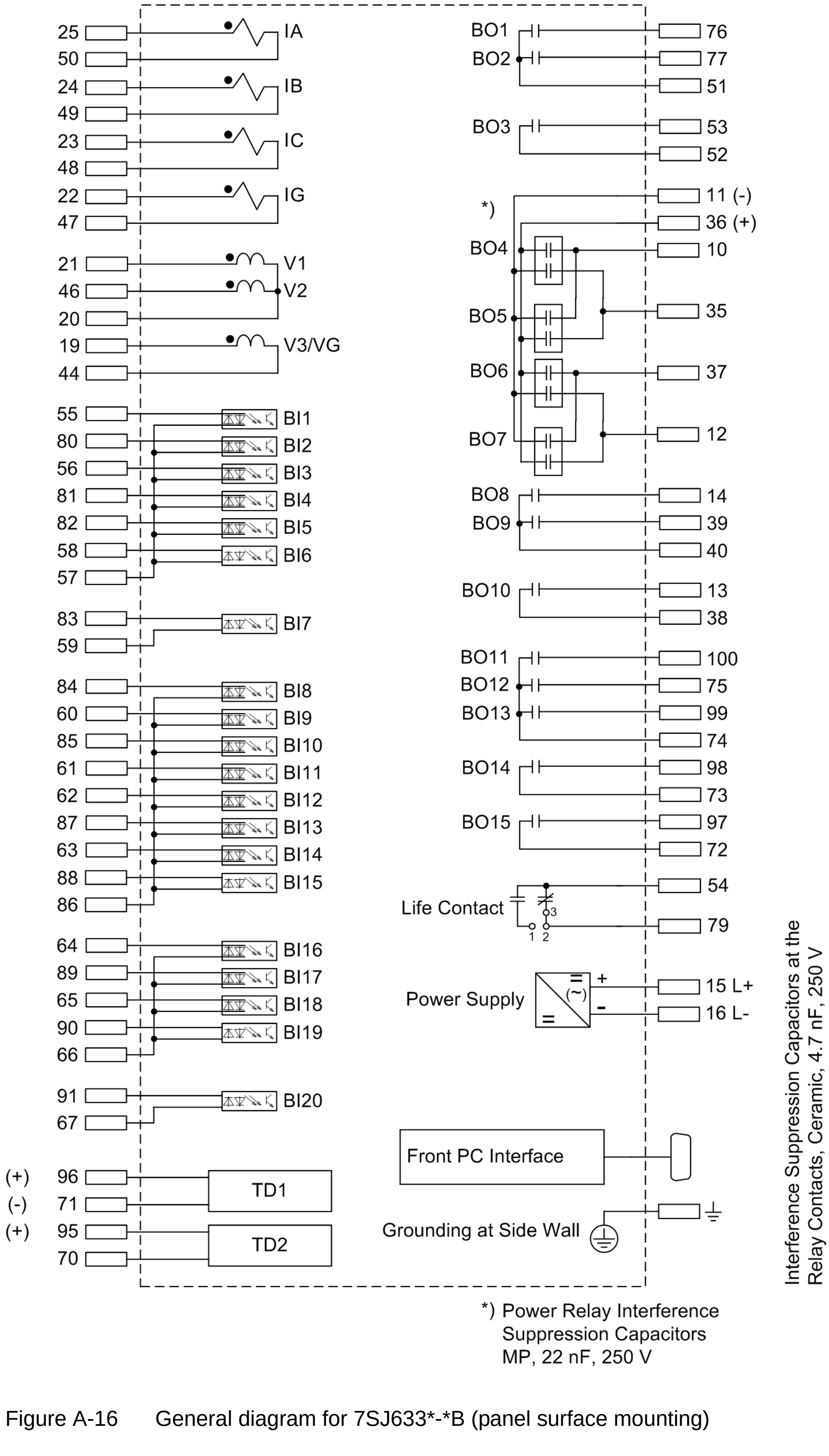


Figure A-16 General diagram for 7SJ633*-*B (panel surface mounting)

A.2.6 7SJ631/2/3 — Interface assignment on housing for panel surface mounting

7SJ631/2/3*-*B (up to release ... /CC)

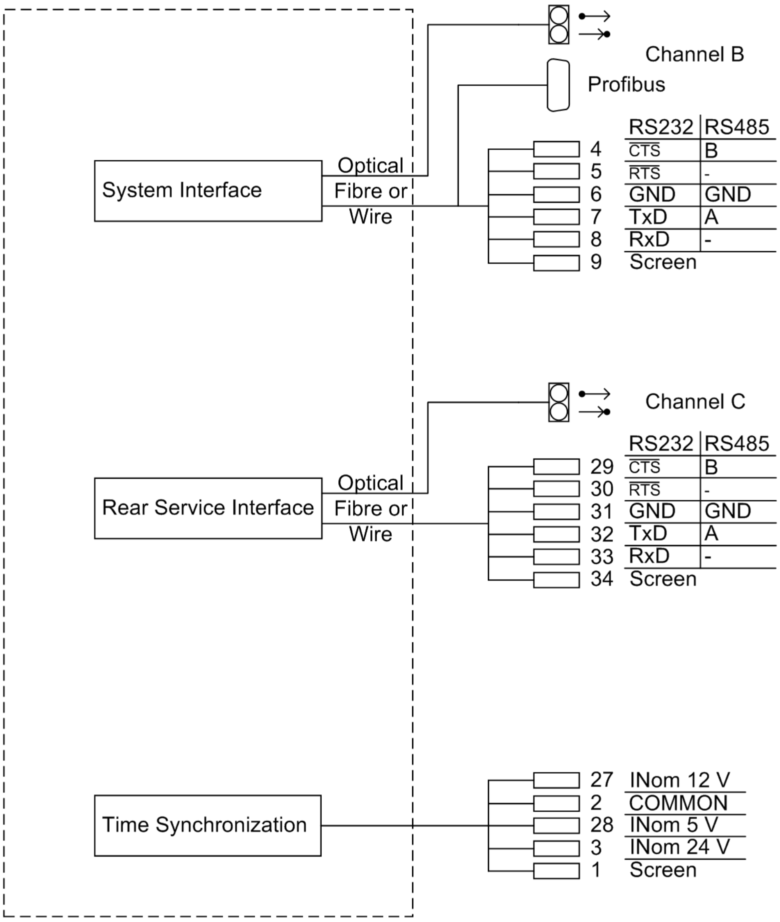


Figure A-17 General diagram 7SJ631/2/3*-*B up to release ... /CC (panel surface mounting)

7SJ631/2/3*-*B (re-lease ... /DD and higher)

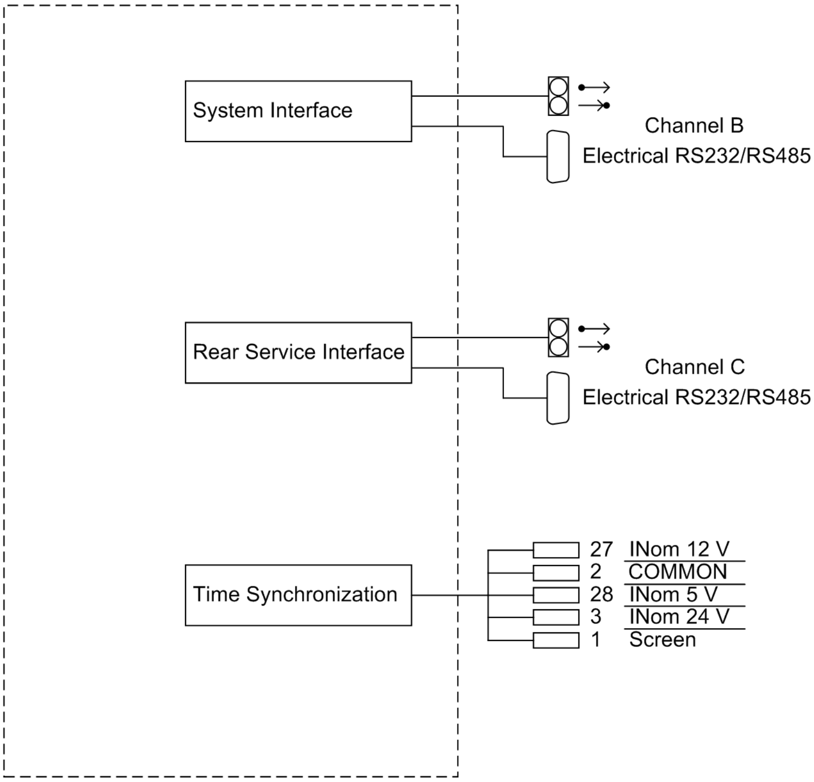


Figure A-18 General diagram for 7SJ631/2/3*–*B, release ... /DD and higher (panel surface mounting)

A.2.7 7SJ635/6 — Housing for panel surface mounting

7SJ635*-*B

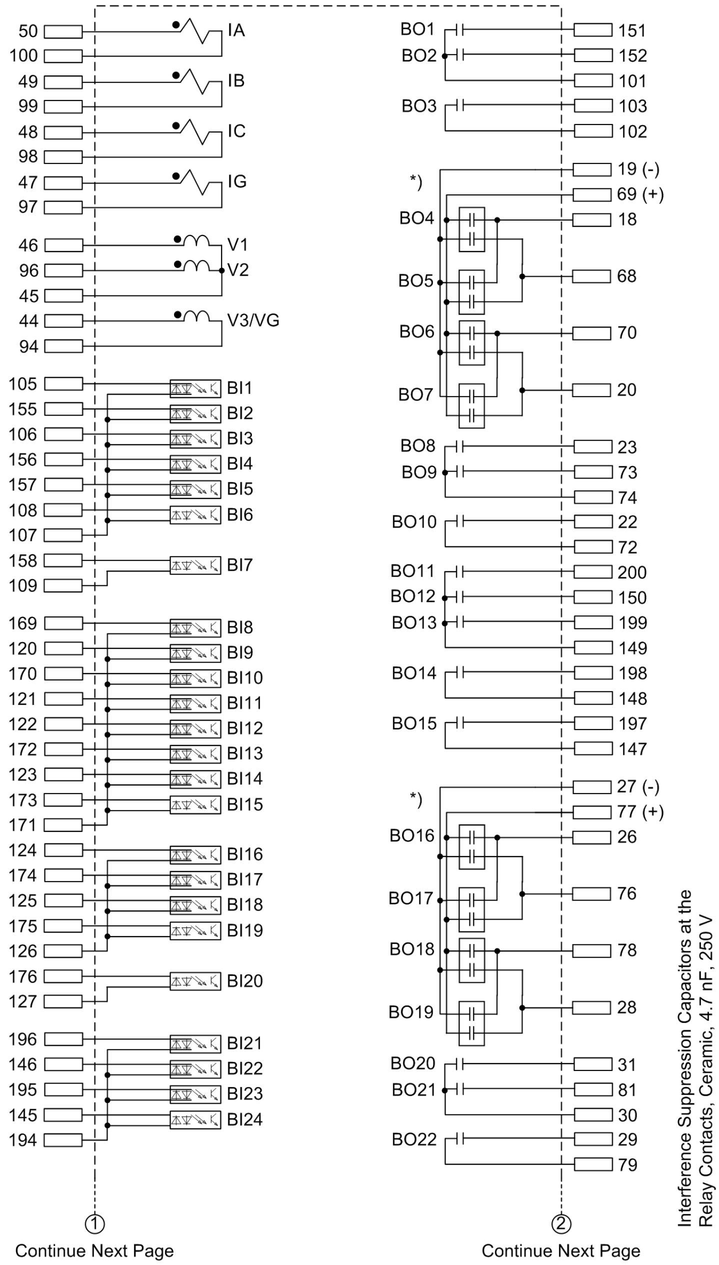


Figure A-19 General diagram for 7SJ635*-*B (panel surface mounting), part 1

7SJ635*-*B

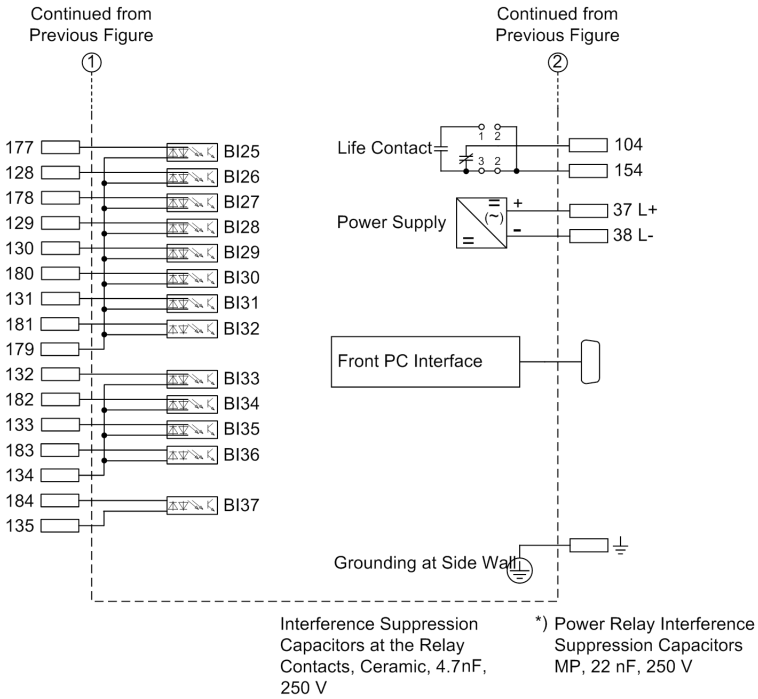


Figure A-20 General diagram for 7SJ635*-*B (panel surface mounting), part 2

7SJ636*-*B

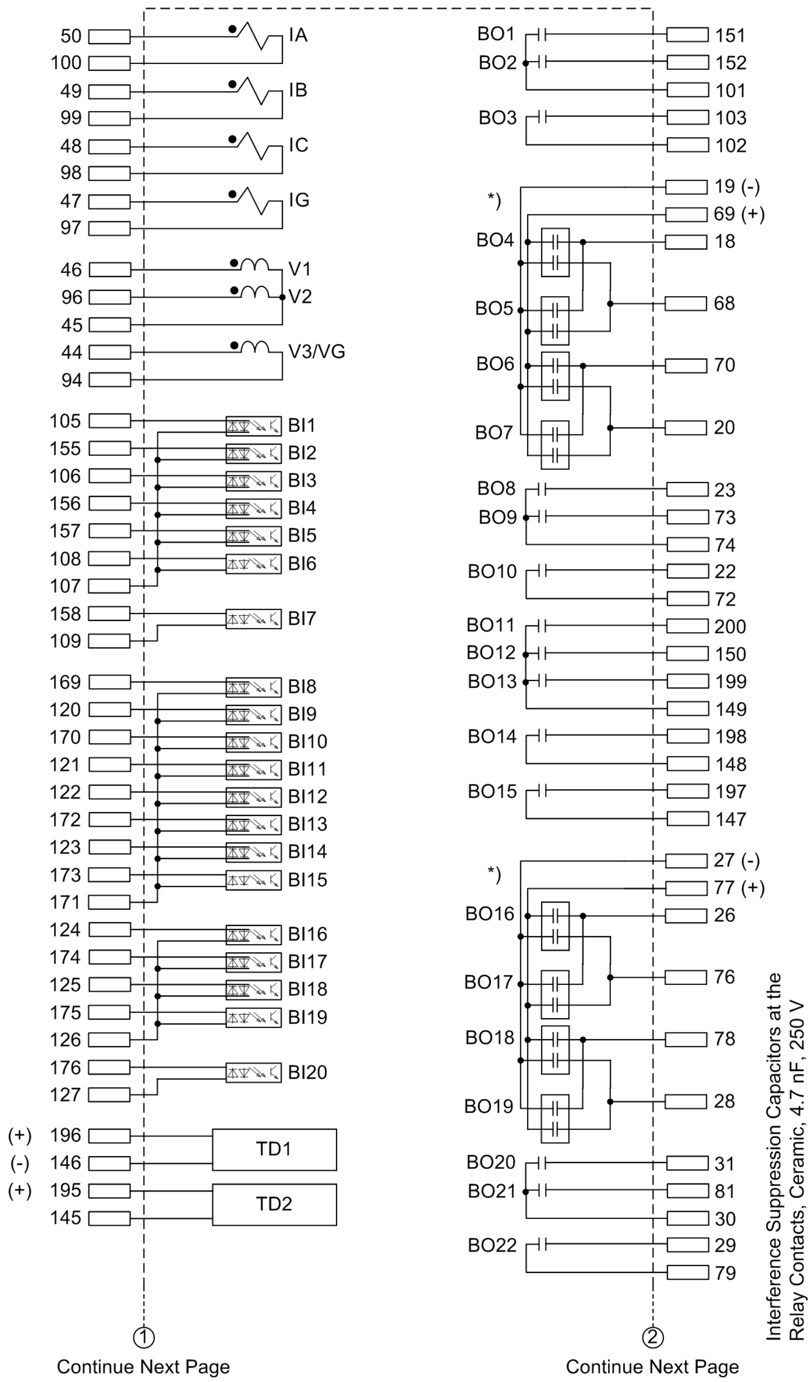


Figure A-21 General diagram for 7SJ636*-*B (panel surface mounting), part 1

7SJ636*-*B

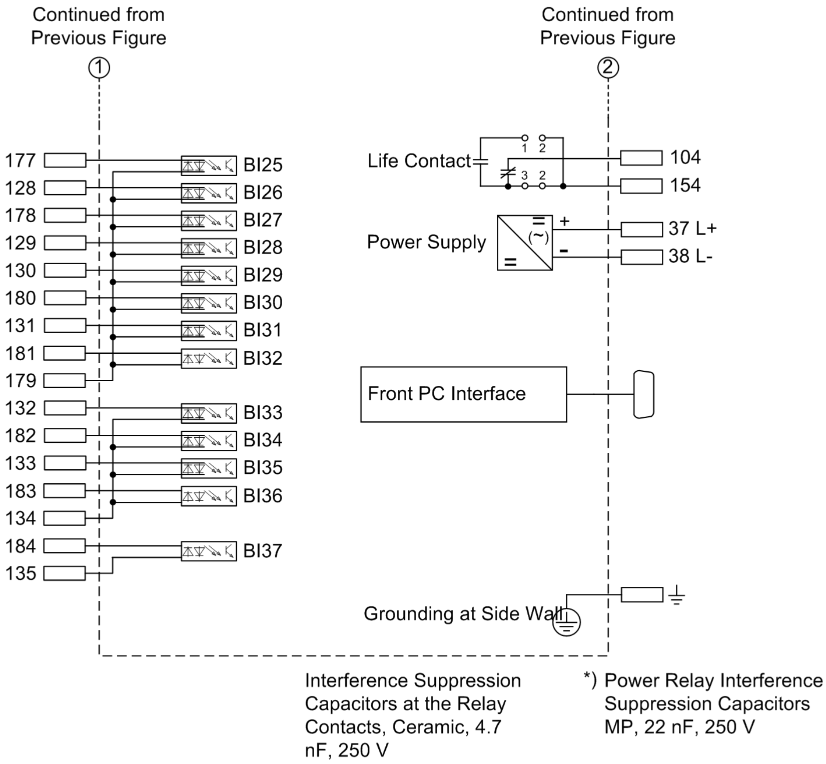


Figure A-22 General diagram for 7SJ636*-*B (panel surface mounting), part 2

A.2.8 7SJ635/6 — Interface assignment on housing for panel surface mounting

7SJ635/6*-*B (up to release ... /CC)

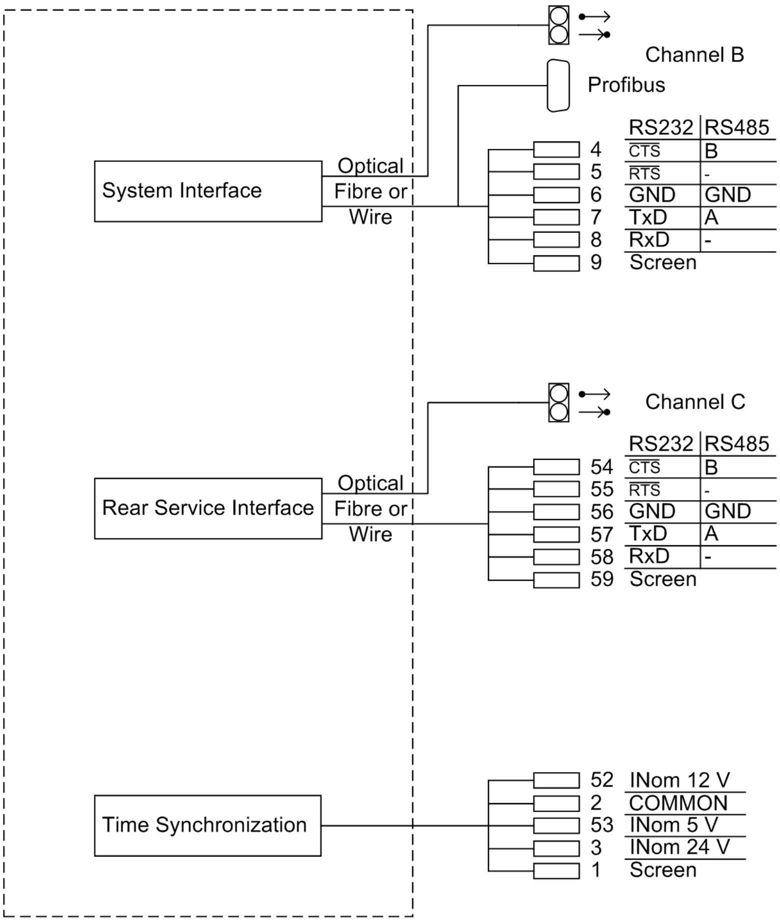


Figure A-23 General diagram for 7SJ635/6*-*B up to release ... /CC (panel surface mounting)

7SJ635/6*-*B (release ... /DD and higher)

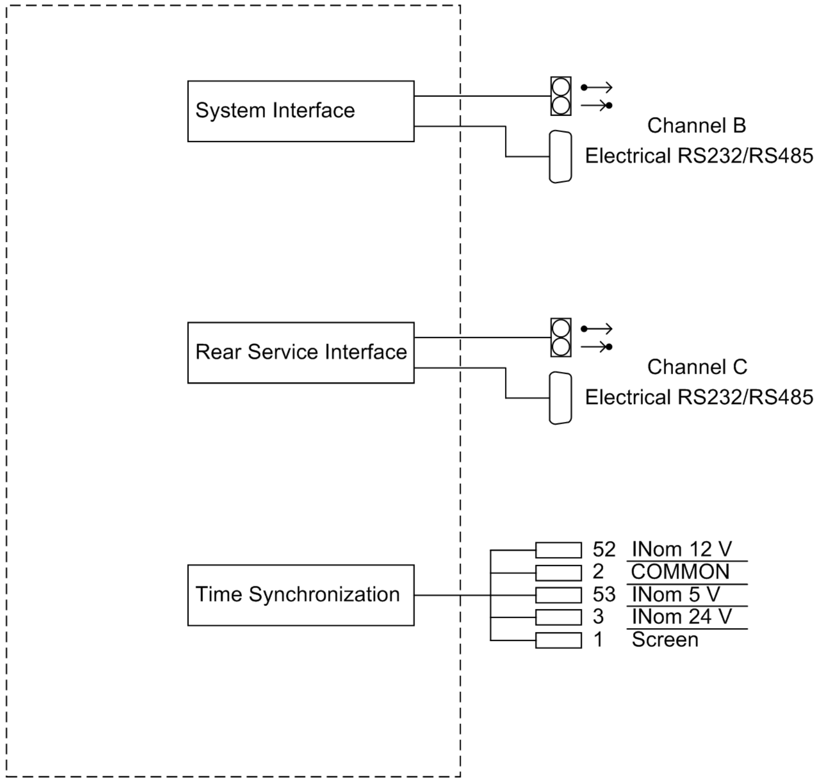


Figure A-24 General diagram for 7SJ635/6*-*, release ... /DD and higher (panel surface mounted)

A.2.9 7SJ63 — Housing with detached operator panel

7SJ631*-*A/C

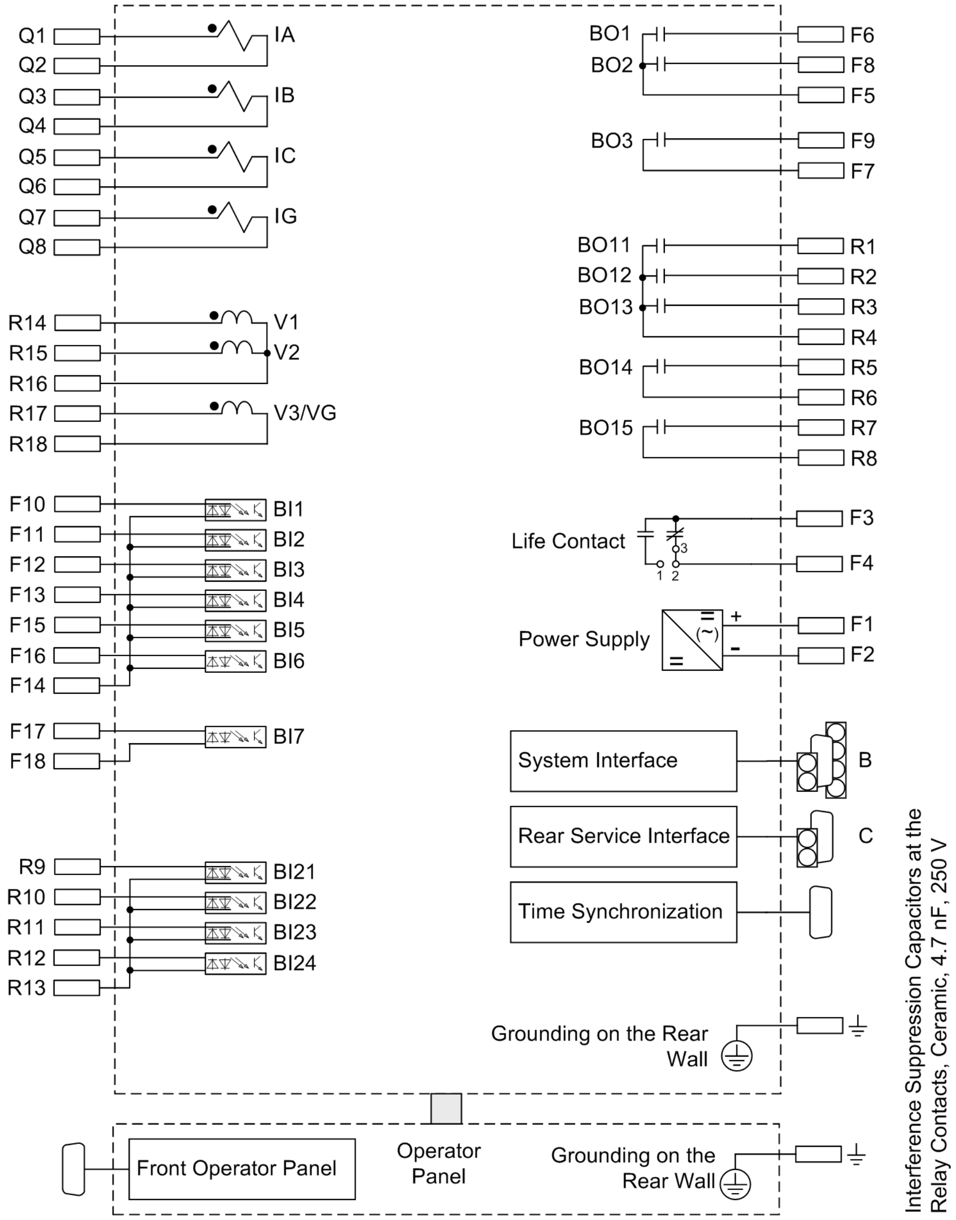


Figure A-25 General diagram 7SJ631*-*A/C (panel surface mounting with detached operator panel)

7SJ632*-*A/C

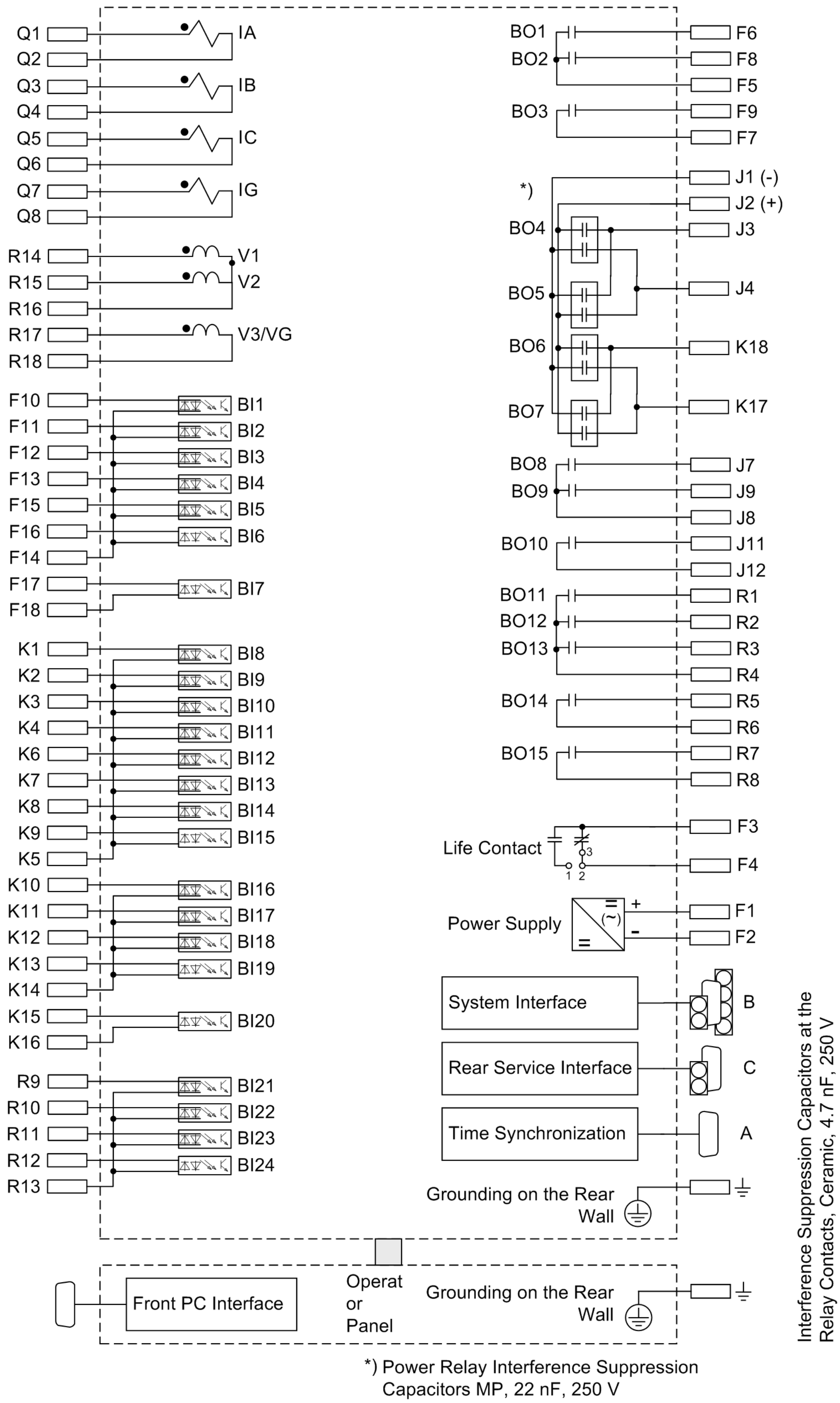


Figure A-26 General diagram 7SJ632*-*A/C (panel surface mounting with detached operator panel)

7SJ633*-*A/C

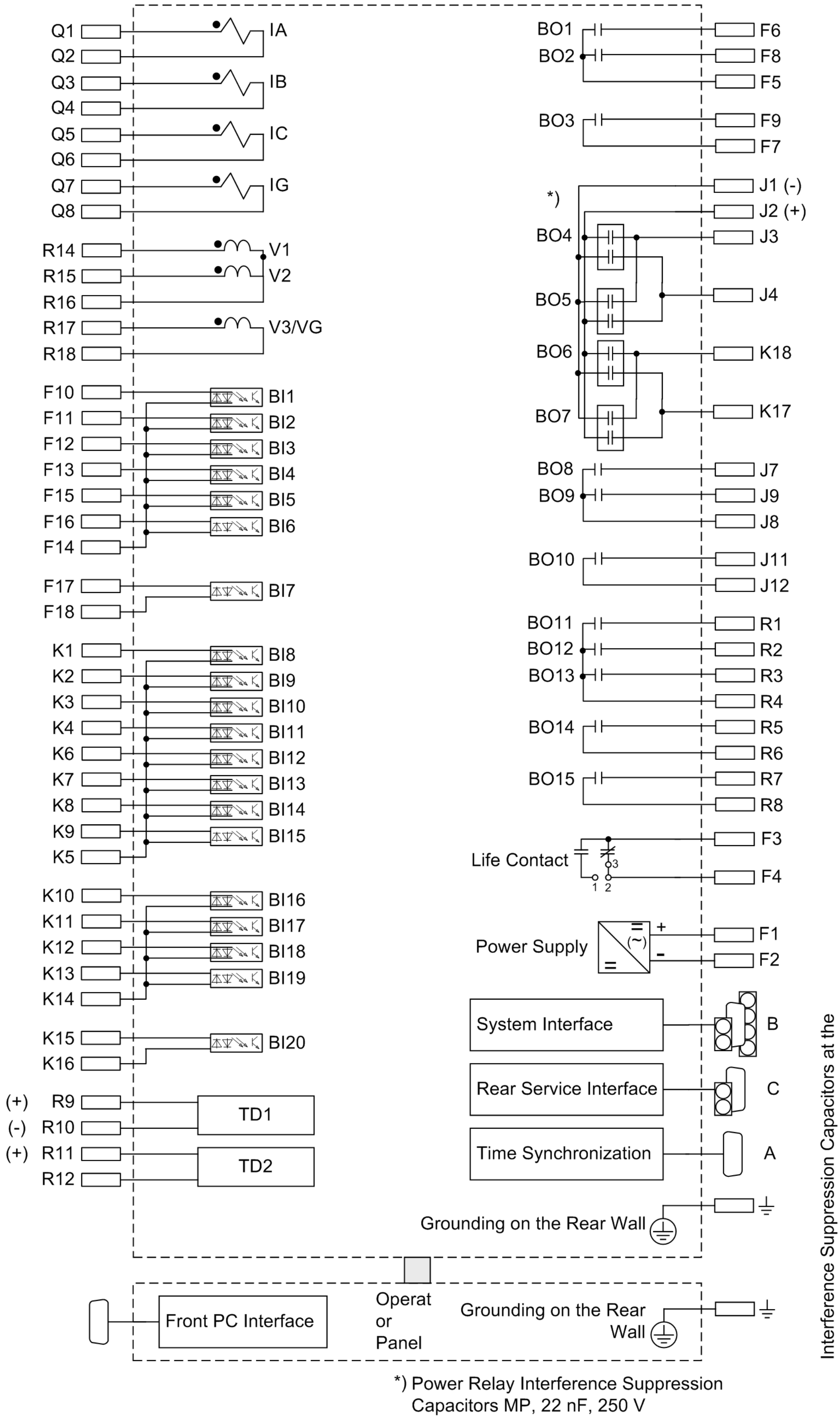


Figure A-27 General diagram 7SJ633*-*A/C (panel surface mounting with detached operator panel)

7SJ635*-*A/C

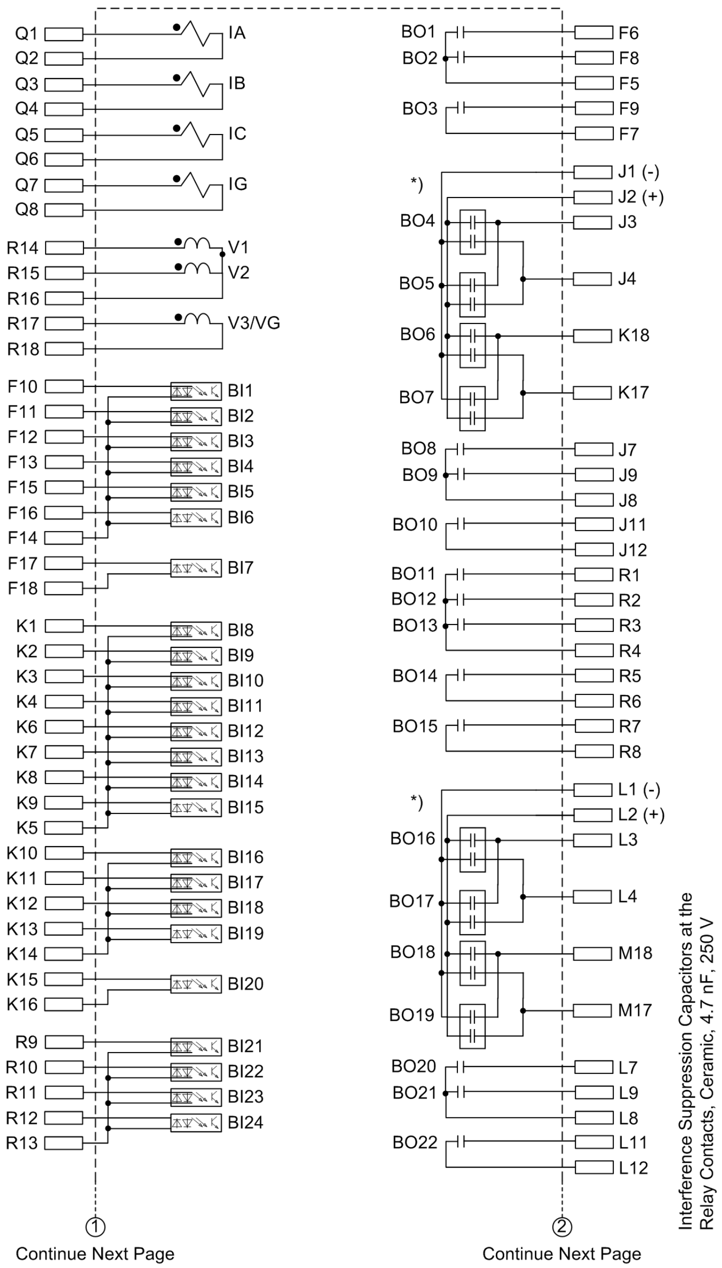


Figure A-28 General diagram 7SJ635*-*A/C (panel surface mounting with detached operator panel), part 1

7SJ635*-*A/C

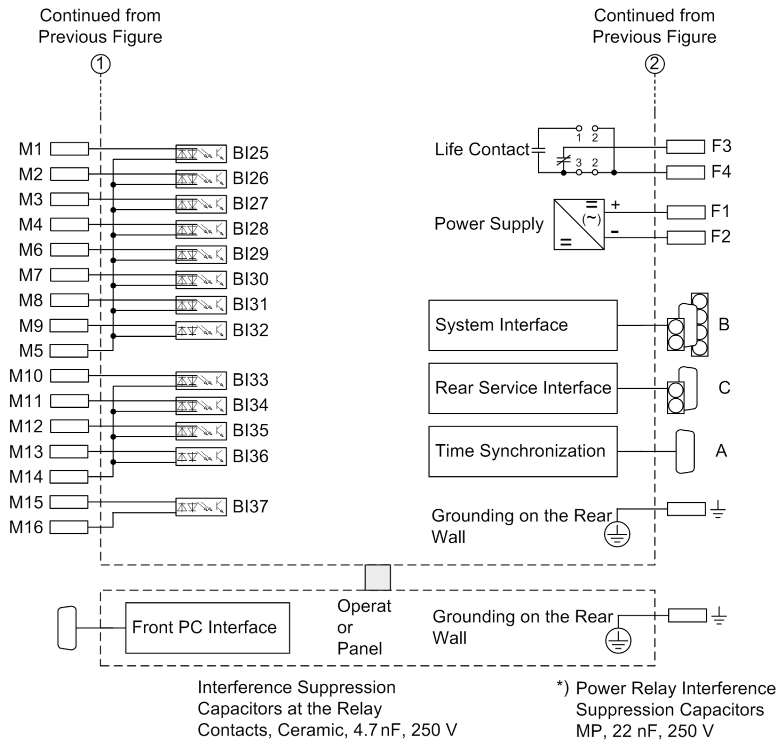


Figure A-29 General diagram 7SJ635*-*A/C (panel surface mounting with detached operator panel), part 2

7SJ636*-*A/C

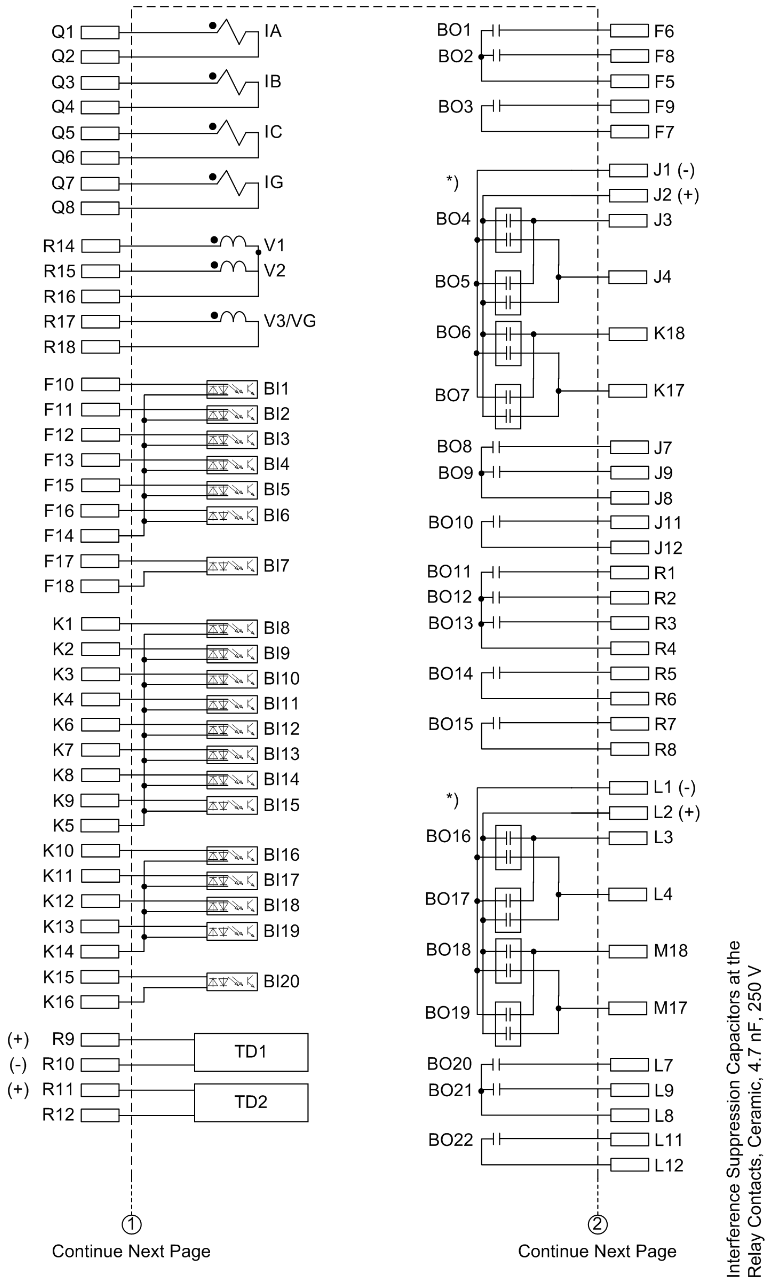


Figure A-30 General diagram 7SJ636*-*A/C (panel surface mounting with detached operator panel), part 1

7SJ636*-*A/C

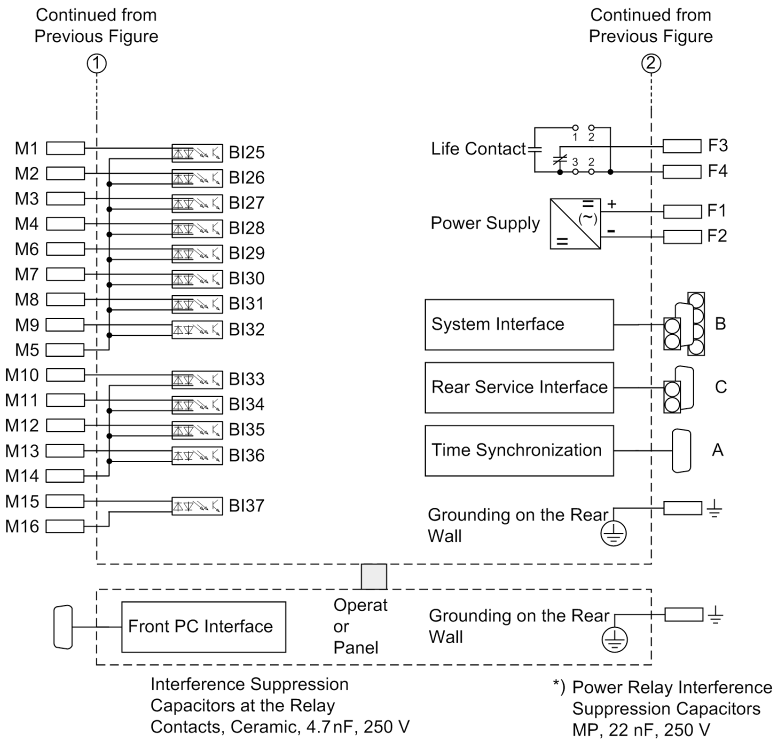


Figure A-31 General diagram 7SJ636*-*A/C (panel surface mounting with detached operator panel), part 2

A.2.10 7SJ63 — Housing for Panel Surface Mounting without Operator Panel

7SJ631*-*F/G

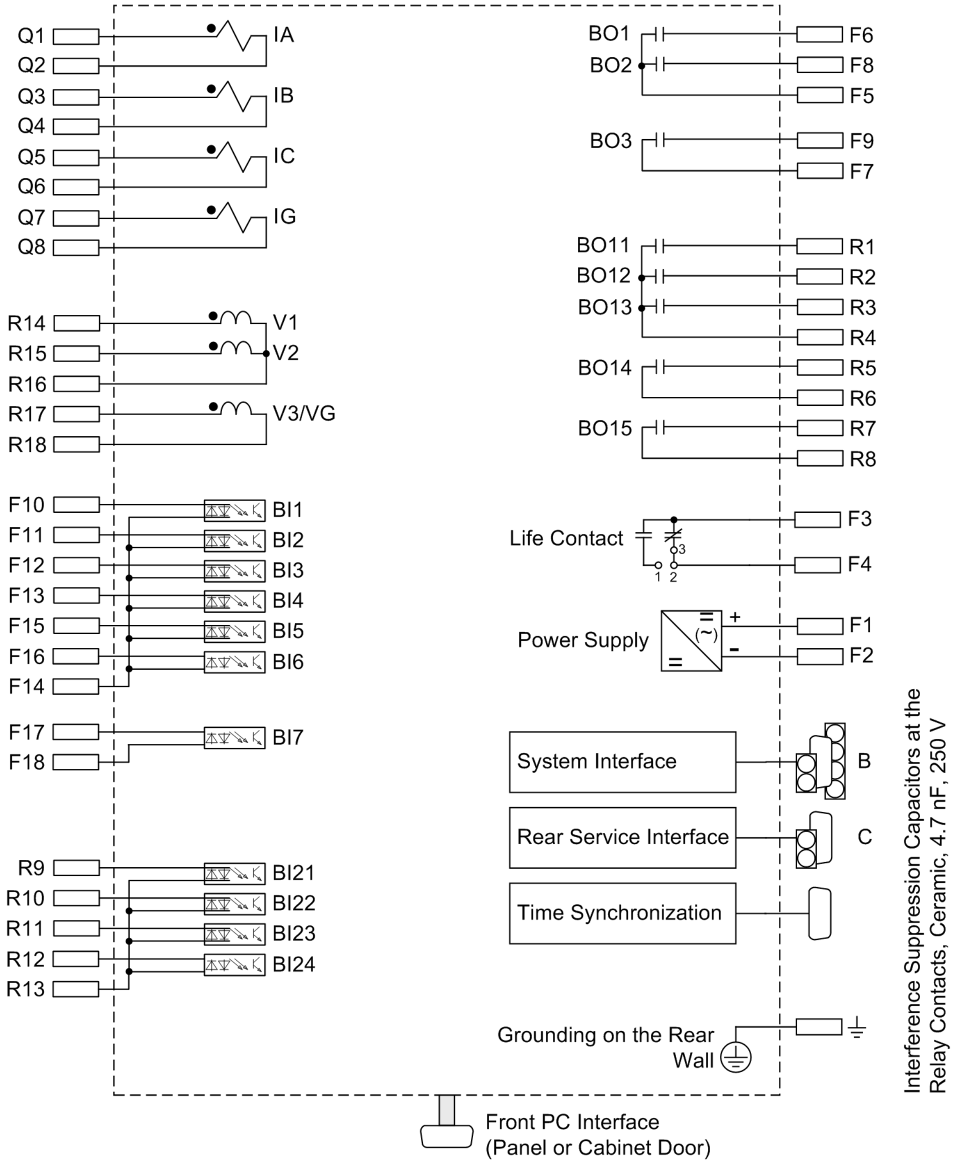


Figure A-32 General diagram 7SJ631*-*F/G (devices for panel surface mounting without operator panel)

7SJ632*-*F/G

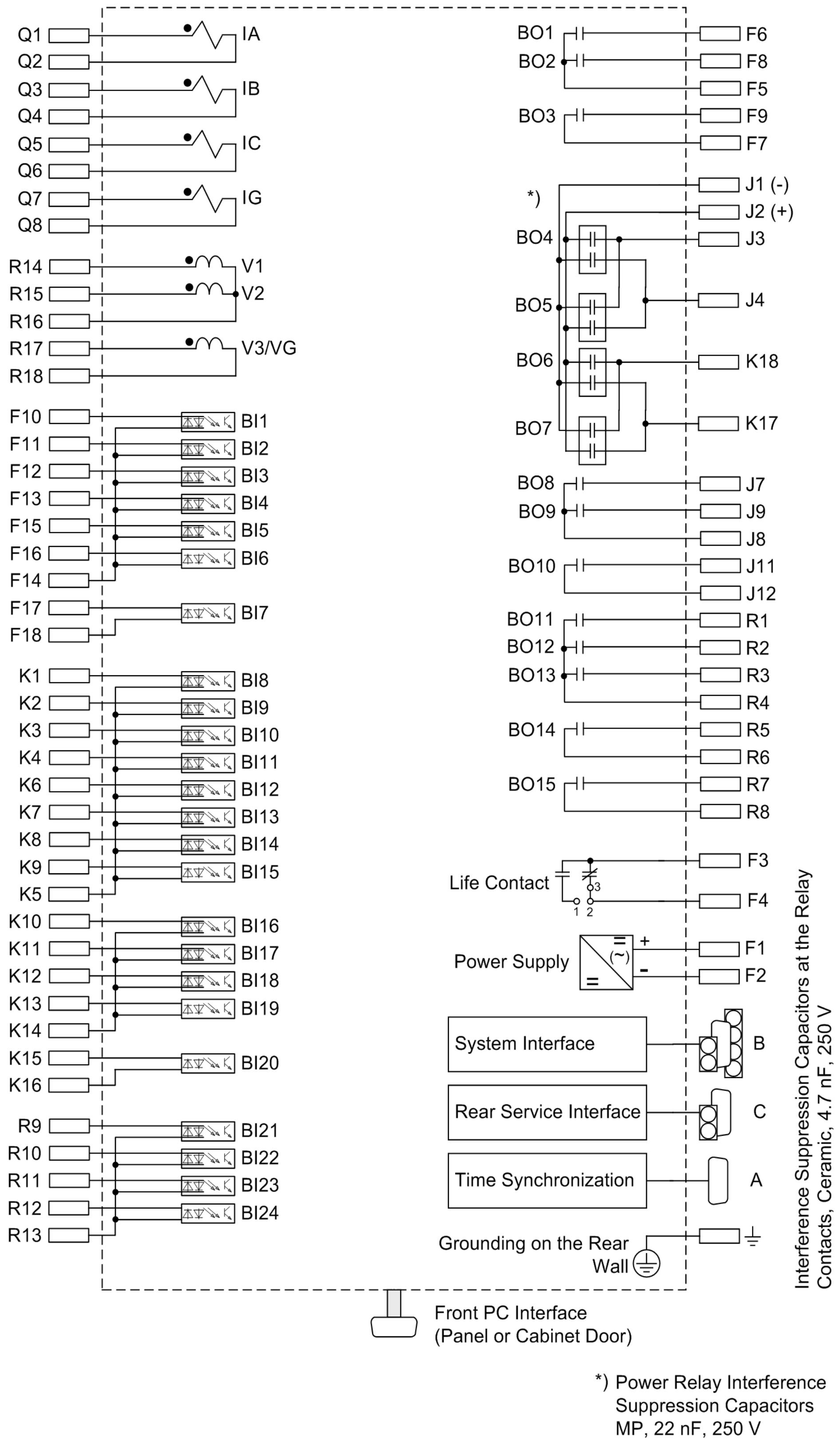


Figure A-33 General diagram 7SJ632*-*F/G (devices for panel surface mounting without operation unit)

7SJ633*-*F/G

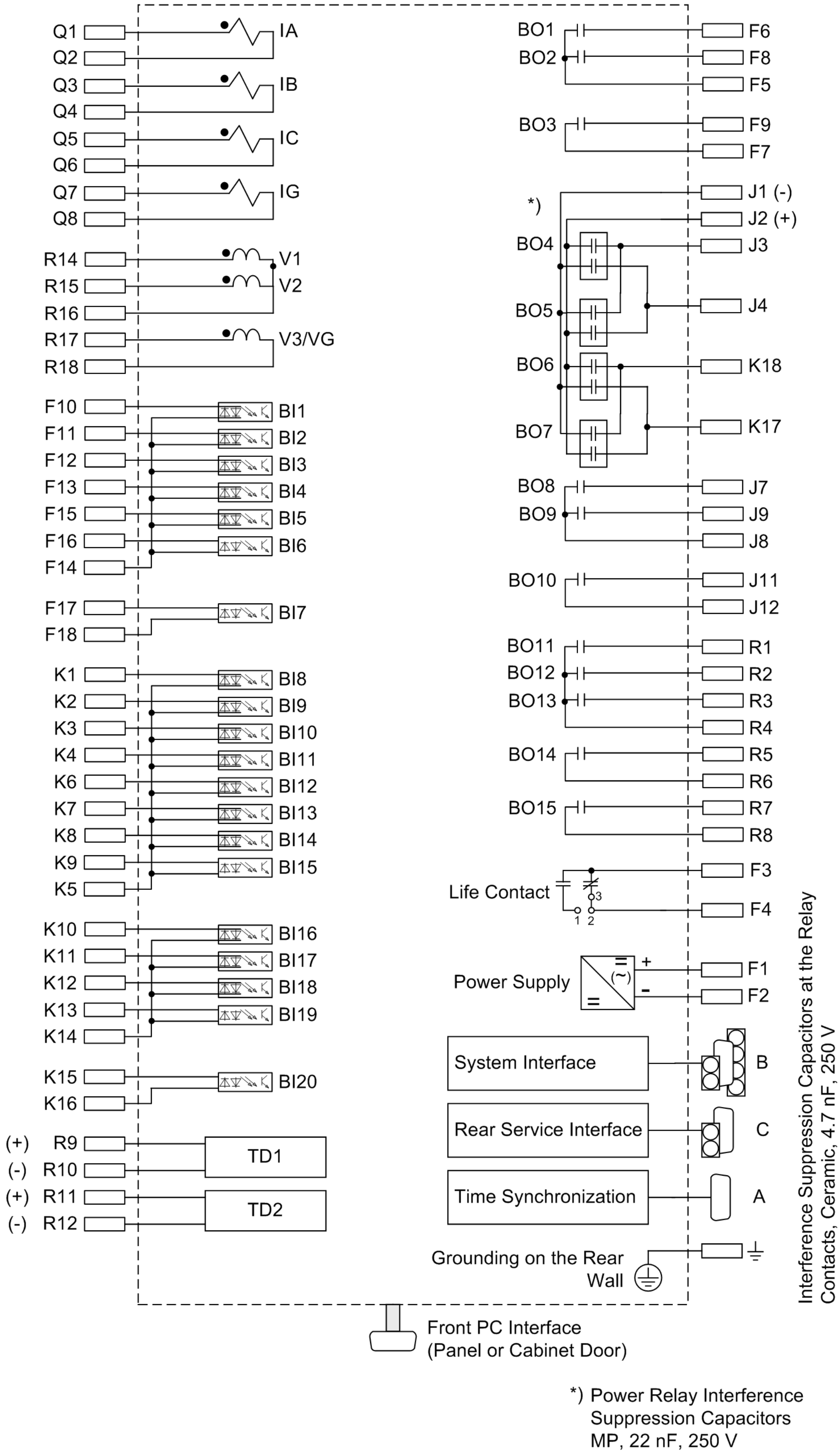


Figure A-34 General diagram 7SJ633*-*F/G (devices for panel surface mounting without operation unit)

7SJ635*-*F/G

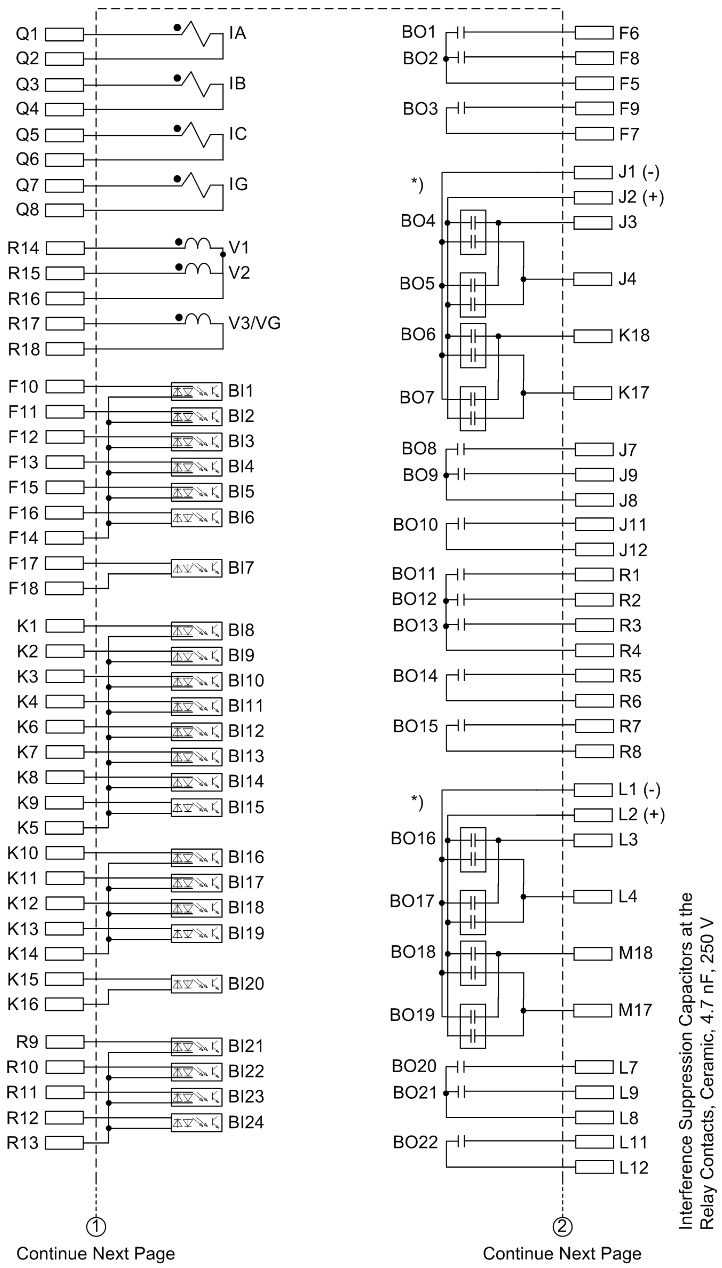


Figure A-35 General diagram 7SJ635*-*F/G (devices for panel surface mounting without operation unit), part 1

7SJ635*-*F/G

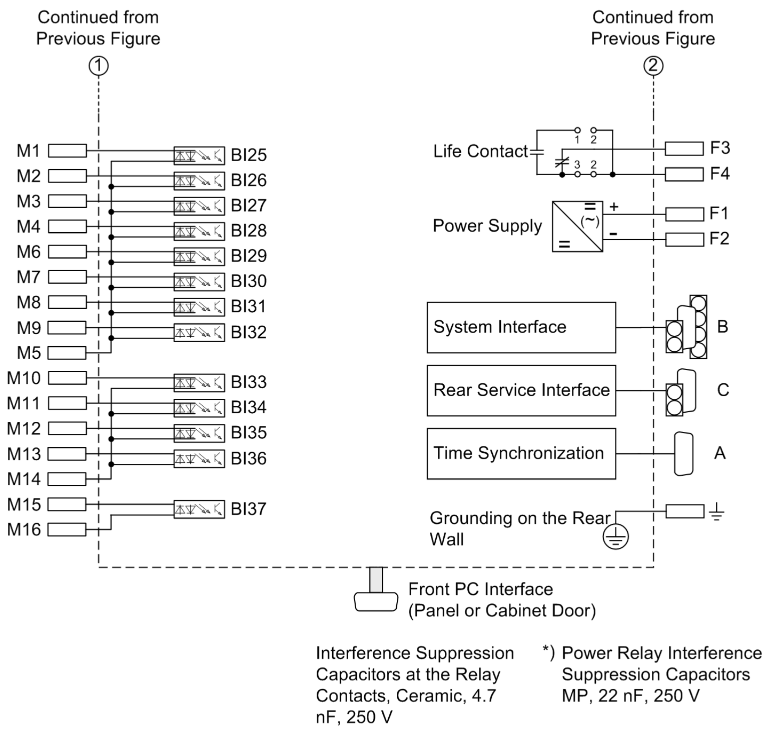


Figure A-36 General diagram 7SJ635*-*F/G (devices for panel surface mounting without operation unit), part 2

7SJ636*-*F/G

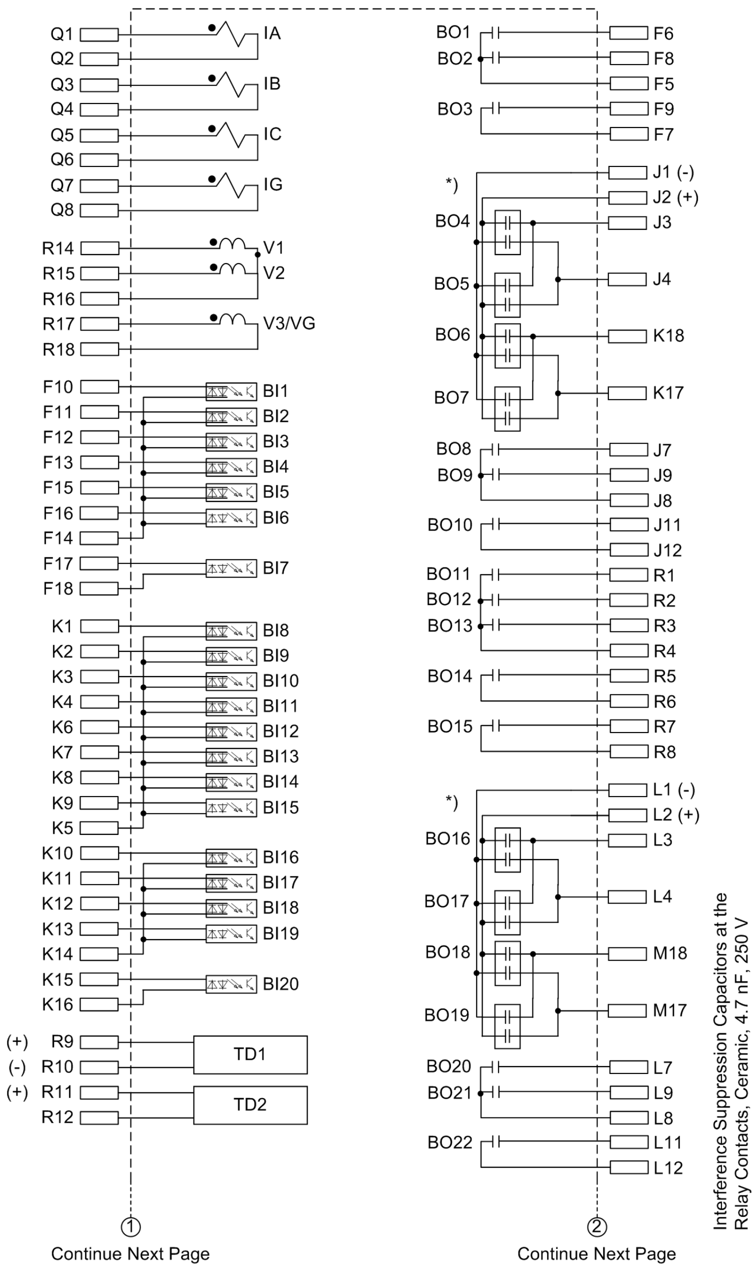


Figure A-37 General diagram 7SJ636*-*F/G (devices for panel surface mounting without operator panel), part 1

7SJ636*-*F/G

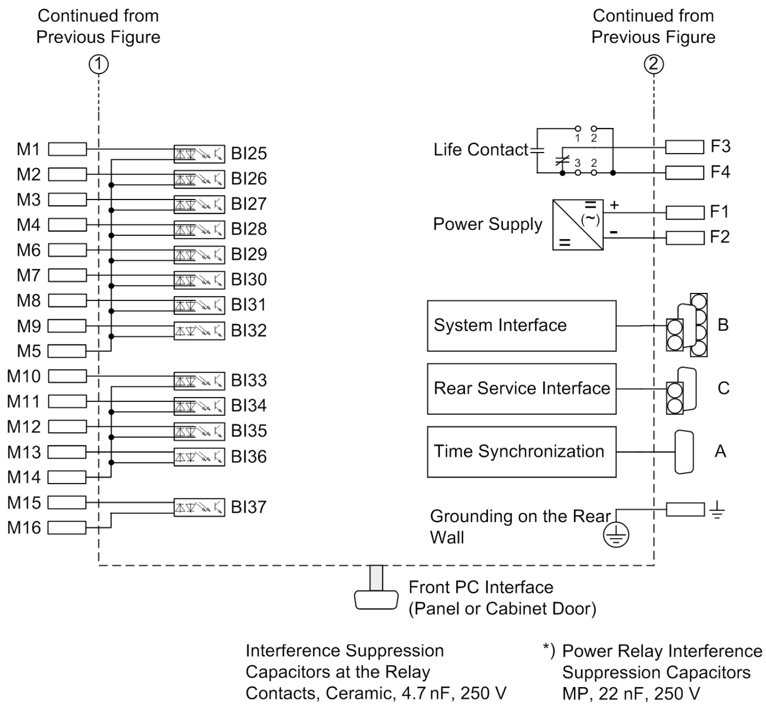


Figure A-38 General diagram 7SJ636*-*F/G (devices for panel surface mounting without operator panel), part 2

A.2.11 7SJ64 — Housing for Panel Flush Mounting or Cubicle Installation

7SJ640*-*D/E

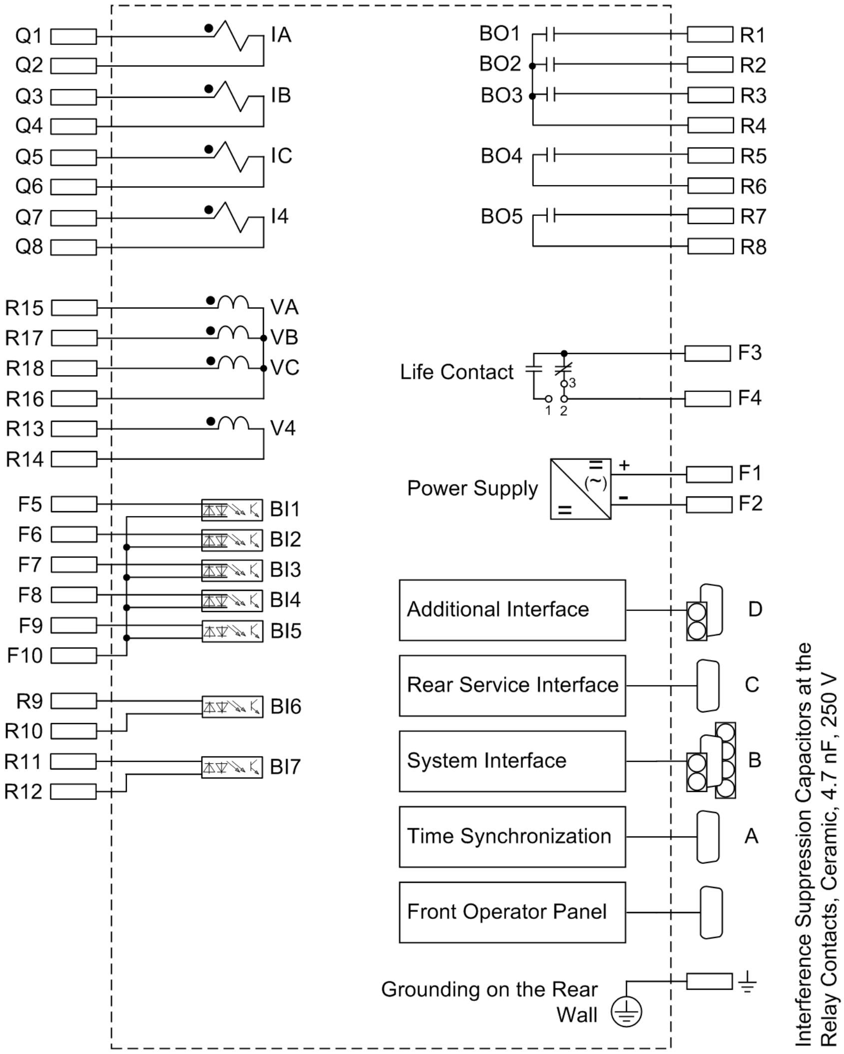


Figure A-39 General diagram for 7SJ640*–*D/E (panel flush mounting or cubicle mounting)

7SJ641*-*D/E

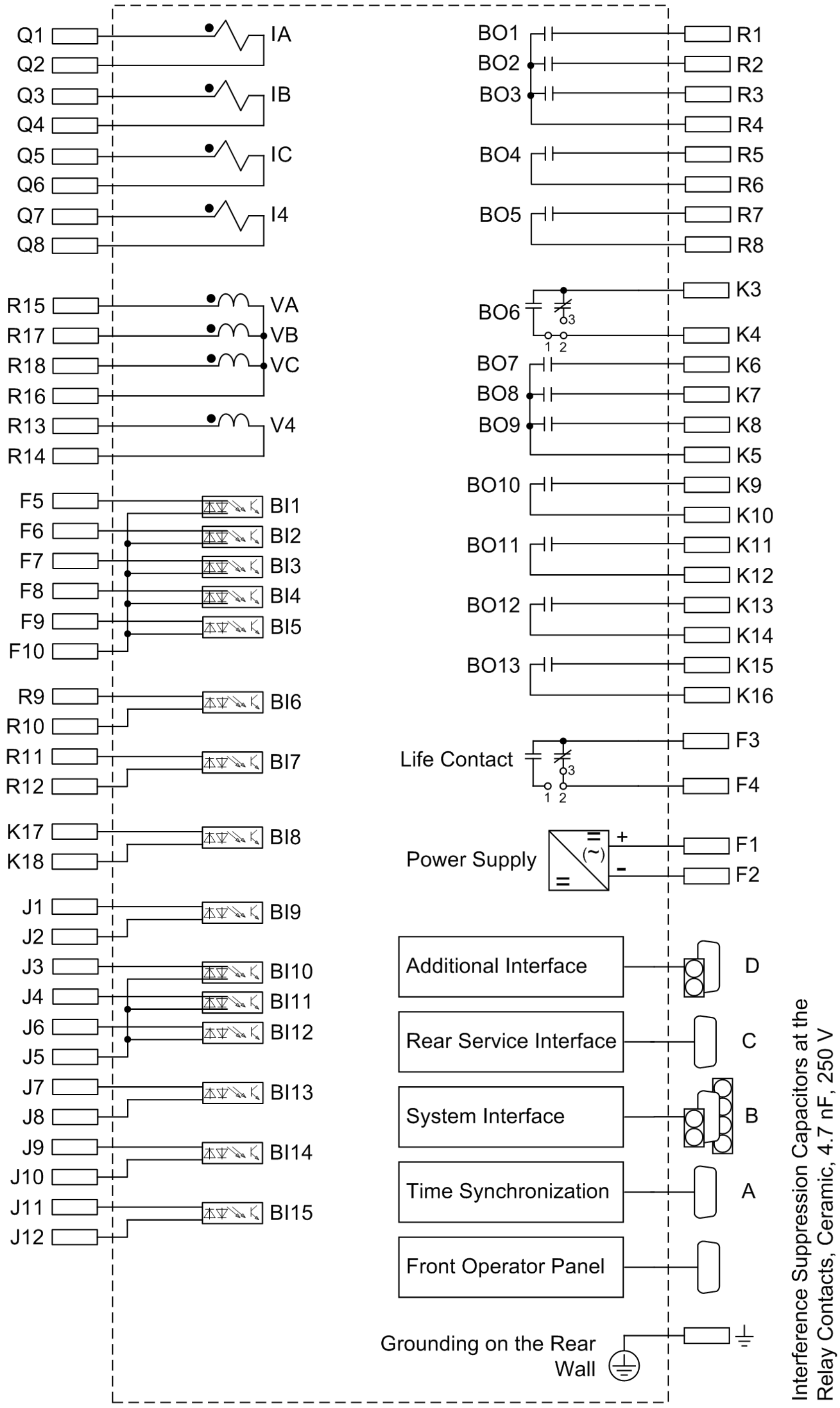


Figure A-40 General diagram for 7SJ641*–*D/E (panel flush mounting or cubicle mounting)

7SJ642*-*D/E

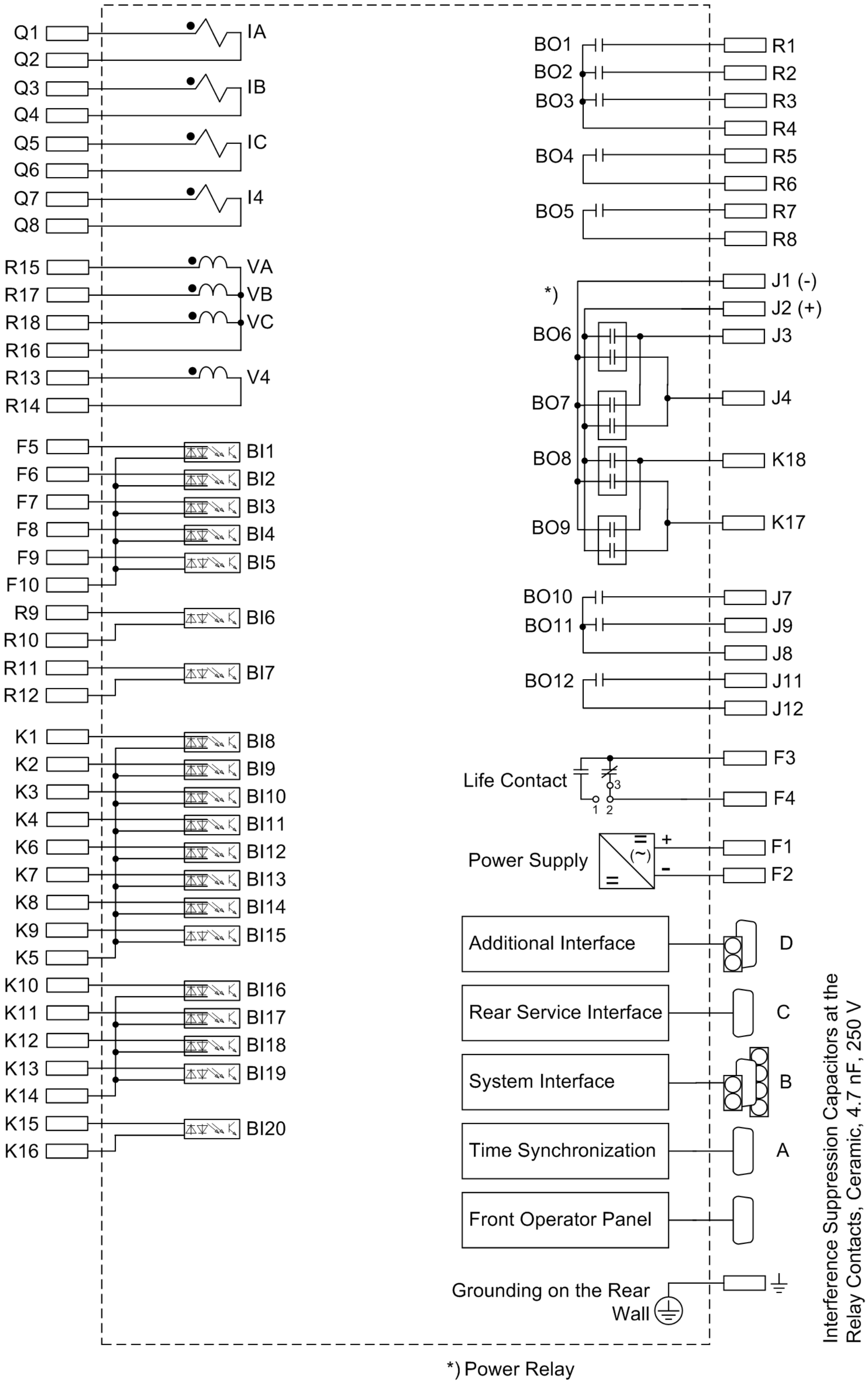


Figure A-41 General diagram for 7SJ642*–*D/E (panel flush mounting or cubicle mounting)

7SJ645*-*D/E

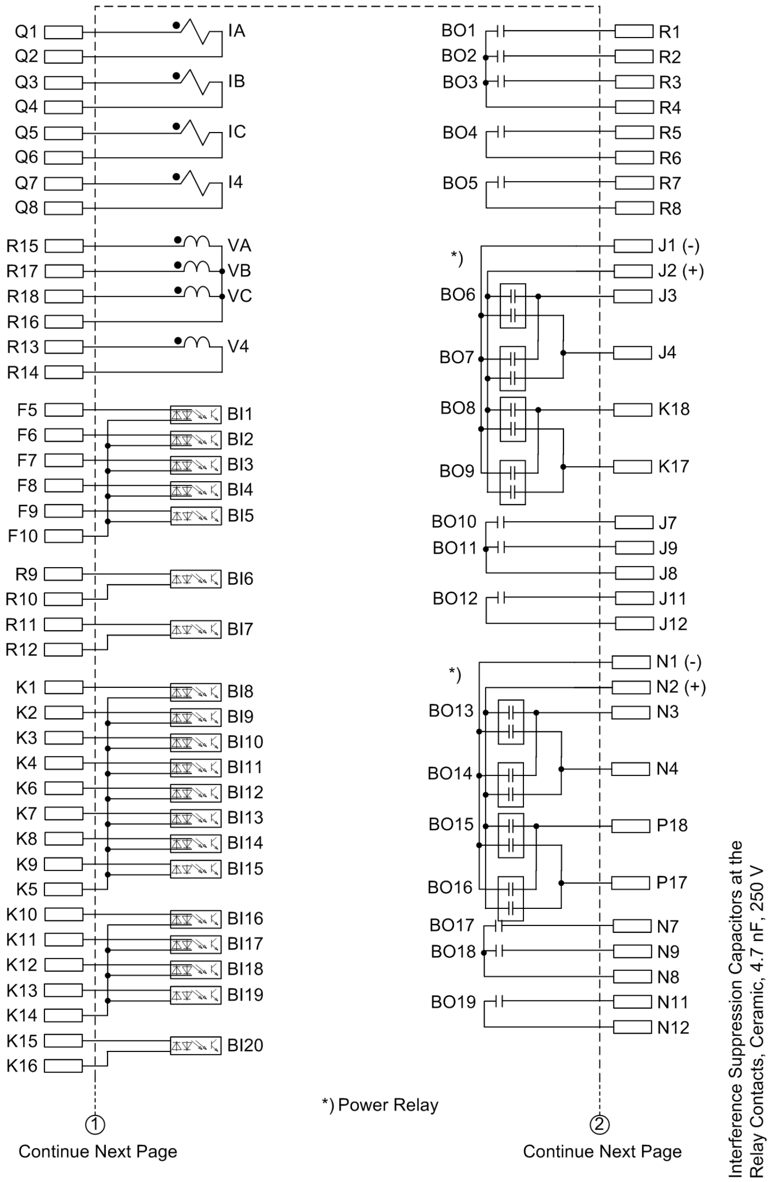


Figure A-42 General diagram for 7SJ645*–*D/E (panel flush mounting or cubicle mounting), part 1

7SJ645*-*D/E

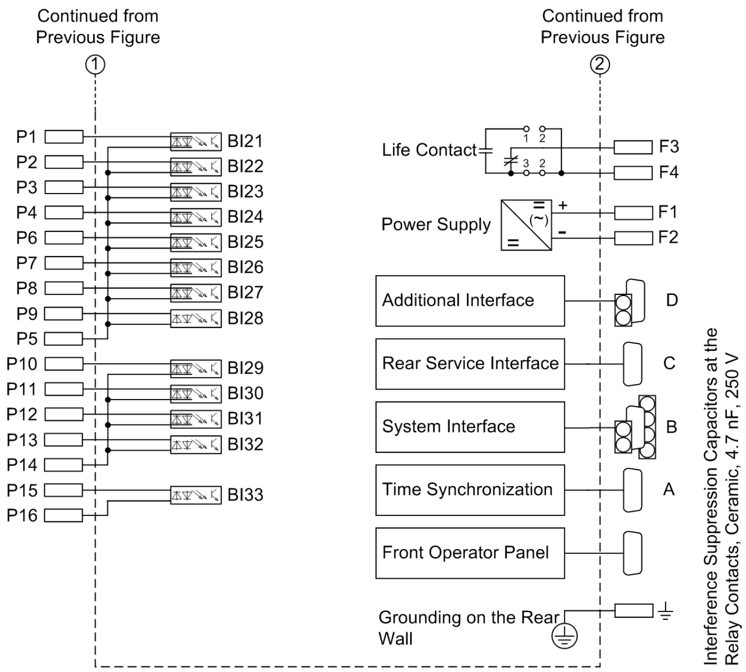


Figure A-43 General diagram for 7SJ645*–*D/E (panel flush mounting or cubicle mounting), part 2

A.2.12 7SJ64 — Housing for Panel Surface Mounting

7SJ640*-*B

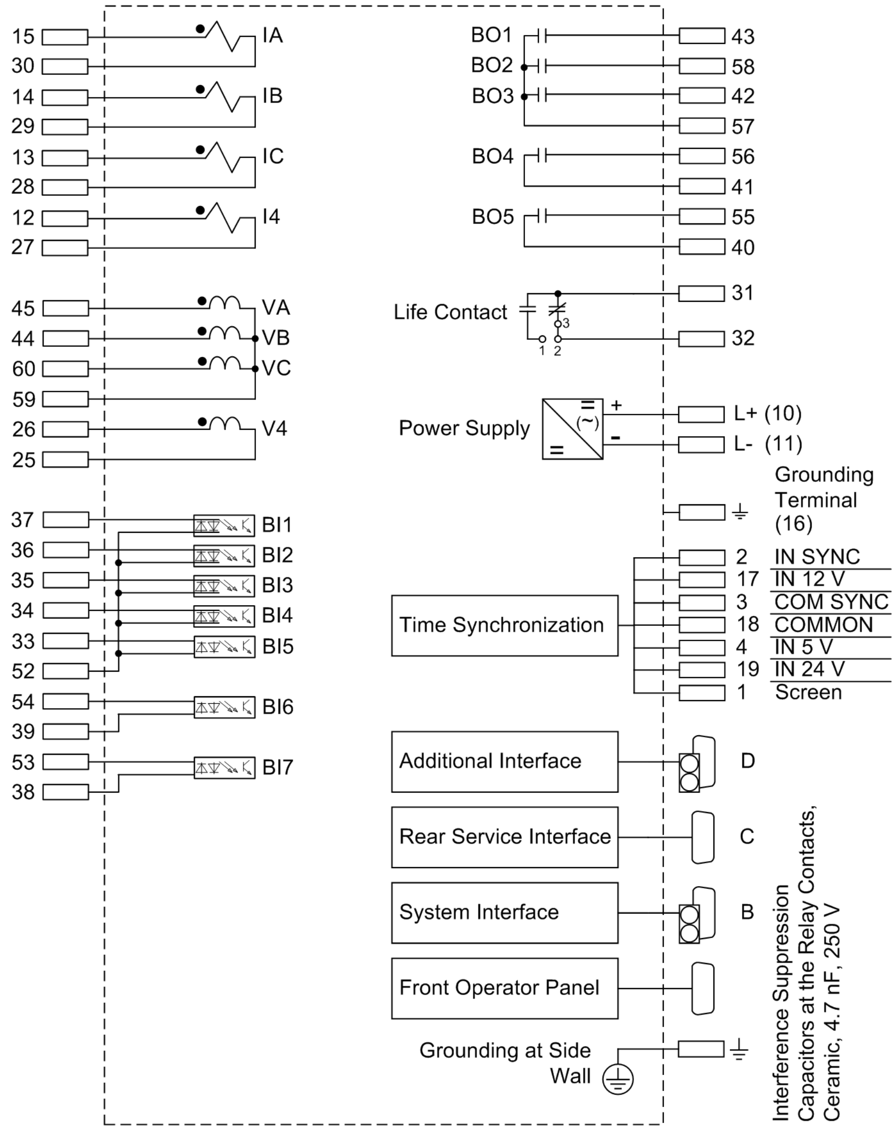


Figure A-44 General diagram for 7SJ640*–*B (panel surface mounted)

7SJ641*-*B

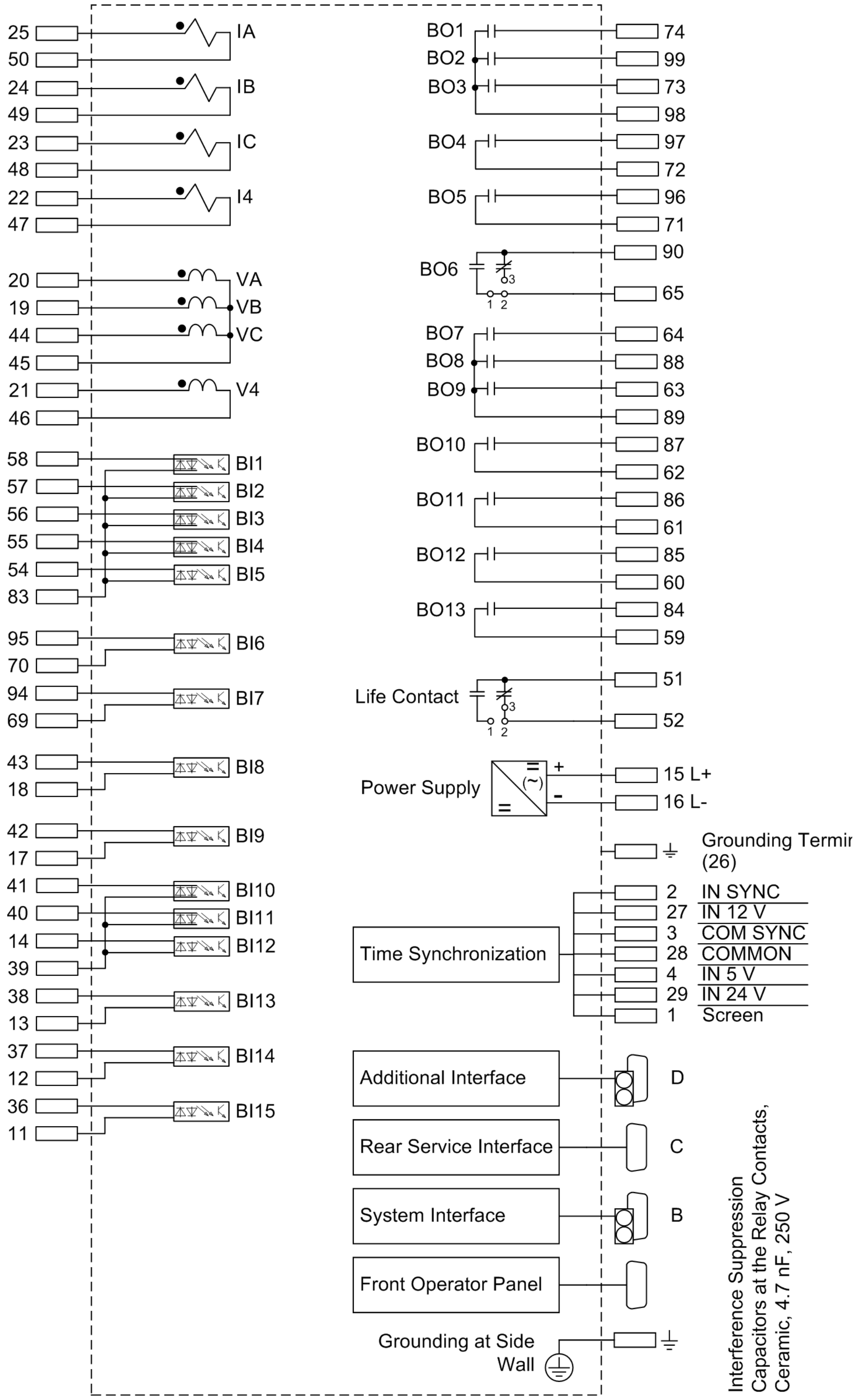


Figure A-45 General diagram for 7SJ641*–*B (panel surface mounting)

7SJ642*-*B

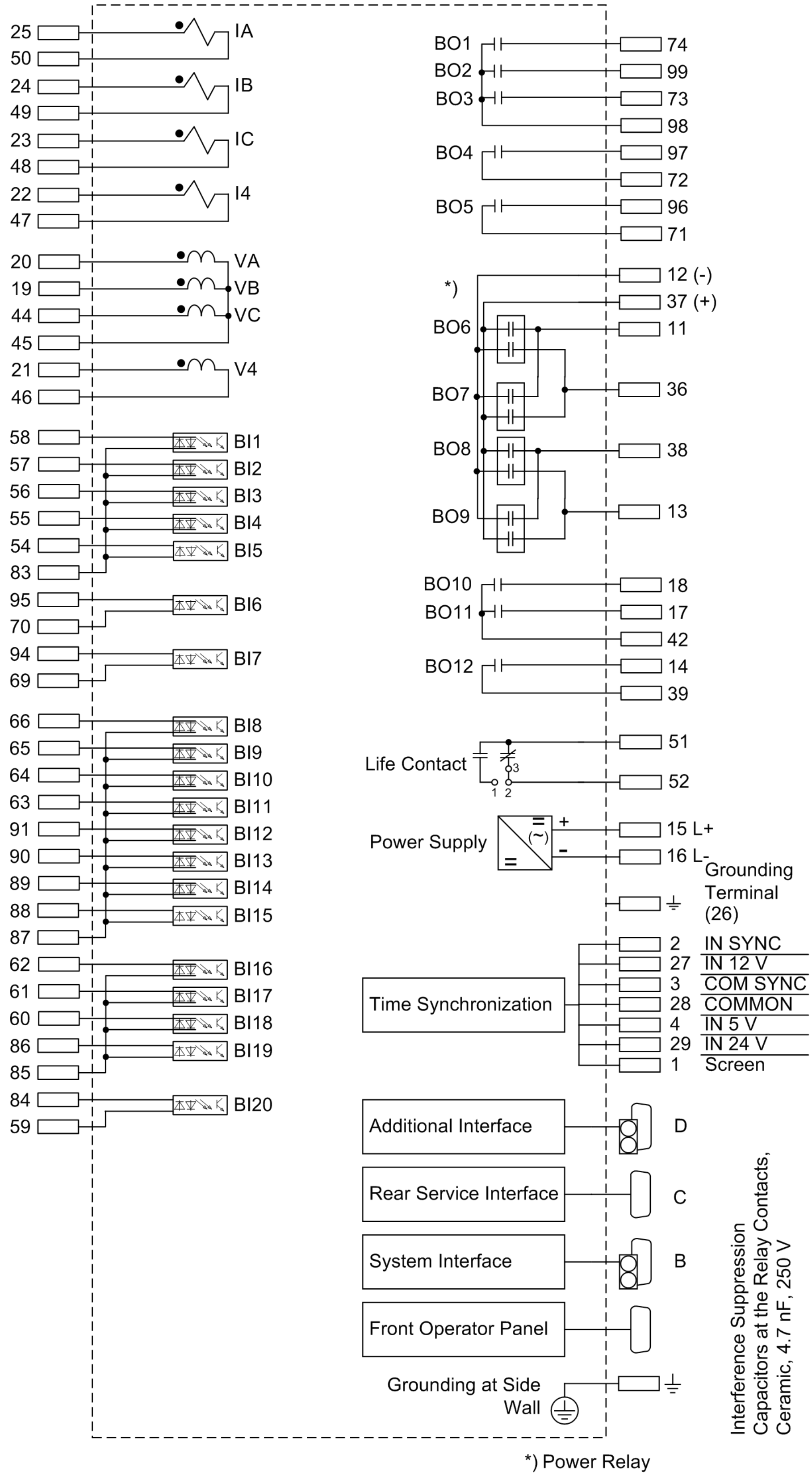


Figure A-46 General diagram for 7SJ642*–*B (panel surface mounting)

7SJ645*-*B

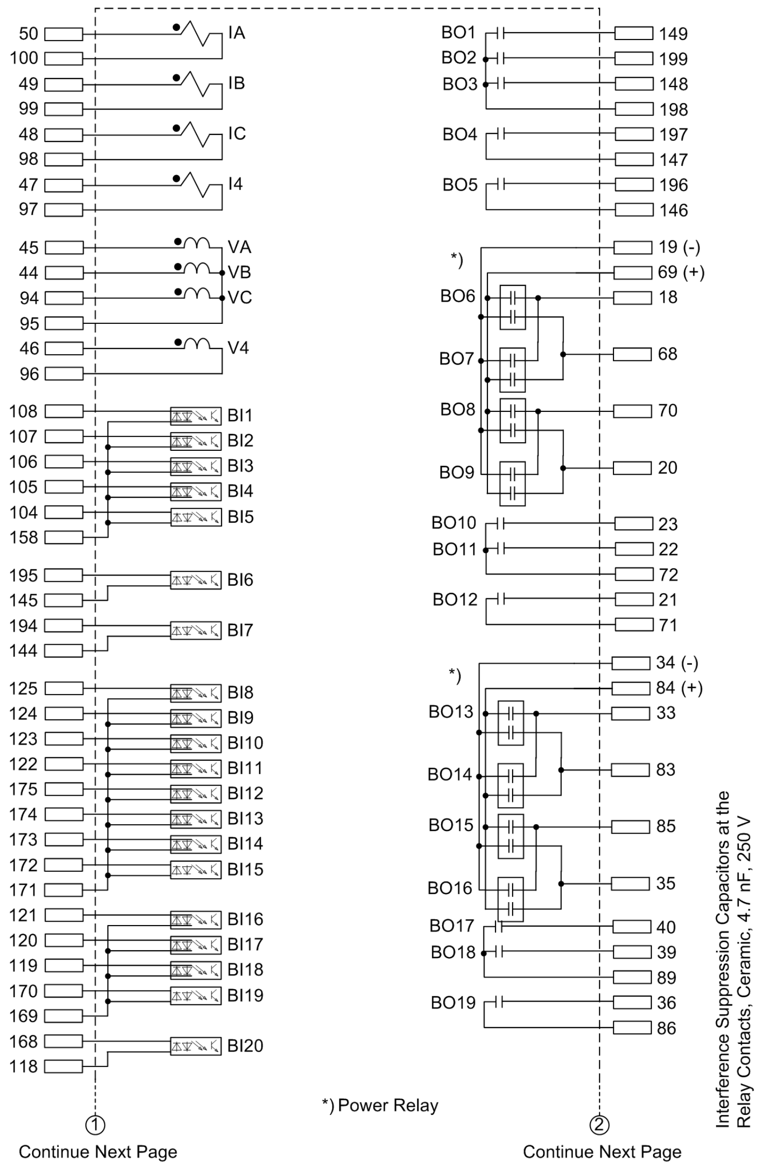


Figure A-47 General diagram for 7SJ645*–*B (panel surface mounting), part 1

7SJ645*-*B

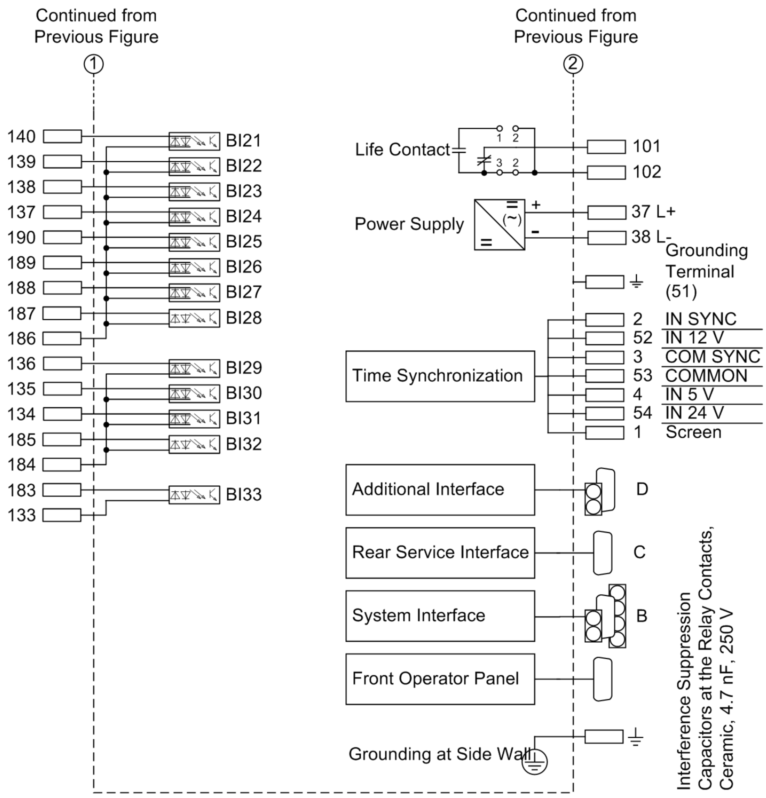


Figure A-48 General diagram for 7SJ645*–*B (panel surface mounting), part 2

A.2.13 7SJ64 — Housing with Detached Operator Panel

7SJ641*-*A/C

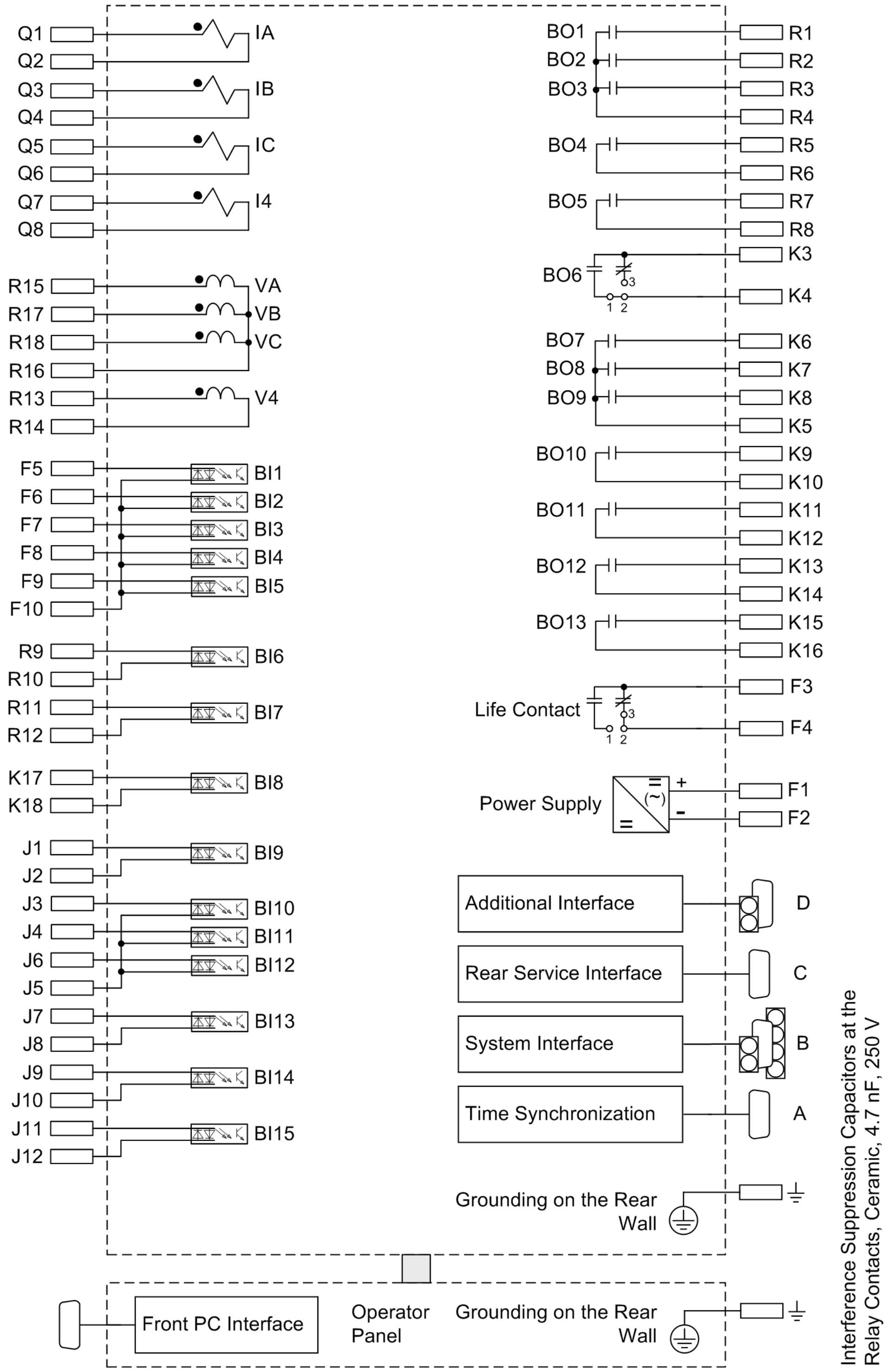


Figure A-49 General diagram 7SJ641*–*A/C (panel surface mounting with detached operator panel)

7SJ642*-*A/C

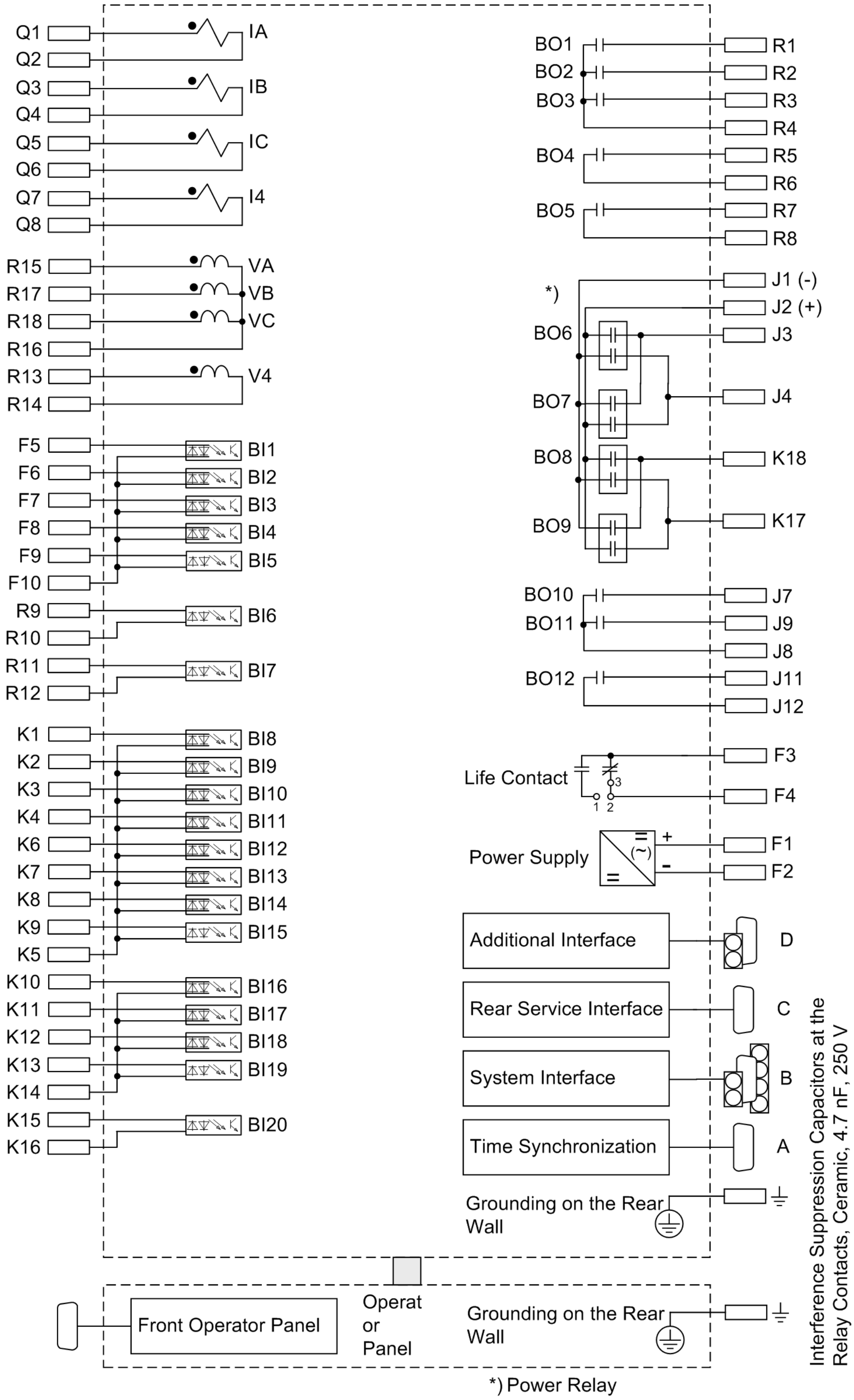


Figure A-50 General diagram 7SJ642*–*A/C (panel surface mounting with detached operator panel)

7SJ645*-*A/C

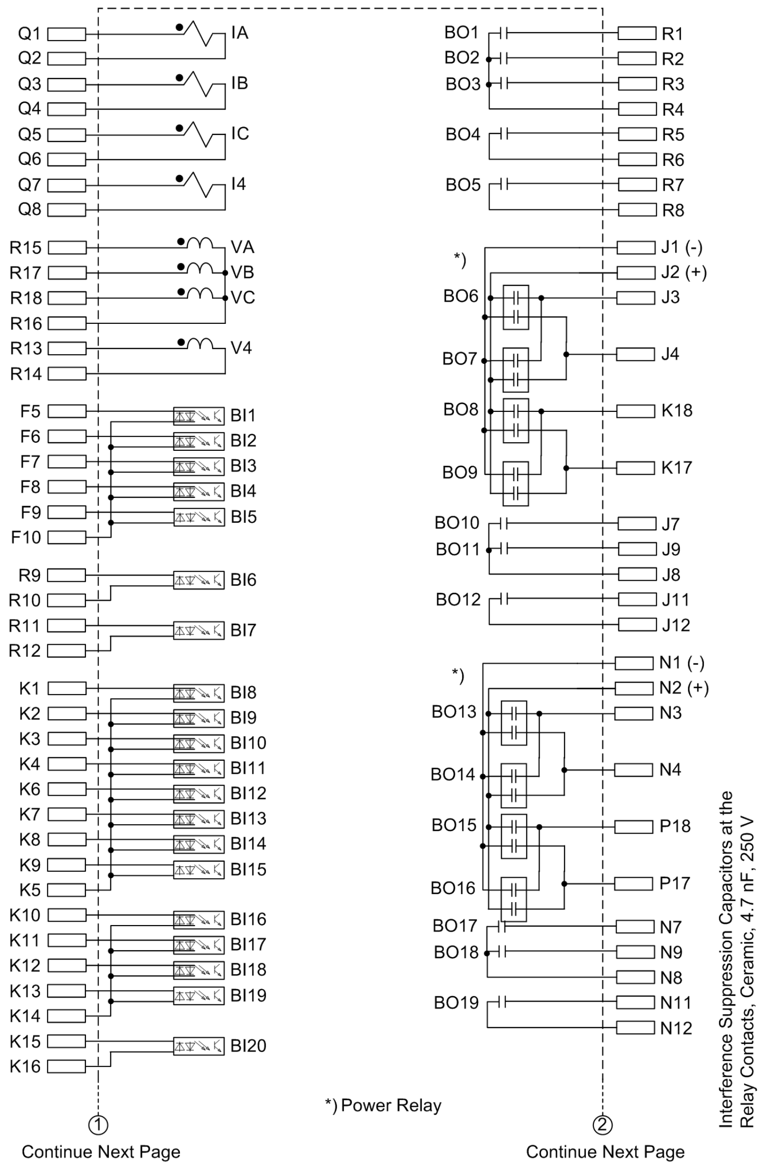


Figure A-51 General diagram 7SJ645*–*A/C (panel surface mounting with detached operator panel), part 1

7SJ645*-*A/C

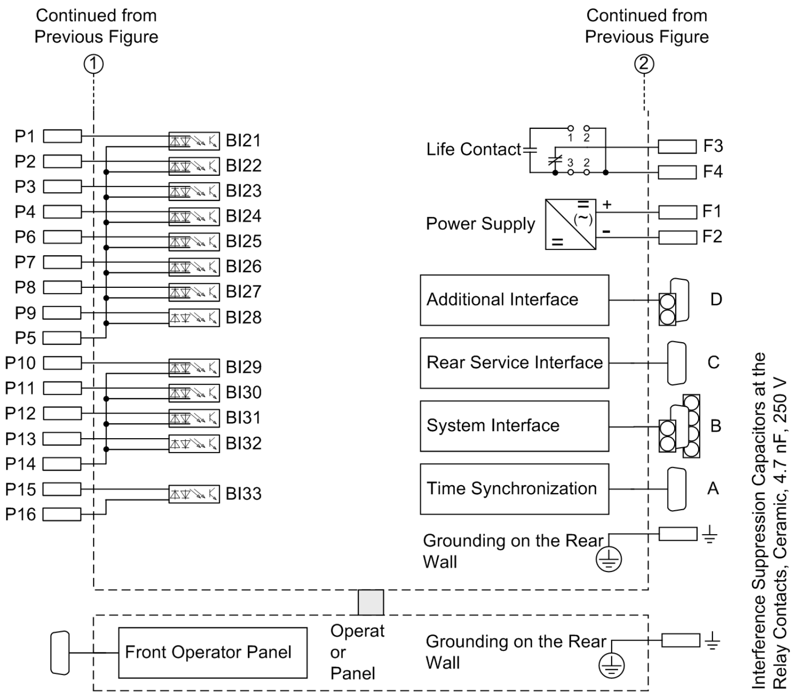


Figure A-52 General diagram 7SJ645*–*A/C (panel surface mounting with detached operator panel), part 2

A.2.14 7SJ64 — Housing for Panel Surface Mounting without Operator Panel

7SJ641*-*F/G

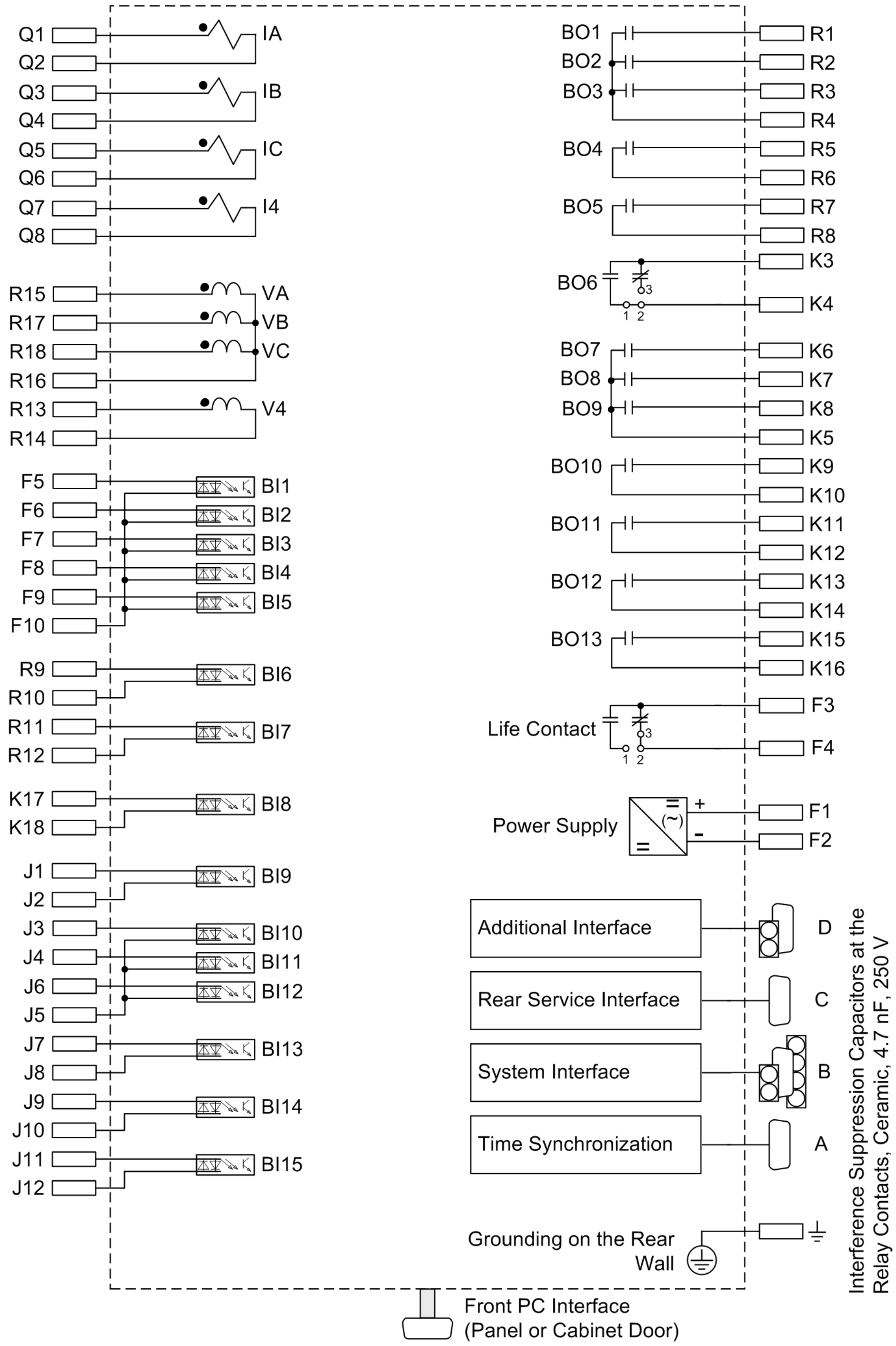


Figure A-53 General diagram 7SJ641*–*F/G (devices for panel surface mounting without operation unit)

7SJ642*-*F/G

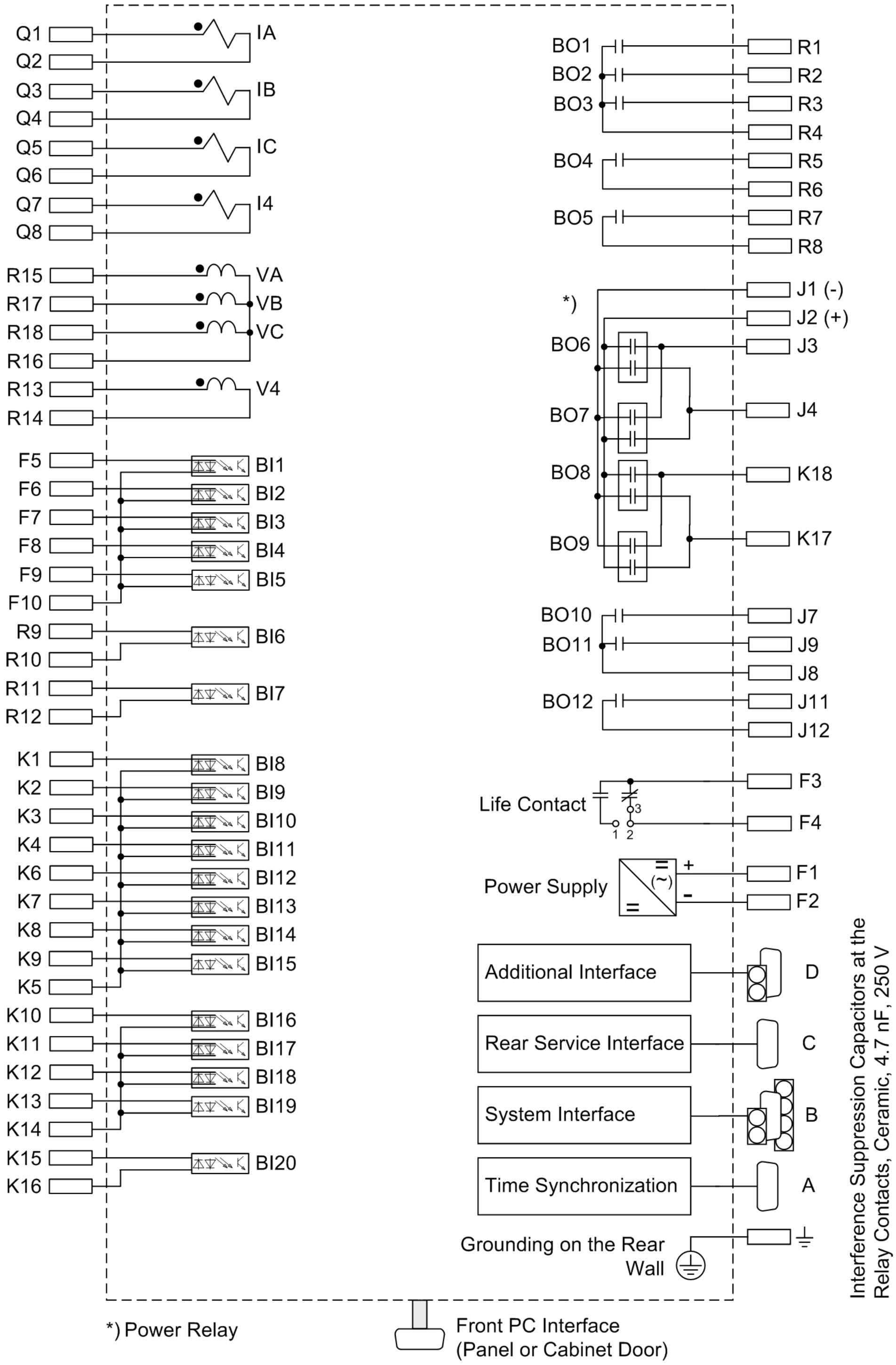


Figure A-54 General diagram 7SJ642*–*F/G (panel surface mounting without operator panel)

7SJ645*-*F/G

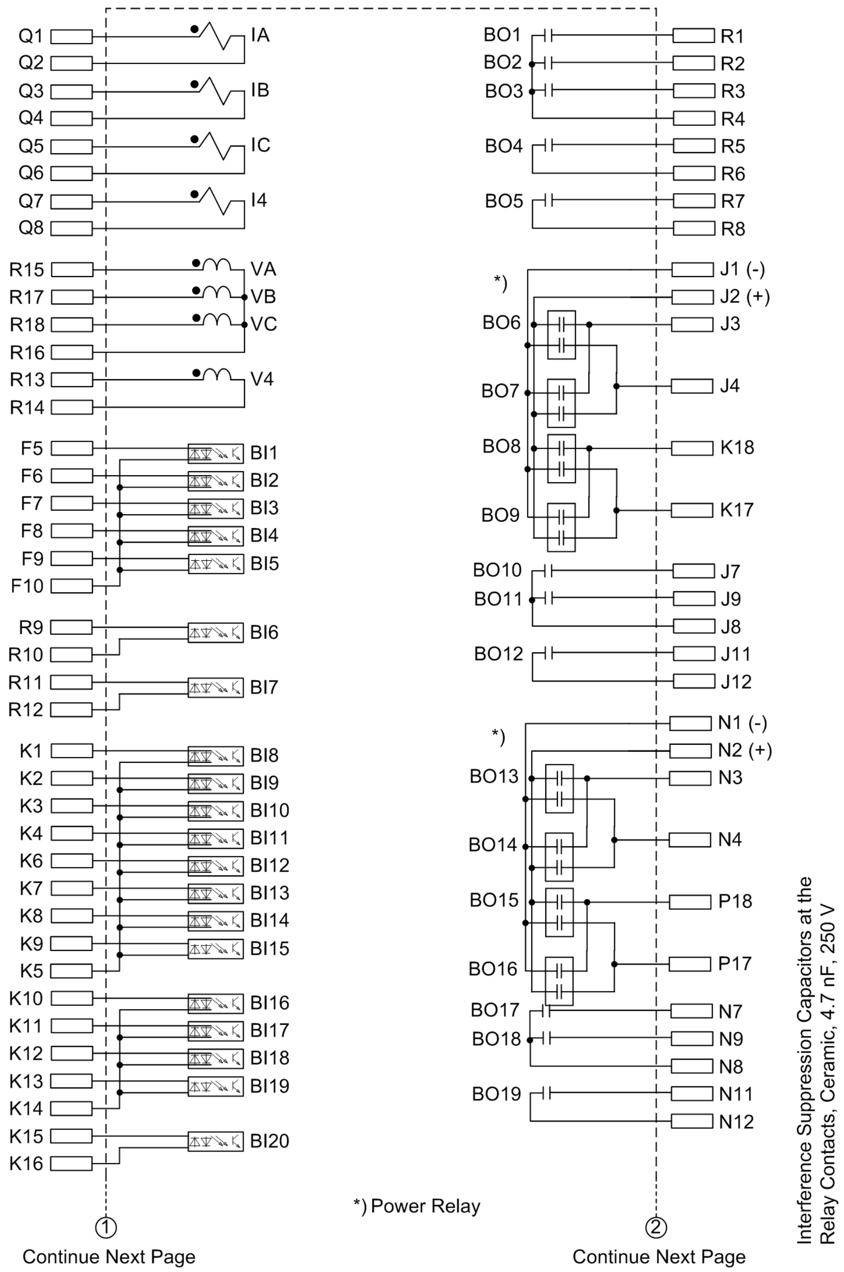


Figure A-55 General diagram 7SJ645*–*F/G (devices for panel surface mounting without operator panel), part 1

7SJ645*-*F/G

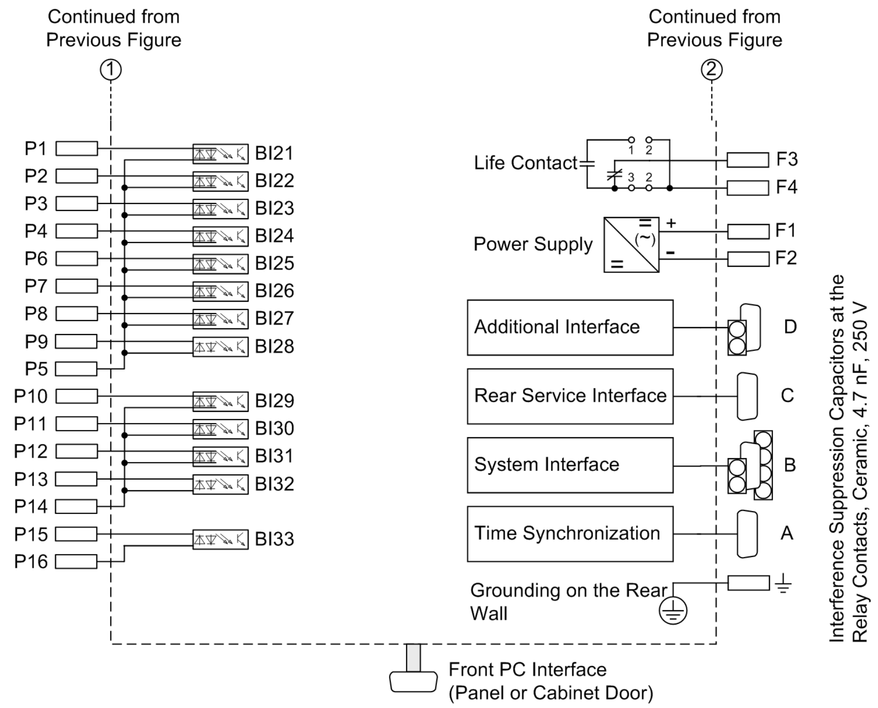


Figure A-56 General diagram 7SJ645*–*F/G (devices for panel surface mounting without operator panel), part 2

A.2.15 Connector Assignment

On the Ports

	RS232	RS485	Profibus FMS Slave, RS485 Profibus DP Slave, RS485	Modbus, RS485 DNP3.0, RS485	Ethernet RS232
1	Shield (electrically connected with shield end)				Tx+
2	RxD	—	—	—	Tx-
3	TxD	A/A’ (RxD/TxD-N)	B/B’ (RxD/TxD-P)	A	Rx+
4	—	—	CNTR-A (TTL)	RTS (TTL level)	—
5	GND	C/C’ (GND)	C/C’ (GND)	GND1	—
6	—	—	+5 V (max. load <100 mA)	VCC1	Rx-
7	RTS	—*)	—	—	—
8	CTS	B/B’ (RxD/TxD-P)	A/A’ (RxD/TxD-N)	B	—
9	—	—	—	—	

*) Pin 7 also carries the RTS signal with RS232 level when operated as RS485 interface.
Pin 7 must therefore not be connected!

On the time Synchronization Port

Pin no.	Designation	Signal Meaning
1	P24_TSIG	Input 24 V
2	P5_TSIG	Input 5 V
3	M_TSIG	Return Line
4	—*)	—*)
5	Screen	Screen Potential
6	—	—
7	P12_TSIG	Input 12 V
8	P_TSYNC*)	Input 24 V*)
9	Screen	Screen Potential

*) assigned, but not available

A.3 Connection Examples

A.3.1 Connection Examples for 7SJ62

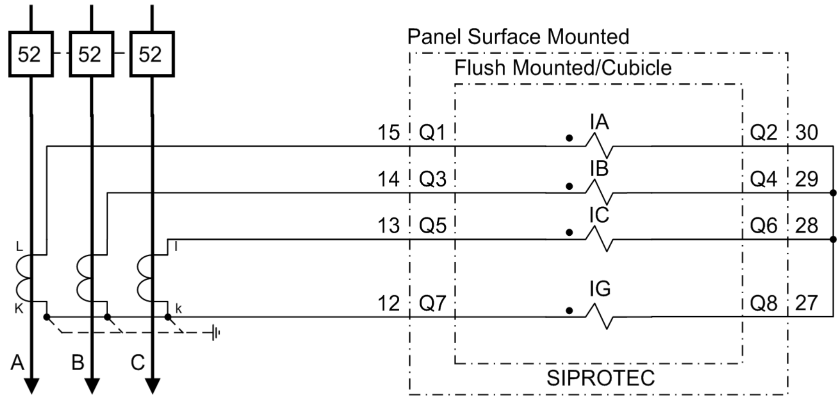


Figure A-57 7SJ62: Current connections to three current transformers with a starpoint connection for ground current (grounded-Wye connection with residual 3I0 neutral current), normal circuit layout appropriate for all networks

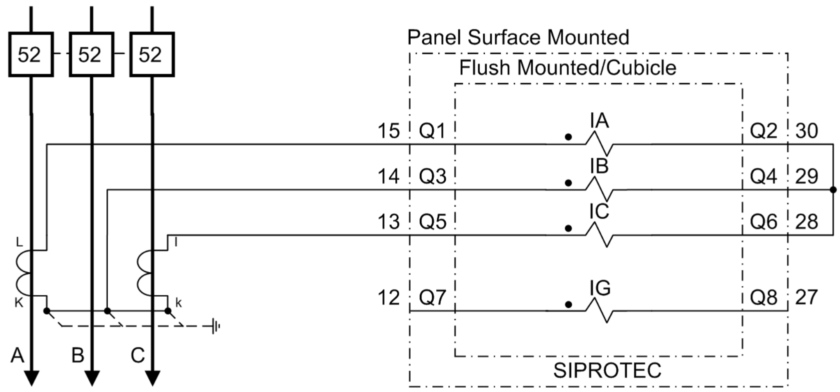
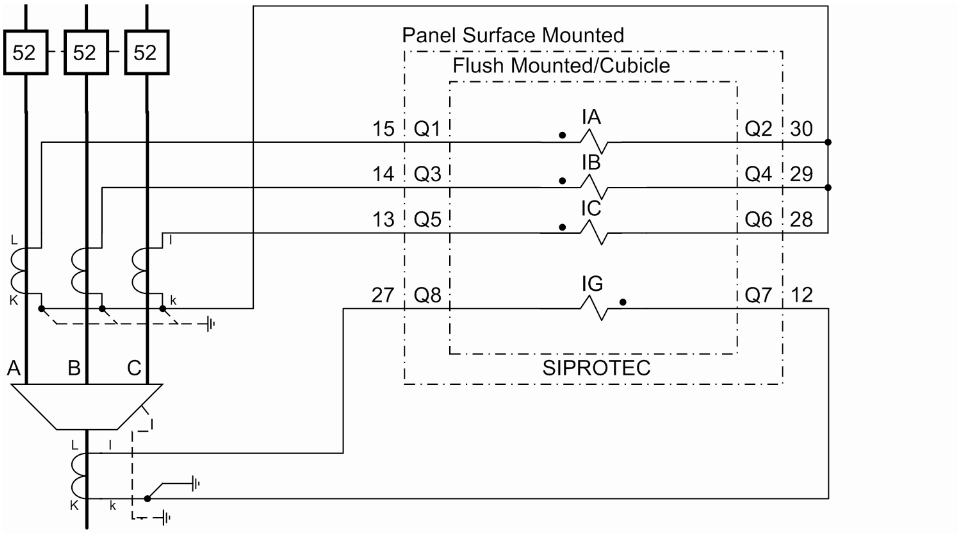


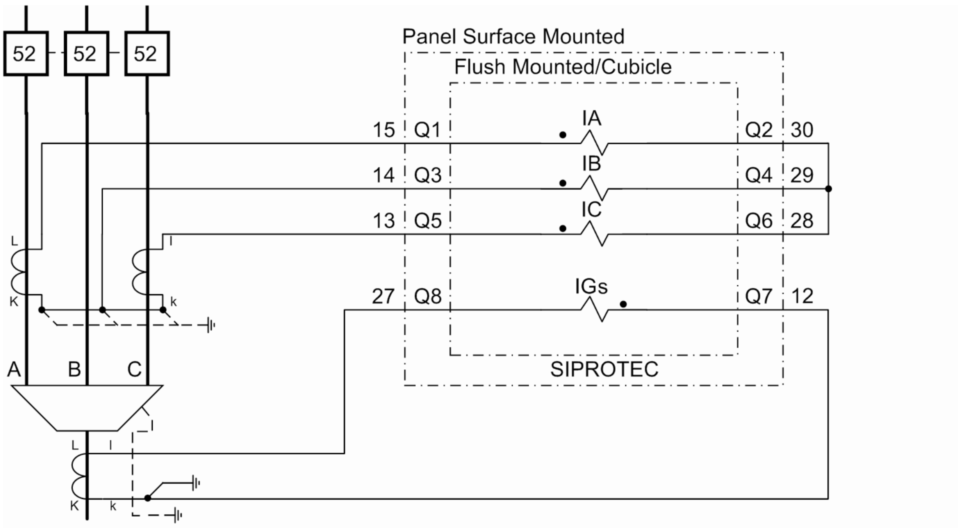
Figure A-58 7SJ62: Current connections to two current transformers - only for ungrounded or compensated networks



Important! Cable Shield Grounding must be done on the Cable Side!

Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be changed!

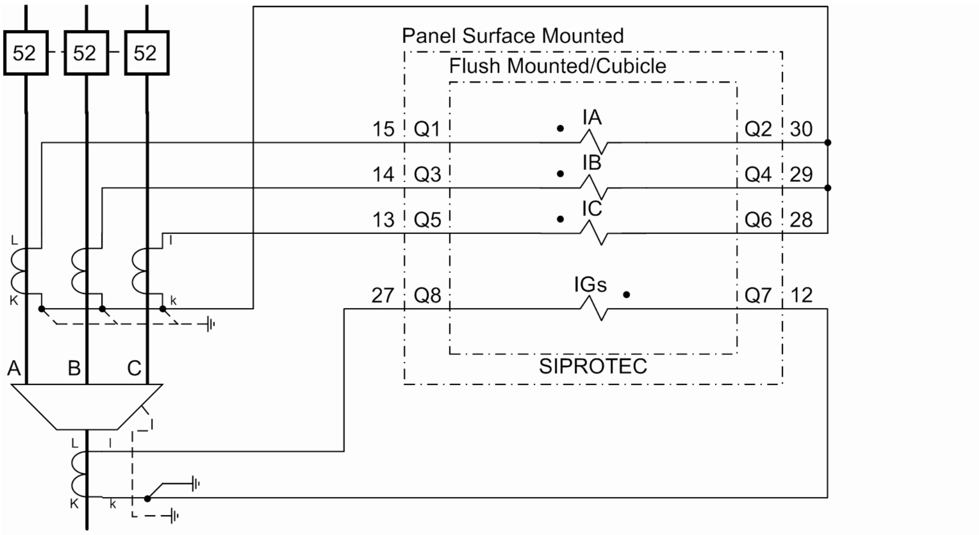
Figure A-59 7SJ62: Current connections to three current transformers and a core balance neutral current transformer for ground current – preferred for effectively or low-resistance grounded networks



Important! Cable Shield Grounding must be done on the Cable Side!

Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be changed!

Figure A-60 7SJ62: Current connections to two current transformers and core balance neutral current transformer for sensitive ground fault detection - only for un-grounded or compensated networks



Important! Cable Shield Grounding must be done on the Cable Side!

Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be changed!

Figure A-61 7SJ62: Current connections to three current transformers – core balance neutral current transformers for sensitive ground fault detection.

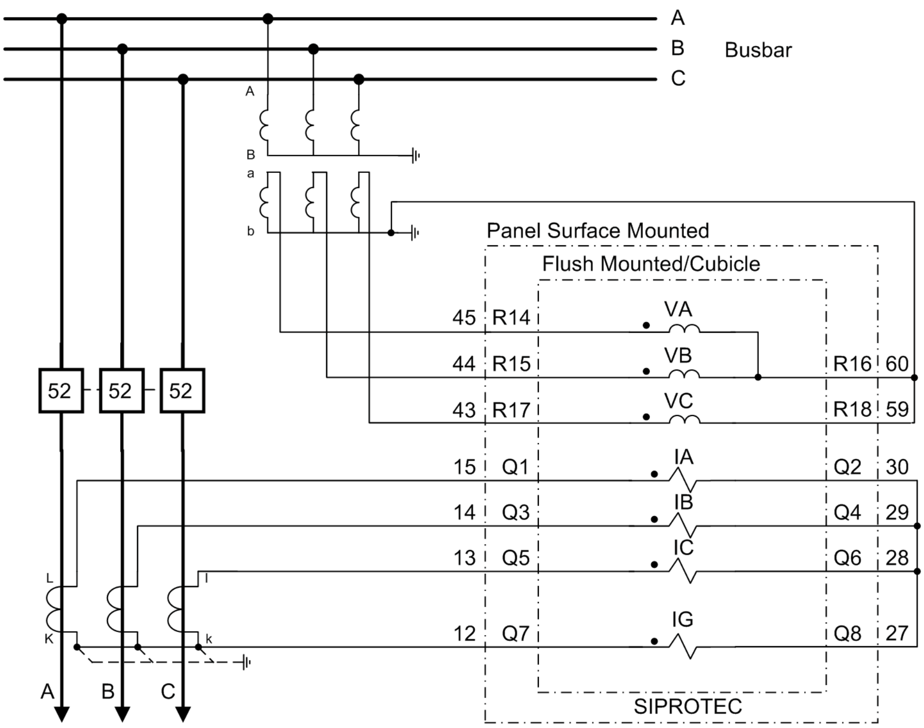


Figure A-62 7SJ62: Current and voltage connections to three current transformers and three voltage transformers (phase-ground), normal circuit layout – appropriate for all networks

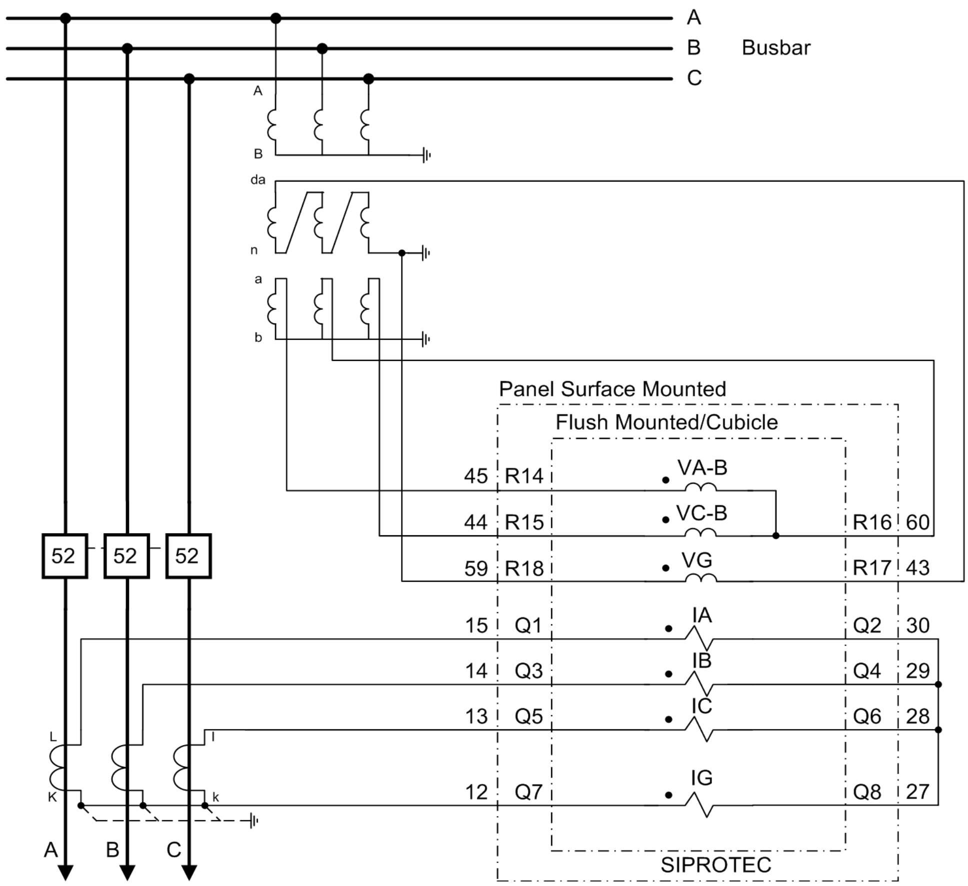


Figure A-63 7SJ62: Current and voltage connections to three current transformers, two voltage transformers (phase-phase) and open delta VT for VG, appropriate for all networks

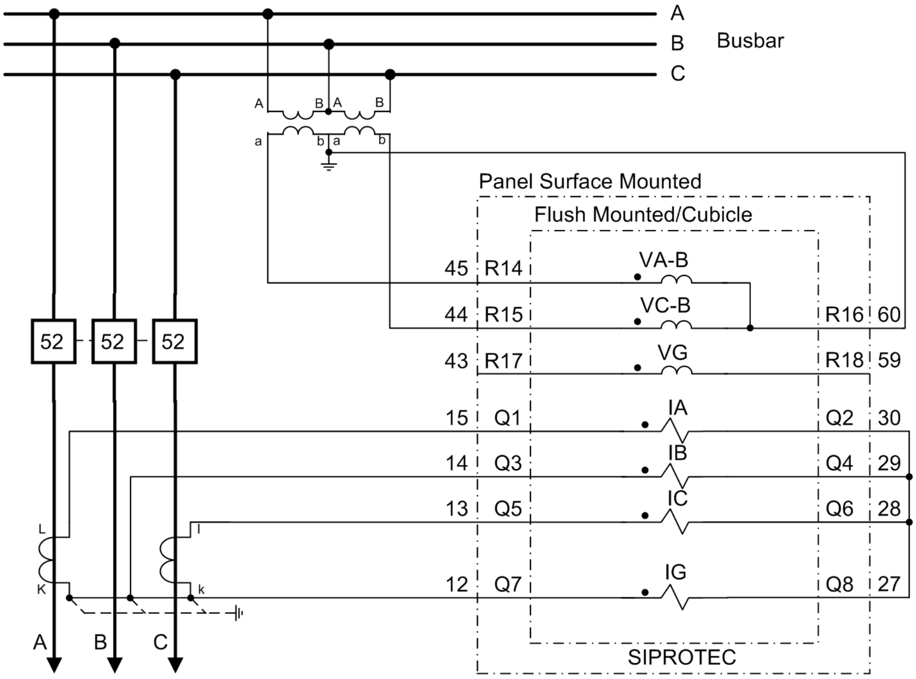


Figure A-64 7SJ62: Current and voltage connections to two current transformers and two voltage transformers, for ungrounded or compensated networks, if no ground protections is needed

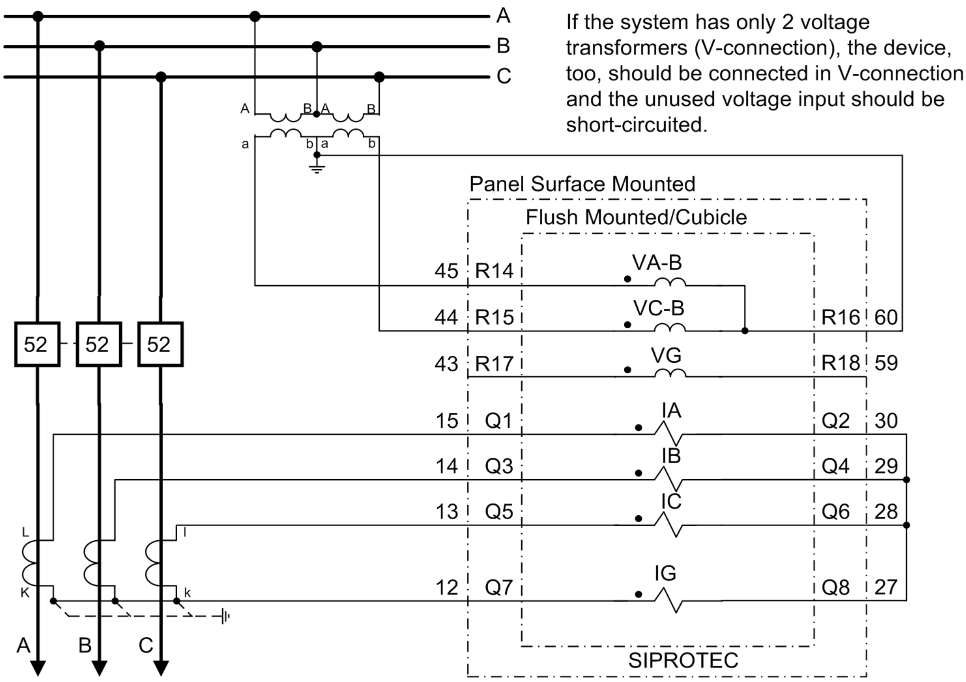
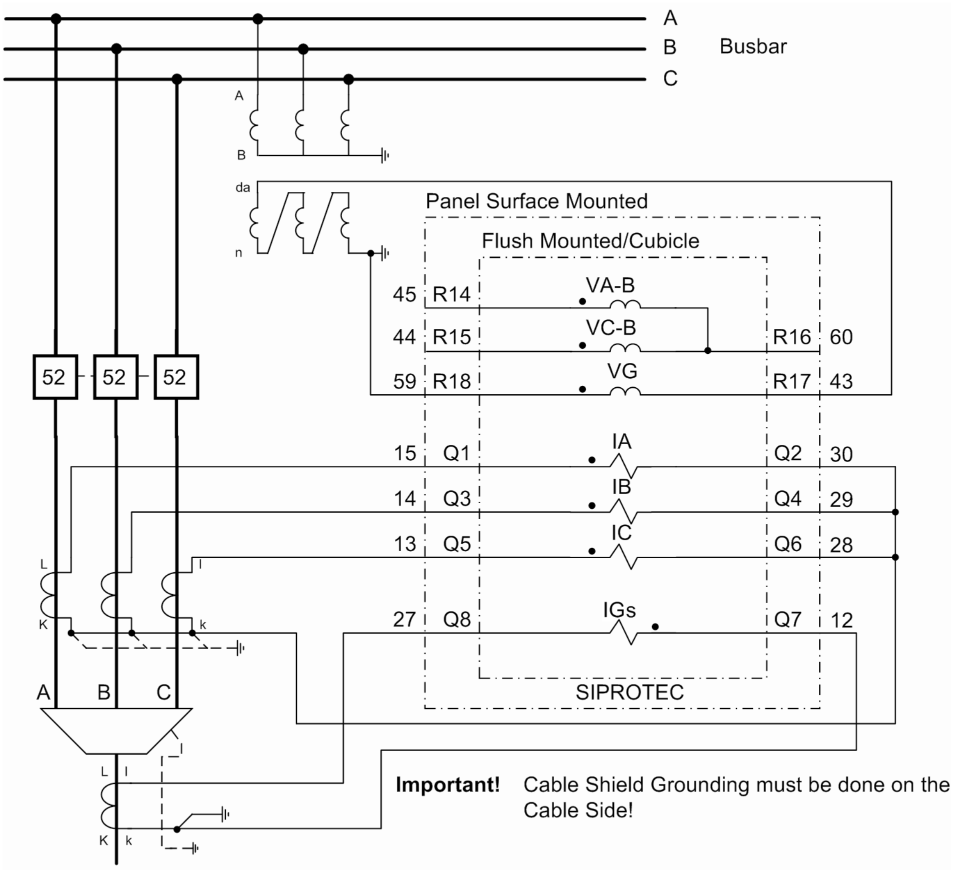
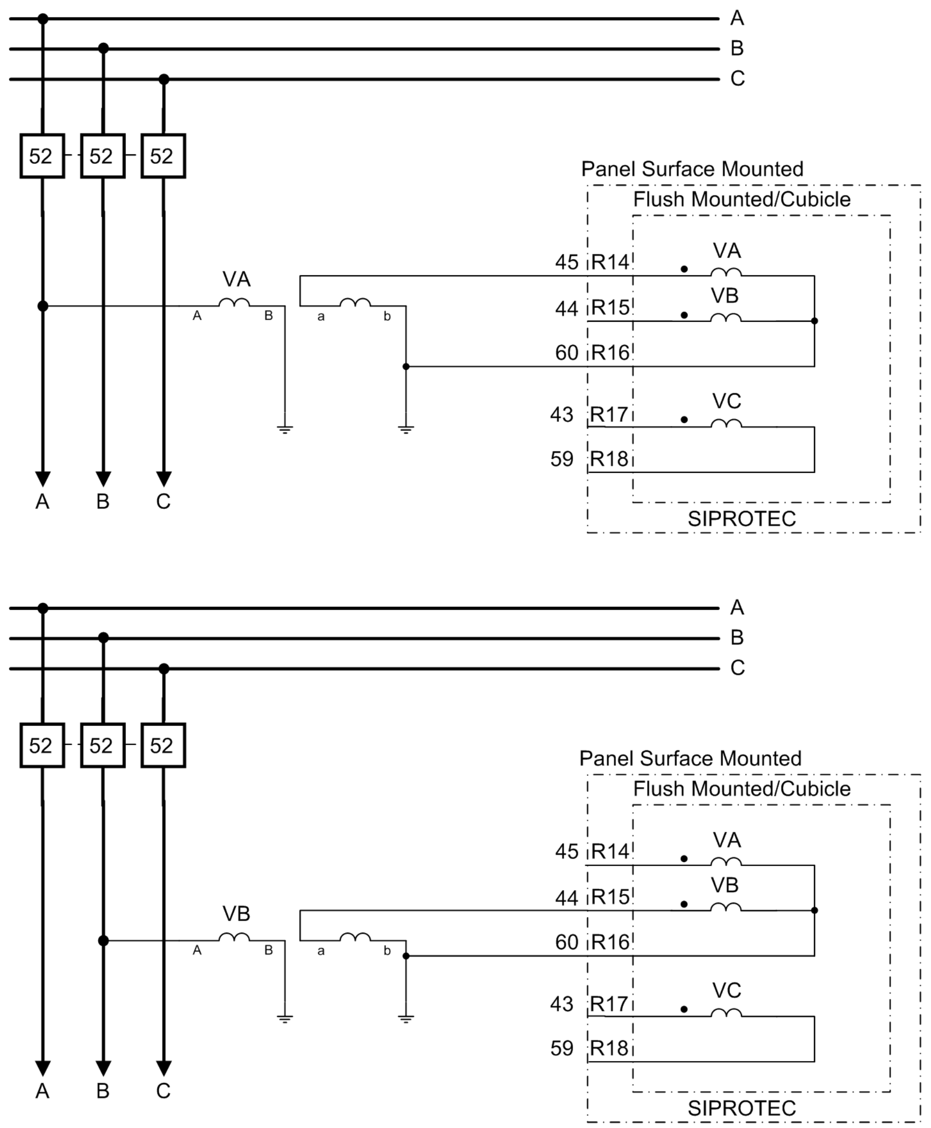


Figure A-65 7SJ62: Connection (grounded-Wye connection), two voltage transformers, for ungrounded or compensated networks; no directional ground protection, since displacement voltage cannot be calculated



Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be changed!

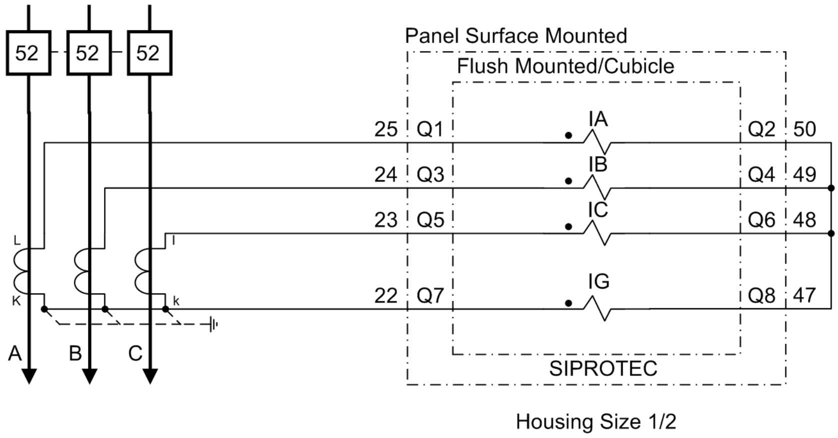
Figure A-66 7SJ62: Current and voltage connections to three current transformers, core balance neutral current transformers and open delta voltage transformers, maximum precision for sensitive ground fault detection



for VC accordingly

Figure A-67 7SJ62: Connection circuit for single-phase voltage transformers with phase-to-ground voltages

A.3.2 Connection Examples for 7SJ63



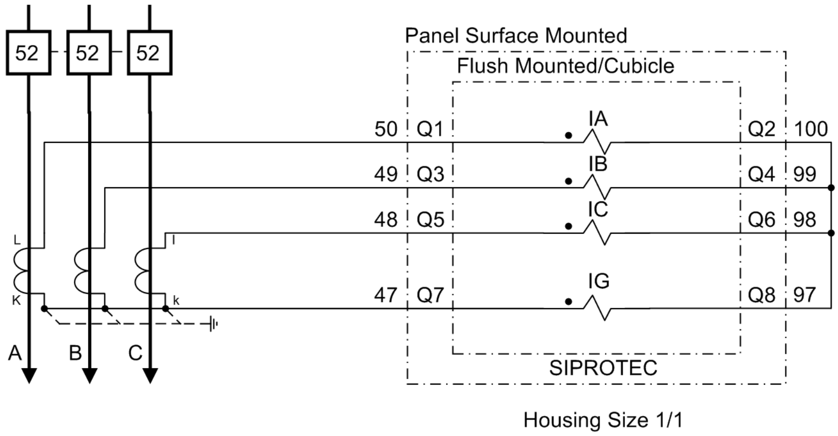
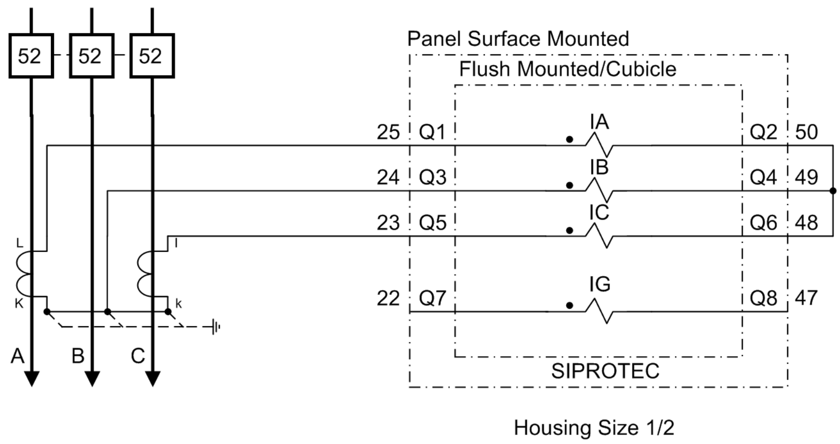


Figure A-68 7SJ63: Current connections to three current transformers with a starpoint connection for ground current (Grounded-Wye Connection with residual 3I0 Neutral Current), normal circuit layout \endash appropriate for all networks



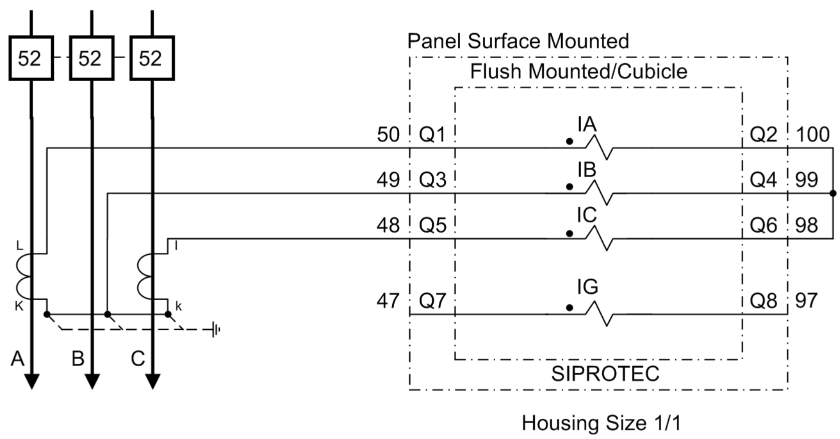
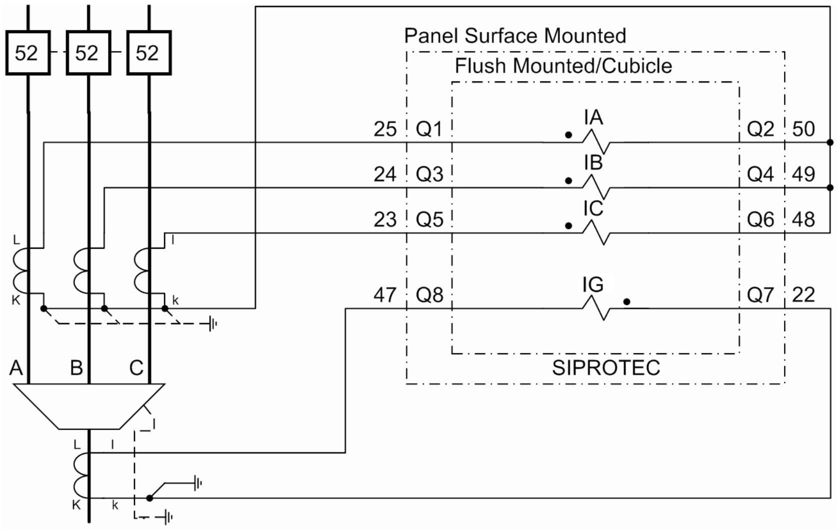


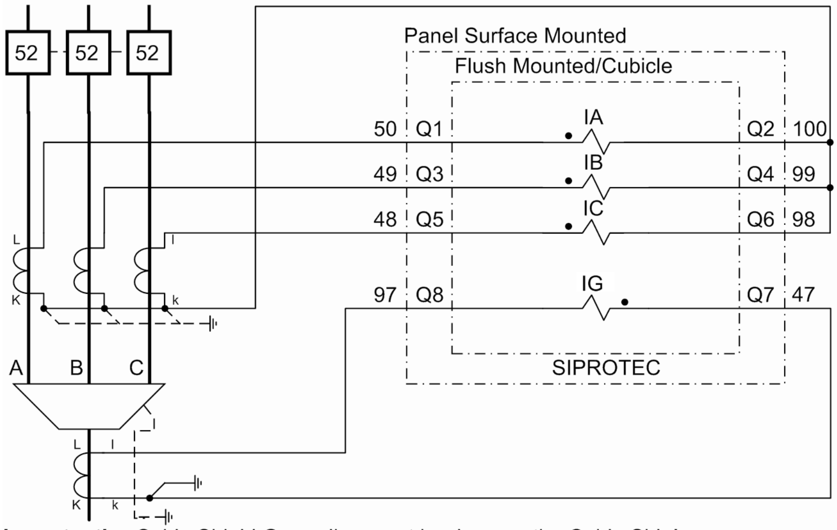
Figure A-69 7SJ63: Current connections to two current transformers - only for ungrounded or compensated networks



Important! Cable Shield Grounding must be done on the Cable Side!

Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be changed!

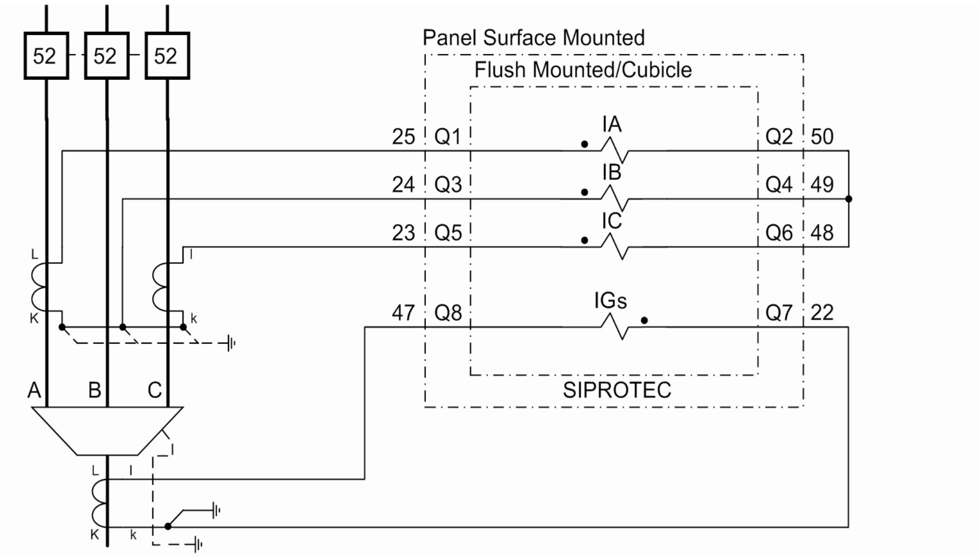
Housing Size 1/2



Important! Cable Shield Grounding must be done on the Cable Side!

Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be changed!

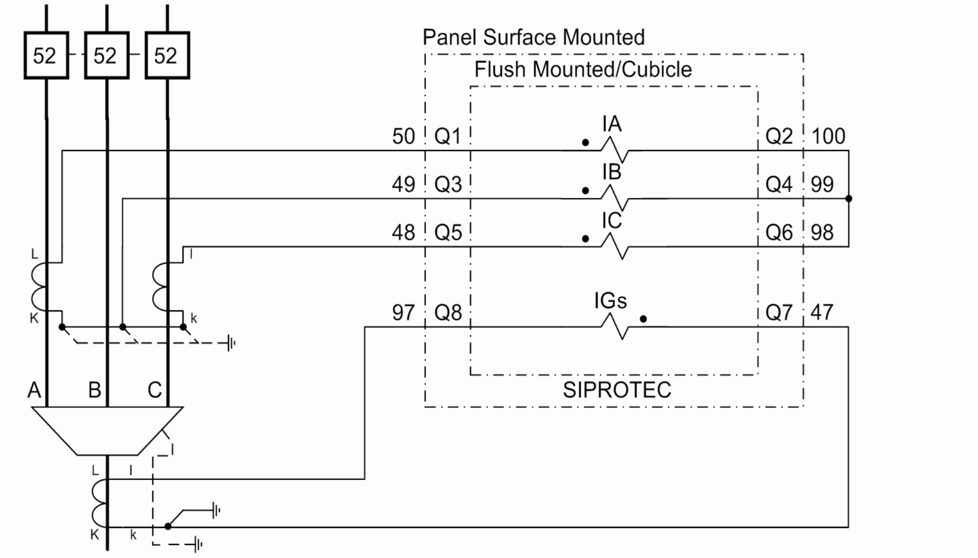
Figure A-70 7SJ63: Current connections to three current transformers and a core balance neutral current transformer for ground current – preferred for effectively or low-resistance grounded networks



Important! Cable Shield Grounding must be done on the Cable Side!

Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be changed!

Housing Size 1/2

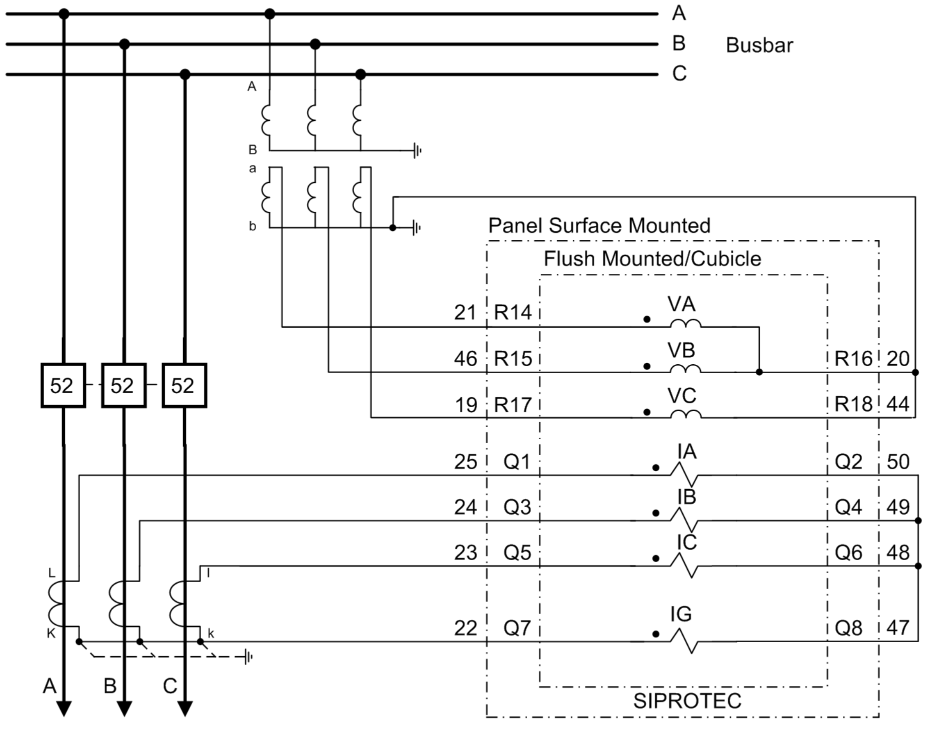


Important! Cable Shield Grounding must be done on the Cable Side!

Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be changed!

Housing Size 1/1

Figure A-71 7SJ63: Current connections to two current transformers and core balance neutral current transformer for sensitive ground fault detection - only for ungrounded or compensated networks



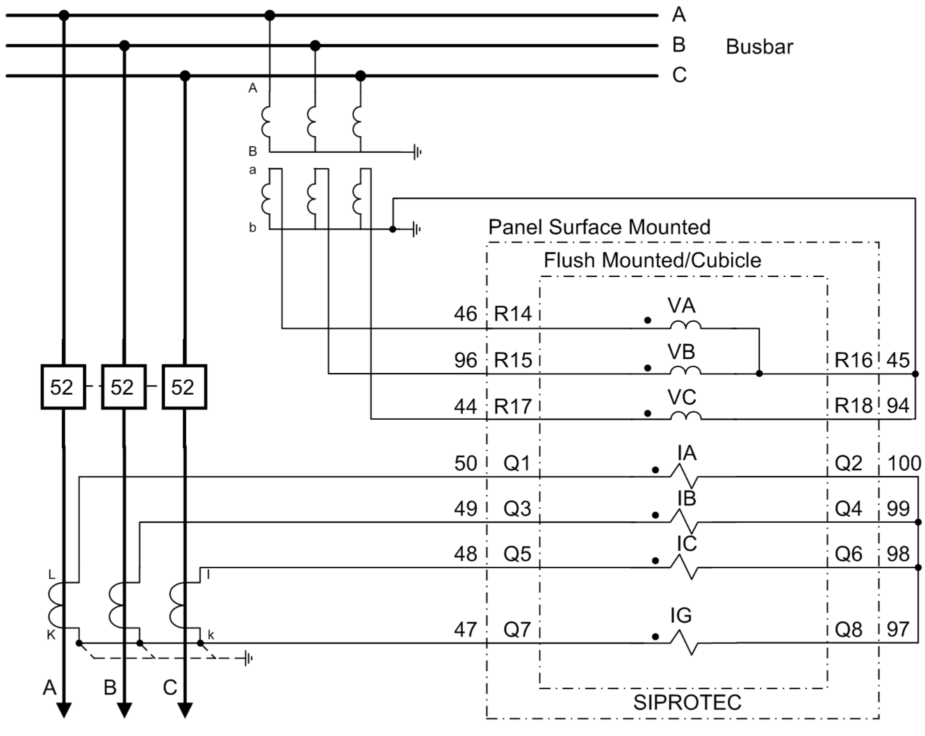
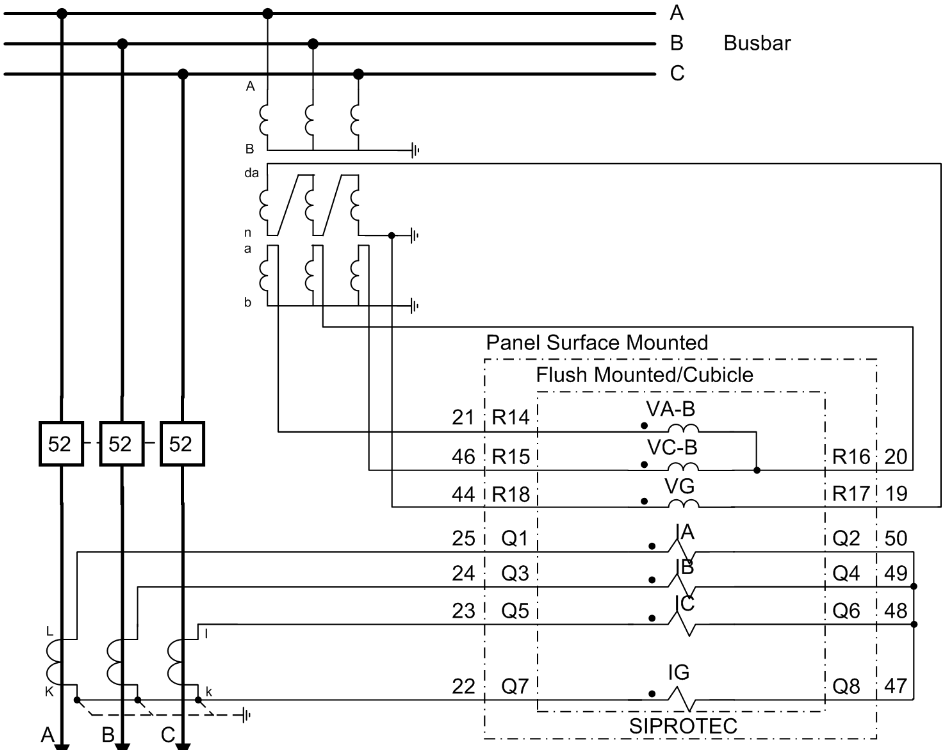


Figure A-72 7SJ63: Current and voltage connections to three current transformers and three voltage transformers (phase-ground), normal circuit layout – appropriate for all networks



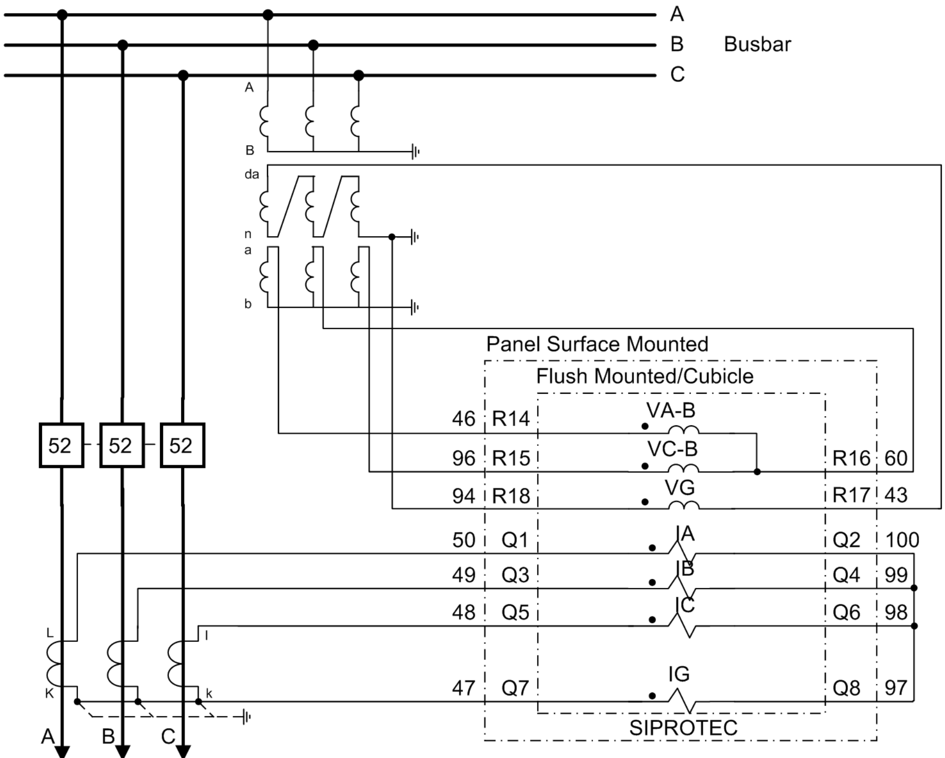
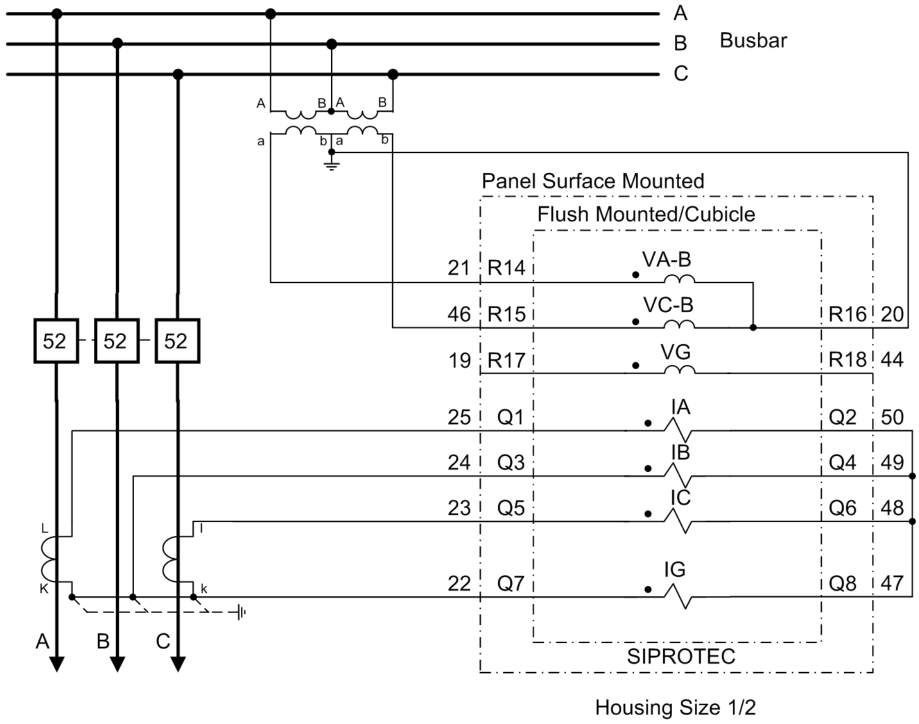


Figure A-73 7SJ63: Current and voltage connections to three current transformers, two voltage transformers (phase-phase) and open delta VT for VG, appropriate for all networks



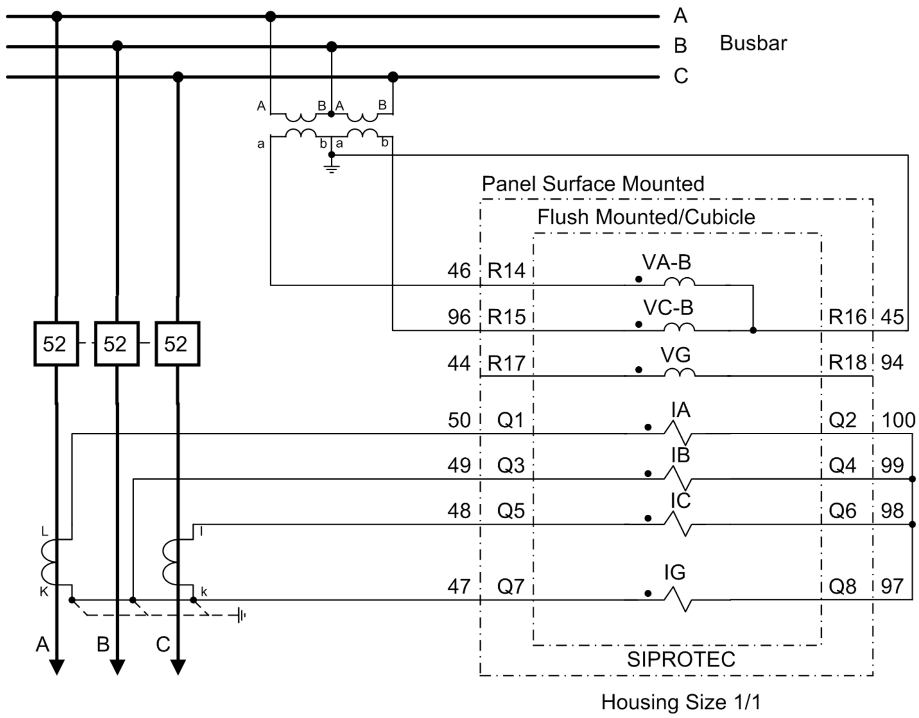
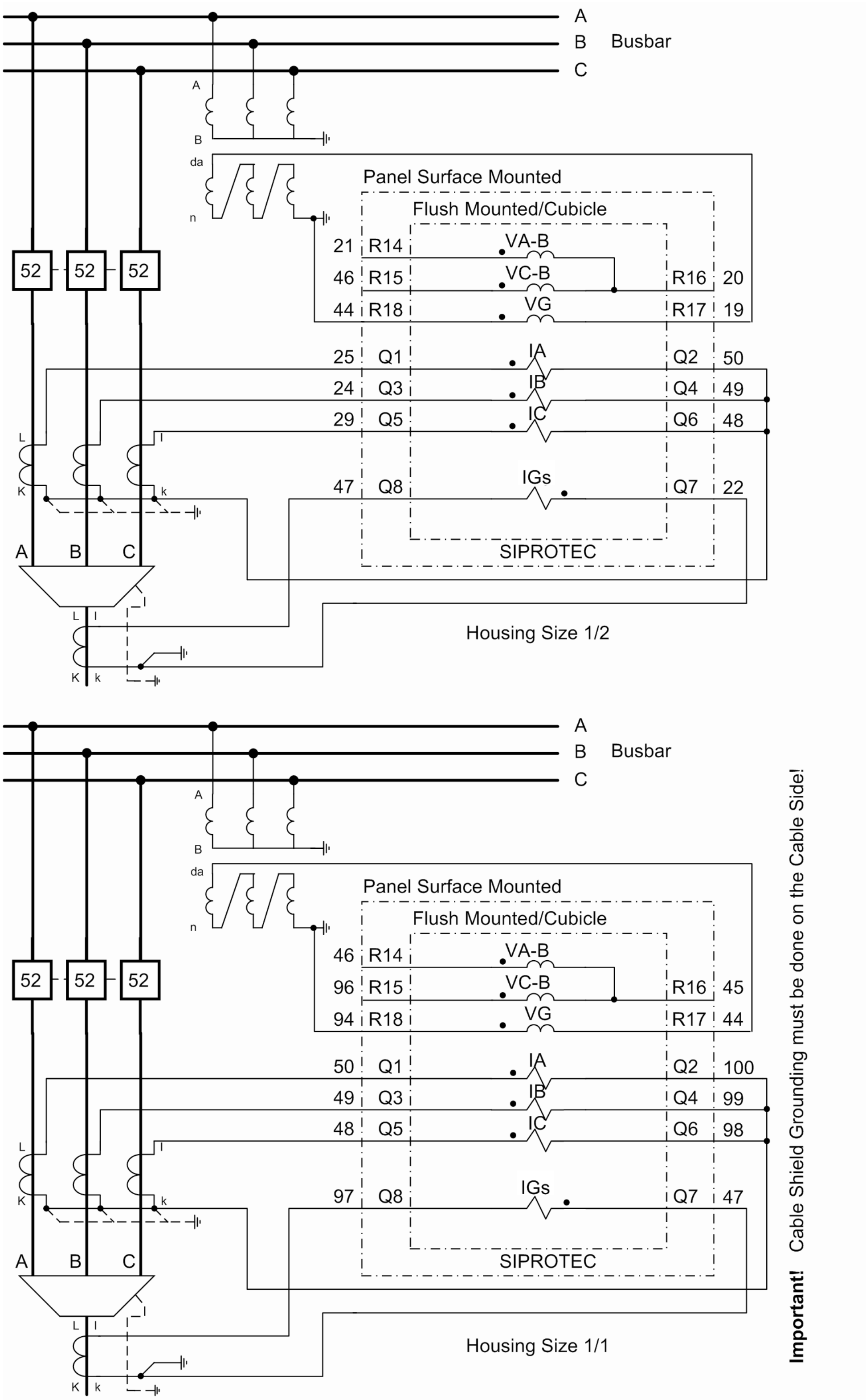
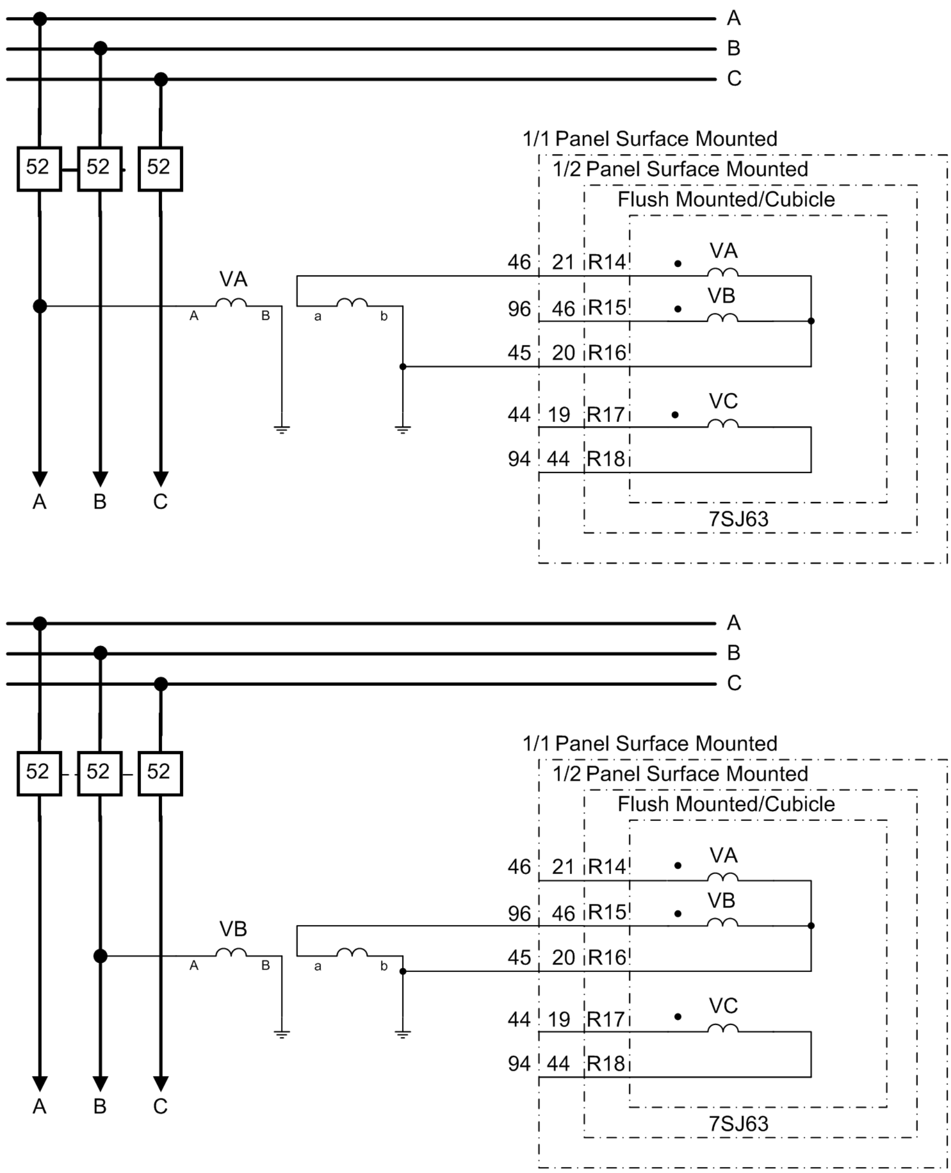


Figure A-74 7SJ63: Current and voltage connections to two current transformers and two voltage transformers, for ungrounded or compensated networks, if no directional ground protections is needed



Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be

Figure A-75 7SJ63: Current and voltage connections to three current transformers, core balance neutral current transformers and open delta voltage transformers, maximum precision for sensitive ground fault detection



for VC accordingly

Figure A-76 7SJ63: Connection circuit for single-phase voltage transformers with phase-to-ground voltages

A.3.3 Connection Examples for 7SJ64

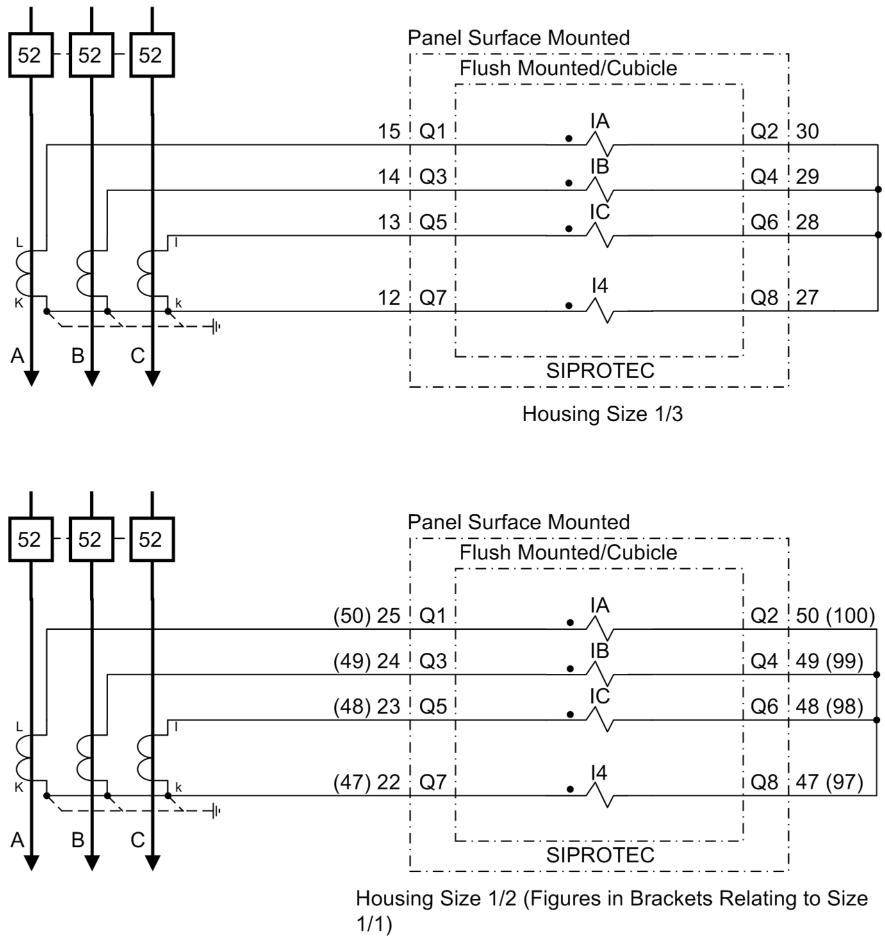
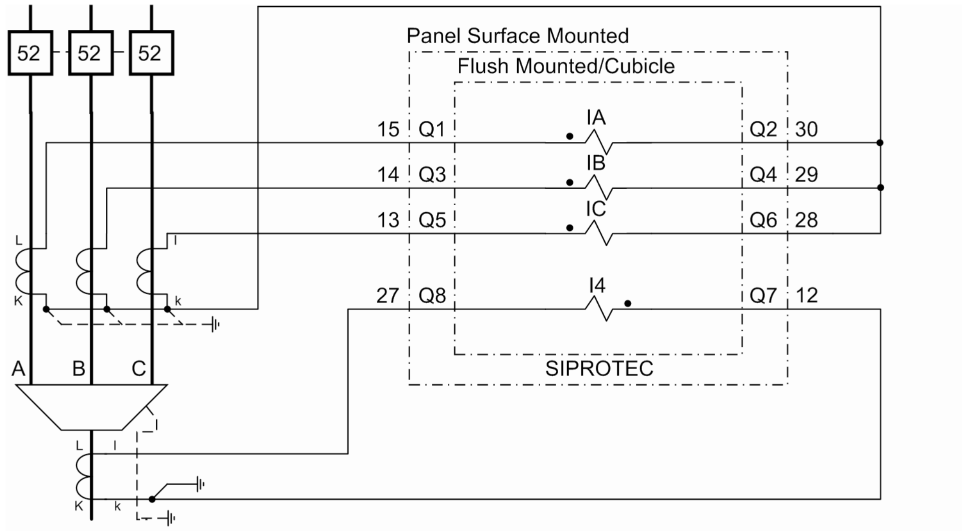


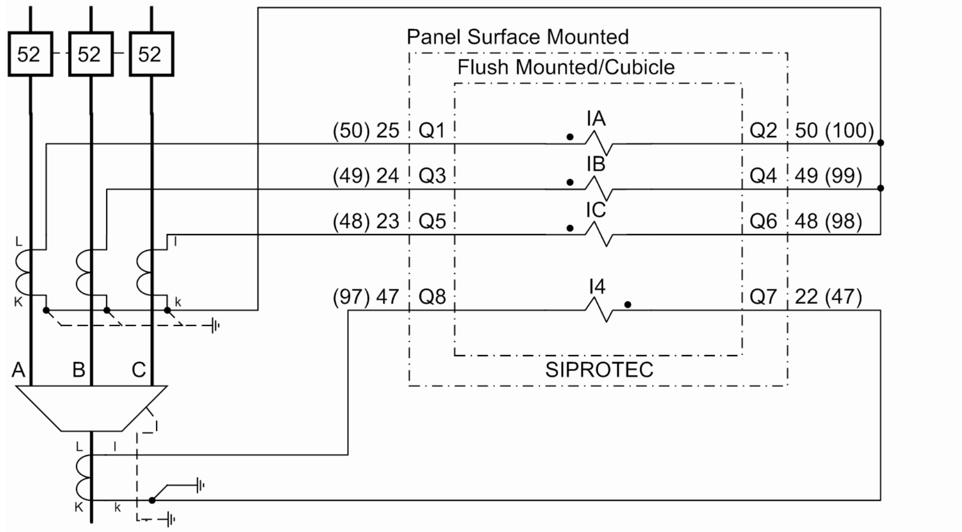
Figure A-77 7SJ64: Current connections to three current transformers with a starpoint connection for ground current (residual 3I0 neutral current), normal circuit layout



Important! Cable Shield Grounding must be done on the Cable Side!

Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and I at Q7 and Q8 must be changed!

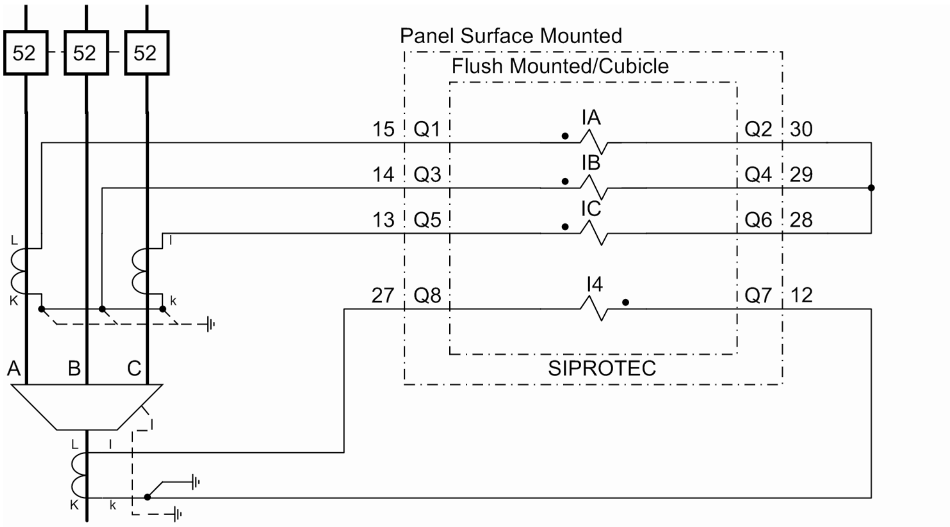
Housing Size 1/3



Important! Cable Shield Grounding must be done on the Cable Side!

Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and I at Q7 and Q8 must be changed!

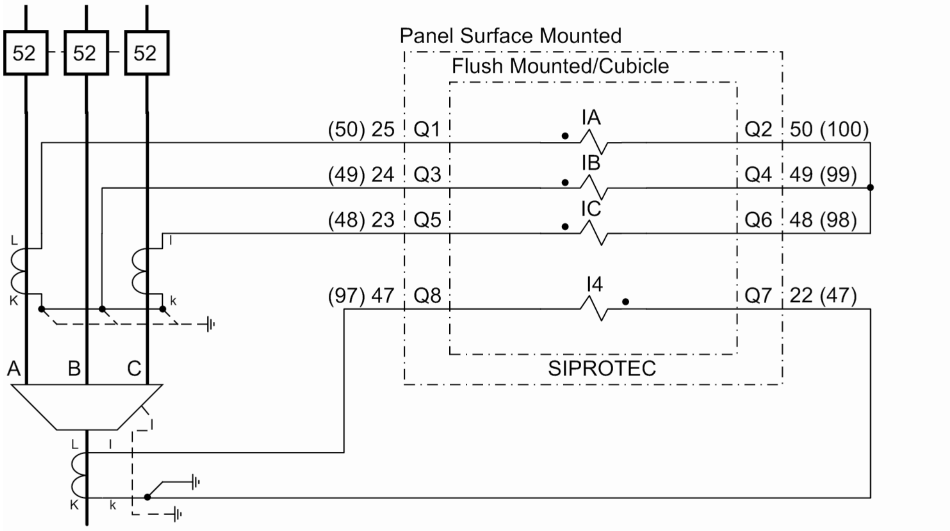
Figure A-78 7SJ64: Current connections to three current transformers with separate ground current transformer (summation current transformer or cable core balance current transformer)



Important! Cable Shield Grounding must be done on the Cable Side!

Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be changed!

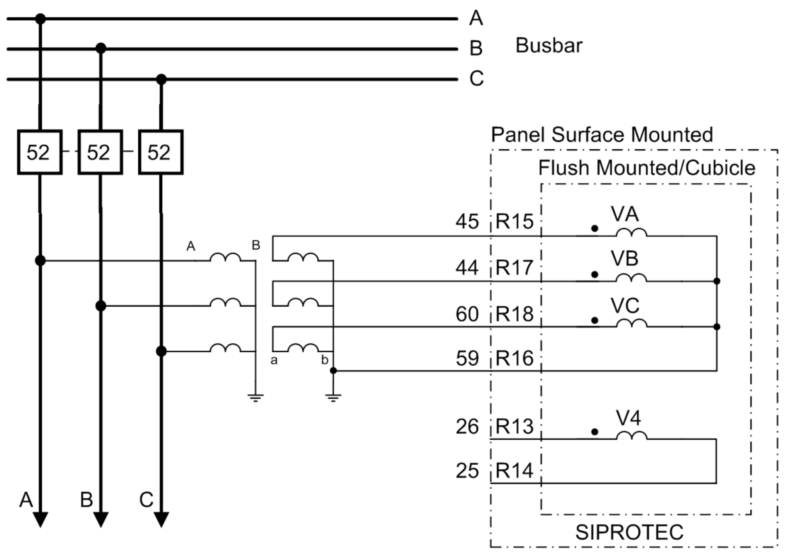
Housing Size 1/3



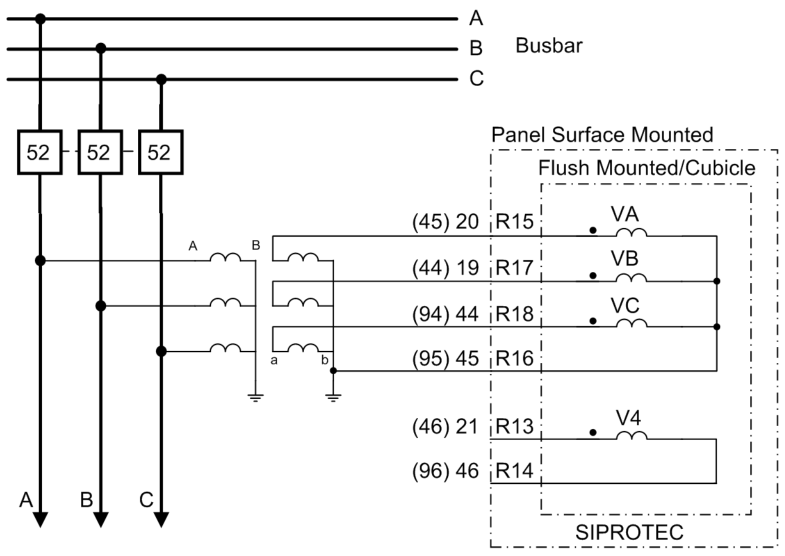
Important! Cable Shield Grounding must be done on the Cable Side!

Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be changed!

Figure A-79 7SJ64: Current connections to two current transformers and core balance neutral current transformer for sensitive ground fault detection - only for ungrounded or compensated networks

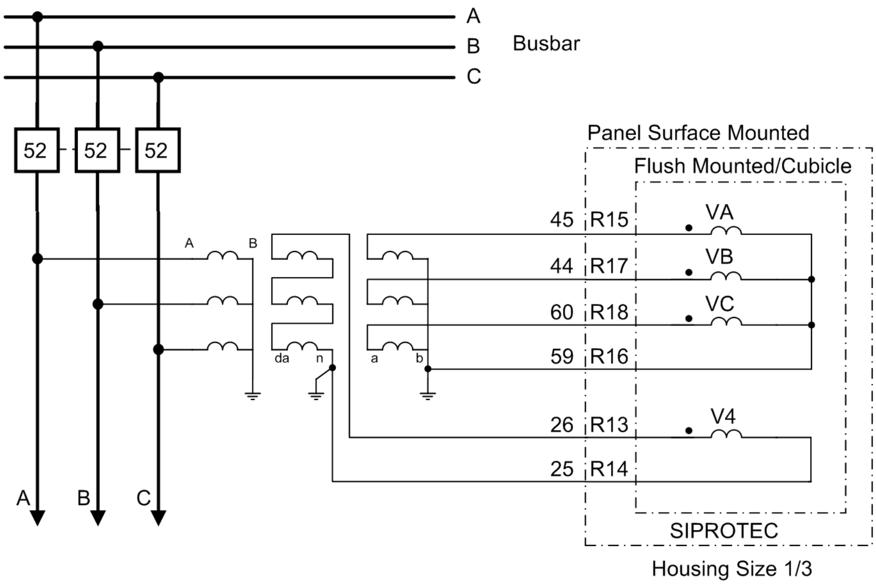


Housing Size 1/3



Housing Size 1/2 (Figures in Brackets Relating to Size 1/1)

Figure A-80 7SJ64: Voltage connections to three Wye-connected voltage transformers (normal circuit layout)



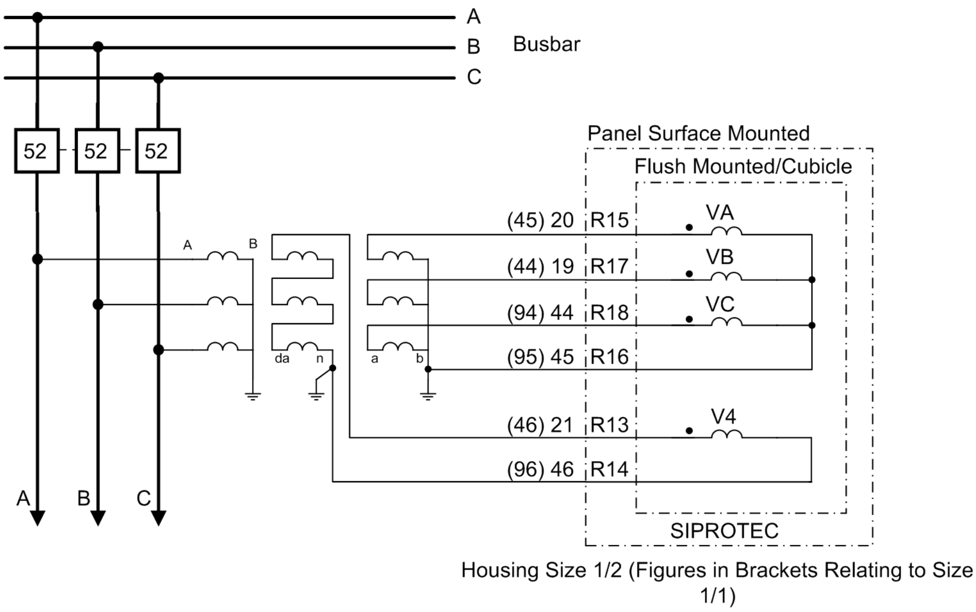
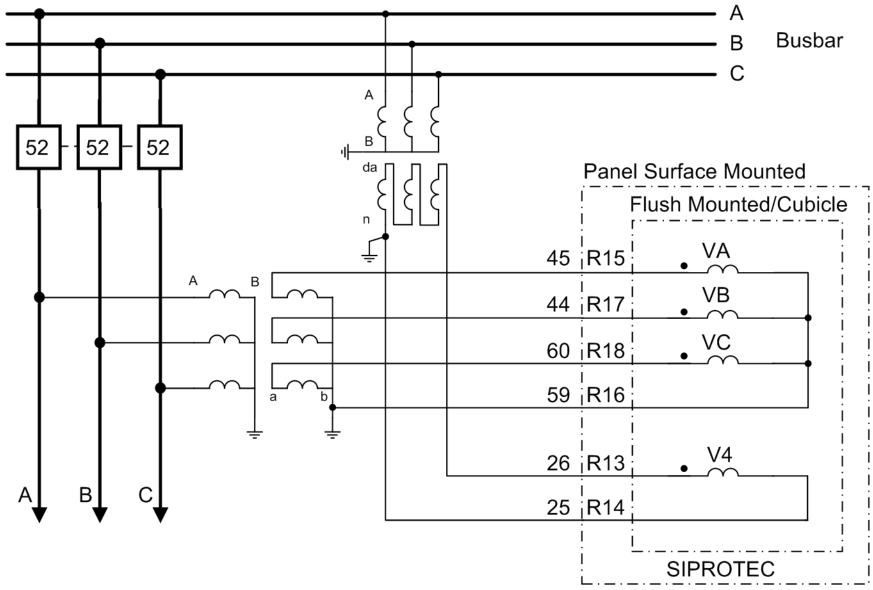
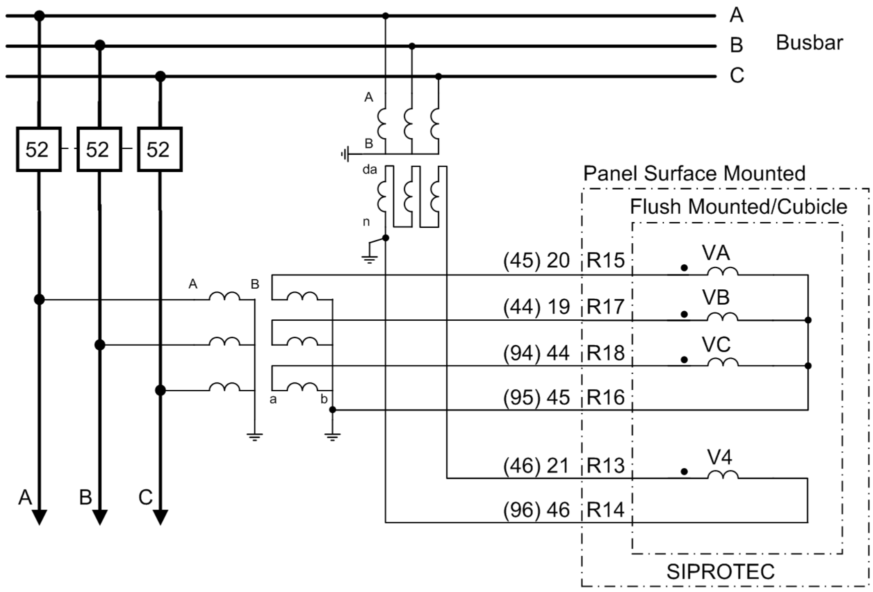


Figure A-81 7SJ64: Voltage connections to three Wye-connected voltage transformers with additional open-delta windings (da–dn–winding)

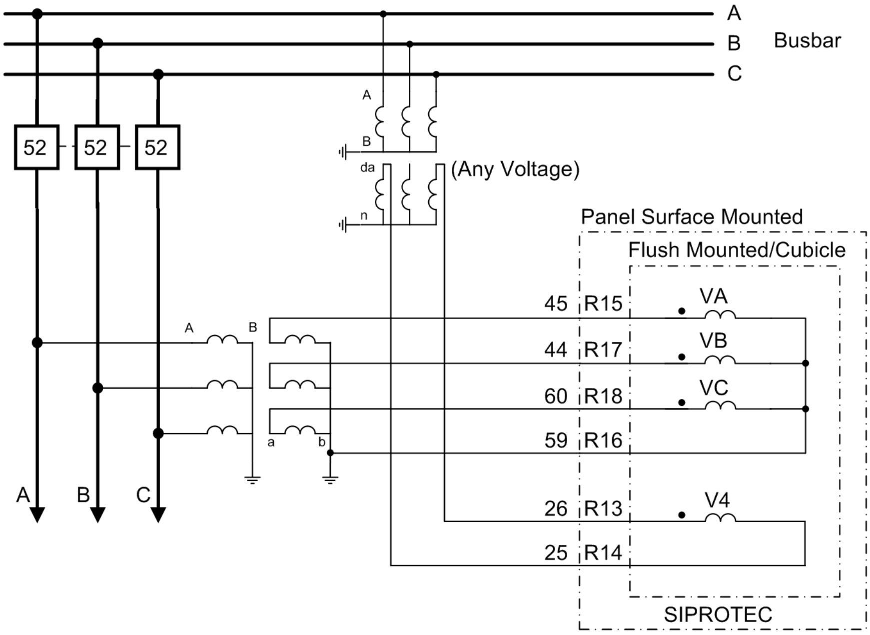


Housing Size 1/3

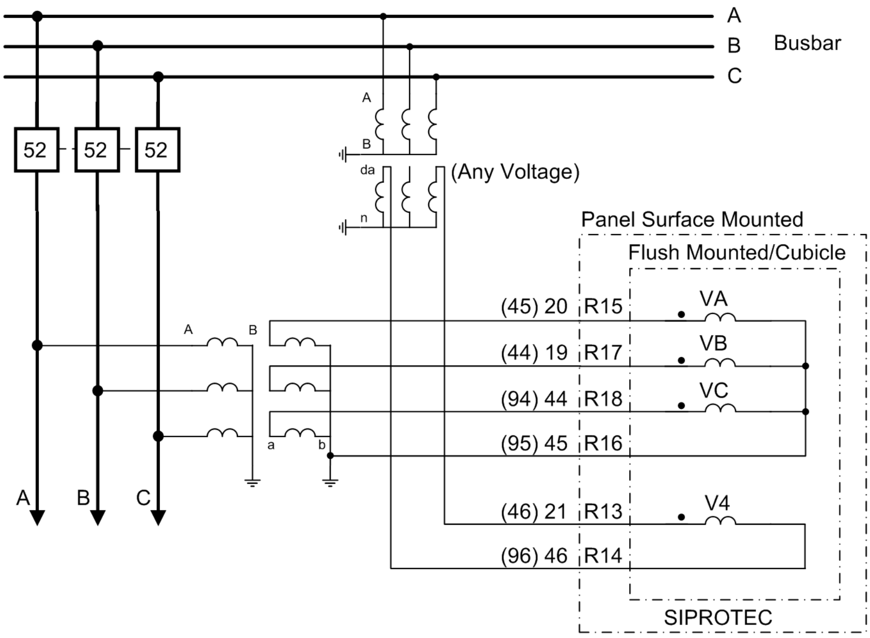


Housing Size 1/2 (Figures in Brackets Relating to Size 1/1)

Figure A-82 7SJ64: Voltage connections to three Wye-connected voltage transformers with additional open-delta windings (da–dn–winding) from the busbar

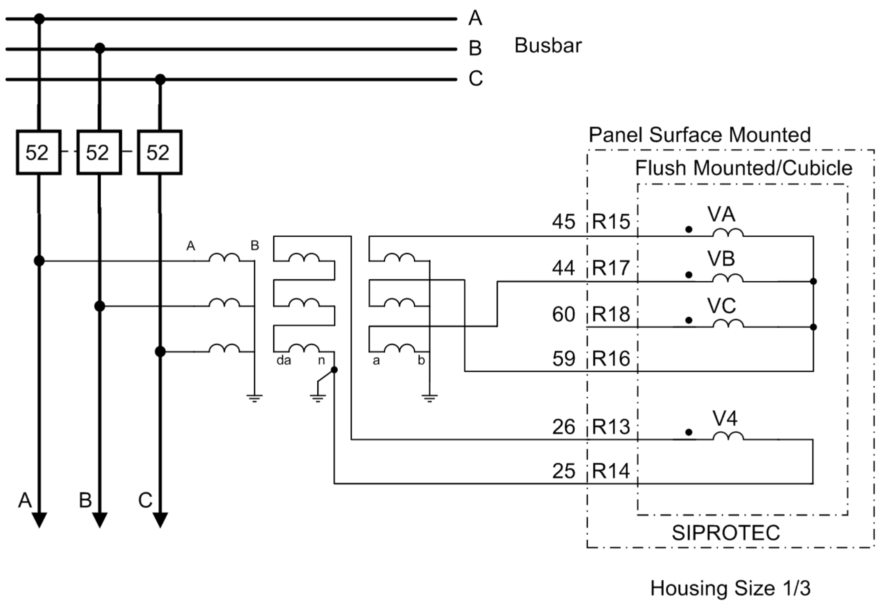


Housing Size 1/3



Housing Size 1/2 (Figures in Brackets Relating to Si: 1/1)

Figure A-83 7SJ64: Voltage connections to three Wye-connected voltage transformers and additionally to any phase-to-phase voltage (for synchronism check for example)



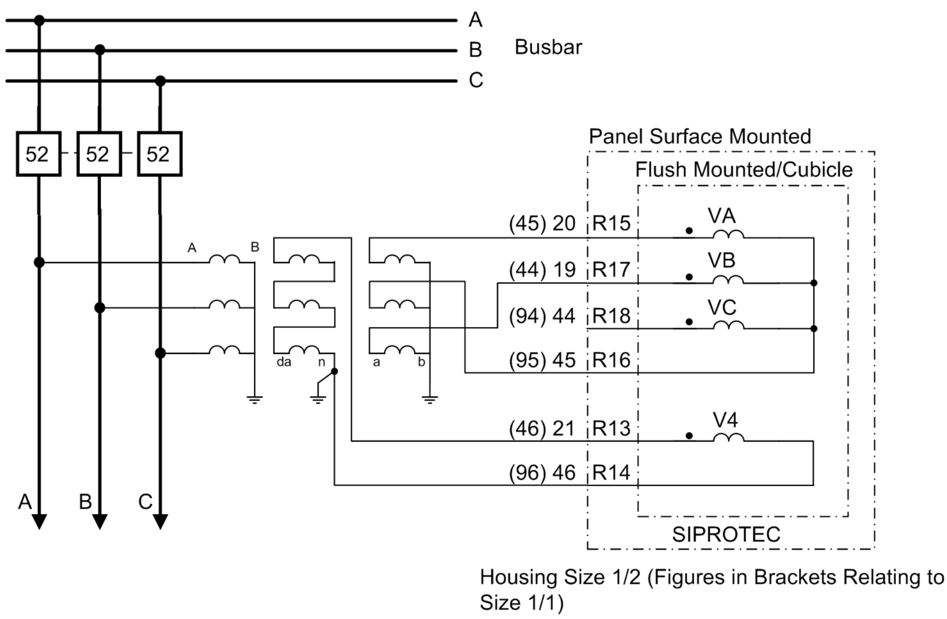
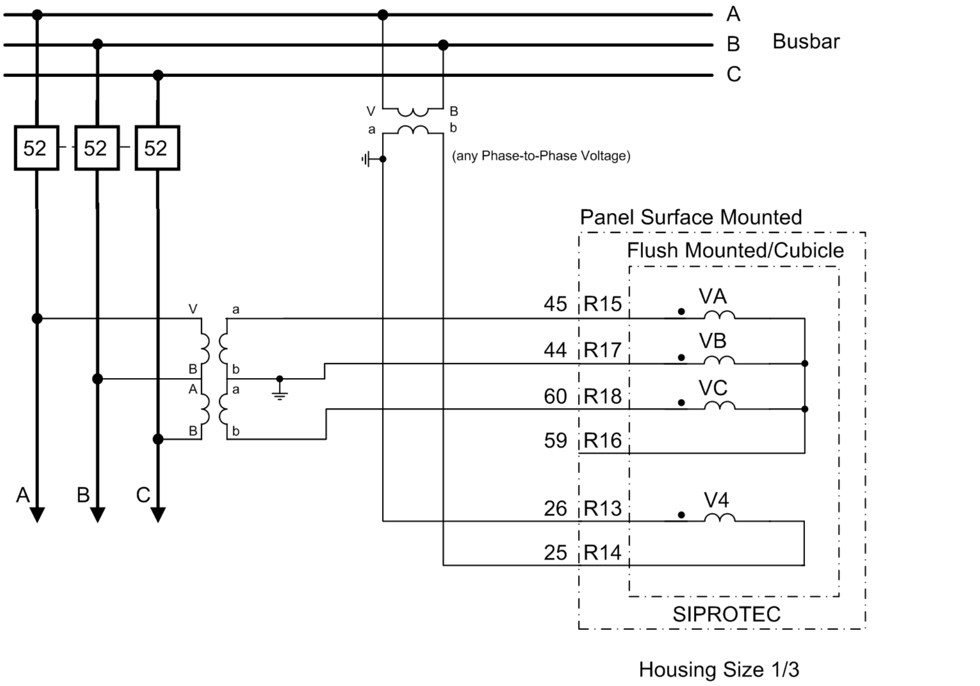


Figure A-84 7SJ64: Two phase-to-phase voltages to three Wye-connected voltage transformers with additional open-delta windings (da–dn–winding)



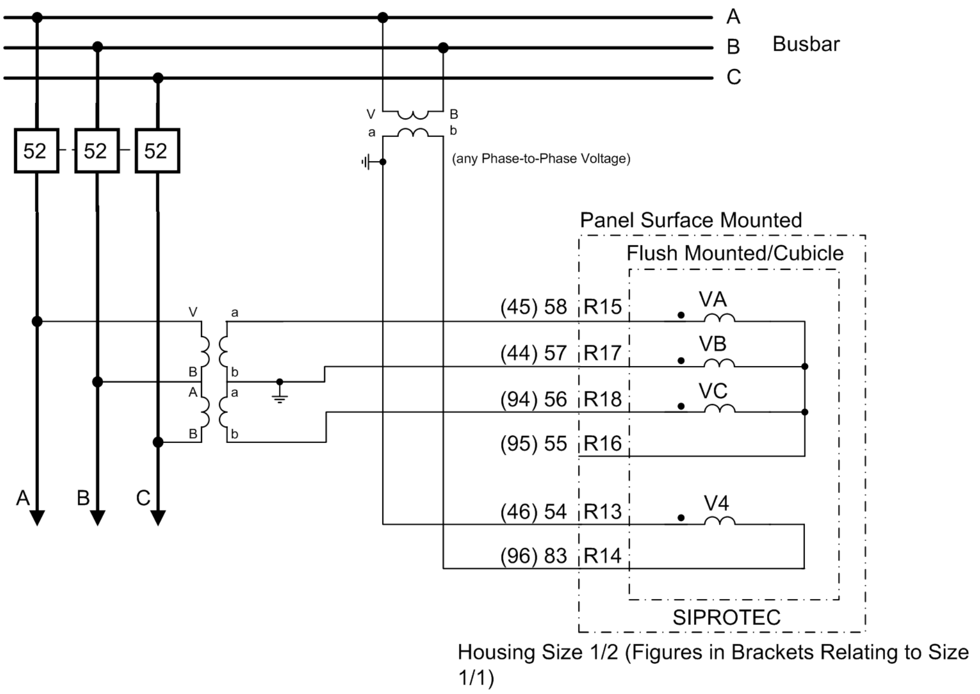


Figure A-85 7SJ64: Voltage connections to two voltage transformers and additionally to any phase-to-phase voltage (for synchronism check for example) With this type of connection it is not possible to determine the zero sequence voltage V0. Functions that use the zero sequence voltage must be hidden or disabled.

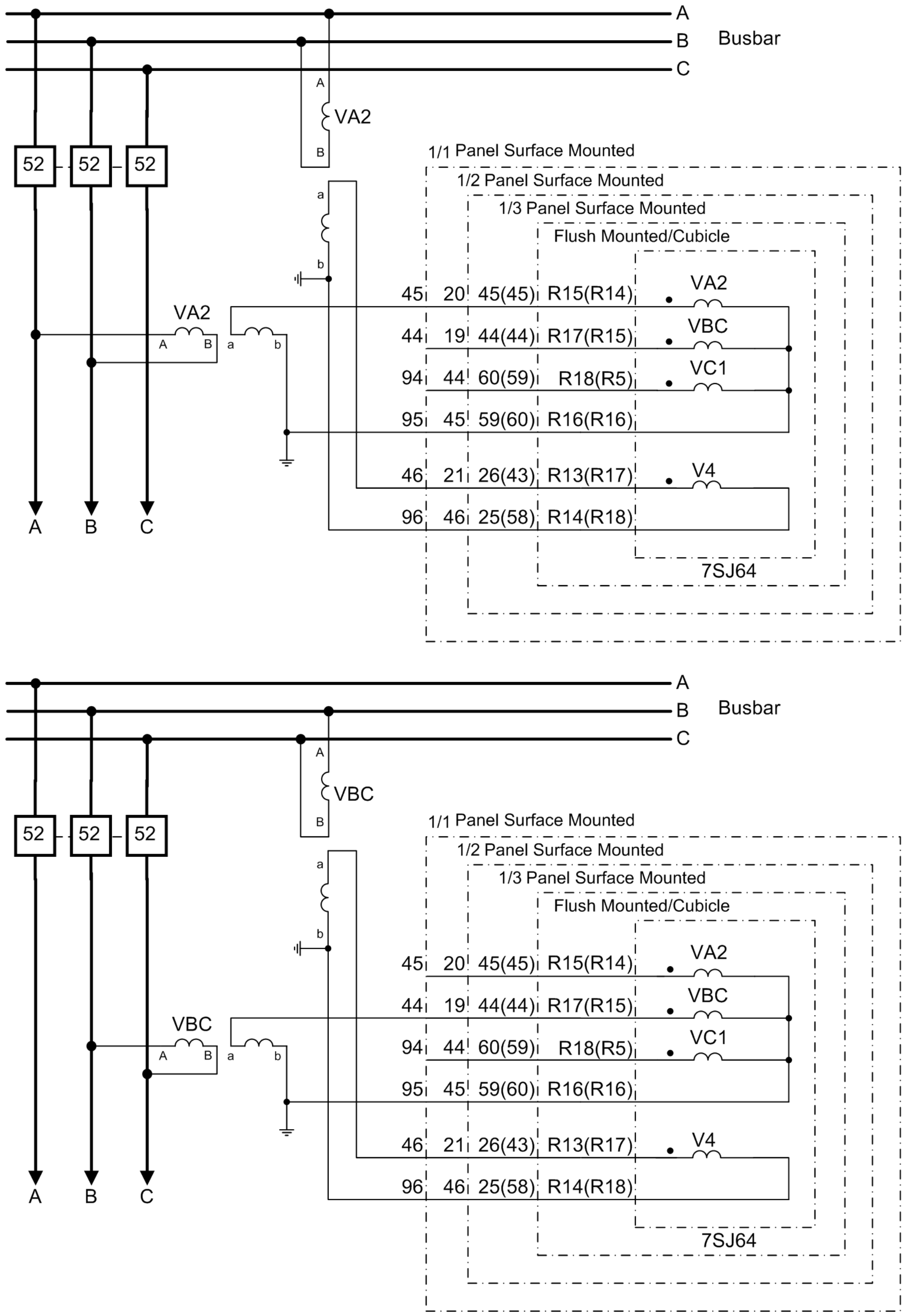
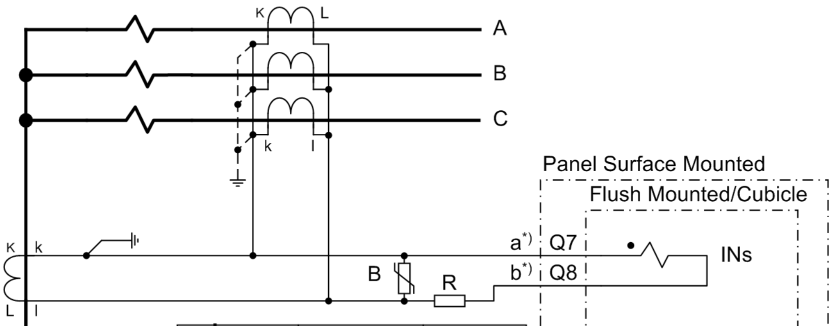


Figure A-86 7SJ64: Connection circuit for single-phase voltage transformers with phase-to-phase voltages

A.3.4 Connection example for high-impedance ground fault differential protection



	7SJ62 7SJ640	7SJ631/2/3 7SJ641/2	7SJ635/6 7SJ645
a*)	12	22	47
b*)	27	47	97

Figure A-87 High-impedance differential protection for a grounded transformer winding (showing the partial connection for the high-impedance differential protection)

A.3.5 Connection Examples for RTD-Box

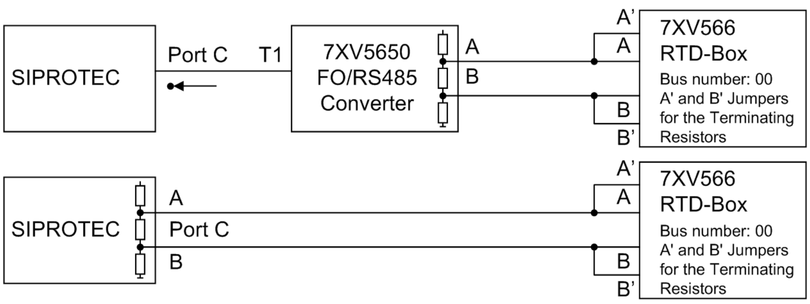


Figure A-88 Simplex operation with one RTD-Box, above: optical design (1 FO); below: design with RS 485

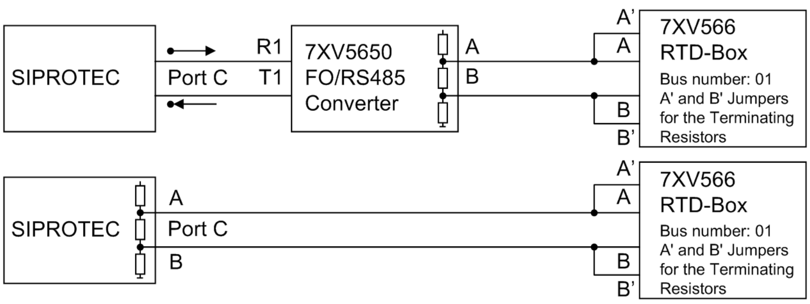


Figure A-89 Half-duplex operation with one RTD-Box, above: optical design (2 FOs); below: design with RS 485

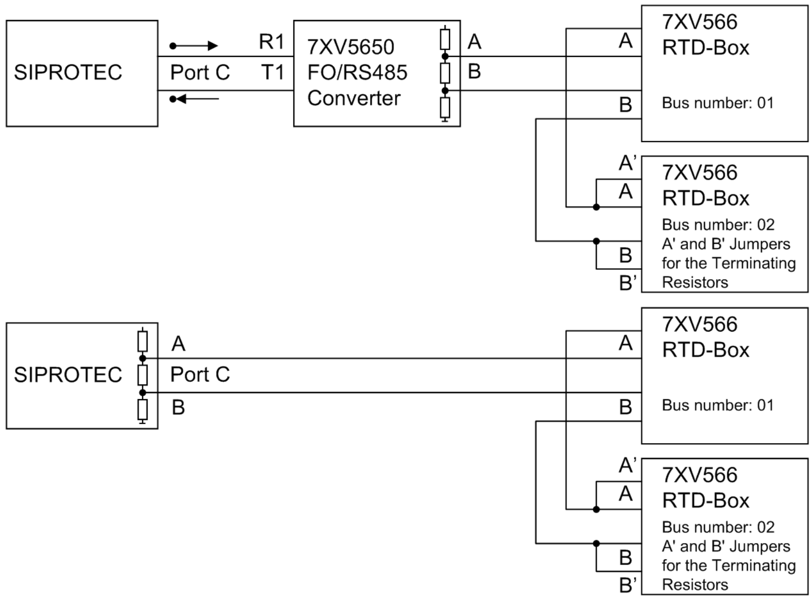


Figure A-90 Half-duplex operation with two RTD-Boxes, above: optical design (2 FOs); below: design with RS 485

Alternatively to the above figures, when 7SJ64 uses a converter it must be connected to Port D otherwise Port C or D can be used.

A.4 Current Transformer Requirements

The requirements for phase current transformers are usually determined by the overcurrent time protection, particularly by the high-current element settings. Besides, there is a minimum requirement based on experience.

The recommendations are given according to the standard IEC 60044-1.

The standards IEC 60044-6, BS 3938 and ANSI/IEEE C 57.13 are referred to for converting the requirement into the knee-point voltage and other transformer classes.

A.4.1 Accuracy limiting factors

Effective and Rated Accuracy Limiting Factor

Required minimum effective accuracy limiting factor	$K_{ALF'} = \frac{50-2_{PU}}{I_{pNom}}$ but at least 20	
	with	
	$K_{ALF'}$	Minimum effective accuracy limiting factor
	$50\text{-}2_{PU}$	Primary pickup value of the high-current element
	I_{pNom}	Primary nominal transformer current
Resulting rated accuracy limiting factor	$K_{ALF} = \frac{R_{BC}+R_{Ct}}{R_{BN}+R_{Ct}} \cdot K_{ALF'}$	
	with	
	K_{ALF}	Rated accuracy limiting factor
	R_{BC}	Connected burden resistance (device and cables)
	R_{BN}	Nominal burden resistance
	R_{Ct}	Transformer internal burden resistance

Calculation example according to IEC 60044–1

I_{sNom} = 1 A $K_{ALF'}$ = 20 R_{BC} = 0.6 Ω (device and cables) R_{Ct} = 3 Ω R_{BN} = 5 Ω (5 VA)	$K_{ALF} = \frac{0.6+3}{5+3} \cdot 20 = 9$ K_{ALF} set to 10, so that: 5P10, 5 VA
with I_{sNom} = secondary transformer nominal current	

A.4.2 Class conversion

Table A-1 Conversion into other classes

British Standard BS 3938	$V_k = \frac{(R_{Ct} + R_{BN}) \cdot I_{sNom}}{1.3} \cdot K_{ALF}$	
ANSI/IEEE C 57.13, class C	$V_{s.t.max} = 20 \cdot I_{sNom} \cdot R_{BN} \cdot \frac{K_{ALF}}{20}$ I_{sNom} = 5 A (typical value)	
IEC 60044-6 (transient response), class TPS	$V_{al} = K \cdot K_{SSC} \cdot (R_{Ct} + R_{BN}) \cdot I_{sNom}$ $K \approx 1$ $K_{SSC} \approx K_{ALF}$	
Classes TPX, TPY, TPZ	Calculated as in Chapter A.4.1 where: $K_{SSC} \approx K_{ALF}$ T_P depending on power system and specified closing sequence	
	with	
	V_k	Knee-point voltage
	R_{Ct}	Internal burden resistance
	R_{BN}	Nominal burden resistance
	I_{sNom}	secondary nominal transformer current
	K_{ALF}	Rated accuracy limiting factor
	$V_{s.t.max}$	sec. terminal volt. at 20 I_{pNom}
	V_{al}	sec. magnetization limit voltage
	K	Dimensioning factor
	K_{SSC}	Factor symmetr. Rated fault current
	T_P	Primary time constant

A.4.3 Cable core balance current transformer

General

The requirements to the cable core balance current transformer are determined by the function „sensitive ground fault detection“.

The recommendations are given according to the standard IEC 60044-1.

Requirements

Transformation ratio, typical It may be necessary to select a different transformation ratio to suit the specific power system and thus the amount of the maximum ground fault current.	60 / 1
Accuracy limiting factor	FS = 10
Minimal Power	1.2 VA
Maximal connected burden resistance - For secondary current threshold values ≥ 20 mA - For secondary current threshold values < 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 neutral grounding and function operating principle

Starpoint	isolated	compensated	high-resistance grounded
Function directional	Class 1	Class 1	Class 1
Function non-directional	Class 3	Class 1	Class 3

For extremely small ground fault currents it may become necessary to correct the angle at the device (see function description of „sensitive ground fault detection“).

A.5 Default Settings

When the device leaves the factory, a large number of LED indications, binary inputs and outputs as well as function keys are already preset. They are summarized in the following table.

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	50/51 Ph A PU 67 A picked up	1762 2692	50/51 Phase A picked up 67/67-TOC Phase A picked up
LED3	50/51 Ph B PU 67 B picked up	1763 2693	50/51 Phase B picked up 67/67-TOC Phase B picked up
LED4	50/51 Ph C PU 67 C picked up	1764 2694	50/51 Phase C picked up 67/67-TOC Phase C picked up
LED5	50N/51NPickedup 67N picked up	1765 2695	50N/51N picked up 67N/67N-TOC picked up
LED6	Failure Σ I Fail I balance Fail V balance Fail Ph. Seq. I Fail Ph. Seq. V	162 163 167 175 176	Failure: Current Summation Failure: Current Balance Failure: Voltage Balance Failure: Phase Sequence Current Failure: Phase Sequence Voltage
LED7	Not configured	1	No Function configured
LED8	Brk OPENED		Breaker OPENED
LED9	>Door open		>Cabinet door open
LED10	>CB wait		>CB waiting for Spring charged
LED11	Not configured	1	No Function configured
LED12	Not configured	1	No Function configured
LED13	Not configured	1	No Function configured
LED14	Not configured	1	No Function configured

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	>BLOCK 50-2 >BLOCK 50N-2	1721 1724	>BLOCK 50-2 >BLOCK 50N-2
BI2	>Reset LED	5	>Reset LED
BI3	>Light on		>Back Light on
BI4	>52-b 52Breaker	4602	>52-b contact (OPEN, if bkr is closed) 52 Breaker
BI5	>52-a 52Breaker	4601	>52-a contact (OPEN, if bkr is open) 52 Breaker

Table A-5 Further binary input presettings for 7SJ631*-

Binary Input	Default function	Function No.	Description
BI6	Disc.Swit.		Disconnect Switch
BI7	Disc.Swit.		Disconnect Switch
BI21	GndSwit.		Ground Switch
BI22	GndSwit.		Ground Switch
BI23	>CB ready		>CB ready Spring is charged
BI24	>DoorClose		>Door closed

Table A-6 Further binary input presettings for 7SJ632*- 7SJ633*- 7SJ635*- 7SJ636*- as well as 7SJ641* 7SJ642*- 7SJ645*-

Binary Input	Default function	Function No.	Description
BI6	Disc.Swit.		Disconnect Switch
BI7	Disc.Swit.		Disconnect Switch
BI8	GndSwit.		Ground Switch
BI9	GndSwit.		Ground Switch
BI11	>CB ready		>CB ready Spring is charged
BI12	>DoorClose		>Door closed

A.5.3 Binary Output

Table A-7 Further Output Relay Presettings for all 7SJ62**- and 7SJ63**-

Binary Output	Default function	Function No.	Description
BO1	Relay TRIP 52Breaker	511	Relay GENERAL TRIP command 52 Breaker
BO2	52Breaker 79 Close	 2851	52 Breaker 79 - Close command
BO3	52Breaker 79 Close	 2851	52 Breaker 79 - Close command

Table A-8 Further Output Relay Presettings for 7SJ62**-

Binary Output	Default function	Function No.	Description
BO4	Failure Σ I Fail I balance Fail V balance Fail Ph. Seq. I Fail Ph. Seq. V	162 163 167 175 176	Failure: Current Summation Failure: Current Balance Failure: Voltage Balance Failure: Phase Sequence Current Failure: Phase Sequence Voltage
BO7	Relay PICKUP	501	Relay PICKUP

Table A-9 Further Output Relay Presettings for 7SJ63**-

Binary Output	Default function	Function No.	Description
BO11	GndSwit.		Ground Switch
BO12	GndSwit.		Ground Switch
BO13	Disc.Swit.		Disconnect Switch
BO14	Disc.Swit.		Disconnect Switch
BO15	Failure Σ I Fail I balance Fail V balance Fail Ph. Seq. I Fail Ph. Seq. V	162 163 167 175 176	Failure: Current Summation Failure: Current Balance Failure: Voltage Balance Failure: Phase Sequence Current Failure: Phase Sequence Voltage

Table A-10 Further Output Relay Presettings for 7SJ632*-, 7SJ633*-, 7SJ635*- 7SJ636*-

Binary Output	Default function	Function No.	Description
BO10	Relay PICKUP	501	Relay PICKUP

Table A-11 Further Output Relay Presettings for 7SJ64**-

Binary Output	Default function	Function No.	Description
BO3	Relay TRIP 52Breaker	511	Relay GENERAL TRIP command 52 Breaker
BO4	52Breaker 79 Close	 2851	52 Breaker 79 - Close command
BO5	52Breaker 79 Close	 2851	52 Breaker 79 - Close command

Table A-12 Further Output Relay Presettings for 7SJ641*-, 7SJ642*- and 7SJ645*-

Binary Output	Default function	Function No.	Description
BO1	GndSwit.		Ground Switch
BO2	GndSwit.		Ground Switch
BO10	Disc.Swit.		Disconnect Switch
BO11	Disc.Swit.		Disconnect Switch

A.5.4 Function Keys

Table A-13 Applies to All Devices and Ordered Variants

Function Keys	Default function	Function No.	Description
F1	Display of operational indications	-	-
F2	Display of the primary operational measured values	-	-
F3	An overview of the last eight network faults	-	-
F4	Not allocated	-	-

A.5.5 Default Display

Devices featuring 4-line display provide a number of predefined measured value pages. The start page of the default display, which will open after device startup, can be selected via parameter 640 **Start image DD**

Devices featuring a graphic display have a default display that provides a graphical representation of the current operating status and/or selected measured values. The displayed parameters are selected during configuration.

4-Line Display of 7SJ62

Side1

```
A▮100.0A   12▮  12.0kV      IA   =                  VA2   =
B▮100.0A   23▮  12.0kV      IB   =                  VBC   =
C▮100.0A   31▮  12.0kV      IC   =                  VC1   =
G▮   0.0A  G ▮   0.0kV      IG   =                  VG    =
```

Side2

```
%   IL    VPh-G VPh-Ph
A ▮100.0 100.0   100.0      IA   =   VA-G =         VA2   =
B ▮100.0 100.0   100.0      IB   =   VB-G =         VBC   =
C ▮100.0 100.0   100.0      IC   =   VC-G =         VC1   =
```

Side3

```
I1:100.00A       f:50.0Hz   I1   =               Frequency =
V1: 12.00kV                 V1   =
P : 3.60MW  cos φ: 1.00     P    =               cos φ     =
Q : 0.00MVAR                Q    =
```

Side4

```
S: 3.60MVA V12:12.0kV       S    =                  VA2   =
P: 3.60MW   IB:100.0A       P    =                  VB    =
Q: 3.60MVAR                 Q    =                        =
f: 50.0Hz  cos φ:   1.00    f    =                  cos φ =
```

Side 5

```
A ▮100.0A                   IA   =
B ▮100.0A                   IB   =
C ▮100.0A                   IC   =
G ▮   0.0A                  IG   =
```

Figure A-91 Default display for configurations without extended measured values (13th position of MLFB = 0 or 1)

Side1

```
A▮100.0A  12▮ 12.0kV
B▮100.0A  23▮ 12.0kV
C▮100.0A  31▮ 12.0kV
G▮   0.0A  G ▮  0.0kV
```

IA	=			VA2	=
IB	=			VBC	=
IC	=			VC1	=
IG	=			VG	=

Side2

```
%   IL    VPh-G VPh-Ph
A ▮100.0 100.0   100.0
B ▮100.0 100.0   100.0
C ▮100.0 100.0   100.0
```

IA	=	VA-G	=	VA2	=
IB	=	VB-G	=	VBC	=
IC	=	VC-G	=	VC1	=

Side3

```
I1:100.00A      f:50.0Hz
V1: 12.00kV
P : 3.60MW  cos φ: 1.00
Q : 0.00MVAR
```

I1	=			Frequency	=
V1	=				
P	=			cos φ	=
Q	=				

Side4

```
S: 3.60MVA V12:12.0kV
P: 3.60MW   IB:100.0A
Q: 3.60MVAR
f: 50.0Hz  cos φ:   1.00
```

S	=			VA2	=
P	=			VB	=
Q	=				=
f	=			cos φ	=

Side 5

```
A ▮100.0A   MAX100.0A
B ▮100.0A   MAX100.0A
C ▮100.0A   MAX100.0A
E ▮   0.0A
```

IA	=			IAmax	=
IB	=			IBmax	=
IC	=			ICmax	=
IG	=				

Side 6

```
A ▮100.0A
B ▮100.0A
C ▮100.0A
G ▮   0.0A
```

IA	=
IB	=
IC	=
IG	=

Figure A-92 Default display for configurations with extended measured values (13th position of MLFB = 2 or 3)

4-Line Display of 7SJ640

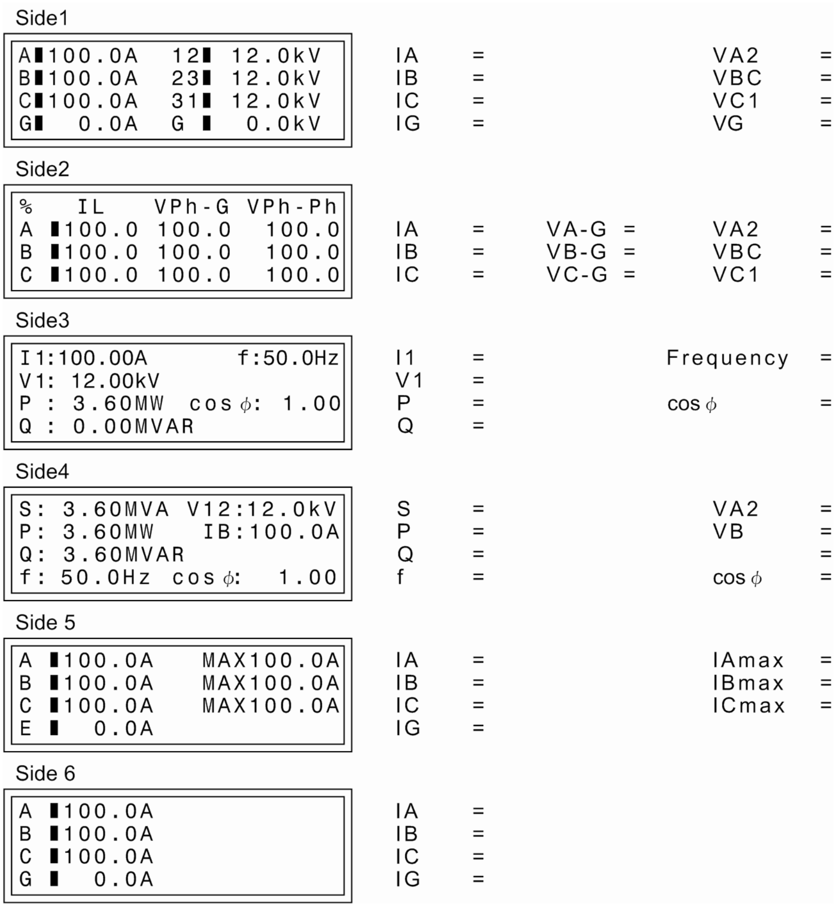
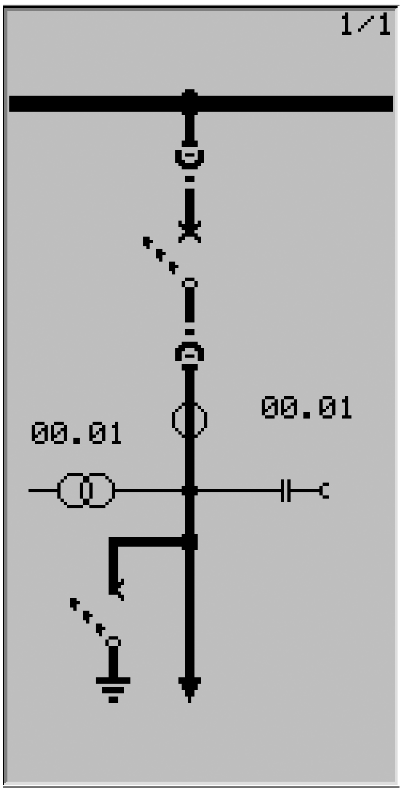


Figure A-93 Default display of the 4-line display 7SJ640*-)

Graphic Display of 7SJ63 and 7SJ641/2/5



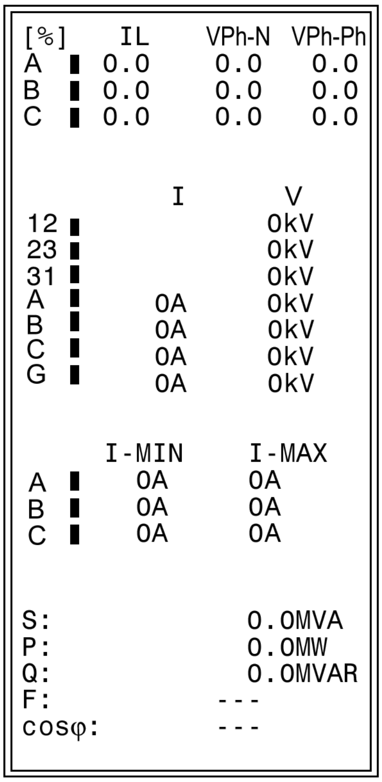


Figure A-94 Default displays for graphic display

Spontaneous Fault Indication of the 4–Line Display

The spontaneous annunciations on devices with 4–line display serve to display the most important data about a fault. They appear automatically in the display after general interrogation of the device, in the sequence shown in the following figure.

50-1 PICKUP		Protective Function that Picked up First;
50-1 TRIP		Protective Function that Tripped Last;
T - Pickup	= 320 ms	Operating Time from General Pickup to Dropout;
T - TRIP	= 197 ms	Operating Time from General Pickup to the First Trip Command;

Figure A-95 Display of spontaneous annunciations in the 4–line display of the device

Spontaneous Fault Indication of the Graphic Display

All devices featuring a graphic display allow to select whether or not to view automatically the most important fault data on the display after a general interrogation. The information corresponds to those of Figure A-95.

A.5.6 Pre-defined CFC Charts

Some CFC Charts are already supplied with the SIPROTEC® device. Depending on the variant the following charts may be implemented:

Device and System Logic

The NEGATOR block assigns the input signal „DataStop“ directly to an output. This is not directly possible without the interconnection of this block.

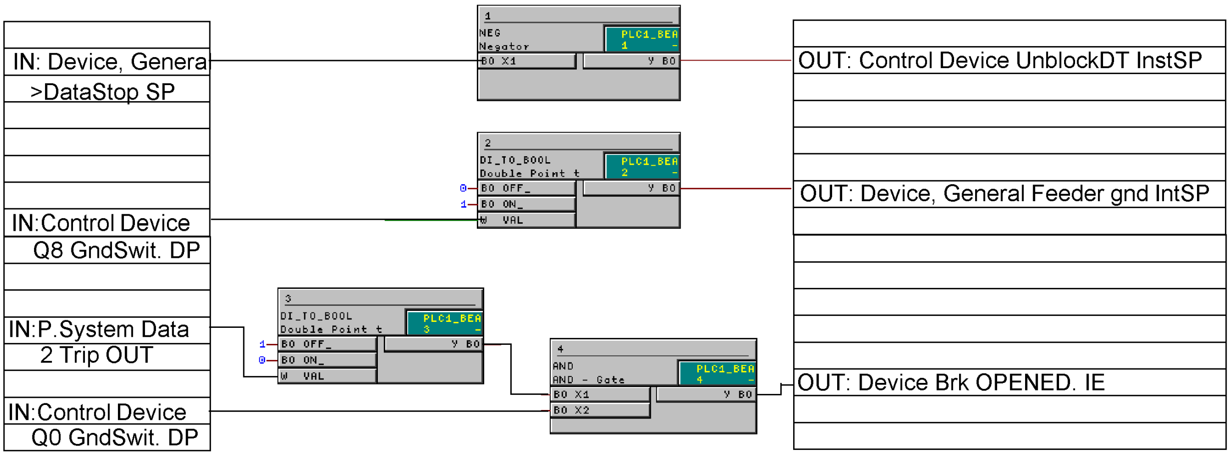


Figure A-96 Logical links between input and output

Setpoints MV

Using modules on the running sequence "measured value processing", a low current monitor for the three phase currents is implemented. The output message is set high as soon as one of the three phase currents falls below the set threshold:

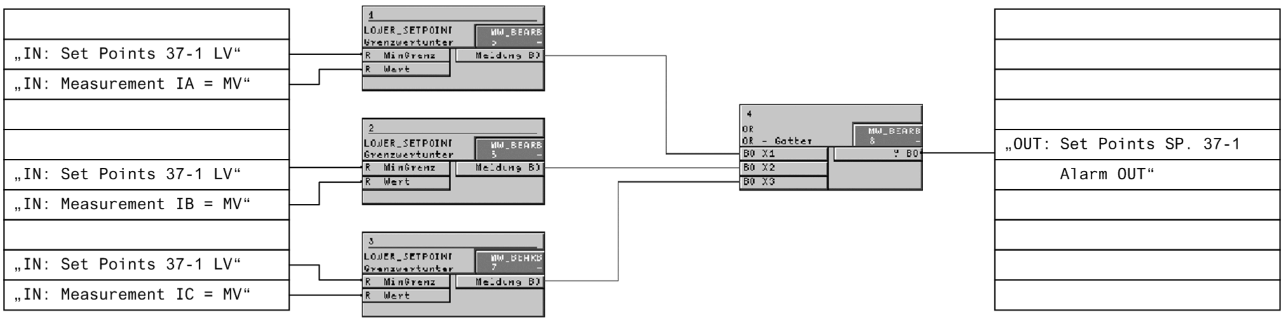


Figure A-97 Undercurrent monitoring

Blocks of the task level "MW_BEARB" (measured value processing) are used to implement the overcurrent monitoring and the power monitoring.

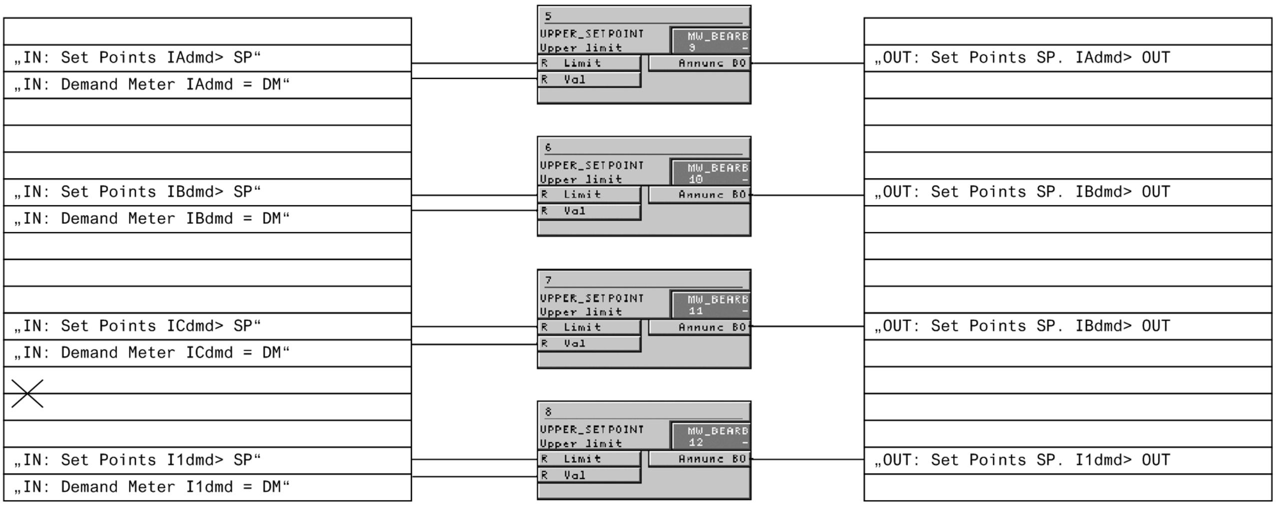


Figure A-98 Overcurrent monitoring

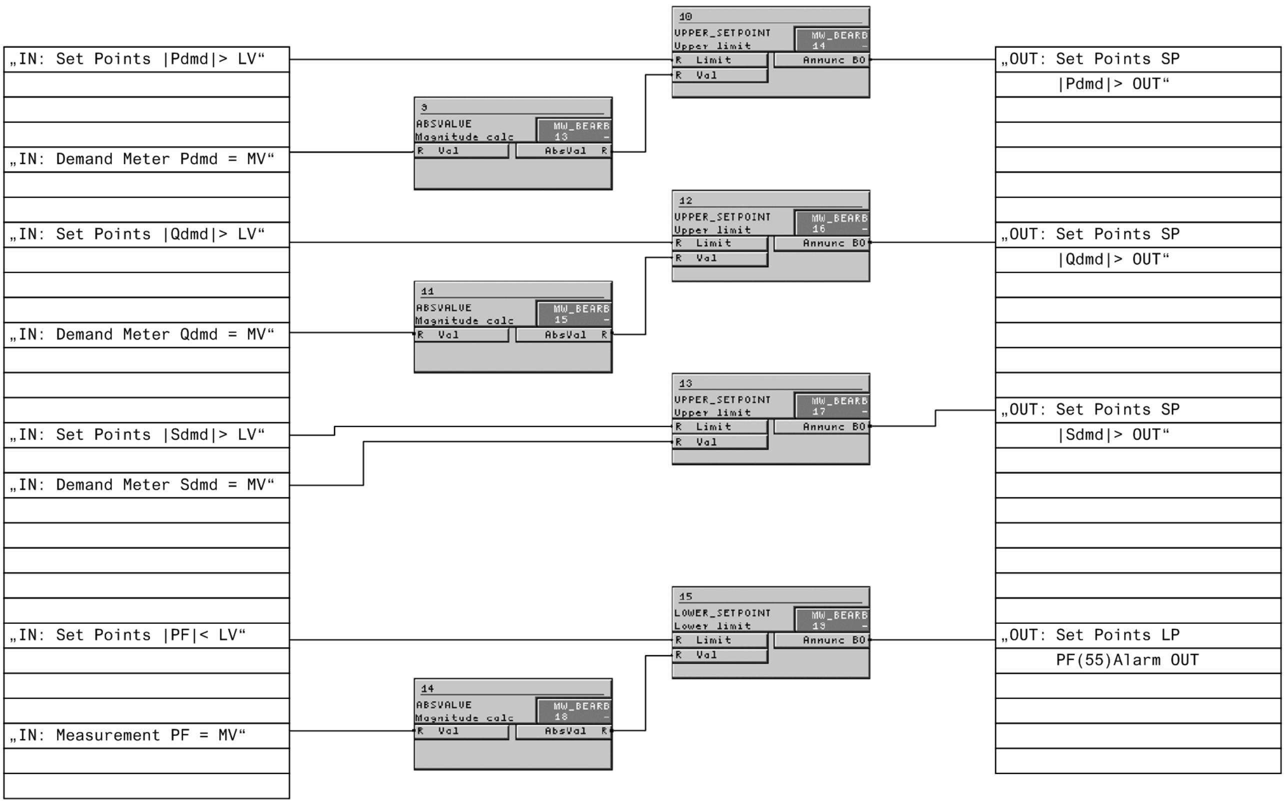
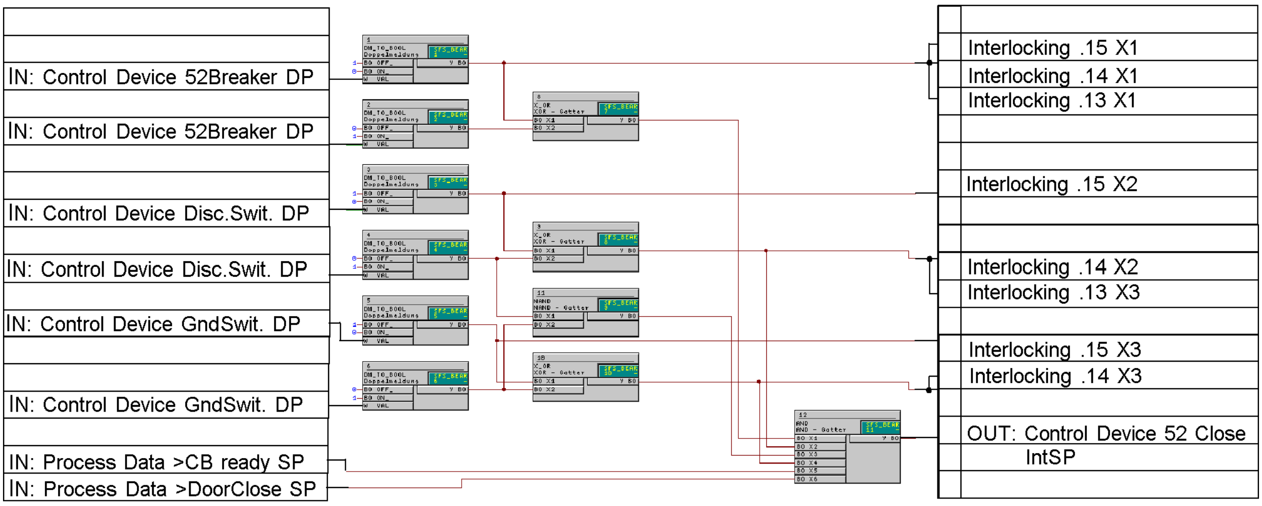


Figure A-99 Power monitoring

Interlocking with 7SJ63/64

Standard interlocking for three switching devices (52, Disc. and GndSw):



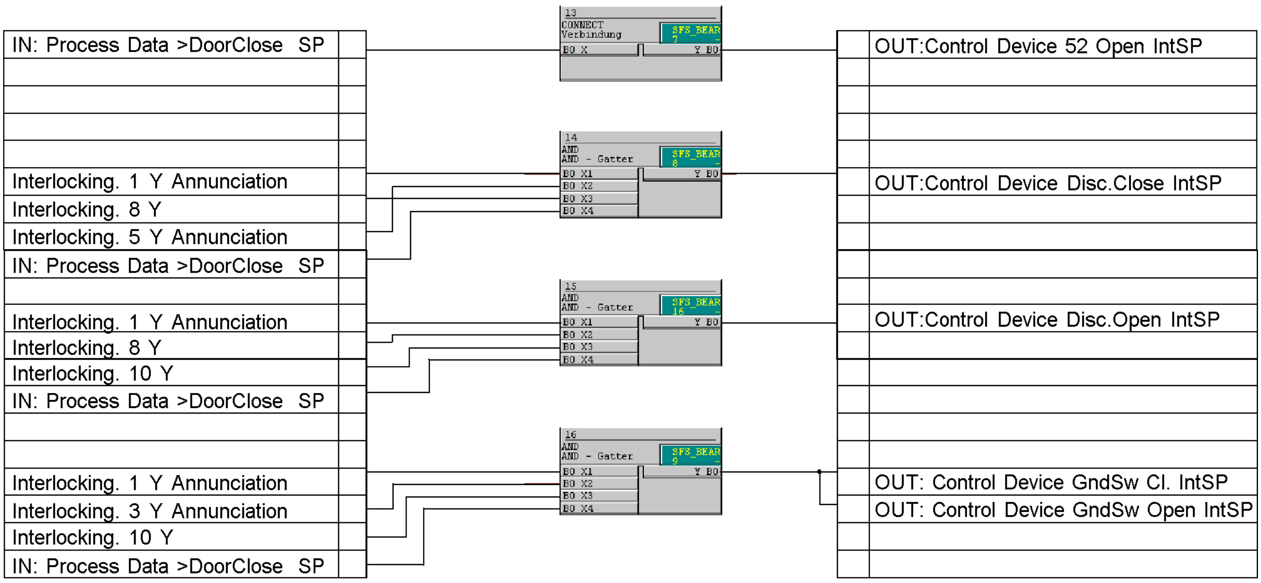


Figure A-100 Standard interlocking for circuit breaker, disconnector and ground switch

A.6 Protocol-dependent Functions

Protocol → Function ↓	IEC 60870-5-103	IEC 61850 Ethernet (EN 100)	PROFIBUS DP	PROFIBUS FMS	DNP3.0 Modbus ASCII/RTU	Additional Interface (optional)
Operational Measured Values	Yes	Yes	Yes	Yes	Yes	Yes
Metered values	Yes	Yes	Yes	Yes	Yes	Yes
Fault Recording	Yes	Yes	No. Only via additional service interface	Yes	No. Only via additional service interface	Yes
Remote relay setting	No. Only via additional service interface	Yes	No. Only via additional service interface	Yes	No. Only via additional service interface	Yes
User-defined messages and switching objects	Yes	Yes	Yes	Yes	Yes	Yes
Time Synchronization	Yes	Yes	Yes	Yes	Yes	—
Messages with time stamp	Yes	Yes	Yes	Yes	Yes	Yes
Commissioning aids						
Measured value indication blocking	Yes	Yes	No	Yes	No	Yes
Creating test messages	Yes	Yes	No	Yes	No	Yes
Physical mode	Asynchronous	Synchronous	Asynchronous	Asynchronous	Asynchronous	—
Transmission Mode	Cyclically/Event	Cyclically/Event	Cyclically	Cyclically/Event	Cyclically/event (DNP) Cyclically (Modbus)	—
Baud rate	9600, 19200	Up to 100 MBaud	Up to 1.5 MBaud	Up to 1.5 MBaud	2400 to 19200	4800 to 115200
Type	- RS232 - RS485 - Fiber-optic cables	Ethernet TP	- RS485 - Optical fiber (Double ring)	- RS485 - Optical fiber (Single ring, Double ring)	- RS 485 - Optical fiber	- RS232 - RS485 - Optical fiber

A.7 Functional Scope

Addr.	Parameter	Setting Options	Default Setting	Comments
103	Grp Chge OPTION	Disabled Enabled	Disabled	Setting Group Change Option
104	OSC. FAULT REC.	Disabled Enabled	Disabled	Oscillographic Fault Records
112	Charac. Phase	Disabled Definite Time TOC IEC TOC ANSI User Defined PU User def. Reset	Definite Time	50/51
113	Charac. Ground	Disabled Definite Time TOC IEC TOC ANSI User Defined PU User def. Reset	Definite Time	50N/51N
115	67/67-TOC	Disabled Definite Time TOC IEC TOC ANSI User Defined PU User def. Reset	Definite Time	67, 67-TOC
116	67N/67N-TOC	Disabled Definite Time TOC IEC TOC ANSI User Defined PU User def. Reset	Definite Time	67N, 67N-TOC
117	Coldload Pickup	Disabled Enabled	Disabled	Cold Load Pickup
122	InrushRestraint	Disabled Enabled	Disabled	2nd Harmonic Inrush Restraint
127	50 1Ph	Disabled Enabled	Disabled	50 1Ph
131	Sens. Gnd Fault	Disabled Definite Time User Defined PU Log. inverse A Log. Inverse B	Disabled	(sensitive) Ground fault
133	INTERM.EF	Disabled with Ignd with 3I0 with Ignd,sens.	Disabled	Intermittent earth fault protection
140	46	Disabled TOC ANSI TOC IEC Definite Time	Disabled	46 Negative Sequence Protection
141	48	Disabled Enabled	Disabled	48 Startup Supervision of Motors
142	49	Disabled No ambient temp With amb. temp.	Disabled	49 Thermal Overload Protection

Addr.	Parameter	Setting Options	Default Setting	Comments
143	66 #of Starts	Disabled Enabled	Disabled	66 Startup Counter for Motors
150	27/59	Disabled Enabled	Disabled	27, 59 Under/Overvoltage Protection
154	81 O/U	Disabled Enabled	Disabled	81 Over/Underfrequency Protection
161	25 Function 1	Disabled ASYN/SYNCHRON SYNCHROCHECK	Disabled	25 Function group 1
162	25 Function 2	Disabled ASYN/SYNCHRON SYNCHROCHECK	Disabled	25 Function group 2
163	25 Function 3	Disabled ASYN/SYNCHRON SYNCHROCHECK	Disabled	25 Function group 3
164	25 Function 4	Disabled ASYN/SYNCHRON SYNCHROCHECK	Disabled	25 Function group 4
170	50BF	Disabled Enabled	Disabled	50BF Breaker Failure Protection
171	79 Auto Recl.	Disabled Enabled	Disabled	79 Auto-Reclose Function
172	52 B.WEAR MONIT	Disabled Ix-Method 2P-Method I2t-Method	Disabled	52 Breaker Wear Monitoring
180	Fault Locator	Disabled Enabled	Disabled	Fault Locator
182	74 Trip Ct Supv	Disabled 2 Binary Inputs 1 Binary Input	Disabled	74TC Trip Circuit Supervision
190	RTD-BOX INPUT	Disabled Port C	Disabled	External Temperature Input

Addr.	Parameter	Setting Options	Default Setting	Comments
191	RTD CONNECTION	6 RTD simplex 6 RTD HDX 12 RTD HDX	6 RTD simplex	Ext. Temperature Input Connection Type
-	FLEXIBLE FUNC. 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
201	CT Starpoint	P.System Data 1		towards Line towards Busbar	towards Line	CT Starpoint
202	Vnom PRIMARY	P.System Data 1		0.10 .. 800.00 kV	12.00 kV	Rated Primary Voltage
203	Vnom SECONDARY	P.System Data 1		100 .. 225 V	100 V	Rated Secondary Voltage (L-L)
204	CT PRIMARY	P.System Data 1		10 .. 50000 A	100 A	CT Rated Primary Current
205	CT SECONDARY	P.System Data 1		1A 5A	1A	CT Rated Secondary Current
206A	Vph / Vdelta	P.System Data 1		1.00 .. 3.00	1.73	Matching ratio Phase-VT To Open-Delta-VT
209	PHASE SEQ.	P.System Data 1		A B C A C B	A B C	Phase Sequence
210A	TMin TRIP CMD	P.System Data 1		0.01 .. 32.00 sec	0.15 sec	Minimum TRIP Command Duration
211A	TMax CLOSE CMD	P.System Data 1		0.01 .. 32.00 sec	1.00 sec	Maximum Close Command Duration
212	BkrClosed I MIN	P.System Data 1	1A	0.04 .. 1.00 A	0.04 A	Closed Breaker Min. Current Threshold
			5A	0.20 .. 5.00 A	0.20 A	
213	VT Connect. 3ph	P.System Data 1		Van, Vbn, Vcn Vab, Vbc, VGnd Van,Vbn,Vcn,VGn Van,Vbn,Vcn,VSy	Van, Vbn, Vcn	VT Connection, three-phase
214	Rated Frequency	P.System Data 1		50 Hz 60 Hz	50 Hz	Rated Frequency
215	Distance Unit	P.System Data 1		km Miles	km	Distance measurement unit
217	Ignd-CT PRIM	P.System Data 1		1 .. 50000 A	60 A	Ignd-CT rated primary current
218	Ignd-CT SEC	P.System Data 1		1A 5A	1A	Ignd-CT rated secondary current
235A	ATEX100	P.System Data 1		NO YES	NO	Storage of th. Replicas w/o Power Supply
240	VT Connect. 1ph	P.System Data 1		NO Van Vbn Vcn Vab Vbc Vca	NO	VT Connection, single-phase
250A	50/51 2-ph prot	P.System Data 1		ON OFF	OFF	50, 51 Time Overcurrent with 2ph. prot.
260	Ir-52	P.System Data 1		10 .. 50000 A	125 A	Rated Normal Current (52 Breaker)
261	OP.CYCLES AT Ir	P.System Data 1		100 .. 1000000	10000	Switching Cycles at Rated Normal Current
262	Isc-52	P.System Data 1		10 .. 100000 A	25000 A	Rated Short-Circuit Breaking Current
263	OP.CYCLES Isc	P.System Data 1		1 .. 1000	50	Switch. Cycles at Rated Short-Cir. Curr.
264	Ix EXPONENT	P.System Data 1		1.0 .. 3.0	2.0	Exponent for the Ix-Method
265	Cmd.via control	P.System Data 1		(Setting options depend on configuration)	None	52 B.Wear: Open Cmd. via Control Device
266	T 52 BREAKTIME	P.System Data 1		1 .. 600 ms	80 ms	Breaktime (52 Breaker)
267	T 52 OPENING	P.System Data 1		1 .. 500 ms	65 ms	Opening Time (52 Breaker)
276	TEMP. UNIT	P.System Data 1		Celsius Fahrenheit	Celsius	Unit of temperature measurement

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
302	CHANGE	Change Group		Group A Group B Group C Group D Binary Input Protocol	Group A	Change to Another Setting Group
401	WAVEFORMTRIGGER	Osc. Fault Rec.		Save w. Pickup Save w. TRIP Start w. TRIP	Save w. Pickup	Waveform Capture
402	WAVEFORM DATA	Osc. Fault Rec.		Fault event Pow.Sys.Flt.	Fault event	Scope of Waveform Data
403	MAX. LENGTH	Osc. Fault Rec.		0.30 .. 5.00 sec	2.00 sec	Max. length of a Waveform Capture Record
404	PRE. TRIG. TIME	Osc. Fault Rec.		0.05 .. 0.50 sec	0.25 sec	Captured Waveform Prior to Trigger
405	POST REC. TIME	Osc. Fault Rec.		0.05 .. 0.50 sec	0.10 sec	Captured Waveform after Event
406	BinIn CAPT.TIME	Osc. Fault Rec.		0.10 .. 5.00 sec; ∞	0.50 sec	Capture Time via Binary Input
610	FltDisp.LED/LCD	Device, General		Target on PU Target on TRIP	Target on PU	Fault Display on LED / LCD
611	Spont. FltDisp.	Device, General		YES NO	NO	Spontaneous display of flt.an-nunciations
613A	Gnd O/Cprot. w.	P.System Data 1		Ignd (measured) 3I0 (calcul.)	Ignd (measured)	Ground Overcurrent protection with
614A	OP. QUANTITY 59	P.System Data 1		Vphph V2	Vphph	Opera. Quantity for 59 Overvolt. Prot.
615A	OP. QUANTITY 27	P.System Data 1		V1 Vphph	V1	Opera. Quantity for 27 Undervolt. Prot.
640	Start image DD	Device, General		image 1 image 2 image 3 image 4 image 5 image 6	image 1	Start image Default Display
1101	FullScaleVolt.	P.System Data 2		0.10 .. 800.00 kV	12.00 kV	Measurem:FullScaleVolt-age(Equipm.rating)
1102	FullScaleCurr.	P.System Data 2		10 .. 50000 A	100 A	Measurem:FullScaleCur-rent(Equipm.rating)
1103	RG/RL Ratio	P.System Data 2		-0.33 .. 7.00	1.00	RG/RL - Ratio of Gnd to Line Re-sistance
1104	XG/XL Ratio	P.System Data 2		-0.33 .. 7.00	1.00	XG/XL - Ratio of Gnd to Line Re-actance
1105	x'	P.System Data 2	1A	0.0050 .. 15.0000 Ω/mi	0.2420 Ω/mi	x' - Line Reactance per length unit
			5A	0.0010 .. 3.0000 Ω/mi	0.0484 Ω/mi	
1106	x'	P.System Data 2	1A	0.0050 .. 9.5000 Ω/km	0.1500 Ω/km	x' - Line Reactance per length unit
			5A	0.0010 .. 1.9000 Ω/km	0.0300 Ω/km	
1107	I MOTOR START	P.System Data 2	1A	0.40 .. 10.00 A	2.50 A	Motor Start Current (Block 49, Start 48)
			5A	2.00 .. 50.00 A	12.50 A	
1108	P,Q sign	P.System Data 2		not reversed reversed	not reversed	P,Q operational measured values sign
1201	FCT 50/51	50/51 Overcur.		ON OFF	ON	50, 51 Phase Time Overcurrent
1202	50-2 PICKUP	50/51 Overcur.	1A	0.10 .. 35.00 A; ∞	2.00 A	50-2 Pickup
			5A	0.50 .. 175.00 A; ∞	10.00 A	
1203	50-2 DELAY	50/51 Overcur.		0.00 .. 60.00 sec; ∞	0.00 sec	50-2 Time Delay
1204	50-1 PICKUP	50/51 Overcur.	1A	0.10 .. 35.00 A; ∞	1.00 A	50-1 Pickup
			5A	0.50 .. 175.00 A; ∞	5.00 A	
1205	50-1 DELAY	50/51 Overcur.		0.00 .. 60.00 sec; ∞	0.50 sec	50-1 Time Delay
1207	51 PICKUP	50/51 Overcur.	1A	0.10 .. 4.00 A	1.00 A	51 Pickup
			5A	0.50 .. 20.00 A	5.00 A	
1208	51 TIME DIAL	50/51 Overcur.		0.05 .. 3.20 sec; ∞	0.50 sec	51 Time Dial
1209	51 TIME DIAL	50/51 Overcur.		0.50 .. 15.00 ; ∞	5.00	51 Time Dial
1210	51 Drop-out	50/51 Overcur.		Instantaneous Disk Emulation	Disk Emulation	Drop-out characteristic

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
1211	51 IEC CURVE	50/51 Overcur.		Normal Inverse Very Inverse Extremely Inv. Long Inverse	Normal Inverse	IEC Curve
1212	51 ANSI CURVE	50/51 Overcur.		Very Inverse Inverse Short Inverse Long Inverse Moderately Inv. Extremely Inv. Definite Inv.	Very Inverse	ANSI Curve
1213A	MANUAL CLOSE	50/51 Overcur.		50-2 instant. 50 -1 instant. 51 instant. Inactive	50-2 instant.	Manual Close Mode
1214A	50-2 active	50/51 Overcur.		Always with 79 active	Always	50-2 active
1215A	50 T DROP-OUT	50/51 Overcur.		0.00 .. 60.00 sec	0.00 sec	50 Drop-Out Time Delay
1230	51/51N	50/51 Overcur.		1.00 .. 20.00 I/Ip; ∞ 0.01 .. 999.00 TD		51/51N
1231	MofPU Res T/Tp	50/51 Overcur.		0.05 .. 0.95 I/Ip; ∞ 0.01 .. 999.00 TD		Multiple of Pickup <-> T/Tp
1301	FCT 50N/51N	50/51 Overcur.		ON OFF	ON	50N, 51N Ground Time Overcur-rent
1302	50N-2 PICKUP	50/51 Overcur.	1A	0.05 .. 35.00 A; ∞	0.50 A	50N-2 Pickup
			5A	0.25 .. 175.00 A; ∞	2.50 A	
1303	50N-2 DELAY	50/51 Overcur.		0.00 .. 60.00 sec; ∞	0.10 sec	50N-2 Time Delay
1304	50N-1 PICKUP	50/51 Overcur.	1A	0.05 .. 35.00 A; ∞	0.20 A	50N-1 Pickup
			5A	0.25 .. 175.00 A; ∞	1.00 A	
1305	50N-1 DELAY	50/51 Overcur.		0.00 .. 60.00 sec; ∞	0.50 sec	50N-1 Time Delay
1307	51N PICKUP	50/51 Overcur.	1A	0.05 .. 4.00 A	0.20 A	51N Pickup
			5A	0.25 .. 20.00 A	1.00 A	
1308	51N TIME DIAL	50/51 Overcur.		0.05 .. 3.20 sec; ∞	0.20 sec	51N Time Dial
1309	51N TIME DIAL	50/51 Overcur.		0.50 .. 15.00 ; ∞	5.00	51N Time Dial
1310	51N Drop-out	50/51 Overcur.		Instantaneous Disk Emulation	Disk Emulation	Drop-Out Characteristic
1311	51N IEC CURVE	50/51 Overcur.		Normal Inverse Very Inverse Extremely Inv. Long Inverse	Normal Inverse	IEC Curve
1312	51N ANSI CURVE	50/51 Overcur.		Very Inverse Inverse Short Inverse Long Inverse Moderately Inv. Extremely Inv. Definite Inv.	Very Inverse	ANSI Curve
1313A	MANUAL CLOSE	50/51 Overcur.		50N-2 instant. 50N-1 instant. 51N instant. Inactive	50N-2 instant.	Manual Close Mode
1314A	50N-2 active	50/51 Overcur.		Always With 79 Active	Always	50N-2 active
1315A	50N T DROP-OUT	50/51 Overcur.		0.00 .. 60.00 sec	0.00 sec	50N Drop-Out Time Delay
1330	50N/51N	50/51 Overcur.		1.00 .. 20.00 I/Ip; ∞ 0.01 .. 999.00 TD		50N/51N
1331	MofPU Res T/TEp	50/51 Overcur.		0.05 .. 0.95 I/Ip; ∞ 0.01 .. 999.00 TD		Multiple of Pickup <-> T/TEp
1501	FCT 67/67-TOC	67 Direct. O/C		OFF ON	OFF	67, 67-TOC Phase Time Over-current
1502	67-2 PICKUP	67 Direct. O/C	1A	0.10 .. 35.00 A; ∞	2.00 A	67-2 Pickup
			5A	0.50 .. 175.00 A; ∞	10.00 A	
1503	67-2 DELAY	67 Direct. O/C		0.00 .. 60.00 sec; ∞	0.10 sec	67-2 Time Delay
1504	67-1 PICKUP	67 Direct. O/C	1A	0.10 .. 35.00 A; ∞	1.00 A	67-1 Pickup
			5A	0.50 .. 175.00 A; ∞	5.00 A	

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
1505	67-1 DELAY	67 Direct. O/C		0.00 .. 60.00 sec; ∞	0.50 sec	67-1Time Delay
1507	67-TOC PICKUP	67 Direct. O/C	1A	0.10 .. 4.00 A	1.00 A	67-TOC Pickup
			5A	0.50 .. 20.00 A	5.00 A	
1508	67 TIME DIAL	67 Direct. O/C		0.05 .. 3.20 sec; ∞	0.50 sec	67-TOC Time Dial
1509	67 TIME DIAL	67 Direct. O/C		0.50 .. 15.00 ; ∞	5.00	67-TOC Time Dial
1510	67-TOC Drop-out	67 Direct. O/C		Instantaneous Disk Emulation	Disk Emulation	Drop-Out Characteristic
1511	67- IEC CURVE	67 Direct. O/C		Normal Inverse Very Inverse Extremely Inv. Long Inverse	Normal Inverse	IEC Curve
1512	67- ANSI CURVE	67 Direct. O/C		Very Inverse Inverse Short Inverse Long Inverse Moderately Inv. Extremely Inv. Definite Inv.	Very Inverse	ANSI Curve
1513A	MANUAL CLOSE	67 Direct. O/C		67-2 instant. 67-1 instant. 67-TOC instant. Inactive	67-2 instant.	Manual Close Mode
1514A	67 active	67 Direct. O/C		with 79 active always	always	67 active
1516	67 Direction	67 Direct. O/C		Forward Reverse	Forward	Phase Direction
1518A	67 T DROP-OUT	67 Direct. O/C		0.00 .. 60.00 sec	0.00 sec	67 Drop-Out Time Delay
1519A	ROTATION ANGLE	67 Direct. O/C		-180 .. 180 °	45 °	Rotation Angle of Reference Voltage
1530	67	67 Direct. O/C		1.00 .. 20.00 I/Ip; ∞ 0.01 .. 999.00 TD		67
1531	MofPU Res T/Tp	67 Direct. O/C		0.05 .. 0.95 I/Ip; ∞ 0.01 .. 999.00 TD		Multiple of Pickup <-> T/Tp
1601	FCT 67N/67N-TOC	67 Direct. O/C		OFF ON	OFF	67N, 67N-TOC Ground Time Overcurrent
1602	67N-2 PICKUP	67 Direct. O/C	1A	0.05 .. 35.00 A; ∞	0.50 A	67N-2 Pickup
			5A	0.25 .. 175.00 A; ∞	2.50 A	
1603	67N-2 DELAY	67 Direct. O/C		0.00 .. 60.00 sec; ∞	0.10 sec	67N-2 Time Delay
1604	67N-1 PICKUP	67 Direct. O/C	1A	0.05 .. 35.00 A; ∞	0.20 A	67N-1 Pickup
			5A	0.25 .. 175.00 A; ∞	1.00 A	
1605	67N-1 DELAY	67 Direct. O/C		0.00 .. 60.00 sec; ∞	0.50 sec	67N-1 Time Delay
1607	67N-TOC PICKUP	67 Direct. O/C	1A	0.05 .. 4.00 A	0.20 A	67N-TOC Pickup
			5A	0.25 .. 20.00 A	1.00 A	
1608	67N-TOC T-DIAL	67 Direct. O/C		0.05 .. 3.20 sec; ∞	0.20 sec	67N-TOC Time Dial
1609	67N-TOC T-DIAL	67 Direct. O/C		0.50 .. 15.00 ; ∞	5.00	67N-TOC Time Dial
1610	67N-TOC DropOut	67 Direct. O/C		Instantaneous Disk Emulation	Disk Emulation	Drop-Out Characteristic
1611	67N-TOC IEC	67 Direct. O/C		Normal Inverse Very Inverse Extremely Inv. Long Inverse	Normal Inverse	IEC Curve
1612	67N-TOC ANSI	67 Direct. O/C		Very Inverse Inverse Short Inverse Long Inverse Moderately Inv. Extremely Inv. Definite Inv.	Very Inverse	ANSI Curve
1613A	MANUAL CLOSE	67 Direct. O/C		67N-2 instant. 67N-1 instant. 67N-TOC instant Inactive	67N-2 instant.	Manual Close Mode
1614A	67N active	67 Direct. O/C		always with 79 active	always	67N active
1616	67N Direction	67 Direct. O/C		Forward Reverse	Forward	Ground Direction

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
1617	67N POLARIZAT.	67 Direct. O/C		with VN and IN with V2 and I2	with VN and IN	Ground Polarization
1618A	67N T DROP-OUT	67 Direct. O/C		0.00 .. 60.00 sec	0.00 sec	67N Drop-Out Time Delay
1619A	ROTATION ANGLE	67 Direct. O/C		-180 .. 180 °	-45 °	Rotation Angle of Reference Voltage
1630	M.of PU TD	67 Direct. O/C		1.00 .. 20.00 I/Ip; ∞ 0.01 .. 999.00 TD		Multiples of PU Time-Dial
1631	I/IEp Rf T/TEp	67 Direct. O/C		0.05 .. 0.95 I/Ip; ∞ 0.01 .. 999.00 TD		67N TOC
1701	COLDLOAD PICKUP	ColdLoadPickup		OFF ON	OFF	Cold-Load-Pickup Function
1702	Start Condition	ColdLoadPickup		No Current Breaker Contact 79 ready	No Current	Start Condition
1703	CB Open Time	ColdLoadPickup		0 .. 21600 sec	3600 sec	Circuit Breaker OPEN Time
1704	Active Time	ColdLoadPickup		1 .. 21600 sec	3600 sec	Active Time
1705	Stop Time	ColdLoadPickup		1 .. 600 sec; ∞	600 sec	Stop Time
1801	50c-2 PICKUP	ColdLoadPickup	1A	0.10 .. 35.00 A; ∞	10.00 A	50c-2 Pickup
			5A	0.50 .. 175.00 A; ∞	50.00 A	
1802	50c-2 DELAY	ColdLoadPickup		0.00 .. 60.00 sec; ∞	0.00 sec	50c-2 Time Delay
1803	50c-1 PICKUP	ColdLoadPickup	1A	0.10 .. 35.00 A; ∞	2.00 A	50c-1 Pickup
			5A	0.50 .. 175.00 A; ∞	10.00 A	
1804	50c-1 DELAY	ColdLoadPickup		0.00 .. 60.00 sec; ∞	0.30 sec	50c-1 Time Delay
1805	51c PICKUP	ColdLoadPickup	1A	0.10 .. 4.00 A	1.50 A	51c Pickup
			5A	0.50 .. 20.00 A	7.50 A	
1806	51c TIME DIAL	ColdLoadPickup		0.05 .. 3.20 sec; ∞	0.50 sec	51c Time dial
1807	51c TIME DIAL	ColdLoadPickup		0.50 .. 15.00 ; ∞	5.00	51c Time dial
1901	50Nc-2 PICKUP	ColdLoadPickup	1A	0.05 .. 35.00 A; ∞	7.00 A	50Nc-2 Pickup
			5A	0.25 .. 175.00 A; ∞	35.00 A	
1902	50Nc-2 DELAY	ColdLoadPickup		0.00 .. 60.00 sec; ∞	0.00 sec	50Nc-2 Time Delay
1903	50Nc-1 PICKUP	ColdLoadPickup	1A	0.05 .. 35.00 A; ∞	1.50 A	50Nc-1 Pickup
			5A	0.25 .. 175.00 A; ∞	7.50 A	
1904	50Nc-1 DELAY	ColdLoadPickup		0.00 .. 60.00 sec; ∞	0.30 sec	50Nc-1 Time Delay
1905	51Nc PICKUP	ColdLoadPickup	1A	0.05 .. 4.00 A	1.00 A	51Nc Pickup
			5A	0.25 .. 20.00 A	5.00 A	
1906	51Nc T-DIAL	ColdLoadPickup		0.05 .. 3.20 sec; ∞	0.50 sec	51Nc Time Dial
1907	51Nc T-DIAL	ColdLoadPickup		0.50 .. 15.00 ; ∞	5.00	51Nc Time Dial
2001	67c-2 PICKUP	ColdLoadPickup	1A	0.10 .. 35.00 A; ∞	10.00 A	67c-2 Pickup
			5A	0.50 .. 175.00 A; ∞	50.00 A	
2002	67c-2 DELAY	ColdLoadPickup		0.00 .. 60.00 sec; ∞	0.00 sec	67c-2 Time Delay
2003	67c-1 PICKUP	ColdLoadPickup	1A	0.10 .. 35.00 A; ∞	2.00 A	67c-1 Pickup
			5A	0.50 .. 175.00 A; ∞	10.00 A	
2004	67c-1 DELAY	ColdLoadPickup		0.00 .. 60.00 sec; ∞	0.30 sec	67c-1 Time Delay
2005	67c-TOC PICKUP	ColdLoadPickup	1A	0.10 .. 4.00 A	1.50 A	67c Pickup
			5A	0.50 .. 20.00 A	7.50 A	
2006	67c-TOC T-DIAL	ColdLoadPickup		0.05 .. 3.20 sec; ∞	0.50 sec	67c Time Dial
2007	67c-TOC T-DIAL	ColdLoadPickup		0.50 .. 15.00 ; ∞	5.00	67c Time Dial
2101	67Nc-2 PICKUP	ColdLoadPickup	1A	0.05 .. 35.00 A; ∞	7.00 A	67Nc-2 Pickup
			5A	0.25 .. 175.00 A; ∞	35.00 A	
2102	67Nc-2 DELAY	ColdLoadPickup		0.00 .. 60.00 sec; ∞	0.00 sec	67Nc-2 Time Delay
2103	67Nc-1 PICKUP	ColdLoadPickup	1A	0.05 .. 35.00 A; ∞	1.50 A	67Nc-1 Pickup
			5A	0.25 .. 175.00 A; ∞	7.50 A	
2104	67Nc-1 DELAY	ColdLoadPickup		0.00 .. 60.00 sec; ∞	0.30 sec	67Nc-1 Time Delay
2105	67Nc-TOC PICKUP	ColdLoadPickup	1A	0.05 .. 4.00 A	1.00 A	67Nc-TOC Pickup
			5A	0.25 .. 20.00 A	5.00 A	
2106	67Nc-TOC T-DIAL	ColdLoadPickup		0.05 .. 3.20 sec; ∞	0.50 sec	67Nc-TOC Time Dial
2107	67Nc-TOC T-DIAL	ColdLoadPickup		0.50 .. 15.00 ; ∞	5.00	67Nc-TOC Time Dial

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
2201	INRUSH REST.	50/51 Overcur.		OFF ON	OFF	Inrush Restraint
2202	2nd HARMONIC	50/51 Overcur.		10 .. 45 %	15 %	2nd. harmonic in % of fundamental
2203	CROSS BLOCK	50/51 Overcur.		NO YES	NO	Cross Block
2204	CROSS BLK TIMER	50/51 Overcur.		0.00 .. 180.00 sec	0.00 sec	Cross Block Time
2205	I Max	50/51 Overcur.	1A	0.30 .. 25.00 A	7.50 A	Maximum Current for Inrush Restraint
			5A	1.50 .. 125.00 A	37.50 A	
2701	50 1Ph	50 1Ph		OFF ON	OFF	50 1Ph
2702	50 1Ph-2 PICKUP	50 1Ph	1A	0.05 .. 35.00 A; ∞	0.50 A	50 1Ph-2 Pickup
			5A	0.25 .. 175.00 A; ∞	2.50 A	
2703	50 1Ph-2 PICKUP	50 1Ph		0.003 .. 1.500 A; ∞	0.300 A	50 1Ph-2 Pickup
2704	50 1Ph-2 DELAY	50 1Ph		0.00 .. 60.00 sec; ∞	0.10 sec	50 1Ph-2 Time Delay
2705	50 1Ph-1 PICKUP	50 1Ph	1A	0.05 .. 35.00 A; ∞	0.20 A	50 1Ph-1 Pickup
			5A	0.25 .. 175.00 A; ∞	1.00 A	
2706	50 1Ph-1 PICKUP	50 1Ph		0.003 .. 1.500 A; ∞	0.100 A	50 1Ph-1 Pickup
2707	50 1Ph-1 DELAY	50 1Ph		0.00 .. 60.00 sec; ∞	0.50 sec	50 1Ph-1 Time Delay
3101	Sens. Gnd Fault	Sens. Gnd Fault		OFF ON Alarm Only	OFF	(Sensitive) Ground Fault
3102	CT Err. I1	Sens. Gnd Fault		0.001 .. 1.600 A	0.050 A	Current I1 for CT Angle Error
3102	CT Err. I1	Sens. Gnd Fault	1A	0.05 .. 35.00 A	1.00 A	Current I1 for CT Angle Error
			5A	0.25 .. 175.00 A	5.00 A	
3103	CT Err. F1	Sens. Gnd Fault		0.0 .. 5.0 °	0.0 °	CT Angle Error at I1
3104	CT Err. I2	Sens. Gnd Fault		0.001 .. 1.600 A	1.000 A	Current I2 for CT Angle Error
3104	CT Err. I2	Sens. Gnd Fault	1A	0.05 .. 35.00 A	10.00 A	Current I2 for CT Angle Error
			5A	0.25 .. 175.00 A	50.00 A	
3105	CT Err. F2	Sens. Gnd Fault		0.0 .. 5.0 °	0.0 °	CT Angle Error at I2
3106	VPH MIN	Sens. Gnd Fault		10 .. 100 V	40 V	L-Gnd Voltage of Faulted Phase Vph Min
3107	VPH MAX	Sens. Gnd Fault		10 .. 100 V	75 V	L-Gnd Voltage of Unfaulted Phase Vph Max
3108	64-1 VGND	Sens. Gnd Fault		1.8 .. 200.0 V	40.0 V	64-1 Ground Displacement Voltage
3109	64-1 VGND	Sens. Gnd Fault		1.8 .. 170.0 V	40.0 V	64-1 Ground Displacement Voltage
3110	64-1 VGND	Sens. Gnd Fault		10.0 .. 225.0 V	70.0 V	64-1 Ground Displacement Voltage
3111	T-DELAY Pickup	Sens. Gnd Fault		0.04 .. 320.00 sec; ∞	1.00 sec	Time-DELAY Pickup
3112	64-1 DELAY	Sens. Gnd Fault		0.10 .. 40000.00 sec; ∞	10.00 sec	64-1 Time Delay
3113	50Ns-2 PICKUP	Sens. Gnd Fault		0.001 .. 1.500 A	0.300 A	50Ns-2 Pickup
3113	50Ns-2 PICKUP	Sens. Gnd Fault	1A	0.05 .. 35.00 A	10.00 A	50Ns-2 Pickup
			5A	0.25 .. 175.00 A	50.00 A	
3114	50Ns-2 DELAY	Sens. Gnd Fault		0.00 .. 320.00 sec; ∞	1.00 sec	50Ns-2 Time Delay
3115	67Ns-2 DIRECT	Sens. Gnd Fault		Forward Reverse Non-Directional	Forward	67Ns-2 Direction
3117	50Ns-1 PICKUP	Sens. Gnd Fault		0.001 .. 1.500 A	0.100 A	50Ns-1 Pickup
3117	50Ns-1 PICKUP	Sens. Gnd Fault	1A	0.05 .. 35.00 A	2.00 A	50Ns-1 Pickup
			5A	0.25 .. 175.00 A	10.00 A	
3118	50Ns-1 DELAY	Sens. Gnd Fault		0.00 .. 320.00 sec; ∞	2.00 sec	50Ns-1 Time delay
3119	51Ns PICKUP	Sens. Gnd Fault		0.001 .. 1.400 A	0.100 A	51Ns Pickup
3119	51Ns PICKUP	Sens. Gnd Fault		0.003 .. 0.500 A	0.004 A	51Ns Pickup
3119	51Ns PICKUP	Sens. Gnd Fault	1A	0.05 .. 4.00 A	1.00 A	51Ns Pickup
			5A	0.25 .. 20.00 A	5.00 A	
3120	51NsTIME DIAL	Sens. Gnd Fault		0.10 .. 4.00 sec; ∞	1.00 sec	51Ns Time Dial
3121A	50Ns T DROP-OUT	Sens. Gnd Fault		0.00 .. 60.00 sec	0.00 sec	50Ns Drop-Out Time Delay

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
3122	67Ns-1 DIRECT.	Sens. Gnd Fault		Forward Reverse Non-Directional	Forward	67Ns-1 Direction
3123	RELEASE DIRECT.	Sens. Gnd Fault		0.001 .. 1.200 A	0.010 A	Release directional element
3123	RELEASE DIRECT.	Sens. Gnd Fault	1A	0.05 .. 30.00 A	0.50 A	Release directional element
			5A	0.25 .. 150.00 A	2.50 A	
3124	PHI CORRECTION	Sens. Gnd Fault		-45.0 .. 45.0 °	0.0 °	Correction Angle for Dir. Determination
3125	MEAS. METHOD	Sens. Gnd Fault		COS φ SIN φ	COS φ	Measurement method for Direction
3126	RESET DELAY	Sens. Gnd Fault		0 .. 60 sec	1 sec	Reset Delay
3127	51Ns I T min	Sens. Gnd Fault		0.003 .. 1.400 A	1.333 A	51Ns Current at const. Time Delay T min
3127	51Ns I T min	Sens. Gnd Fault	1A	0.05 .. 20.00 A	15.00 A	51Ns Current at const. Time Delay T min
			5A	0.25 .. 100.00 A	75.00 A	
3128	51Ns I T knee	Sens. Gnd Fault		0.003 .. 0.650 A	0.040 A	51Ns Current at Knee Point
3128	51Ns I T knee	Sens. Gnd Fault	1A	0.05 .. 17.00 A	5.00 A	51Ns Current at Knee Point
			5A	0.25 .. 85.00 A	25.00 A	
3129	51Ns T knee	Sens. Gnd Fault		0.20 .. 100.00 sec	23.60 sec	51Ns Time Delay at Knee Point
3130	PU CRITERIA	Sens. Gnd Fault		Vgnd OR INs Vgnd AND INs	Vgnd OR INs	Sensitive Ground Fault PICKUP criteria
3131	M.of PU TD	Sens. Gnd Fault		1.00 .. 20.00 MofPU; ∞ 0.01 .. 999.00 TD		Multiples of PU Time-Dial
3132	51Ns TD	Sens. Gnd Fault		0.05 .. 1.50	0.20	51Ns Time Dial
3140	51Ns Tmin	Sens. Gnd Fault		0.00 .. 30.00 sec	1.20 sec	51Ns Minimum Time Delay
3140	51Ns T min	Sens. Gnd Fault		0.10 .. 30.00 sec	0.80 sec	51Ns Minimum Time Delay
3141	51Ns Tmax	Sens. Gnd Fault		0.00 .. 30.00 sec	5.80 sec	51Ns Maximum Time Delay
3141	51Ns T max	Sens. Gnd Fault		0.50 .. 200.00 sec	93.00 sec	51Ns Maximum Time Delay (at 51Ns PU)
3142	51Ns TIME DIAL	Sens. Gnd Fault		0.05 .. 15.00 sec; ∞	1.35 sec	51Ns Time Dial
3143	51Ns Startpoint	Sens. Gnd Fault		1.0 .. 4.0	1.1	51Ns Start Point of Inverse Charac.
3301	INTERM.EF	Intermit. EF		OFF ON	OFF	Intermittent earth fault protection
3302	Iie>	Intermit. EF	1A	0.05 .. 35.00 A	1.00 A	Pick-up value of interm. E/F stage
			5A	0.25 .. 175.00 A	5.00 A	
3302	Iie>	Intermit. EF	1A	0.05 .. 35.00 A	1.00 A	Pick-up value of interm. E/F stage
			5A	0.25 .. 175.00 A	5.00 A	
3302	Iie>	Intermit. EF		0.005 .. 1.500 A	1.000 A	Pick-up value of interm. E/F stage
3303	T-det.ext.	Intermit. EF		0.00 .. 10.00 sec	0.10 sec	Detection extension time
3304	T-sum det.	Intermit. EF		0.00 .. 100.00 sec	20.00 sec	Sum of detection times
3305	T-reset	Intermit. EF		1 .. 600 sec	300 sec	Reset time
3306	Nos.det.	Intermit. EF		2 .. 10	3	No. of det. for start of int. E/F prot
4001	FCT 46	46 Negative Seq		OFF ON	OFF	46 Negative Sequence Protection
4002	46-1 PICKUP	46 Negative Seq	1A	0.10 .. 3.00 A	0.10 A	46-1 Pickup
			5A	0.50 .. 15.00 A	0.50 A	
4003	46-1 DELAY	46 Negative Seq		0.00 .. 60.00 sec; ∞	1.50 sec	46-1 Time Delay
4004	46-2 PICKUP	46 Negative Seq	1A	0.10 .. 3.00 A	0.50 A	46-2 Pickup
			5A	0.50 .. 15.00 A	2.50 A	
4005	46-2 DELAY	46 Negative Seq		0.00 .. 60.00 sec; ∞	1.50 sec	46-2 Time Delay
4006	46 IEC CURVE	46 Negative Seq		Normal Inverse Very Inverse Extremely Inv.	Extremely Inv.	IEC Curve
4007	46 ANSI CURVE	46 Negative Seq		Extremely Inv. Inverse Moderately Inv. Very Inverse	Extremely Inv.	ANSI Curve

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
4008	46-TOC PICKUP	46 Negative Seq	1A	0.10 .. 2.00 A	0.90 A	46-TOC Pickup
			5A	0.50 .. 10.00 A	4.50 A	
4009	46-TOC TIMEDIAL	46 Negative Seq		0.50 .. 15.00 ; ∞	5.00	46-TOC Time Dial
4010	46-TOC TIMEDIAL	46 Negative Seq		0.05 .. 3.20 sec; ∞	0.50 sec	46-TOC Time Dial
4011	46-TOC RESET	46 Negative Seq		Instantaneous Disk Emulation	Instantaneous	46-TOC Drop Out
4012A	46 T DROP-OUT	46 Negative Seq		0.00 .. 60.00 sec	0.00 sec	46 Drop-Out Time Delay
4101	FCT 48/66	48/66 Motor		OFF ON	OFF	48 / 66 Motor (Startup Moni-tor/Counter)
4102	STARTUP CURRENT	48/66 Motor	1A	0.50 .. 16.00 A	5.00 A	Startup Current
			5A	2.50 .. 80.00 A	25.00 A	
4103	STARTUP TIME	48/66 Motor		1.0 .. 180.0 sec	10.0 sec	Startup Time
4104	LOCK ROTOR TIME	48/66 Motor		0.5 .. 120.0 sec; ∞	2.0 sec	Permissible Locked Rotor Time
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
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	
4207A	Kτ-FACTOR	49 Th.Overload		1.0 .. 10.0	1.0	Kt-FACTOR when motor stops
4208A	T EMERGENCY	49 Th.Overload		10 .. 15000 sec	100 sec	Emergency time
4209	49 TEMP. RISE I	49 Th.Overload		40 .. 200 °C	100 °C	49 Temperature rise at rated sec. curr.
4210	49 TEMP. RISE I	49 Th.Overload		104 .. 392 °F	212 °F	49 Temperature rise at rated sec. curr.
4301	FCT 66	48/66 Motor		OFF ON	OFF	66 Startup Counter for Motors
4302	IStart/IMOTnom	48/66 Motor		1.10 .. 10.00	4.90	I Start / I Motor nominal
4303	T START MAX	48/66 Motor		3 .. 320 sec	10 sec	Maximum Permissible Starting Time
4304	T Equal	48/66 Motor		0.0 .. 320.0 min	1.0 min	Temperature Equalizaton Time
4305	I MOTOR NOMINAL	48/66 Motor	1A	0.20 .. 1.20 A	1.00 A	Rated Motor Current
			5A	1.00 .. 6.00 A	5.00 A	
4306	MAX.WARM STARTS	48/66 Motor		1 .. 4	2	Maximum Number of Warm Starts
4307	#COLD-#WARM	48/66 Motor		1 .. 2	1	Number of Cold Starts - Warm Starts
4308	Kτ at STOP	48/66 Motor		0.2 .. 100.0	5.0	Extension of Time Constant at Stop
4309	Kτ at RUNNING	48/66 Motor		0.2 .. 100.0	2.0	Extension of Time Constant at Running
4310	T MIN. INHIBIT	48/66 Motor		0.2 .. 120.0 min	6.0 min	Minimum Restart Inhibit Time
5001	FCT 59	27/59 O/U Volt.		OFF ON Alarm Only	OFF	59 Overvoltage Protection
5002	59-1 PICKUP	27/59 O/U Volt.		40 .. 260 V	110 V	59-1 Pickup
5003	59-1 PICKUP	27/59 O/U Volt.		40 .. 150 V	110 V	59-1 Pickup
5004	59-1 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	0.50 sec	59-1 Time Delay
5005	59-2 PICKUP	27/59 O/U Volt.		40 .. 260 V	120 V	59-2 Pickup
5006	59-2 PICKUP	27/59 O/U Volt.		40 .. 150 V	120 V	59-2 Pickup
5007	59-2 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	0.50 sec	59-2 Time Delay
5015	59-1 PICKUP V2	27/59 O/U Volt.		2 .. 150 V	30 V	59-1 Pickup V2
5016	59-2 PICKUP V2	27/59 O/U Volt.		2 .. 150 V	50 V	59-2 Pickup V2
5017A	59-1 DOUT RATIO	27/59 O/U Volt.		0.90 .. 0.99	0.95	59-1 Dropout Ratio
5018A	59-2 DOUT RATIO	27/59 O/U Volt.		0.90 .. 0.99	0.95	59-2 Dropout Ratio
5101	FCT 27	27/59 O/U Volt.		OFF ON Alarm Only	OFF	27 Undervoltage Protection

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
5102	27-1 PICKUP	27/59 O/U Volt.		10 .. 210 V	75 V	27-1 Pickup
5103	27-1 PICKUP	27/59 O/U Volt.		10 .. 120 V	75 V	27-1 Pickup
5106	27-1 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	1.50 sec	27-1 Time Delay
5110	27-2 PICKUP	27/59 O/U Volt.		10 .. 210 V	70 V	27-2 Pickup
5111	27-2 PICKUP	27/59 O/U Volt.		10 .. 120 V	70 V	27-2 Pickup
5112	27-2 DELAY	27/59 O/U Volt.		0.00 .. 100.00 sec; ∞	0.50 sec	27-2 Time Delay
5113A	27-1 DOUT RATIO	27/59 O/U Volt.		1.01 .. 3.00	1.20	27-1 Dropout Ratio
5114A	27-2 DOUT RATIO	27/59 O/U Volt.		1.01 .. 3.00	1.20	27-2 Dropout Ratio
5120A	CURRENT SUPERV.	27/59 O/U Volt.		OFF ON	ON	Current Supervision
5301	FUSE FAIL MON.	Measurem.Superv		ON OFF	OFF	Fuse Fail Monitor
5302	FUSE FAIL 3Vo	Measurem.Superv		10 .. 100 V	30 V	Zero Sequence Voltage
5303	FUSE FAIL RESID	Measurem.Superv	1A	0.10 .. 1.00 A	0.10 A	Residual Current
			5A	0.50 .. 5.00 A	0.50 A	
5401	FCT 81 O/U	81 O/U Freq.		OFF ON	OFF	81 Over/Under Frequency Protection
5402	Vmin	81 O/U Freq.		10 .. 150 V	65 V	Minimum required voltage for operation
5403	81-1 PICKUP	81 O/U Freq.		45.50 .. 54.50 Hz	49.50 Hz	81-1 Pickup
5404	81-1 PICKUP	81 O/U Freq.		55.50 .. 64.50 Hz	59.50 Hz	81-1 Pickup
5405	81-1 DELAY	81 O/U Freq.		0.00 .. 100.00 sec; ∞	60.00 sec	81-1 Time Delay
5406	81-2 PICKUP	81 O/U Freq.		45.50 .. 54.50 Hz	49.00 Hz	81-2 Pickup
5407	81-2 PICKUP	81 O/U Freq.		55.50 .. 64.50 Hz	59.00 Hz	81-2 Pickup
5408	81-2 DELAY	81 O/U Freq.		0.00 .. 100.00 sec; ∞	30.00 sec	81-2 Time Delay
5409	81-3 PICKUP	81 O/U Freq.		45.50 .. 54.50 Hz	47.50 Hz	81-3 Pickup
5410	81-3 PICKUP	81 O/U Freq.		55.50 .. 64.50 Hz	57.50 Hz	81-3 Pickup
5411	81-3 DELAY	81 O/U Freq.		0.00 .. 100.00 sec; ∞	3.00 sec	81-3 Time delay
5412	81-4 PICKUP	81 O/U Freq.		45.50 .. 54.50 Hz	51.00 Hz	81-4 Pickup
5413	81-4 PICKUP	81 O/U Freq.		55.50 .. 64.50 Hz	61.00 Hz	81-4 Pickup
5414	81-4 DELAY	81 O/U Freq.		0.00 .. 100.00 sec; ∞	30.00 sec	81-4 Time delay
6101	Synchronizing	SYNC function 1		ON OFF	OFF	Synchronizing Function
6102	SyncCB	SYNC function 1		(Setting options depend on configuration)	None	Synchronizable circuit breaker
6103	Vmin	SYNC function 1		20 .. 125 V	90 V	Minimum voltage limit: Vmin
6104	Vmax	SYNC function 1		20 .. 140 V	110 V	Maximum voltage limit: Vmax
6105	V<	SYNC function 1		1 .. 60 V	5 V	Threshold V1, V2 without voltage
6106	V>	SYNC function 1		20 .. 140 V	80 V	Threshold V1, V2 with voltage
6107	SYNC V1<V2>	SYNC function 1		YES NO	NO	ON-Command at V1< and V2>
6108	SYNC V1>V2<	SYNC function 1		YES NO	NO	ON-Command at V1> and V2<
6109	SYNC V1<V2<	SYNC function 1		YES NO	NO	ON-Command at V1< and V2<
6110A	Direct CO	SYNC function 1		YES NO	NO	Direct ON-Command
6111A	TSUP VOLTAGE	SYNC function 1		0.00 .. 60.00 sec	0.10 sec	Supervision time of V1>;V2> or V1<;V2<
6112	T-SYN. DURATION	SYNC function 1		0.01 .. 1200.00 sec; ∞	30.00 sec	Maximum duration of Synchronization
6113A	25 Synchron	SYNC function 1		YES NO	YES	Switching at synchronous condition
6120	T-CB close	SYNC function 1		0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
6121	Balancing V1/V2	SYNC function 1		0.50 .. 2.00	1.00	Balancing factor V1/V2
6122A	ANGLE ADJUSTM.	SYNC function 1		0 .. 360 °	0 °	Angle adjustment (transformer)

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
6123	CONNECTIONof V2	SYNC function 1		A-G B-G C-G A-B B-C C-A	A-B	Connection of V2
6125	VT Vn2, primary	SYNC function 1		0.10 .. 800.00 kV	12.00 kV	VT nominal voltage V2, primary
6130	dV ASYN V2>V1	SYNC function 1		0.5 .. 50.0 V	2.0 V	Maximum voltage difference V2>V1
6131	dV ASYN V2<V1	SYNC function 1		0.5 .. 50.0 V	2.0 V	Maximum voltage difference V2<V1
6132	df ASYN f2>f1	SYNC function 1		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6133	df ASYN f2<f1	SYNC function 1		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6140	SYNC PERMIS.	SYNC function 1		YES NO	YES	Switching at synchronous condi-tions
6141	F SYNCHRON	SYNC function 1		0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6142	dV SYNC V2>V1	SYNC function 1		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6143	dV SYNC V2<V1	SYNC function 1		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6144	dα SYNC α2> α1	SYNC function 1		2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6145	dα SYNC α2< α1	SYNC function 1		2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6146	T SYNC-DELAY	SYNC function 1		0.00 .. 60.00 sec	0.00 sec	Release delay at synchronous conditions
6150	dV SYNCHK V2>V1	SYNC function 1		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6151	dV SYNCHK V2<V1	SYNC function 1		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6152	df SYNCHK f2>f1	SYNC function 1		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6153	df SYNCHK f2<f1	SYNC function 1		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6154	dα SYNCHK α2>α1	SYNC function 1		2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6155	dα SYNCHK α2<α1	SYNC function 1		2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6201	Synchronizing	SYNC function 2		ON OFF	OFF	Synchronizing Function
6202	SyncCB	SYNC function 2		(Setting options depend on configuration)	None	Synchronizable circuit breaker
6203	Vmin	SYNC function 2		20 .. 125 V	90 V	Minimum voltage limit: Vmin
6204	Vmax	SYNC function 2		20 .. 140 V	110 V	Maximum voltage limit: Vmax
6205	V<	SYNC function 2		1 .. 60 V	5 V	Threshold V1, V2 without voltage
6206	V>	SYNC function 2		20 .. 140 V	80 V	Threshold V1, V2 with voltage
6207	SYNC V1<V2>	SYNC function 2		YES NO	NO	ON-Command at V1< and V2>
6208	SYNC V1>V2<	SYNC function 2		YES NO	NO	ON-Command at V1> and V2<
6209	SYNC V1<V2<	SYNC function 2		YES NO	NO	ON-Command at V1< and V2<
6210A	Direct CO	SYNC function 2		YES NO	NO	Direct ON-Command
6211A	TSUP VOLTAGE	SYNC function 2		0.00 .. 60.00 sec	0.10 sec	Supervision time of V1>;V2> or V1<;V2<
6212	T-SYN. DURATION	SYNC function 2		0.01 .. 1200.00 sec; ∞	30.00 sec	Maximum duration of Synchroni-zation
6213A	25 Synchron	SYNC function 2		YES NO	YES	Switching at synchronous condi-tion
6220	T-CB close	SYNC function 2		0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
6221	Balancing V1/V2	SYNC function 2		0.50 .. 2.00	1.00	Balancing factor V1/V2

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
6222A	ANGLE ADJUSTM.	SYNC function 2		0 .. 360 °	0 °	Angle adjustment (transformer)
6223	CONNECTIONof V2	SYNC function 2		A-G B-G C-G A-B B-C C-A	A-B	Connection of V2
6225	VT Vn2, primary	SYNC function 2		0.10 .. 800.00 kV	12.00 kV	VT nominal voltage V2, primary
6230	dV ASYN V2>V1	SYNC function 2		0.5 .. 50.0 V	2.0 V	Maximum voltage difference V2>V1
6231	dV ASYN V2<V1	SYNC function 2		0.5 .. 50.0 V	2.0 V	Maximum voltage difference V2<V1
6232	df ASYN f2>f1	SYNC function 2		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6233	df ASYN f2<f1	SYNC function 2		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6240	SYNC PERMIS.	SYNC function 2		YES NO	YES	Switching at synchronous conditions
6241	F SYNCHRON	SYNC function 2		0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6242	dV SYNC V2>V1	SYNC function 2		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6243	dV SYNC V2<V1	SYNC function 2		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6244	dα SYNC α2> α1	SYNC function 2		2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6245	dα SYNC α2< α1	SYNC function 2		2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6246	T SYNC-DELAY	SYNC function 2		0.00 .. 60.00 sec	0.00 sec	Release delay at synchronous conditions
6250	dV SYNCHK V2>V1	SYNC function 2		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6251	dV SYNCHK V2<V1	SYNC function 2		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6252	df SYNCHK f2>f1	SYNC function 2		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6253	df SYNCHK f2<f1	SYNC function 2		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6254	dα SYNCHK α2>α1	SYNC function 2		2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6255	dα SYNCHK α2<α1	SYNC function 2		2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6301	Synchronizing	SYNC function 3		ON OFF	OFF	Synchronizing Function
6302	SyncCB	SYNC function 3		(Setting options depend on configuration)	None	Synchronizable circuit breaker
6303	Vmin	SYNC function 3		20 .. 125 V	90 V	Minimum voltage limit: Vmin
6304	Vmax	SYNC function 3		20 .. 140 V	110 V	Maximum voltage limit: Vmax
6305	V<	SYNC function 3		1 .. 60 V	5 V	Threshold V1, V2 without voltage
6306	V>	SYNC function 3		20 .. 140 V	80 V	Threshold V1, V2 with voltage
6307	SYNC V1<V2>	SYNC function 3		YES NO	NO	ON-Command at V1< and V2>
6308	SYNC V1>V2<	SYNC function 3		YES NO	NO	ON-Command at V1> and V2<
6309	SYNC V1<V2<	SYNC function 3		YES NO	NO	ON-Command at V1< and V2<
6310A	Direct CO	SYNC function 3		YES NO	NO	Direct ON-Command
6311A	TSUP VOLTAGE	SYNC function 3		0.00 .. 60.00 sec	0.10 sec	Supervision time of V1>;V2> or V1<;V2<
6312	T-SYN. DURATION	SYNC function 3		0.01 .. 1200.00 sec; ∞	30.00 sec	Maximum duration of Synchronization
6313A	25 Synchron	SYNC function 3		YES NO	YES	Switching at synchronous condition
6320	T-CB close	SYNC function 3		0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
6321	Balancing V1/V2	SYNC function 3		0.50 .. 2.00	1.00	Balancing factor V1/V2
6322A	ANGLE ADJUSTM.	SYNC function 3		0 .. 360 °	0 °	Angle adjustment (transformer)
6323	CONNECTIONof V2	SYNC function 3		A-G B-G C-G A-B B-C C-A	A-B	Connection of V2
6325	VT Vn2, primary	SYNC function 3		0.10 .. 800.00 kV	12.00 kV	VT nominal voltage V2, primary
6330	dV ASYN V2>V1	SYNC function 3		0.5 .. 50.0 V	2.0 V	Maximum voltage difference V2>V1
6331	dV ASYN V2<V1	SYNC function 3		0.5 .. 50.0 V	2.0 V	Maximum voltage difference V2<V1
6332	df ASYN f2>f1	SYNC function 3		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6333	df ASYN f2<f1	SYNC function 3		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6340	SYNC PERMIS.	SYNC function 3		YES NO	YES	Switching at synchronous conditions
6341	F SYNCHRON	SYNC function 3		0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6342	dV SYNC V2>V1	SYNC function 3		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6343	dV SYNC V2<V1	SYNC function 3		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6344	dα SYNC α2> α1	SYNC function 3		2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6345	dα SYNC α2< α1	SYNC function 3		2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6346	T SYNC-DELAY	SYNC function 3		0.00 .. 60.00 sec	0.00 sec	Release delay at synchronous conditions
6350	dV SYNCHK V2>V1	SYNC function 3		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6351	dV SYNCHK V2<V1	SYNC function 3		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6352	df SYNCHK f2>f1	SYNC function 3		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6353	df SYNCHK f2<f1	SYNC function 3		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6354	dα SYNCHK α2>α1	SYNC function 3		2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6355	dα SYNCHK α2<α1	SYNC function 3		2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6401	Synchronizing	SYNC function 4		ON OFF	OFF	Synchronizing Function
6402	SyncCB	SYNC function 4		(Setting options depend on configuration)	None	Synchronizable circuit breaker
6403	Vmin	SYNC function 4		20 .. 125 V	90 V	Minimum voltage limit: Vmin
6404	Vmax	SYNC function 4		20 .. 140 V	110 V	Maximum voltage limit: Vmax
6405	V<	SYNC function 4		1 .. 60 V	5 V	Threshold V1, V2 without voltage
6406	V>	SYNC function 4		20 .. 140 V	80 V	Threshold V1, V2 with voltage
6407	SYNC V1<V2>	SYNC function 4		YES NO	NO	ON-Command at V1< and V2>
6408	SYNC V1>V2<	SYNC function 4		YES NO	NO	ON-Command at V1> and V2<
6409	SYNC V1<V2<	SYNC function 4		YES NO	NO	ON-Command at V1< and V2<
6410A	Direct CO	SYNC function 4		YES NO	NO	Direct ON-Command
6411A	TSUP VOLTAGE	SYNC function 4		0.00 .. 60.00 sec	0.10 sec	Supervision time of V1>;V2> or V1<;V2<
6412	T-SYN. DURATION	SYNC function 4		0.01 .. 1200.00 sec; ∞	30.00 sec	Maximum duration of Synchronization
6413A	25 Synchron	SYNC function 4		YES NO	YES	Switching at synchronous condition

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
6420	T-CB close	SYNC function 4		0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
6421	Balancing V1/V2	SYNC function 4		0.50 .. 2.00	1.00	Balancing factor V1/V2
6422A	ANGLE ADJUSTM.	SYNC function 4		0 .. 360 °	0 °	Angle adjustment (transformer)
6423	CONNECTIONof V2	SYNC function 4		A-G B-G C-G A-B B-C C-A	A-B	Connection of V2
6425	VT Vn2, primary	SYNC function 4		0.10 .. 800.00 kV	12.00 kV	VT nominal voltage V2, primary
6430	dV ASYN V2>V1	SYNC function 4		0.5 .. 50.0 V	2.0 V	Maximum voltage difference V2>V1
6431	dV ASYN V2<V1	SYNC function 4		0.5 .. 50.0 V	2.0 V	Maximum voltage difference V2<V1
6432	df ASYN f2>f1	SYNC function 4		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6433	df ASYN f2<f1	SYNC function 4		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6440	SYNC PERMIS.	SYNC function 4		YES NO	YES	Switching at synchronous condi-tions
6441	F SYNCHRON	SYNC function 4		0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6442	dV SYNC V2>V1	SYNC function 4		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6443	dV SYNC V2<V1	SYNC function 4		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6444	dα SYNC α2> α1	SYNC function 4		2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6445	dα SYNC α2< α1	SYNC function 4		2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6446	T SYNC-DELAY	SYNC function 4		0.00 .. 60.00 sec	0.00 sec	Release delay at synchronous conditions
6450	dV SYNCHK V2>V1	SYNC function 4		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2>V1
6451	dV SYNCHK V2<V1	SYNC function 4		0.5 .. 50.0 V	5.0 V	Maximum voltage difference V2<V1
6452	df SYNCHK f2>f1	SYNC function 4		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6453	df SYNCHK f2<f1	SYNC function 4		0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6454	dα SYNCHK α2>α1	SYNC function 4		2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6455	dα SYNCHK α2<α1	SYNC function 4		2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
7001	FCT 50BF	50BF BkrFailure		OFF ON	OFF	50BF Breaker Failure Protection
7004	Chk BRK CONTACT	50BF BkrFailure		OFF ON	OFF	Check Breaker contacts
7005	TRIP-Timer	50BF BkrFailure		0.06 .. 60.00 sec; ∞	0.25 sec	TRIP-Timer
7101	FCT 79	79M Auto Recl.		OFF ON	OFF	79 Auto-Reclose Function
7103	BLOCK MC Dur.	79M Auto Recl.		0.50 .. 320.00 sec; 0	1.00 sec	AR blocking duration after manual close
7105	TIME RESTRAINT	79M Auto Recl.		0.50 .. 320.00 sec	3.00 sec	79 Auto Reclosing reset time
7108	SAFETY 79 ready	79M Auto Recl.		0.01 .. 320.00 sec	0.50 sec	Safety Time until 79 is ready
7113	CHECK CB?	79M Auto Recl.		No check Chk each cycle	No check	Check circuit breaker before AR?
7114	T-Start MONITOR	79M Auto Recl.		0.01 .. 320.00 sec; ∞	0.50 sec	AR start-signal monitoring time
7115	CB TIME OUT	79M Auto Recl.		0.10 .. 320.00 sec	3.00 sec	Circuit Breaker (CB) Supervision Time
7116	Max. DEAD EXT.	79M Auto Recl.		0.50 .. 1800.00 sec; ∞	100.00 sec	Maximum dead time extension
7117	T-ACTION	79M Auto Recl.		0.01 .. 320.00 sec; ∞	∞ sec	Action time
7118	T DEAD DELAY	79M Auto Recl.		0.0 .. 1800.0 sec; ∞	1.0 sec	Maximum Time Delay of Dead-Time Start

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
7127	DEADTIME 1: PH	79M Auto Recl.		0.01 .. 320.00 sec	0.50 sec	Dead Time 1: Phase Fault
7128	DEADTIME 1: G	79M Auto Recl.		0.01 .. 320.00 sec	0.50 sec	Dead Time 1: Ground Fault
7129	DEADTIME 2: PH	79M Auto Recl.		0.01 .. 320.00 sec	0.50 sec	Dead Time 2: Phase Fault
7130	DEADTIME 2: G	79M Auto Recl.		0.01 .. 320.00 sec	0.50 sec	Dead Time 2: Ground Fault
7131	DEADTIME 3: PH	79M Auto Recl.		0.01 .. 320.00 sec	0.50 sec	Dead Time 3: Phase Fault
7132	DEADTIME 3: G	79M Auto Recl.		0.01 .. 320.00 sec	0.50 sec	Dead Time 3: Ground Fault
7133	DEADTIME 4: PH	79M Auto Recl.		0.01 .. 320.00 sec	0.50 sec	Dead Time 4: Phase Fault
7134	DEADTIME 4: G	79M Auto Recl.		0.01 .. 320.00 sec	0.50 sec	Dead Time 4: Ground Fault
7135	# OF RECL. GND	79M Auto Recl.		0 .. 9	1	Number of Reclosing Cycles Ground
7136	# OF RECL. PH	79M Auto Recl.		0 .. 9	1	Number of Reclosing Cycles Phase
7137	Cmd.via control	79M Auto Recl.		(Setting options depend on configuration)	None	Close command via control device
7138	Internal SYNC	79M Auto Recl.		(Setting options depend on configuration)	None	Internal 25 synchronisation
7139	External SYNC	79M Auto Recl.		YES NO	NO	External 25 synchronisation
7140	ZONE SEQ.COORD.	79M Auto Recl.		OFF ON	OFF	ZSC - Zone sequence coordina-tion
7150	50-1	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	50-1
7151	50N-1	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	50N-1
7152	50-2	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	50-2
7153	50N-2	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	50N-2
7154	51	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	51
7155	51N	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	51N
7156	67-1	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	67-1
7157	67N-1	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	67N-1
7158	67-2	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	67-2
7159	67N-2	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	67N-2
7160	67 TOC	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	67 TOC
7161	67N TOC	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	67N TOC
7162	sens Ground Flt	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	(Sensitive) Ground Fault
7163	46	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	46
7164	BINARY INPUT	79M Auto Recl.		No influence Starts 79 Stops 79	No influence	Binary Input
7165	3Pol.PICKUP BLK	79M Auto Recl.		YES NO	NO	3 Pole Pickup blocks 79

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
7200	bef.1.Cy:50-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 50-1
7201	bef.1.Cy:50N-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 50N-1
7202	bef.1.Cy:50-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 50-2
7203	bef.1.Cy:50N-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 50N-2
7204	bef.1.Cy:51	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 51
7205	bef.1.Cy:51N	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 51N
7206	bef.1.Cy:67-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67-1
7207	bef.1.Cy:67N-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67N-1
7208	bef.1.Cy:67-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67-2
7209	bef.1.Cy:67N-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67N-2
7210	bef.1.Cy:67 TOC	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67 TOC
7211	bef.1.Cy:67NTOC	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 1. Cycle: 67N TOC
7212	bef.2.Cy:50-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 50-1
7213	bef.2.Cy:50N-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 50N-1
7214	bef.2.Cy:50-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 50-2
7215	bef.2.Cy:50N-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 50N-2
7216	bef.2.Cy:51	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 51
7217	bef.2.Cy:51N	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 51N
7218	bef.2.Cy:67-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67-1
7219	bef.2.Cy:67N-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67N-1
7220	bef.2.Cy:67-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67-2
7221	bef.2.Cy:67N-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67N-2
7222	bef.2.Cy:67 TOC	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67 TOC

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
7223	bef.2.Cy:67NTOC	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 2. Cycle: 67N TOC
7224	bef.3.Cy:50-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 50-1
7225	bef.3.Cy:50N-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 50N-1
7226	bef.3.Cy:50-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 50-2
7227	bef.3.Cy:50N-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 50N-2
7228	bef.3.Cy:51	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 51
7229	bef.3.Cy:51N	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 51N
7230	bef.3.Cy:67-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67-1
7231	bef.3.Cy:67N-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67N-1
7232	bef.3.Cy:67-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67-2
7233	bef.3.Cy:67N-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67N-2
7234	bef.3.Cy:67 TOC	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67 TOC
7235	bef.3.Cy:67NTOC	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 3. Cycle: 67N TOC
7236	bef.4.Cy:50-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 50-1
7237	bef.4.Cy:50N-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 50N-1
7238	bef.4.Cy:50-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 50-2
7239	bef.4.Cy:50N-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 50N-2
7240	bef.4.Cy:51	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 51
7241	bef.4.Cy:51N	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 51N
7242	bef.4.Cy:67-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67-1
7243	bef.4.Cy:67N-1	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67N-1
7244	bef.4.Cy:67-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67-2
7245	bef.4.Cy:67N-2	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67N-2

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
7246	bef.4.Cy:67 TOC	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67 TOC
7247	bef.4.Cy:67NTOC	79M Auto Recl.		Set value T=T instant. T=0 blocked T=∞	Set value T=T	before 4. Cycle: 67N TOC
8001	START	Fault Locator		Pickup TRIP	Pickup	Start fault locator with
8101	MEASURE. SUPERV	Measurem.Superv		OFF ON	ON	Measurement Supervision
8102	BALANCE V-LIMIT	Measurem.Superv		10 .. 100 V	50 V	Voltage Threshold for Balance Monitoring
8103	BAL. FACTOR V	Measurem.Superv		0.58 .. 0.90	0.75	Balance Factor for Voltage Monitor
8104	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	
8105	BAL. FACTOR I	Measurem.Superv		0.10 .. 0.90	0.50	Balance Factor for Current Monitor
8106	Σ I THRESHOLD	Measurem.Superv	1A	0.05 .. 2.00 A; ∞	0.10 A	Summated Current Monitoring Threshold
			5A	0.25 .. 10.00 A; ∞	0.50 A	
8107	Σ I FACTOR	Measurem.Superv		0.00 .. 0.95	0.10	Summated Current Monitoring Factor
8201	FCT 74TC	74TC TripCirc.		ON OFF	ON	74TC TRIP Circuit Supervision
8301	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.,10 Subs 5 Min., 5 Subs	60 Min., 1 Sub	Demand Calculation Intervals
8302	DMD Sync.Time	Demand meter		On The Hour 15 After Hour 30 After Hour 45 After Hour	On The Hour	Demand Synchronization Time
8311	MinMax cycRESET	Min/Max meter		NO YES	YES	Automatic Cyclic Reset Function
8312	MiMa RESET TIME	Min/Max meter		0 .. 1439 min	0 min	MinMax Reset Timer
8313	MiMa RESETCYCLE	Min/Max meter		1 .. 365 Days	7 Days	MinMax Reset Cycle Period
8314	MinMaxRES.START	Min/Max meter		1 .. 365 Days	1 Days	MinMax Start Reset Cycle in
8315	MeterResolution	Energy		Standard Factor 10 Factor 100	Standard	Meter resolution
9011A	RTD 1 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Pt 100 Ω	RTD 1: Type
9012A	RTD 1 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Oil	RTD 1: Location
9013	RTD 1 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD 1: Temperature Stage 1 Pickup
9014	RTD 1 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD 1: Temperature Stage 1 Pickup
9015	RTD 1 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD 1: Temperature Stage 2 Pickup
9016	RTD 1 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD 1: Temperature Stage 2 Pickup
9021A	RTD 2 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 2: Type

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
9022A	RTD 2 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Other	RTD 2: Location
9023	RTD 2 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD 2: Temperature Stage 1 Pickup
9024	RTD 2 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD 2: Temperature Stage 1 Pickup
9025	RTD 2 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD 2: Temperature Stage 2 Pickup
9026	RTD 2 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD 2: Temperature Stage 2 Pickup
9031A	RTD 3 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 3: Type
9032A	RTD 3 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Other	RTD 3: Location
9033	RTD 3 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD 3: Temperature Stage 1 Pickup
9034	RTD 3 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD 3: Temperature Stage 1 Pickup
9035	RTD 3 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD 3: Temperature Stage 2 Pickup
9036	RTD 3 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD 3: Temperature Stage 2 Pickup
9041A	RTD 4 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 4: Type
9042A	RTD 4 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Other	RTD 4: Location
9043	RTD 4 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD 4: Temperature Stage 1 Pickup
9044	RTD 4 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD 4: Temperature Stage 1 Pickup
9045	RTD 4 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD 4: Temperature Stage 2 Pickup
9046	RTD 4 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD 4: Temperature Stage 2 Pickup
9051A	RTD 5 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 5: Type
9052A	RTD 5 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Other	RTD 5: Location
9053	RTD 5 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD 5: Temperature Stage 1 Pickup
9054	RTD 5 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD 5: Temperature Stage 1 Pickup
9055	RTD 5 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD 5: Temperature Stage 2 Pickup
9056	RTD 5 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD 5: Temperature Stage 2 Pickup
9061A	RTD 6 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 6: Type

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
9062A	RTD 6 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Other	RTD 6: Location
9063	RTD 6 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD 6: Temperature Stage 1 Pickup
9064	RTD 6 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD 6: Temperature Stage 1 Pickup
9065	RTD 6 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD 6: Temperature Stage 2 Pickup
9066	RTD 6 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD 6: Temperature Stage 2 Pickup
9071A	RTD 7 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 7: Type
9072A	RTD 7 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Other	RTD 7: Location
9073	RTD 7 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD 7: Temperature Stage 1 Pickup
9074	RTD 7 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD 7: Temperature Stage 1 Pickup
9075	RTD 7 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD 7: Temperature Stage 2 Pickup
9076	RTD 7 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD 7: Temperature Stage 2 Pickup
9081A	RTD 8 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 8: Type
9082A	RTD 8 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Other	RTD 8: Location
9083	RTD 8 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD 8: Temperature Stage 1 Pickup
9084	RTD 8 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD 8: Temperature Stage 1 Pickup
9085	RTD 8 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD 8: Temperature Stage 2 Pickup
9086	RTD 8 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD 8: Temperature Stage 2 Pickup
9091A	RTD 9 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD 9: Type
9092A	RTD 9 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Other	RTD 9: Location
9093	RTD 9 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD 9: Temperature Stage 1 Pickup
9094	RTD 9 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD 9: Temperature Stage 1 Pickup
9095	RTD 9 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD 9: Temperature Stage 2 Pickup
9096	RTD 9 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD 9: Temperature Stage 2 Pickup
9101A	RTD10 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD10: Type

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
9102A	RTD10 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Other	RTD10: Location
9103	RTD10 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD10: Temperature Stage 1 Pickup
9104	RTD10 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD10: Temperature Stage 1 Pickup
9105	RTD10 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD10: Temperature Stage 2 Pickup
9106	RTD10 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD10: Temperature Stage 2 Pickup
9111A	RTD11 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD11: Type
9112A	RTD11 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Other	RTD11: Location
9113	RTD11 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD11: Temperature Stage 1 Pickup
9114	RTD11 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD11: Temperature Stage 1 Pickup
9115	RTD11 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD11: Temperature Stage 2 Pickup
9116	RTD11 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD11: Temperature Stage 2 Pickup
9121A	RTD12 TYPE	RTD-Box		Not connected Pt 100 Ω Ni 120 Ω Ni 100 Ω	Not connected	RTD12: Type
9122A	RTD12 LOCATION	RTD-Box		Oil Ambient Winding Bearing Other	Other	RTD12: Location
9123	RTD12 STAGE 1	RTD-Box		-50 .. 250 °C; ∞	100 °C	RTD12: Temperature Stage 1 Pickup
9124	RTD12 STAGE 1	RTD-Box		-58 .. 482 °F; ∞	212 °F	RTD12: Temperature Stage 1 Pickup
9125	RTD12 STAGE 2	RTD-Box		-50 .. 250 °C; ∞	120 °C	RTD12: Temperature Stage 2 Pickup
9126	RTD12 STAGE 2	RTD-Box		-58 .. 482 °F; ∞	248 °F	RTD12: Temperature Stage 2 Pickup
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 Binray Input	Please select	Selection of Measured Quantity
0	MEAS. METHOD	Flx		Fundamental True RMS Positive seq. Negative seq. Zero sequence	Fundamental	Selection of Measurement Method

Addr.	Parameter	Function	C	Setting Options	Default Setting	Comments
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 Vn	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-Earth	Phase-Phase	Voltage System
0	P.U. THRESHOLD	Flx		0.05 .. 35.00 A	2.00 A	Pickup Threshold
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		2.0 .. 200.0 V	110.0 V	Pickup Threshold
0	P.U. THRESHOLD	Flx		45.50 .. 54.50 Hz	51.00 Hz	Pickup Threshold
0	P.U. THRESHOLD	Flx		55.50 .. 64.50 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		0.5 .. 10.000 W	200.0 W	Pickup Threshold
0	P.U. THRESHOLD	Flx		-0.99 .. 0.99	0.50	Pickup Threshold
0	T TRIP DELAY	Flx		0.00 .. 3600.00 sec	1.00 sec	Trip Time Delay
0A	T PICKUP DELAY	Flx		0.00 .. 60.00 sec	0.00 sec	Pickup Time Delay
0A	T DROPOUT DELAY	Flx		0.00 .. 60.00 sec	0.00 sec	Dropout Time Delay
0A	BLK.by Vol.Loss	Flx		NO YES	YES	Block in case of Meas.-Voltage Loss
0A	DROPOUT RATIO	Flx		0.70 .. 0.99	0.95	Dropout Ratio
0A	DROPOUT RATIO	Flx		1.01 .. 3.00	1.05	Dropout Ratio

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 reassigned to IEC 60 870-5-103 are set to ON / OFF and subjected to general interrogation if the information type is not a spontaneous event („.._Ev“). Further information on messages can be found in detail in the SIPROTEC® 4 System Description, Order No. E50417-H1176-C151.

In columns „Event Log“, „Trip Log“ and „Ground Fault Log“ the following applies:

UPPER CASE NOTATION “ON/OFF”: definitely set, not allocatable

lower case notation “on/off”: preset, allocatable

*: not preset, allocatable

<blank>: neither preset nor allocatable

In column „Marked in Oscill.Record“ the following applies:

UPPER CASE NOTATION “M”: definitely set, not allocatable

lower case notation “m”: preset, allocatable

*: not preset, allocatable

<blank>: neither preset nor allocatable

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
-	>Back Light on (>Light on)	Device, General	SP	On Off	*		*	LED	BI		BO					
-	Reset LED (Reset LED)	Device, General	IntSP	on	*		*	LED			BO		160	19	1	No
-	Stop data transmission (DataStop)	Device, General	IntSP	On Off	*		*	LED			BO		160	20	1	Yes
-	Test mode (Test mode)	Device, General	IntSP	On Off	*		*	LED			BO		160	21	1	Yes
-	Feeder GROUNDED (Feeder gnd)	Device, General	IntSP	*	*		*	LED			BO					
-	Breaker OPENED (Brk OPENED)	Device, General	IntSP	*	*		*	LED			BO					
-	Hardware Test Mode (HWTestMod)	Device, General	IntSP	On Off	*		*	LED			BO					
-	Clock Synchronization (SynchClock)	Device, General	IntSP _Ev	*	*		*									
-	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					
-	Fault Recording Start (FltRecSta)	Osc. Fault Rec.	IntSP	On Off	*		m	LED			BO					
-	Group A (Group A)	Change Group	IntSP	On Off	*		*	LED			BO		160	23	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
-	Group B (Group B)	Change Group	IntSP	On Off	*		*	LED			BO		160	24	1	Yes
-	Group C (Group C)	Change Group	IntSP	On Off	*		*	LED			BO		160	25	1	Yes
-	Group D (Group D)	Change Group	IntSP	On Off	*		*	LED			BO		160	26	1	Yes
-	Control Authority (Cntrl Auth)	Cntrl Authority	DP	On Off	*			LED			BO		101	85	1	Yes
-	Controlmode LOCAL (ModeLOCAL)	Cntrl Authority	DP	On Off	*			LED			BO		101	86	1	Yes
-	Controlmode REMOTE (ModeREMOTE)	Cntrl Authority	IntSP	On Off	*			LED			BO					
-	Control Authority (Cntrl Auth)	Cntrl Authority	IntSP	On Off	*			LED			BO					
-	Controlmode LOCAL (ModeLOCAL)	Cntrl Authority	IntSP	On Off	*			LED			BO					
-	52 Breaker (52Breaker)	Control Device	CF_D12	On Off				LED			BO		240	160	20	
-	52 Breaker (52Breaker)	Control Device	DP	On Off					BI			CB	240	160	1	Yes
-	Disconnect Switch (Disc.Swit.)	Control Device	CF_D2	On Off				LED			BO		240	161	20	
-	Disconnect Switch (Disc.Swit.)	Control Device	DP	On Off					BI			CB	240	161	1	Yes
-	Ground Switch (GndSwit.)	Control Device	CF_D2	On Off				LED			BO		240	164	20	
-	Ground Switch (GndSwit.)	Control Device	DP	On Off					BI			CB	240	164	1	Yes
-	Interlocking: 52 Open (52 Open)	Control Device	IntSP				*	LED			BO					
-	Interlocking: 52 Close (52 Close)	Control Device	IntSP				*	LED			BO					
-	Interlocking: Disconnect switch Open (Disc.Open)	Control Device	IntSP				*	LED			BO					
-	Interlocking: Disconnect switch Close (Disc.Close)	Control Device	IntSP				*	LED			BO					
-	Interlocking: Ground switch Open (GndSw Open)	Control Device	IntSP				*	LED			BO					
-	Interlocking: Ground switch Close (GndSw Cl.)	Control Device	IntSP				*	LED			BO					
-	Unlock data transmission via BI (UnlockDT)	Control Device	IntSP				*	LED			BO					
-	Q2 Open/Close (Q2 Op/Cl)	Control Device	CF_D2	On Off				LED			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_D2	On Off				LED			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_D2	On Off				LED			BO		240	175	20	
-	Fan ON/OFF (Fan ON/OFF)	Control Device	DP	On Off					BI			CB	240	175	1	Yes
-	>CB ready Spring is charged (>CB ready)	Process Data	SP	*	*		*	LED	BI		BO	CB				
-	>Door closed (>DoorClose)	Process Data	SP	*	*		*	LED	BI		BO	CB				

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
-	>Cabinet door open (>Door open)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	101	1	1	Yes
-	>CB waiting for Spring charged (>CB wait)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	101	2	1	Yes
-	>No Voltage (Fuse blown) (>No Volt.)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	160	38	1	Yes
-	>Error Motor Voltage (>Err Mot V)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	181	1	Yes
-	>Error Control Voltage (>ErrCntrlV)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	182	1	Yes
-	>SF6-Loss (>SF6-Loss)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	183	1	Yes
-	>Error Meter (>Err Meter)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	184	1	Yes
-	>Transformer Temperature (>Tx Temp.)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	185	1	Yes
-	>Transformer Danger (>Tx Danger)	Process Data	SP	On Off	*		*	LED	BI		BO	CB	240	186	1	Yes
-	Reset Minimum and Maximum counter (ResMinMax)	Min/Max meter	IntSP_Ev	ON												
-	Reset meter (Meter res)	Energy	IntSP_Ev	ON					BI							
-	Error Systeminterface (SysIntErr.)	Protocol	IntSP	On Off	*	*		LED			BO					
-	Threshold Value 1 (ThreshVal1)	Thresh.-Switch	IntSP	On Off				LED		FC TN	BO	CB				
1	No Function configured (Not configured)	Device, General	SP	*	*											
2	Function Not Available (Non Existent)	Device, General	SP	*	*											
3	>Synchronize Internal Real Time Clock (>Time Synch)	Device, General	SP_Ev	*	*			LED	BI		BO		135	48	1	Yes
4	>Trigger Waveform Capture (>Trig.Wave.Cap.)	Osc. Fault Rec.	SP	*	*		m	LED	BI		BO		135	49	1	Yes
5	>Reset LED (>Reset LED)	Device, General	SP	*	*		*	LED	BI		BO		135	50	1	Yes
7	>Setting Group Select Bit 0 (>Set Group Bit0)	Change Group	SP	*	*		*	LED	BI		BO		135	51	1	Yes
8	>Setting Group Select Bit 1 (>Set Group Bit1)	Change Group	SP	*	*		*	LED	BI		BO		135	52	1	Yes
009.0100	Failure EN100 Modul (Failure Modul)	EN100-Modul 1	IntSP	On Off	*		*	LED			BO					
009.0101	Failure EN100 Link Channel 1 (Ch1) (Fail Ch1)	EN100-Modul 1	IntSP	On Off	*		*	LED			BO					
009.0102	Failure EN100 Link Channel 2 (Ch2) (Fail Ch2)	EN100-Modul 1	IntSP	On Off	*		*	LED			BO					
15	>Test mode (>Test mode)	Device, General	SP	*	*		*	LED	BI		BO		135	53	1	Yes
16	>Stop data transmission (>DataStop)	Device, General	SP	*	*		*	LED	BI		BO		135	54	1	Yes
51	Device is Operational and Protecting (Device OK)	Device, General	OUT	On Off	*		*	LED			BO		135	81	1	Yes
52	At Least 1 Protection Funct. is Active (ProtActive)	Device, General	IntSP	On Off	*		*	LED			BO		160	18	1	Yes
55	Reset Device (Reset Device)	Device, General	OUT	on	*		*									
56	Initial Start of Device (Initial Start)	Device, General	OUT	on	*		*	LED			BO		160	5	1	No
67	Resume (Resume)	Device, General	OUT	on	*		*	LED			BO					

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
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		160	22	1	Yes
71	Settings Check (Settings Check)	Device, General	OUT	*	*		*	LED			BO					
72	Level-2 change (Level-2 change)	Device, General	OUT	On Off	*		*	LED			BO					
110	Event lost (Event Lost)	Device, General	OUT_Ev	on	*			LED			BO		135	130	1	No
113	Flag Lost (Flag Lost)	Device, General	OUT	on	*		m	LED			BO		135	136	1	Yes
125	Chatter ON (Chatter ON)	Device, General	OUT	On Off	*		*	LED			BO		135	145	1	Yes
126	Protection ON/OFF (via system port) (ProtON/OFF)	P.System Data 2	IntSP	On Off	*		*	LED			BO					
127	79 ON/OFF (via system port) (79 ON/OFF)	79M Auto Recl.	IntSP	On Off	*		*	LED			BO					
140	Error with a summary alarm (Error Sum Alarm)	Device, General	OUT	On Off	*		*	LED			BO		160	47	1	Yes
144	Error 5V (Error 5V)	Device, General	OUT	On Off	*		*	LED			BO					
145	Error 0V (Error 0V)	Device, General	OUT	On Off	*		*	LED			BO					
146	Error -5V (Error -5V)	Device, General	OUT	On Off	*		*	LED			BO					
147	Error Power Supply (Error Pwr-Supply)	Device, General	OUT	On Off	*		*	LED			BO					
160	Alarm Summary Event (Alarm Sum Event)	Device, General	OUT	On Off	*		*	LED			BO		160	46	1	Yes
161	Failure: General Current Supervision (Fail I Superv.)	Measurem.Superv	OUT	On Off	*		*	LED			BO		160	32	1	Yes
162	Failure: Current Summation (Failure Σ I)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	182	1	Yes
163	Failure: Current Balance (Fail I balance)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	183	1	Yes
167	Failure: Voltage Balance (Fail V balance)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	186	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 instantaneous) (VT FuseFail)	Measurem.Superv	OUT	On Off	*		*	LED			BO					
170.0001	>25-group 1 activate (>25-1 act)	SYNC function 1	SP	On Off			*	LED	BI							
170.0001	>25-group 2 activate (>25-2 act)	SYNC function 2	SP	On Off			*	LED	BI							
170.0001	>25-group 3 activate (>25-3 act)	SYNC function 3	SP	On Off			*	LED	BI							
170.0001	>25-group 4 activate (>25-4 act)	SYNC function 4	SP	On Off			*	LED	BI							
170.0043	>25 Sync. Measurement Only (>25 Measu. Only)	SYNC function 1	SP	On Off			*	LED	BI							
170.0043	>25 Sync. Measurement Only (>25 Measu. Only)	SYNC function 2	SP	On Off			*	LED	BI							
170.0043	>25 Sync. Measurement Only (>25 Measu. Only)	SYNC function 3	SP	On Off			*	LED	BI							

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
170.0043	>25 Sync. Measurement Only (>25 Measu. Only)	SYNC function 4	SP	On Off			*	LED	BI							
170.0049	25 Sync. Release of CLOSE Command (25 CloseRelease)	SYNC function 1	OUT	On Off			*	LED			BO		41	201	1	Yes
170.0049	25 Sync. Release of CLOSE Command (25 CloseRelease)	SYNC function 2	OUT	On Off			*	LED			BO					
170.0049	25 Sync. Release of CLOSE Command (25 CloseRelease)	SYNC function 3	OUT	On Off			*	LED			BO					
170.0049	25 Sync. Release of CLOSE Command (25 CloseRelease)	SYNC function 4	OUT	On Off			*	LED			BO					
170.0050	25 Synchronization Error (25 Sync. Error)	SYNC function 1	OUT	On Off			*	LED			BO		41	202	1	Yes
170.0050	25 Synchronization Error (25 Sync. Error)	SYNC function 2	OUT	On Off			*	LED			BO					
170.0050	25 Synchronization Error (25 Sync. Error)	SYNC function 3	OUT	On Off			*	LED			BO					
170.0050	25 Synchronization Error (25 Sync. Error)	SYNC function 4	OUT	On Off			*	LED			BO					
170.0051	25-group 1 is BLOCKED (25-1 BLOCK)	SYNC function 1	OUT	On Off			*	LED			BO		41	204	1	Yes
170.0051	25-group 2 is BLOCKED (25-2 BLOCK)	SYNC function 2	OUT	On Off			*	LED			BO					
170.0051	25-group 3 is BLOCKED (25-3 BLOCK)	SYNC function 3	OUT	On Off			*	LED			BO					
170.0051	25-group 4 is BLOCKED (25-4 BLOCK)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2007	25 Sync. Measuring request of Control (25 Measu. req.)	SYNC function 1	SP	On Off			*	LED								
170.2007	25 Sync. Measuring request of Control (25 Measu. req.)	SYNC function 2	SP	On Off			*	LED								
170.2007	25 Sync. Measuring request of Control (25 Measu. req.)	SYNC function 3	SP	On Off			*	LED								
170.2007	25 Sync. Measuring request of Control (25 Measu. req.)	SYNC function 4	SP	On Off			*	LED								
170.2008	>BLOCK 25-group 1 (>BLK 25-1)	SYNC function 1	SP	On Off			*	LED	BI							
170.2008	>BLOCK 25-group 2 (>BLK 25-2)	SYNC function 2	SP	On Off			*	LED	BI							
170.2008	>BLOCK 25-group 3 (>BLK 25-3)	SYNC function 3	SP	On Off			*	LED	BI							
170.2008	>BLOCK 25-group 4 (>BLK 25-4)	SYNC function 4	SP	On Off			*	LED	BI							
170.2009	>25 Direct Command output (>25direct CO)	SYNC function 1	SP	On Off			*	LED	BI							
170.2009	>25 Direct Command output (>25direct CO)	SYNC function 2	SP	On Off			*	LED	BI							
170.2009	>25 Direct Command output (>25direct CO)	SYNC function 3	SP	On Off			*	LED	BI							
170.2009	>25 Direct Command output (>25direct CO)	SYNC function 4	SP	On Off			*	LED	BI							
170.2011	>25 Start of synchronization (>25 Start)	SYNC function 1	SP	On Off			*	LED	BI							
170.2011	>25 Start of synchronization (>25 Start)	SYNC function 2	SP	On Off			*	LED	BI							
170.2011	>25 Start of synchronization (>25 Start)	SYNC function 3	SP	On Off			*	LED	BI							

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
170.2011	>25 Start of synchronization (>25 Start)	SYNC function 4	SP	On Off			*	LED	BI							
170.2012	>25 Stop of synchronization (>25 Stop)	SYNC function 1	SP	On Off			*	LED	BI							
170.2012	>25 Stop of synchronization (>25 Stop)	SYNC function 2	SP	On Off			*	LED	BI							
170.2012	>25 Stop of synchronization (>25 Stop)	SYNC function 3	SP	On Off			*	LED	BI							
170.2012	>25 Stop of synchronization (>25 Stop)	SYNC function 4	SP	On Off			*	LED	BI							
170.2013	>25 Switch to V1> and V2< (>25 V1>V2<)	SYNC function 1	SP	On Off			*	LED	BI							
170.2013	>25 Switch to V1> and V2< (>25 V1>V2<)	SYNC function 2	SP	On Off			*	LED	BI							
170.2013	>25 Switch to V1> and V2< (>25 V1>V2<)	SYNC function 3	SP	On Off			*	LED	BI							
170.2013	>25 Switch to V1> and V2< (>25 V1>V2<)	SYNC function 4	SP	On Off			*	LED	BI							
170.2014	>25 Switch to V1< and V2> (>25 V1<V2>)	SYNC function 1	SP	On Off			*	LED	BI							
170.2014	>25 Switch to V1< and V2> (>25 V1<V2>)	SYNC function 2	SP	On Off			*	LED	BI							
170.2014	>25 Switch to V1< and V2> (>25 V1<V2>)	SYNC function 3	SP	On Off			*	LED	BI							
170.2014	>25 Switch to V1< and V2> (>25 V1<V2>)	SYNC function 4	SP	On Off			*	LED	BI							
170.2015	>25 Switch to V1< and V2< (>25 V1<V2<)	SYNC function 1	SP	On Off			*	LED	BI							
170.2015	>25 Switch to V1< and V2< (>25 V1<V2<)	SYNC function 2	SP	On Off			*	LED	BI							
170.2015	>25 Switch to V1< and V2< (>25 V1<V2<)	SYNC function 3	SP	On Off			*	LED	BI							
170.2015	>25 Switch to V1< and V2< (>25 V1<V2<)	SYNC function 4	SP	On Off			*	LED	BI							
170.2016	>25 Switch to Sync (>25 synchr.)	SYNC function 1	SP	On Off			*	LED	BI							
170.2016	>25 Switch to Sync (>25 synchr.)	SYNC function 2	SP	On Off			*	LED	BI							
170.2016	>25 Switch to Sync (>25 synchr.)	SYNC function 3	SP	On Off			*	LED	BI							
170.2016	>25 Switch to Sync (>25 synchr.)	SYNC function 4	SP	On Off			*	LED	BI							
170.2022	25-group 1: measurement in progress (25-1 meas.)	SYNC function 1	OUT	On Off			*	LED			BO		41	203	1	Yes
170.2022	25-group 2: measurement in progress (25-2 meas.)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2022	25-group 3: measurement in progress (25-3 meas.)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2022	25-group 4: measurement in progress (25-4 meas.)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2025	25 Monitoring time exceeded (25 MonTimeExc)	SYNC function 1	OUT	On Off			*	LED			BO		41	205	1	Yes
170.2025	25 Monitoring time exceeded (25 MonTimeExc)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2025	25 Monitoring time exceeded (25 MonTimeExc)	SYNC function 3	OUT	On Off			*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
170.2025	25 Monitoring time exceeded (25 MonTimeExc)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2026	25 Synchronization conditions okay (25 Synchron)	SYNC function 1	OUT	On Off			*	LED			BO		41	206	1	Yes
170.2026	25 Synchronization conditions okay (25 Synchron)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2026	25 Synchronization conditions okay (25 Synchron)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2026	25 Synchronization conditions okay (25 Synchron)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2027	25 Condition V1>V2< fulfilled (25 V1> V2<)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2027	25 Condition V1>V2< fulfilled (25 V1> V2<)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2027	25 Condition V1>V2< fulfilled (25 V1> V2<)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2027	25 Condition V1>V2< fulfilled (25 V1> V2<)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2028	25 Condition V1<V2> fulfilled (25 V1< V2>)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2028	25 Condition V1<V2> fulfilled (25 V1< V2>)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2028	25 Condition V1<V2> fulfilled (25 V1< V2>)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2028	25 Condition V1<V2> fulfilled (25 V1< V2>)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2029	25 Condition V1<V2< fulfilled (25 V1< V2<)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2029	25 Condition V1<V2< fulfilled (25 V1< V2<)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2029	25 Condition V1<V2< fulfilled (25 V1< V2<)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2029	25 Condition V1<V2< fulfilled (25 V1< V2<)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2030	25 Voltage difference (Vdiff) okay (25 Vdiff ok)	SYNC function 1	OUT	On Off			*	LED			BO		41	207	1	Yes
170.2030	25 Voltage difference (Vdiff) okay (25 Vdiff ok)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2030	25 Voltage difference (Vdiff) okay (25 Vdiff ok)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2030	25 Voltage difference (Vdiff) okay (25 Vdiff ok)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2031	25 Frequency difference (fdiff) okay (25 fdiff ok)	SYNC function 1	OUT	On Off			*	LED			BO		41	208	1	Yes
170.2031	25 Frequency difference (fdiff) okay (25 fdiff ok)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2031	25 Frequency difference (fdiff) okay (25 fdiff ok)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2031	25 Frequency difference (fdiff) okay (25 fdiff ok)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2032	25 Angle difference (alphadiff) okay (25 αdiff ok)	SYNC function 1	OUT	On Off			*	LED			BO		41	209	1	Yes
170.2032	25 Angle difference (alphadiff) okay (25 αdiff ok)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2032	25 Angle difference (alphadiff) okay (25 αdiff ok)	SYNC function 3	OUT	On Off			*	LED			BO					

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
170.2032	25 Angle difference (alphadiff) okay (25 αdiff ok)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2033	25 Frequency f1 > fmax permissible (25 f1>>)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2033	25 Frequency f1 > fmax permissible (25 f1>>)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2033	25 Frequency f1 > fmax permissible (25 f1>>)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2033	25 Frequency f1 > fmax permissible (25 f1>>)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2034	25 Frequency f1 < fmin permissible (25 f1<<)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2034	25 Frequency f1 < fmin permissible (25 f1<<)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2034	25 Frequency f1 < fmin permissible (25 f1<<)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2034	25 Frequency f1 < fmin permissible (25 f1<<)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2035	25 Frequency f2 > fmax permissible (25 f2>>)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2035	25 Frequency f2 > fmax permissible (25 f2>>)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2035	25 Frequency f2 > fmax permissible (25 f2>>)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2035	25 Frequency f2 > fmax permissible (25 f2>>)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2036	25 Frequency f2 < fmin permissible (25 f2<<)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2036	25 Frequency f2 < fmin permissible (25 f2<<)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2036	25 Frequency f2 < fmin permissible (25 f2<<)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2036	25 Frequency f2 < fmin permissible (25 f2<<)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2037	25 Voltage V1 > Vmax permissible (25 V1>>)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2037	25 Voltage V1 > Vmax permissible (25 V1>>)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2037	25 Voltage V1 > Vmax permissible (25 V1>>)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2037	25 Voltage V1 > Vmax permissible (25 V1>>)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2038	25 Voltage V1 < Vmin permissible (25 V1<<)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2038	25 Voltage V1 < Vmin permissible (25 V1<<)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2038	25 Voltage V1 < Vmin permissible (25 V1<<)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2038	25 Voltage V1 < Vmin permissible (25 V1<<)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2039	25 Voltage V2 > Vmax permissible (25 V2>>)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2039	25 Voltage V2 > Vmax permissible (25 V2>>)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2039	25 Voltage V2 > Vmax permissible (25 V2>>)	SYNC function 3	OUT	On Off			*	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
170.2039	25 Voltage V2 > Vmax permissible (25 V2>>)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2040	25 Voltage V2 < Vmin permissible (25 V2<<)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2040	25 Voltage V2 < Vmin permissible (25 V2<<)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2040	25 Voltage V2 < Vmin permissible (25 V2<<)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2040	25 Voltage V2 < Vmin permissible (25 V2<<)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2090	25 Vdiff too large (V2>V1) (25 V2>V1)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2090	25 Vdiff too large (V2>V1) (25 V2>V1)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2090	25 Vdiff too large (V2>V1) (25 V2>V1)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2090	25 Vdiff too large (V2>V1) (25 V2>V1)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2091	25 Vdiff too large (V2<V1) (25 V2<V1)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2091	25 Vdiff too large (V2<V1) (25 V2<V1)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2091	25 Vdiff too large (V2<V1) (25 V2<V1)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2091	25 Vdiff too large (V2<V1) (25 V2<V1)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2092	25 fdiff too large (f2>f1) (25 f2>f1)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2092	25 fdiff too large (f2>f1) (25 f2>f1)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2092	25 fdiff too large (f2>f1) (25 f2>f1)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2092	25 fdiff too large (f2>f1) (25 f2>f1)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2093	25 fdiff too large (f2<f1) (25 f2<f1)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2093	25 fdiff too large (f2<f1) (25 f2<f1)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2093	25 fdiff too large (f2<f1) (25 f2<f1)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2093	25 fdiff too large (f2<f1) (25 f2<f1)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2094	25 alphadiff too large (a2>a1) (25 $\alpha2>\alpha1$)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2094	25 alphadiff too large (a2>a1) (25 $\alpha2>\alpha1$)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2094	25 alphadiff too large (a2>a1) (25 $\alpha2>\alpha1$)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2094	25 alphadiff too large (a2>a1) (25 $\alpha2>\alpha1$)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2095	25 alphadiff too large (a2<a1) (25 $\alpha2<\alpha1$)	SYNC function 1	OUT	On Off			*	LED			BO					
170.2095	25 alphadiff too large (a2<a1) (25 $\alpha2<\alpha1$)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2095	25 alphadiff too large (a2<a1) (25 $\alpha2<\alpha1$)	SYNC function 3	OUT	On Off			*	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
170.2095	25 alphadiff too large (a2<a1) (25 $\alpha2<\alpha1$)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2096	25 Multiple selection of func-groups (25 FG-Error)	SYNC function 1	OUT	On Off				LED			BO					
170.2096	25 Multiple selection of func-groups (25 FG-Error)	SYNC function 2	OUT	On Off				LED			BO					
170.2096	25 Multiple selection of func-groups (25 FG-Error)	SYNC function 3	OUT	On Off				LED			BO					
170.2096	25 Multiple selection of func-groups (25 FG-Error)	SYNC function 4	OUT	On Off				LED			BO					
170.2097	25 Setting error (25 Set-Error)	SYNC function 1	OUT	On Off				LED			BO					
170.2097	25 Setting error (25 Set-Error)	SYNC function 2	OUT	On Off				LED			BO					
170.2097	25 Setting error (25 Set-Error)	SYNC function 3	OUT	On Off				LED			BO					
170.2097	25 Setting error (25 Set-Error)	SYNC function 4	OUT	On Off				LED			BO					
170.2101	Sync-group 1 is switched OFF (25-1 OFF)	SYNC function 1	OUT	On Off			*	LED			BO		41	36	1	Yes
170.2101	Sync-group 2 is switched OFF (25-2 OFF)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2101	Sync-group 3 is switched OFF (25-3 OFF)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2101	Sync-group 4 is switched OFF (25-4 OFF)	SYNC function 4	OUT	On Off			*	LED			BO					
170.2102	>BLOCK 25 CLOSE command (>BLK 25 CLOSE)	SYNC function 1	SP	On Off			*	LED	BI							
170.2102	>BLOCK 25 CLOSE command (>BLK 25 CLOSE)	SYNC function 2	SP	On Off			*	LED	BI							
170.2102	>BLOCK 25 CLOSE command (>BLK 25 CLOSE)	SYNC function 3	SP	On Off			*	LED	BI							
170.2102	>BLOCK 25 CLOSE command (>BLK 25 CLOSE)	SYNC function 4	SP	On Off			*	LED	BI							
170.2103	25 CLOSE command is BLOCKED (25 CLOSE BLK)	SYNC function 1	OUT	On Off			*	LED			BO		41	37	1	Yes
170.2103	25 CLOSE command is BLOCKED (25 CLOSE BLK)	SYNC function 2	OUT	On Off			*	LED			BO					
170.2103	25 CLOSE command is BLOCKED (25 CLOSE BLK)	SYNC function 3	OUT	On Off			*	LED			BO					
170.2103	25 CLOSE command is BLOCKED (25 CLOSE BLK)	SYNC function 4	OUT	On Off			*	LED			BO					
171	Failure: Phase Sequence (Fail Ph. Seq.)	Measurem.Superv	OUT	On Off	*		*	LED			BO		160	35	1	Yes
175	Failure: Phase Sequence Current (Fail Ph. Seq. I)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	191	1	Yes
176	Failure: Phase Sequence Voltage (Fail Ph. Seq. V)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	192	1	Yes
177	Failure: Battery empty (Fail Battery)	Device, General	OUT	On Off	*		*	LED			BO					
178	I/O-Board Error (I/O-Board error)	Device, General	OUT	On Off	*		*	LED			BO					
183	Error Board 1 (Error Board 1)	Device, General	OUT	On Off	*		*	LED			BO					
184	Error Board 2 (Error Board 2)	Device, General	OUT	On Off	*		*	LED			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
185	Error Board 3 (Error Board 3)	Device, General	OUT	On Off	*		*	LED			BO					
186	Error Board 4 (Error Board 4)	Device, General	OUT	On Off	*		*	LED			BO					
187	Error Board 5 (Error Board 5)	Device, General	OUT	On Off	*		*	LED			BO					
188	Error Board 6 (Error Board 6)	Device, General	OUT	On Off	*		*	LED			BO					
189	Error Board 7 (Error Board 7)	Device, General	OUT	On Off	*		*	LED			BO					
191	Error: Offset (Error Offset)	Device, General	OUT	On Off	*		*	LED			BO					
192	Error:1A/5Ajumper different from setting (Error1A/5Awrong)	Device, General	OUT	On Off	*											
193	Alarm: NO calibration data available (Alarm NO calibr)	Device, General	OUT	On Off	*		*	LED			BO					
194	Error: Neutral CT different from MLFB (Error neutralCT)	Device, General	OUT	On Off	*											
197	Measurement Supervision is switched OFF (MeasSup OFF)	Measurem.Superv	OUT	On Off	*		*	LED			BO		135	197	1	Yes
203	Waveform data deleted (Wave. deleted)	Osc. Fault Rec.	OUT_ Ev	on	*			LED			BO		135	203	1	No
220	Error: Range CT Ph wrong (CT Ph wrong)	Device, General	OUT	On Off	*											
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		BO					
235.2111	>Function $00 instantaneous TRIP (>$00 instant.)	Flx	SP	On Off	On Off	*	*	LED	BI		BO					
235.2112	>Function $00 Direct TRIP (>$00 Dir.TRIP)	Flx	SP	On Off	On Off	*	*	LED	BI		BO					
235.2113	>Function $00 BLOCK TRIP Time Delay (>$00 BLK.TDly)	Flx	SP	On Off	On Off	*	*	LED	BI		BO					
235.2114	>Function $00 BLOCK TRIP (>$00 BLK.TRIP)	Flx	SP	On Off	On Off	*	*	LED	BI		BO					
235.2115	>Function $00 BLOCK TRIP Phase A (>$00 BL.TripA)	Flx	SP	On Off	On Off	*	*	LED	BI		BO					
235.2116	>Function $00 BLOCK TRIP Phase B (>$00 BL.TripB)	Flx	SP	On Off	On Off	*	*	LED	BI		BO					
235.2117	>Function $00 BLOCK TRIP Phase C (>$00 BL.TripC)	Flx	SP	On Off	On Off	*	*	LED	BI		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					

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
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					
236.2127	BLOCK Flexible Function (BLK. Flex.Fct.)	Device, General	IntSP	On Off	*	*	*	LED			BO					
264	Failure: RTD-Box 1 (Fail: RTD-Box 1)	RTD-Box	OUT	On Off	*		*	LED			BO					
267	Failure: RTD-Box 2 (Fail: RTD-Box 2)	RTD-Box	OUT	On Off	*		*	LED			BO					
268	Supervision Pressure (Superv.Pressure)	Measurement	OUT	On Off	*		*	LED			BO					
269	Supervision Temperature (Superv.Temp.)	Measurement	OUT	On Off	*		*	LED			BO					
270	Set Point Pressure< (SP. Pressure<)	Set Points(MV)	OUT	On Off	*		*	LED			BO					
271	Set Point Temp> (SP. Temp>)	Set Points(MV)	OUT	On Off	*		*	LED			BO					
272	Set Point Operating Hours (SP. Op Hours>)	SetPoint(Stat)	OUT	On Off	*		*	LED			BO		135	229	1	Yes
273	Set Point Phase A dmd> (SP. I A dmd>)	Set Points(MV)	OUT	On Off	*		*	LED			BO		135	230	1	Yes
274	Set Point Phase B dmd> (SP. I B dmd>)	Set Points(MV)	OUT	On Off	*		*	LED			BO		135	234	1	Yes
275	Set Point Phase C dmd> (SP. I C dmd>)	Set Points(MV)	OUT	On Off	*		*	LED			BO		135	235	1	Yes
276	Set Point positive sequence I1dmd> (SP. I1dmd>)	Set Points(MV)	OUT	On Off	*		*	LED			BO		135	236	1	Yes
277	Set Point |Pdmd|> (SP. |Pdmd|>)	Set Points(MV)	OUT	On Off	*		*	LED			BO		135	237	1	Yes
278	Set Point |Qdmd|> (SP. |Qdmd|>)	Set Points(MV)	OUT	On Off	*		*	LED			BO		135	238	1	Yes
279	Set Point |Sdmd|> (SP. |Sdmd|>)	Set Points(MV)	OUT	On Off	*		*	LED			BO		135	239	1	Yes
284	Set Point 37-1 Undercurrent alarm (SP. 37-1 alarm)	Set Points(MV)	OUT	On Off	*		*	LED			BO		135	244	1	Yes
285	Set Point 55 Power factor alarm (SP. PF(55)alarm)	Set Points(MV)	OUT	On Off	*		*	LED			BO		135	245	1	Yes
301	Power System fault (Pow.Sys.Flt.)	Device, General	OUT	On Off	On Off								135	231	2	Yes
302	Fault Event (Fault Event)	Device, General	OUT	*	on								135	232	2	Yes
303	sensitive Ground fault (sens Gnd flt)	Device, General	OUT	On Off	*	ON							135	233	1	Yes
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

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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					
409	>BLOCK Op Counter (>BLOCK Op Count)	Statistics	SP	On Off			*	LED	BI		BO					
412	>Theta MIN/MAX Buffer Reset (>Θ MiMa Reset)	Min/Max meter	SP	on	*		*	LED	BI		BO					
501	Relay PICKUP (Relay PICKUP)	P.System Data 2	OUT		ON		m	LED			BO		150	151	2	Yes
502	Relay Drop Out (Relay Drop Out)	Device, General	SP	*	*											
510	General CLOSE of relay (Relay CLOSE)	Device, General	SP	*	*											
511	Relay GENERAL TRIP command (Relay TRIP)	P.System Data 2	OUT		ON		m	LED			BO		150	161	2	Yes
533	Primary fault current Ia (Ia =)	P.System Data 2	VI		On Off								150	177	4	No
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
561	Manual close signal detected (Man.Clos.Detect)	P.System Data 2	OUT	On Off	*		*	LED			BO					
916	Increment of active energy (WpΔ=)	Energy	-													
917	Increment of reactive energy (WqΔ=)	Energy	-													
1020	Counter of operating hours (Op.Hours=)	Statistics	VI													
1021	Accumulation of interrupted current Ph A (Σ Ia =)	Statistics	VI													
1022	Accumulation of interrupted current Ph B (Σ Ib =)	Statistics	VI													

No.	Description	Function	Type of In-for-matio n	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
1023	Accumulation of interrupted current Ph C (Σ Ic =)	Statistics	VI													
1106	>Start Fault Locator (>Start Flt. Loc)	Fault Locator	SP	on	*		*	LED	BI		BO		151	6	1	Yes
1118	Flt Locator: secondary REAC-TANCE (Xsec =)	Fault Locator	VI		On Off								151	18	4	No
1119	Flt Locator: Distance to fault (dist =)	Fault Locator	VI		On Off								151	19	4	No
1123	Fault Locator Loop AG (FL Loop AG)	Fault Locator	OUT	*	on		*	LED			BO					
1124	Fault Locator Loop BG (FL Loop BG)	Fault Locator	OUT	*	on		*	LED			BO					
1125	Fault Locator Loop CG (FL Loop CG)	Fault Locator	OUT	*	on		*	LED			BO					
1126	Fault Locator Loop AB (FL Loop AB)	Fault Locator	OUT	*	on		*	LED			BO					
1127	Fault Locator Loop BC (FL Loop BC)	Fault Locator	OUT	*	on		*	LED			BO					
1128	Fault Locator Loop CA (FL Loop CA)	Fault Locator	OUT	*	on		*	LED			BO					
1132	Fault location invalid (Flt.Loc.in-valid)	Fault Locator	OUT	*	on		*	LED			BO					
1201	>BLOCK 64 (>BLOCK 64)	Sens. Gnd Fault	SP	On Off	*		*	LED	BI		BO		151	101	1	Yes
1202	>BLOCK 50Ns-2 (>BLOCK 50Ns-2)	Sens. Gnd Fault	SP	On Off	*		*	LED	BI		BO		151	102	1	Yes
1203	>BLOCK 50Ns-1 (>BLOCK 50Ns-1)	Sens. Gnd Fault	SP	On Off	*		*	LED	BI		BO		151	103	1	Yes
1204	>BLOCK 51Ns (>BLOCK 51Ns)	Sens. Gnd Fault	SP	On Off	*		*	LED	BI		BO		151	104	1	Yes
1207	>BLOCK 50Ns/67Ns (>BLK 50Ns/67Ns)	Sens. Gnd Fault	SP	On Off	*		*	LED	BI		BO		151	107	1	Yes
1211	50Ns/67Ns is OFF (50Ns/67Ns OFF)	Sens. Gnd Fault	OUT	On Off	*		*	LED			BO		151	111	1	Yes
1212	50Ns/67Ns is ACTIVE (50Ns/67Ns ACT)	Sens. Gnd Fault	OUT	On Off	*		*	LED			BO		151	112	1	Yes
1215	64 displacement voltage pick up (64 Pickup)	Sens. Gnd Fault	OUT	*	On Off		*	LED			BO		151	115	2	Yes
1217	64 displacement voltage element TRIP (64 TRIP)	Sens. Gnd Fault	OUT	*	on		m	LED			BO		151	117	2	Yes
1221	50Ns-2 Pickup (50Ns-2 Pickup)	Sens. Gnd Fault	OUT	*	On Off		*	LED			BO		151	121	2	Yes
1223	50Ns-2 TRIP (50Ns-2 TRIP)	Sens. Gnd Fault	OUT	*	on		m	LED			BO		151	123	2	Yes
1224	50Ns-1 Pickup (50Ns-1 Pickup)	Sens. Gnd Fault	OUT	*	On Off		*	LED			BO		151	124	2	Yes
1226	50Ns-1 TRIP (50Ns-1 TRIP)	Sens. Gnd Fault	OUT	*	on		m	LED			BO		151	126	2	Yes
1227	51Ns picked up (51Ns Pickup)	Sens. Gnd Fault	OUT	*	On Off		*	LED			BO		151	127	2	Yes
1229	51Ns TRIP (51Ns TRIP)	Sens. Gnd Fault	OUT	*	on		m	LED			BO		151	129	2	Yes
1230	Sensitive ground fault detection BLOCKED (Sens. Gnd block)	Sens. Gnd Fault	OUT	On Off	On Off		*	LED			BO		151	130	1	Yes
1264	Corr. Resistive Earth current (IEEa =)	Sens. Gnd Fault	VI			On Off										
1265	Corr. Reactive Earth current (IEEr =)	Sens. Gnd Fault	VI			On Off										

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
1266	Earth current, absolute Value (IEE =)	Sens. Gnd Fault	VI			On Off										
1267	Displacement Voltage VGND, 3Vo (VGND, 3Vo)	Sens. Gnd Fault	VI			On Off										
1271	Sensitive Ground fault pick up (Sens.Gnd Pickup)	Sens. Gnd Fault	OUT	*	*		*						151	171	1	Yes
1272	Sensitive Ground fault picked up in Ph A (Sens. Gnd Ph A)	Sens. Gnd Fault	OUT	On Off	on	On Off	*	LED			BO		160	48	1	Yes
1273	Sensitive Ground fault picked up in Ph B (Sens. Gnd Ph B)	Sens. Gnd Fault	OUT	On Off	on	On Off	*	LED			BO		160	49	1	Yes
1274	Sensitive Ground fault picked up in Ph C (Sens. Gnd Ph C)	Sens. Gnd Fault	OUT	On Off	on	On Off	*	LED			BO		160	50	1	Yes
1276	Sensitive Gnd fault in forward direction (SensGnd Forward)	Sens. Gnd Fault	OUT	On Off	on	On Off	*	LED			BO		160	51	1	Yes
1277	Sensitive Gnd fault in reverse direction (SensGnd Reverse)	Sens. Gnd Fault	OUT	On Off	on	On Off	*	LED			BO		160	52	1	Yes
1278	Sensitive Gnd fault direction undefined (SensGnd undef.)	Sens. Gnd Fault	OUT	On Off	on	On Off	*	LED			BO		151	178	1	Yes
1403	>BLOCK 50BF (>BLOCK 50BF)	50BF BkrFailure	SP	On Off	*		*	LED	BI		BO		166	103	1	Yes
1431	>50BF initiated externally (>50BF ext SRC)	50BF BkrFailure	SP	On Off	*		*	LED	BI		BO		166	104	1	Yes
1451	50BF is switched OFF (50BF OFF)	50BF BkrFailure	OUT	On Off	*		*	LED			BO		166	151	1	Yes
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	On Off	*		*	LED			BO		166	153	1	Yes
1456	50BF (internal) PICKUP (50BF int Pickup)	50BF BkrFailure	OUT	*	On Off		*	LED			BO		166	156	2	Yes
1457	50BF (external) PICKUP (50BF ext Pickup)	50BF BkrFailure	OUT	*	On Off		*	LED			BO		166	157	2	Yes
1471	50BF TRIP (50BF TRIP)	50BF BkrFailure	OUT	*	on		m	LED			BO		160	85	2	No
1480	50BF (internal) TRIP (50BF int TRIP)	50BF BkrFailure	OUT	*	on		*	LED			BO		166	180	2	Yes
1481	50BF (external) TRIP (50BF ext TRIP)	50BF BkrFailure	OUT	*	on		*	LED			BO		166	181	2	Yes
1503	>BLOCK 49 Overload Protection (>BLOCK 49 O/L)	49 Th.Overload	SP	*	*		*	LED	BI		BO		167	3	1	Yes
1507	>Emergency start of motors (>EmergencyStart)	49 Th.Overload	SP	On Off	*		*	LED	BI		BO		167	7	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		m	LED			BO		167	21	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
1580	>49 Reset of Thermal Overload Image (>RES 49 Image)	49 Th.Overload	SP	On Off	*		*	LED	BI		BO					
1581	49 Thermal Overload Image reset (49 Image res.)	49 Th.Overload	OUT	On Off	*		*	LED			BO					
1704	>BLOCK 50/51 (>BLK 50/51)	50/51 Overcur.	SP	*	*		*	LED	BI		BO					
1714	>BLOCK 50N/51N (>BLK 50N/51N)	50/51 Overcur.	SP	*	*		*	LED	BI		BO					
1721	>BLOCK 50-2 (>BLOCK 50-2)	50/51 Overcur.	SP	*	*		*	LED	BI		BO		60	1	1	Yes
1722	>BLOCK 50-1 (>BLOCK 50-1)	50/51 Overcur.	SP	*	*		*	LED	BI		BO		60	2	1	Yes
1723	>BLOCK 51 (>BLOCK 51)	50/51 Overcur.	SP	*	*		*	LED	BI		BO		60	3	1	Yes
1724	>BLOCK 50N-2 (>BLOCK 50N-2)	50/51 Overcur.	SP	*	*		*	LED	BI		BO		60	4	1	Yes
1725	>BLOCK 50N-1 (>BLOCK 50N-1)	50/51 Overcur.	SP	*	*		*	LED	BI		BO		60	5	1	Yes
1726	>BLOCK 51N (>BLOCK 51N)	50/51 Overcur.	SP	*	*		*	LED	BI		BO		60	6	1	Yes
1730	>BLOCK Cold-Load-Pickup (>BLOCK CLP)	ColdLoadPickup	SP	*	*		*	LED	BI		BO					
1731	>BLOCK Cold-Load-Pickup stop timer (>BLK CLP stpTim)	ColdLoadPickup	SP	On Off	*		*	LED	BI		BO		60	243	1	Yes
1732	>ACTIVATE Cold-Load-Pickup (>ACTIVATE CLP)	ColdLoadPickup	SP	On Off	*		*	LED	BI		BO					
1751	50/51 O/C switched OFF (50/51 PH OFF)	50/51 Overcur.	OUT	On Off	*		*	LED			BO		60	21	1	Yes
1752	50/51 O/C is BLOCKED (50/51 PH BLK)	50/51 Overcur.	OUT	On Off	On Off		*	LED			BO		60	22	1	Yes
1753	50/51 O/C is ACTIVE (50/51 PH ACT)	50/51 Overcur.	OUT	On Off	*		*	LED			BO		60	23	1	Yes
1756	50N/51N is OFF (50N/51N OFF)	50/51 Overcur.	OUT	On Off	*		*	LED			BO		60	26	1	Yes
1757	50N/51N is BLOCKED (50N/51N BLK)	50/51 Overcur.	OUT	On Off	On Off		*	LED			BO		60	27	1	Yes
1758	50N/51N is ACTIVE (50N/51N ACT)	50/51 Overcur.	OUT	On Off	*		*	LED			BO		60	28	1	Yes
1761	50(N)/51(N) O/C PICKUP (50(N)/51(N) PU)	50/51 Overcur.	OUT	*	On Off		m	LED			BO		160	84	2	Yes
1762	50/51 Phase A picked up (50/51 Ph A PU)	50/51 Overcur.	OUT	*	On Off		m	LED			BO		160	64	2	Yes
1763	50/51 Phase B picked up (50/51 Ph B PU)	50/51 Overcur.	OUT	*	On Off		m	LED			BO		160	65	2	Yes
1764	50/51 Phase C picked up (50/51 Ph C PU)	50/51 Overcur.	OUT	*	On Off		m	LED			BO		160	66	2	Yes
1765	50N/51N picked up (50N/51NPickedup)	50/51 Overcur.	OUT	*	On Off		m	LED			BO		160	67	2	Yes
1791	50(N)/51(N) TRIP (50(N)/51(N)TRIP)	50/51 Overcur.	OUT	*	on		m	LED			BO		160	68	2	No
1800	50-2 picked up (50-2 picked up)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	75	2	Yes
1804	50-2 Time Out (50-2 TimeOut)	50/51 Overcur.	OUT	*	*		*	LED			BO		60	49	2	Yes
1805	50-2 TRIP (50-2 TRIP)	50/51 Overcur.	OUT	*	on		m	LED			BO		160	91	2	No
1810	50-1 picked up (50-1 picked up)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	76	2	Yes
1814	50-1 Time Out (50-1 TimeOut)	50/51 Overcur.	OUT	*	*		*	LED			BO		60	53	2	Yes
1815	50-1 TRIP (50-1 TRIP)	50/51 Overcur.	OUT	*	on		m	LED			BO		160	90	2	No
1820	51 picked up (51 picked up)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	77	2	Yes
1824	51 Time Out (51 Time Out)	50/51 Overcur.	OUT	*	*		*	LED			BO		60	57	2	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
1825	51 TRIP (51 TRIP)	50/51 Overcur.	OUT	*	on		m	LED			BO		60	58	2	Yes
1831	50N-2 picked up (50N-2 picked up)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	59	2	Yes
1832	50N-2 Time Out (50N-2 TimeOut)	50/51 Overcur.	OUT	*	*		*	LED			BO		60	60	2	Yes
1833	50N-2 TRIP (50N-2 TRIP)	50/51 Overcur.	OUT	*	on		m	LED			BO		160	93	2	No
1834	50N-1 picked up (50N-1 picked up)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	62	2	Yes
1835	50N-1 Time Out (50N-1 TimeOut)	50/51 Overcur.	OUT	*	*		*	LED			BO		60	63	2	Yes
1836	50N-1 TRIP (50N-1 TRIP)	50/51 Overcur.	OUT	*	on		m	LED			BO		160	92	2	No
1837	51N picked up (51N picked up)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	64	2	Yes
1838	51N Time Out (51N TimeOut)	50/51 Overcur.	OUT	*	*		*	LED			BO		60	65	2	Yes
1839	51N TRIP (51N TRIP)	50/51 Overcur.	OUT	*	on		m	LED			BO		60	66	2	Yes
1840	Phase A inrush detection (PhA InrushDet)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	101	2	Yes
1841	Phase B inrush detection (PhB InrushDet)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	102	2	Yes
1842	Phase C inrush detection (PhC InrushDet)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	103	2	Yes
1843	Cross blk: PhX blocked PhY (INRUSH X-BLK)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	104	2	Yes
1851	50-1 BLOCKED (50-1 BLOCKED)	50/51 Overcur.	OUT	On Off	On Off		*	LED			BO		60	105	1	Yes
1852	50-2 BLOCKED (50-2 BLOCKED)	50/51 Overcur.	OUT	On Off	On Off		*	LED			BO		60	106	1	Yes
1853	50N-1 BLOCKED (50N-1 BLOCKED)	50/51 Overcur.	OUT	On Off	On Off		*	LED			BO		60	107	1	Yes
1854	50N-2 BLOCKED (50N-2 BLOCKED)	50/51 Overcur.	OUT	On Off	On Off		*	LED			BO		60	108	1	Yes
1855	51 BLOCKED (51 BLOCKED)	50/51 Overcur.	OUT	On Off	On Off		*	LED			BO		60	109	1	Yes
1856	51N BLOCKED (51N BLOCKED)	50/51 Overcur.	OUT	On Off	On Off		*	LED			BO		60	110	1	Yes
1866	51 Disk emulation Pickup (51 Disk Pickup)	50/51 Overcur.	OUT	*	*		*	LED			BO					
1867	51N Disk emulation picked up (51N Disk Pickup)	50/51 Overcur.	OUT	*	*		*	LED			BO					
1994	Cold-Load-Pickup switched OFF (CLP OFF)	ColdLoadPickup	OUT	On Off	*		*	LED			BO		60	244	1	Yes
1995	Cold-Load-Pickup is BLOCKED (CLP BLOCKED)	ColdLoadPickup	OUT	On Off	On Off		*	LED			BO		60	245	1	Yes
1996	Cold-Load-Pickup is RUNNING (CLP running)	ColdLoadPickup	OUT	On Off	*		*	LED			BO		60	246	1	Yes
1997	Dynamic settings are ACTIVE (Dyn set. ACTIVE)	ColdLoadPickup	OUT	On Off	*		*	LED			BO		60	247	1	Yes
2604	>BLOCK 67/67-TOC (>BLK 67/67-TOC)	67 Direct. O/C	SP	*	*		*	LED	BI		BO					
2614	>BLOCK 67N/67N-TOC (>BLK 67N/67NTOC)	67 Direct. O/C	SP	*	*		*	LED	BI		BO					
2615	>BLOCK 67-2 (>BLOCK 67-2)	67 Direct. O/C	SP	*	*		*	LED	BI		BO		63	73	1	Yes
2616	>BLOCK 67N-2 (>BLOCK 67N-2)	67 Direct. O/C	SP	*	*		*	LED	BI		BO		63	74	1	Yes
2621	>BLOCK 67-1 (>BLOCK 67-1)	67 Direct. O/C	SP	*	*		*	LED	BI		BO		63	1	1	Yes
2622	>BLOCK 67-TOC (>BLOCK 67-TOC)	67 Direct. O/C	SP	*	*		*	LED	BI		BO		63	2	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
2623	>BLOCK 67N-1 (>BLOCK 67N-1)	67 Direct. O/C	SP	*	*		*	LED	BI		BO		63	3	1	Yes
2624	>BLOCK 67N-TOC (>BLOCK 67N-TOC)	67 Direct. O/C	SP	*	*		*	LED	BI		BO		63	4	1	Yes
2628	Phase A forward (Phase A forward)	67 Direct. O/C	OUT	on	*		*	LED			BO		63	81	1	Yes
2629	Phase B forward (Phase B forward)	67 Direct. O/C	OUT	on	*		*	LED			BO		63	82	1	Yes
2630	Phase C forward (Phase C forward)	67 Direct. O/C	OUT	on	*		*	LED			BO		63	83	1	Yes
2632	Phase A reverse (Phase A reverse)	67 Direct. O/C	OUT	on	*		*	LED			BO		63	84	1	Yes
2633	Phase B reverse (Phase B reverse)	67 Direct. O/C	OUT	on	*		*	LED			BO		63	85	1	Yes
2634	Phase C reverse (Phase C reverse)	67 Direct. O/C	OUT	on	*		*	LED			BO		63	86	1	Yes
2635	Ground forward (Ground forward)	67 Direct. O/C	OUT	on	*		*	LED			BO		63	87	1	Yes
2636	Ground reverse (Ground reverse)	67 Direct. O/C	OUT	on	*		*	LED			BO		63	88	1	Yes
2637	67-1 is BLOCKED (67-1 BLOCKED)	67 Direct. O/C	OUT	On Off	On Off		*	LED			BO		63	91	1	Yes
2642	67-2 picked up (67-2 picked up)	67 Direct. O/C	OUT	*	On Off		*	LED			BO		63	67	2	Yes
2646	67N-2 picked up (67N-2 picked up)	67 Direct. O/C	OUT	*	On Off		*	LED			BO		63	62	2	Yes
2647	67-2 Time Out (67-2 Time Out)	67 Direct. O/C	OUT	*	*		*	LED			BO		63	71	2	Yes
2648	67N-2 Time Out (67N-2 Time Out)	67 Direct. O/C	OUT	*	*		*	LED			BO		63	63	2	Yes
2649	67-2 TRIP (67-2 TRIP)	67 Direct. O/C	OUT	*	on		m	LED			BO		63	72	2	Yes
2651	67/67-TOC switched OFF (67/67-TOC OFF)	67 Direct. O/C	OUT	On Off	*		*	LED			BO		63	10	1	Yes
2652	67/67-TOC is BLOCKED (67 BLOCKED)	67 Direct. O/C	OUT	On Off	On Off		*	LED			BO		63	11	1	Yes
2653	67/67-TOC is ACTIVE (67 ACTIVE)	67 Direct. O/C	OUT	On Off	*		*	LED			BO		63	12	1	Yes
2655	67-2 is BLOCKED (67-2 BLOCKED)	67 Direct. O/C	OUT	On Off	On Off		*	LED			BO		63	92	1	Yes
2656	67N/67N-TOC switched OFF (67N OFF)	67 Direct. O/C	OUT	On Off	*		*	LED			BO		63	13	1	Yes
2657	67N/67N-TOC is BLOCKED (67N BLOCKED)	67 Direct. O/C	OUT	On Off	On Off		*	LED			BO		63	14	1	Yes
2658	67N/67N-TOC is ACTIVE (67N ACTIVE)	67 Direct. O/C	OUT	On Off	*		*	LED			BO		63	15	1	Yes
2659	67N-1 is BLOCKED (67N-1 BLOCKED)	67 Direct. O/C	OUT	On Off	On Off		*	LED			BO		63	93	1	Yes
2660	67-1 picked up (67-1 picked up)	67 Direct. O/C	OUT	*	On Off		*	LED			BO		63	20	2	Yes
2664	67-1 Time Out (67-1 Time Out)	67 Direct. O/C	OUT	*	*		*	LED			BO		63	24	2	Yes
2665	67-1 TRIP (67-1 TRIP)	67 Direct. O/C	OUT	*	on		m	LED			BO		63	25	2	Yes
2668	67N-2 is BLOCKED (67N-2 BLOCKED)	67 Direct. O/C	OUT	On Off	On Off		*	LED			BO		63	94	1	Yes
2669	67-TOC is BLOCKED (67-TOC BLOCKED)	67 Direct. O/C	OUT	On Off	On Off		*	LED			BO		63	95	1	Yes
2670	67-TOC picked up (67-TOC pickedup)	67 Direct. O/C	OUT	*	On Off		*	LED			BO		63	30	2	Yes
2674	67-TOC Time Out (67-TOC Time Out)	67 Direct. O/C	OUT	*	*		*	LED			BO		63	34	2	Yes

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				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
2675	67-TOC TRIP (67-TOC TRIP)	67 Direct. O/C	OUT	*	on		m	LED			BO		63	35	2	Yes
2676	67-TOC disk emulation is ACTIVE (67-TOC DiskPU)	67 Direct. O/C	OUT	*	*		*	LED			BO					
2677	67N-TOC is BLOCKED (67N-TOC BLOCKED)	67 Direct. O/C	OUT	On Off	On Off		*	LED			BO		63	96	1	Yes
2679	67N-2 TRIP (67N-2 TRIP)	67 Direct. O/C	OUT	*	on		m	LED			BO		63	64	2	Yes
2681	67N-1 picked up (67N-1 picked up)	67 Direct. O/C	OUT	*	On Off		*	LED			BO		63	41	2	Yes
2682	67N-1 Time Out (67N-1 Time Out)	67 Direct. O/C	OUT	*	*		*	LED			BO		63	42	2	Yes
2683	67N-1 TRIP (67N-1 TRIP)	67 Direct. O/C	OUT	*	on		m	LED			BO		63	43	2	Yes
2684	67N-TOC picked up (67N-TOCPickedup)	67 Direct. O/C	OUT	*	On Off		*	LED			BO		63	44	2	Yes
2685	67N-TOC Time Out (67N-TOC TimeOut)	67 Direct. O/C	OUT	*	*		*	LED			BO		63	45	2	Yes
2686	67N-TOC TRIP (67N-TOC TRIP)	67 Direct. O/C	OUT	*	on		m	LED			BO		63	46	2	Yes
2687	67N-TOC disk emulation is ACTIVE (67N-TOC Disk PU)	67 Direct. O/C	OUT	*	*		*	LED			BO					
2691	67/67N picked up (67/67N pickedup)	67 Direct. O/C	OUT	*	On Off		m	LED			BO		63	50	2	Yes
2692	67/67-TOC Phase A picked up (67 A picked up)	67 Direct. O/C	OUT	*	On Off		*	LED			BO		63	51	2	Yes
2693	67/67-TOC Phase B picked up (67 B picked up)	67 Direct. O/C	OUT	*	On Off		*	LED			BO		63	52	2	Yes
2694	67/67-TOC Phase C picked up (67 C picked up)	67 Direct. O/C	OUT	*	On Off		*	LED			BO		63	53	2	Yes
2695	67N/67N-TOC picked up (67N picked up)	67 Direct. O/C	OUT	*	On Off		*	LED			BO		63	54	2	Yes
2696	67/67N TRIP (67/67N TRIP)	67 Direct. O/C	OUT	*	on		m	LED			BO		63	55	2	Yes
2701	>79 ON (>79 ON)	79M Auto Recl.	SP	On Off	*		*	LED	BI		BO		40	1	1	Yes
2702	>79 OFF (>79 OFF)	79M Auto Recl.	SP	On Off	*		*	LED	BI		BO		40	2	1	Yes
2703	>BLOCK 79 (>BLOCK 79)	79M Auto Recl.	SP	On Off	*		*	LED	BI		BO		40	3	1	Yes
2711	>79 External start of internal A/R (>79 Start)	79M Auto Recl.	SP	*	On Off		*	LED	BI		BO					
2715	>Start 79 Ground program (>Start 79 Gnd)	79M Auto Recl.	SP	*	on		*	LED	BI		BO		40	15	2	Yes
2716	>Start 79 Phase program (>Start 79 Ph)	79M Auto Recl.	SP	*	on		*	LED	BI		BO		40	16	2	Yes
2720	>Enable 50/67-(N)-2 (override 79 blk) (>Enable ANSI#-2)	P.System Data 2	SP	On Off	*		*	LED	BI		BO		40	20	1	Yes
2722	>Switch zone sequence coordi-nation ON (>ZSC ON)	79M Auto Recl.	SP	On Off	*		*	LED	BI		BO					
2723	>Switch zone sequence coordi-nation OFF (>ZSC OFF)	79M Auto Recl.	SP	On Off	*		*	LED	BI		BO					
2730	>Circuit breaker READY for re-closing (>CB Ready)	79M Auto Recl.	SP	On Off	*		*	LED	BI		BO		40	30	1	Yes
2731	>79: Sync. release from ext. sync.-check (>Sync.release)	79M Auto Recl.	SP	*	on		*	LED	BI		BO					
2753	79: Max. Dead Time Start Delay expired (79 DT delay ex.)	79M Auto Recl.	OUT	on	*		*	LED			BO					
2754	>79: Dead Time Start Delay (>79 DT St.Delay)	79M Auto Recl.	SP	On Off	*		*	LED	BI		BO					

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2781	79 Auto recloser is switched OFF (79 OFF)	79M Auto Recl.	OUT	on	*		*	LED			BO		40	81	1	Yes
2782	79 Auto recloser is switched ON (79 ON)	79M Auto Recl.	IntSP	On Off	*		*	LED			BO		160	16	1	Yes
2784	79 Auto recloser is NOT ready (79 is NOT ready)	79M Auto Recl.	OUT	On Off	*		*	LED			BO		160	130	1	Yes
2785	79 - Auto-reclose is dynamically BLOCKED (79 DynBlock)	79M Auto Recl.	OUT	On Off	on		*	LED			BO		40	85	1	Yes
2788	79: CB ready monitoring window expired (79 T-CBreadyExp)	79M Auto Recl.	OUT	on	*		*	LED			BO					
2801	79 - in progress (79 in progress)	79M Auto Recl.	OUT	*	on		*	LED			BO		40	101	2	Yes
2808	79: CB open with no trip (79 BLK: CB open)	79M Auto Recl.	OUT	On Off	*		*	LED			BO					
2809	79: Start-signal monitoring time expired (79 T-Start Exp)	79M Auto Recl.	OUT	on	*		*	LED			BO					
2810	79: Maximum dead time expired (79 TdeadMax Exp)	79M Auto Recl.	OUT	on	*		*	LED			BO					
2823	79: no starter configured (79 no starter)	79M Auto Recl.	OUT	On Off	*		*	LED			BO					
2824	79: no cycle configured (79 no cycle)	79M Auto Recl.	OUT	On Off	*		*	LED			BO					
2827	79: blocking due to trip (79 BLK by trip)	79M Auto Recl.	OUT	on	*		*	LED			BO					
2828	79: blocking due to 3-phase pickup (79 BLK:3ph p.u.)	79M Auto Recl.	OUT	on	*		*	LED			BO					
2829	79: action time expired before trip (79 Tact expired)	79M Auto Recl.	OUT	on	*		*	LED			BO					
2830	79: max. no. of cycles exceeded (79 Max. No. Cyc)	79M Auto Recl.	OUT	on	*		*	LED			BO					
2844	79 1st cycle running (79 1stCyc. run.)	79M Auto Recl.	OUT	*	on		*	LED			BO					
2845	79 2nd cycle running (79 2ndCyc. run.)	79M Auto Recl.	OUT	*	on		*	LED			BO					
2846	79 3rd cycle running (79 3rdCyc. run.)	79M Auto Recl.	OUT	*	on		*	LED			BO					
2847	79 4th or higher cycle running (79 4thCyc. run.)	79M Auto Recl.	OUT	*	on		*	LED			BO					
2851	79 - Close command (79 Close)	79M Auto Recl.	OUT	*	on		m	LED			BO		160	128	2	No
2862	79 - cycle successful (79 Successful)	79M Auto Recl.	OUT	on	on		*	LED			BO		40	162	1	Yes
2863	79 - Lockout (79 Lockout)	79M Auto Recl.	OUT	on	on		*	LED			BO		40	163	2	Yes
2865	79: Synchro-check request (79 Sync.Request)	79M Auto Recl.	OUT	*	on		*	LED			BO					
2878	79-A/R single phase reclosing sequence (79 L-N Sequence)	79M Auto Recl.	OUT	*	on		*	LED			BO		40	180	2	Yes
2879	79-A/R multi-phase reclosing sequence (79 L-L Sequence)	79M Auto Recl.	OUT	*	on		*	LED			BO		40	181	2	Yes
2883	Zone Sequencing is active (ZSC active)	79M Auto Recl.	OUT	On Off	on		*	LED			BO					
2884	Zone sequence coordination switched ON (ZSC ON)	79M Auto Recl.	OUT	on	*		*	LED			BO					
2885	Zone sequence coordination switched OFF (ZSC OFF)	79M Auto Recl.	OUT	on	*		*	LED			BO					
2889	79 1st cycle zone extension release (79 1.CycZoneRel)	79M Auto Recl.	OUT	*	*		*	LED			BO					

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2890	79 2nd cycle zone extension release (79 2.CycZoneRel)	79M Auto Recl.	OUT	*	*		*	LED			BO					
2891	79 3rd cycle zone extension release (79 3.CycZoneRel)	79M Auto Recl.	OUT	*	*		*	LED			BO					
2892	79 4th cycle zone extension release (79 4.CycZoneRel)	79M Auto Recl.	OUT	*	*		*	LED			BO					
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													
2899	79: Close request to Control Function (79 CloseRequest)	79M Auto Recl.	OUT	*	on		*	LED			BO					
4601	>52-a contact (OPEN, if bkr is open) (>52-a)	P.System Data 2	SP	On Off	*		*	LED	BI		BO					
4602	>52-b contact (OPEN, if bkr is closed) (>52-b)	P.System Data 2	SP	On Off	*		*	LED	BI		BO					
4822	>BLOCK Motor Startup counter (>BLOCK 66)	48/66 Motor	SP	*	*		*	LED	BI		BO					
4823	>Emergency start (>66 emer.start)	48/66 Motor	SP	On Off	*		*	LED	BI		BO		168	51	1	Yes
4824	66 Motor start protection OFF (66 OFF)	48/66 Motor	OUT	On Off	*		*	LED			BO		168	52	1	Yes
4825	66 Motor start protection BLOCKED (66 BLOCKED)	48/66 Motor	OUT	On Off	On Off		*	LED			BO		168	53	1	Yes
4826	66 Motor start protection ACTIVE (66 ACTIVE)	48/66 Motor	OUT	On Off	*		*	LED			BO		168	54	1	Yes
4827	66 Motor start protection TRIP (66 TRIP)	48/66 Motor	OUT	On Off	*		*	LED			BO		168	55	1	Yes
4828	>66 Reset thermal memory (>66 RM th.repl.)	48/66 Motor	SP	On Off	*		*	LED	BI		BO					
4829	66 Reset thermal memory (66 RM th.repl.)	48/66 Motor	OUT	On Off	*		*	LED			BO					
5143	>BLOCK 46 (>BLOCK 46)	46 Negative Seq	SP	*	*		*	LED	BI		BO		70	126	1	Yes
5145	>Reverse Phase Rotation (>Reverse Rot.)	P.System Data 1	SP	On Off	*		*	LED	BI		BO					
5147	Phase rotation ABC (Rotation ABC)	P.System Data 1	OUT	On Off	*		*	LED			BO		70	128	1	Yes
5148	Phase rotation ACB (Rotation ACB)	P.System Data 1	OUT	On Off	*		*	LED			BO		70	129	1	Yes
5151	46 switched OFF (46 OFF)	46 Negative Seq	OUT	On Off	*		*	LED			BO		70	131	1	Yes
5152	46 is BLOCKED (46 BLOCKED)	46 Negative Seq	OUT	On Off	On Off		*	LED			BO		70	132	1	Yes
5153	46 is ACTIVE (46 ACTIVE)	46 Negative Seq	OUT	On Off	*		*	LED			BO		70	133	1	Yes
5159	46-2 picked up (46-2 picked up)	46 Negative Seq	OUT	*	On Off		*	LED			BO		70	138	2	Yes
5165	46-1 picked up (46-1 picked up)	46 Negative Seq	OUT	*	On Off		*	LED			BO		70	150	2	Yes
5166	46-TOC picked up (46-TOC pickedup)	46 Negative Seq	OUT	*	On Off		*	LED			BO		70	141	2	Yes
5170	46 TRIP (46 TRIP)	46 Negative Seq	OUT	*	on		m	LED			BO		70	149	2	Yes
5171	46 Disk emulation picked up (46 Dsk pickedup)	46 Negative Seq	OUT	*	*		*	LED			BO					
5203	>BLOCK 81O/U (>BLOCK 81O/U)	81 O/U Freq.	SP	On Off	*		*	LED	BI		BO		70	176	1	Yes

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5206	>BLOCK 81-1 (>BLOCK 81-1)	81 O/U Freq.	SP	On Off	*		*	LED	BI		BO		70	177	1	Yes
5207	>BLOCK 81-2 (>BLOCK 81-2)	81 O/U Freq.	SP	On Off	*		*	LED	BI		BO		70	178	1	Yes
5208	>BLOCK 81-3 (>BLOCK 81-3)	81 O/U Freq.	SP	On Off	*		*	LED	BI		BO		70	179	1	Yes
5209	>BLOCK 81-4 (>BLOCK 81-4)	81 O/U Freq.	SP	On Off	*		*	LED	BI		BO		70	180	1	Yes
5211	81 OFF (81 OFF)	81 O/U Freq.	OUT	On Off	*		*	LED			BO		70	181	1	Yes
5212	81 BLOCKED (81 BLOCKED)	81 O/U Freq.	OUT	On Off	On Off		*	LED			BO		70	182	1	Yes
5213	81 ACTIVE (81 ACTIVE)	81 O/U Freq.	OUT	On Off	*		*	LED			BO		70	183	1	Yes
5214	81 Under Voltage Block (81 Under V Blk)	81 O/U Freq.	OUT	On Off	On Off		*	LED			BO		70	184	1	Yes
5232	81-1 picked up (81-1 picked up)	81 O/U Freq.	OUT	*	On Off		*	LED			BO		70	230	2	Yes
5233	81-2 picked up (81-2 picked up)	81 O/U Freq.	OUT	*	On Off		*	LED			BO		70	231	2	Yes
5234	81-3 picked up (81-3 picked up)	81 O/U Freq.	OUT	*	On Off		*	LED			BO		70	232	2	Yes
5235	81-4 picked up (81-4 picked up)	81 O/U Freq.	OUT	*	On Off		*	LED			BO		70	233	2	Yes
5236	81-1 TRIP (81-1 TRIP)	81 O/U Freq.	OUT	*	on		m	LED			BO		70	234	2	Yes
5237	81-2 TRIP (81-2 TRIP)	81 O/U Freq.	OUT	*	on		m	LED			BO		70	235	2	Yes
5238	81-3 TRIP (81-3 TRIP)	81 O/U Freq.	OUT	*	on		m	LED			BO		70	236	2	Yes
5239	81-4 TRIP (81-4 TRIP)	81 O/U Freq.	OUT	*	on		m	LED			BO		70	237	2	Yes
5951	>BLOCK 50 1Ph (>BLK 50 1Ph)	50 1Ph	SP	*	*		*	LED	BI		BO					
5952	>BLOCK 50 1Ph-1 (>BLK 50 1Ph-1)	50 1Ph	SP	*	*		*	LED	BI		BO					
5953	>BLOCK 50 1Ph-2 (>BLK 50 1Ph-2)	50 1Ph	SP	*	*		*	LED	BI		BO					
5961	50 1Ph is OFF (50 1Ph OFF)	50 1Ph	OUT	On Off	*		*	LED			BO					
5962	50 1Ph is BLOCKED (50 1Ph BLOCKED)	50 1Ph	OUT	On Off	On Off		*	LED			BO					
5963	50 1Ph is ACTIVE (50 1Ph ACTIVE)	50 1Ph	OUT	On Off	*		*	LED			BO					
5966	50 1Ph-1 is BLOCKED (50 1Ph-1 BLK)	50 1Ph	OUT	On Off	On Off		*	LED			BO					
5967	50 1Ph-2 is BLOCKED (50 1Ph-2 BLK)	50 1Ph	OUT	On Off	On Off		*	LED			BO					
5971	50 1Ph picked up (50 1Ph Pickup)	50 1Ph	OUT	*	On Off		*	LED			BO					
5972	50 1Ph TRIP (50 1Ph TRIP)	50 1Ph	OUT	*	on		*	LED			BO					
5974	50 1Ph-1 picked up (50 1Ph-1 PU)	50 1Ph	OUT	*	On Off		*	LED			BO					
5975	50 1Ph-1 TRIP (50 1Ph-1 TRIP)	50 1Ph	OUT	*	on		*	LED			BO					
5977	50 1Ph-2 picked up (50 1Ph-2 PU)	50 1Ph	OUT	*	On Off		*	LED			BO					
5979	50 1Ph-2 TRIP (50 1Ph-2 TRIP)	50 1Ph	OUT	*	on		*	LED			BO					
5980	50 1Ph: I at pick up (50 1Ph I:)	50 1Ph	VI	*	On Off											

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log ON/OFF	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
6503	>BLOCK 27 undervoltage protection (>BLOCK 27)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO		74	3	1	Yes
6505	>27-Switch current supervision ON (>27 I SUPRVSN)	27/59 O/U Volt.	SP	On Off	*		*	LED	BI		BO		74	5	1	Yes
6506	>BLOCK 27-1 Undervoltage protection (>BLOCK 27-1)	27/59 O/U Volt.	SP	On Off	*		*	LED	BI		BO		74	6	1	Yes
6508	>BLOCK 27-2 Undervoltage protection (>BLOCK 27-2)	27/59 O/U Volt.	SP	On Off	*		*	LED	BI		BO		74	8	1	Yes
6509	>Failure: Feeder VT (>FAIL:FEEDER VT)	Measurem.Superv	SP	On Off	*		*	LED	BI		BO		74	9	1	Yes
6510	>Failure: Busbar VT (>FAIL: BUS VT)	Measurem.Superv	SP	On Off	*		*	LED	BI		BO		74	10	1	Yes
6513	>BLOCK 59-1 overvoltage protection (>BLOCK 59-1)	27/59 O/U Volt.	SP	*	*		*	LED	BI		BO		74	13	1	Yes
6530	27 Undervoltage protection switched OFF (27 OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		74	30	1	Yes
6531	27 Undervoltage protection is BLOCKED (27 BLOCKED)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		74	31	1	Yes
6532	27 Undervoltage protection is ACTIVE (27 ACTIVE)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		74	32	1	Yes
6533	27-1 Undervoltage picked up (27-1 picked up)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		74	33	2	Yes
6534	27-1 Undervoltage PICKUP w/curr. superv (27-1 PU CS)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		74	34	2	Yes
6537	27-2 Undervoltage picked up (27-2 picked up)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		74	37	2	Yes
6538	27-2 Undervoltage PICKUP w/curr. superv (27-2 PU CS)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		74	38	2	Yes
6539	27-1 Undervoltage TRIP (27-1 TRIP)	27/59 O/U Volt.	OUT	*	on		m	LED			BO		74	39	2	Yes
6540	27-2 Undervoltage TRIP (27-2 TRIP)	27/59 O/U Volt.	OUT	*	on		*	LED			BO		74	40	2	Yes
6565	59-Overvoltage protection switched OFF (59 OFF)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		74	65	1	Yes
6566	59-Overvoltage protection is BLOCKED (59 BLOCKED)	27/59 O/U Volt.	OUT	On Off	On Off		*	LED			BO		74	66	1	Yes
6567	59-Overvoltage protection is ACTIVE (59 ACTIVE)	27/59 O/U Volt.	OUT	On Off	*		*	LED			BO		74	67	1	Yes
6568	59 picked up (59-1 picked up)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO		74	68	2	Yes
6570	59 TRIP (59-1 TRIP)	27/59 O/U Volt.	OUT	*	on		m	LED			BO		74	70	2	Yes
6571	59-2 Overvoltage V>> picked up (59-2 picked up)	27/59 O/U Volt.	OUT	*	On Off		*	LED			BO					
6573	59-2 Overvoltage V>> TRIP (59-2 TRIP)	27/59 O/U Volt.	OUT	*	on		*	LED			BO					
6801	>BLOCK Startup Supervision (>BLK START-SUP)	48/66 Motor	SP	*	*		*	LED	BI		BO					
6805	>Rotor locked (>Rotor locked)	48/66 Motor	SP	*	*		*	LED	BI		BO					
6811	Startup supervision OFF (START-SUP OFF)	48/66 Motor	OUT	On Off	*		*	LED			BO		169	51	1	Yes
6812	Startup supervision is BLOCKED (START-SUP BLK)	48/66 Motor	OUT	On Off	On Off		*	LED			BO		169	52	1	Yes
6813	Startup supervision is ACTIVE (START-SUP ACT)	48/66 Motor	OUT	On Off	*		*	LED			BO		169	53	1	Yes
6821	Startup supervision TRIP (START-SUP TRIP)	48/66 Motor	OUT	*	on		m	LED			BO		169	54	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
6822	Rotor locked (Rotor locked)	48/66 Motor	OUT	*	on		*	LED			BO		169	55	2	Yes
6823	Startup supervision Pickup (START-SUP pu)	48/66 Motor	OUT	On Off	*		*	LED			BO		169	56	1	Yes
6851	>BLOCK 74TC (>BLOCK 74TC)	74TC TripCirc.	SP	*	*		*	LED	BI		BO					
6852	>74TC Trip circuit superv.: trip relay (>74TC trip rel.)	74TC TripCirc.	SP	On Off	*		*	LED	BI		BO		170	51	1	Yes
6853	>74TC Trip circuit superv.: bkr relay (>74TC brk rel.)	74TC TripCirc.	SP	On Off	*		*	LED	BI		BO		170	52	1	Yes
6861	74TC Trip circuit supervision OFF (74TC OFF)	74TC TripCirc.	OUT	On Off	*		*	LED			BO		170	53	1	Yes
6862	74TC Trip circuit supervision is BLOCKED (74TC BLOCKED)	74TC TripCirc.	OUT	On Off	On Off		*	LED			BO		153	16	1	Yes
6863	74TC Trip circuit supervision is ACTIVE (74TC ACTIVE)	74TC TripCirc.	OUT	On Off	*		*	LED			BO		153	17	1	Yes
6864	74TC blocked. Bin. input is not set (74TC ProgFail)	74TC TripCirc.	OUT	On Off	*		*	LED			BO		170	54	1	Yes
6865	74TC Failure Trip Circuit (74TC Trip cir.)	74TC TripCirc.	OUT	On Off	*		*	LED			BO		170	55	1	Yes
6903	>block interm. E/F prot. (>IEF block)	Intermit. EF	SP	*	*		*	LED	BI		BO		152	1	1	Yes
6921	Interm. E/F prot. is switched off (IEF OFF)	Intermit. EF	OUT	On Off	*		*	LED			BO		152	10	1	Yes
6922	Interm. E/F prot. is blocked (IEF blocked)	Intermit. EF	OUT	On Off	On Off		*	LED			BO		152	11	1	Yes
6923	Interm. E/F prot. is active (IEF en-abled)	Intermit. EF	OUT	On Off	*		*	LED			BO		152	12	1	Yes
6924	Interm. E/F detection stage Iie> (IIE Fault det)	Intermit. EF	OUT	*	*		*	LED			BO					
6925	Interm. E/F stab detection (IIE stab.Flt)	Intermit. EF	OUT	*	*		*	LED			BO					
6926	Interm.E/F det.stage Iie> f.Flt. ev.Prot (IIE Flt.det FE)	Intermit. EF	OUT	*	on		*						152	13	2	No
6927	Interm. E/F detected (Inter-mitt.EF)	Intermit. EF	OUT	*	On Off		*	LED			BO		152	14	2	Yes
6928	Counter of det. times elapsed (IEF Tsum exp.)	Intermit. EF	OUT	*	on		*	LED			BO		152	15	2	No
6929	Interm. E/F: reset time running (IEF Tres run.)	Intermit. EF	OUT	*	On Off		*	LED			BO		152	16	2	Yes
6930	Interm. E/F: trip (IEF Trip)	Intermit. EF	OUT	*	on		*	LED			BO		152	17	2	No
6931	Max RMS current value of fault = (Iie/In=)	Intermit. EF	VI		On Off		*						152	18	4	No
6932	No. of detections by stage Iie>= (Nos.IIE=)	Intermit. EF	VI		On Off		*						152	19	4	No
7551	50-1 InRush picked up (50-1 In-RushPU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	80	2	Yes
7552	50N-1 InRush picked up (50N-1 InRushPU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	81	2	Yes
7553	51 InRush picked up (51 InRush-PU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	82	2	Yes
7554	51N InRush picked up (51N In-RushPU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	83	2	Yes
7556	InRush OFF (InRush OFF)	50/51 Overcur.	OUT	On Off	*		*	LED			BO		60	92	1	Yes
7557	InRush BLOCKED (InRush BLK)	50/51 Overcur.	OUT	On Off	On Off		*	LED			BO		60	93	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
7558	InRush Ground detected (InRush Gnd Det)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	94	2	Yes
7559	67-1 InRush picked up (67-1 In-RushPU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	84	2	Yes
7560	67N-1 InRush picked up (67N-1 InRushPU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	85	2	Yes
7561	67-TOC InRush picked up (67-TOC InRushPU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	86	2	Yes
7562	67N-TOC InRush picked up (67N-TOCInRushPU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	87	2	Yes
7563	>BLOCK InRush (>BLOCK InRush)	50/51 Overcur.	SP	*	*		*	LED	BI		BO					
7564	Ground InRush picked up (Gnd InRush PU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	88	2	Yes
7565	Phase A InRush picked up (Ia InRush PU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	89	2	Yes
7566	Phase B InRush picked up (Ib InRush PU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	90	2	Yes
7567	Phase C InRush picked up (Ic InRush PU)	50/51 Overcur.	OUT	*	On Off		*	LED			BO		60	91	2	Yes
14101	Fail: RTD (broken wire/shorted) (Fail: RTD)	RTD-Box	OUT	On Off	*		*	LED			BO					
14111	Fail: RTD 1 (broken wire/shorted) (Fail: RTD 1)	RTD-Box	OUT	On Off	*		*	LED			BO					
14112	RTD 1 Temperature stage 1 picked up (RTD 1 St.1 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14113	RTD 1 Temperature stage 2 picked up (RTD 1 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14121	Fail: RTD 2 (broken wire/shorted) (Fail: RTD 2)	RTD-Box	OUT	On Off	*		*	LED			BO					
14122	RTD 2 Temperature stage 1 picked up (RTD 2 St.1 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14123	RTD 2 Temperature stage 2 picked up (RTD 2 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14131	Fail: RTD 3 (broken wire/shorted) (Fail: RTD 3)	RTD-Box	OUT	On Off	*		*	LED			BO					
14132	RTD 3 Temperature stage 1 picked up (RTD 3 St.1 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14133	RTD 3 Temperature stage 2 picked up (RTD 3 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14141	Fail: RTD 4 (broken wire/shorted) (Fail: RTD 4)	RTD-Box	OUT	On Off	*		*	LED			BO					
14142	RTD 4 Temperature stage 1 picked up (RTD 4 St.1 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14143	RTD 4 Temperature stage 2 picked up (RTD 4 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14151	Fail: RTD 5 (broken wire/shorted) (Fail: RTD 5)	RTD-Box	OUT	On Off	*		*	LED			BO					
14152	RTD 5 Temperature stage 1 picked up (RTD 5 St.1 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14153	RTD 5 Temperature stage 2 picked up (RTD 5 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14161	Fail: RTD 6 (broken wire/shorted) (Fail: RTD 6)	RTD-Box	OUT	On Off	*		*	LED			BO					
14162	RTD 6 Temperature stage 1 picked up (RTD 6 St.1 p.up)	RTD-Box	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
14163	RTD 6 Temperature stage 2 picked up (RTD 6 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14171	Fail: RTD 7 (broken wire/shorted) (Fail: RTD 7)	RTD-Box	OUT	On Off	*		*	LED			BO					
14172	RTD 7 Temperature stage 1 picked up (RTD 7 St.1 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14173	RTD 7 Temperature stage 2 picked up (RTD 7 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14181	Fail: RTD 8 (broken wire/shorted) (Fail: RTD 8)	RTD-Box	OUT	On Off	*		*	LED			BO					
14182	RTD 8 Temperature stage 1 picked up (RTD 8 St.1 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14183	RTD 8 Temperature stage 2 picked up (RTD 8 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14191	Fail: RTD 9 (broken wire/shorted) (Fail: RTD 9)	RTD-Box	OUT	On Off	*		*	LED			BO					
14192	RTD 9 Temperature stage 1 picked up (RTD 9 St.1 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14193	RTD 9 Temperature stage 2 picked up (RTD 9 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14201	Fail: RTD10 (broken wire/shorted) (Fail: RTD10)	RTD-Box	OUT	On Off	*		*	LED			BO					
14202	RTD10 Temperature stage 1 picked up (RTD10 St.1 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14203	RTD10 Temperature stage 2 picked up (RTD10 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14211	Fail: RTD11 (broken wire/shorted) (Fail: RTD11)	RTD-Box	OUT	On Off	*		*	LED			BO					
14212	RTD11 Temperature stage 1 picked up (RTD11 St.1 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14213	RTD11 Temperature stage 2 picked up (RTD11 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14221	Fail: RTD12 (broken wire/shorted) (Fail: RTD12)	RTD-Box	OUT	On Off	*		*	LED			BO					
14222	RTD12 Temperature stage 1 picked up (RTD12 St.1 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
14223	RTD12 Temperature stage 2 picked up (RTD12 St.2 p.up)	RTD-Box	OUT	On Off	*		*	LED			BO					
16001	Sum Current Exponentiation Ph A to Ir^x (ΣI^x A=)	Statistics	VI													
16002	Sum Current Exponentiation Ph B to Ir^x (ΣI^x B=)	Statistics	VI													
16003	Sum Current Exponentiation Ph C to Ir^x (ΣI^x C=)	Statistics	VI													
16005	Threshold Sum Curr. Exponent. exceeded (Threshold ΣI^x>)	SetPoint(Stat)	OUT	On Off	*		*	LED			BO					
16006	Residual Endurance Phase A (Resid.Endu. A=)	Statistics	VI													
16007	Residual Endurance Phase B (Resid.Endu. B=)	Statistics	VI													
16008	Residual Endurance Phase C (Resid.Endu. C=)	Statistics	VI													
16010	Dropped below Threshold CB Res.Endurance (Thresh.R.Endu.<)	SetPoint(Stat)	OUT	On Off	*		*	LED			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
16011	Number of mechanical Trips Phase A (mechan.TRIP A=)	Statistics	VI													
16012	Number of mechanical Trips Phase B (mechan.TRIP B=)	Statistics	VI													
16013	Number of mechanical Trips Phase C (mechan.TRIP C=)	Statistics	VI													
16014	Sum Squared Current Integral Phase A (ΣI^2t A=)	Statistics	VI													
16015	Sum Squared Current Integral Phase B (ΣI^2t B=)	Statistics	VI													
16016	Sum Squared Current Integral Phase C (ΣI^2t C=)	Statistics	VI													
16018	Threshold Sum Squa. Curr. Int. exceeded (Thresh. ΣI^2t>)	SetPoint(Stat)	OUT	On Off	*		*	LED			BO					
16019	>52 Breaker Wear Start Criteria (>52 Wear start)	P.System Data 2	SP	On Off	*		*	LED	BI		BO					
16020	52 Wear blocked by Time Setting Failure (52 WearSet.fail)	P.System Data 2	OUT	On Off	*		*	LED			BO					
16027	52 Breaker Wear Logic blk Ir-CB>=Isc-CB (52WL.blk I PErr)	P.System Data 2	OUT	On Off	*		*	LED			BO					
16028	52 Breaker W.Log.blk SwCyc.Isc>=SwCyc.Ir (52WL.blk n PErr)	P.System Data 2	OUT	On Off	*		*	LED			BO					
16029	Sens.gnd.flt. 51Ns BLOCKED Setting Error (51Ns BLK PaErr)	Sens. Gnd Fault	OUT	On Off	*		*	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	*												

A.10 Group Alarms

No.	Description	Function No.[1)]	Description[1)]
140	Error Sum Alarm	144 145 146 147 177 178 183 184 185 186 187 188 189 191 193	Error 5V Error 0V Error -5V Error PwrSupply Fail Battery I/O-Board error Error Board 1 Error Board 2 Error Board 3 Error Board 4 Error Board 5 Error Board 6 Error Board 7 Error Offset Alarm NO calibr
160	Alarm Sum Event	162 163 167 175 176 264 267	Failure Σ I Fail I balance Fail V balance Fail Ph. Seq. I Fail Ph. Seq. V Fail: RTD-Box 1 Fail: RTD-Box 2
161	Fail I Superv.	162 163	Failure Σ I Fail I balance
171	Fail Ph. Seq.	175 176	Fail Ph. Seq. I Fail Ph. Seq. V

1) The allocation of the individual alarms to the group alarms indicated here applies starting from firmware version V4.62.

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
-	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
-	Pressure< (Press<)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
-	Temp> (Temp>)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
-	37-1 under current (37-1)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
-	|Power Factor|< (|PF|<)	Set Points(MV)	-	-	-	-	-	CFC	CD	DD
-	Number of TRIPs= (#of TRIPs=)	Statistics	-	-	-	-	-	CFC	CD	DD
-	Operating hours greater than (OpHour>)	SetPoint(Stat)	-	-	-	-	-	CFC	CD	DD
170.2050	V1 = (V1 =)	SYNC function 1	130	1	No	9	1	CFC	CD	DD
170.2050	V1 = (V1 =)	SYNC function 2	130	2	No	9	1	CFC	CD	DD
170.2050	V1 = (V1 =)	SYNC function 3	130	3	No	9	1	CFC	CD	DD
170.2050	V1 = (V1 =)	SYNC function 4	130	4	No	9	1	CFC	CD	DD
170.2051	f1 = (f1 =)	SYNC function 1	130	1	No	9	4	CFC	CD	DD
170.2051	f1 = (f1 =)	SYNC function 2	130	2	No	9	4	CFC	CD	DD
170.2051	f1 = (f1 =)	SYNC function 3	130	3	No	9	4	CFC	CD	DD
170.2051	f1 = (f1 =)	SYNC function 4	130	4	No	9	4	CFC	CD	DD
170.2052	V2 = (V2 =)	SYNC function 1	130	1	No	9	3	CFC	CD	DD
170.2052	V2 = (V2 =)	SYNC function 2	130	2	No	9	3	CFC	CD	DD
170.2052	V2 = (V2 =)	SYNC function 3	130	3	No	9	3	CFC	CD	DD
170.2052	V2 = (V2 =)	SYNC function 4	130	4	No	9	3	CFC	CD	DD
170.2053	f2 = (f2 =)	SYNC function 1	130	1	No	9	7	CFC	CD	DD
170.2053	f2 = (f2 =)	SYNC function 2	130	2	No	9	7	CFC	CD	DD
170.2053	f2 = (f2 =)	SYNC function 3	130	3	No	9	7	CFC	CD	DD
170.2053	f2 = (f2 =)	SYNC function 4	130	4	No	9	7	CFC	CD	DD
170.2054	dV = (dV =)	SYNC function 1	130	1	No	9	2	CFC	CD	DD
170.2054	dV = (dV =)	SYNC function 2	130	2	No	9	2	CFC	CD	DD
170.2054	dV = (dV =)	SYNC function 3	130	3	No	9	2	CFC	CD	DD
170.2054	dV = (dV =)	SYNC function 4	130	4	No	9	2	CFC	CD	DD
170.2055	df = (df =)	SYNC function 1	130	1	No	9	5	CFC	CD	DD
170.2055	df = (df =)	SYNC function 2	130	2	No	9	5	CFC	CD	DD
170.2055	df = (df =)	SYNC function 3	130	3	No	9	5	CFC	CD	DD
170.2055	df = (df =)	SYNC function 4	130	4	No	9	5	CFC	CD	DD
170.2056	dalpha = (dα =)	SYNC function 1	130	1	No	9	6	CFC	CD	DD
170.2056	dalpha = (dα =)	SYNC function 2	130	2	No	9	6	CFC	CD	DD
170.2056	dalpha = (dα =)	SYNC function 3	130	3	No	9	6	CFC	CD	DD
170.2056	dalpha = (dα =)	SYNC function 4	130	4	No	9	6	CFC	CD	DD
601	Ia (Ia =)	Measurement	134	137	No	9	1	CFC	CD	DD
602	Ib (Ib =)	Measurement	160	145	Yes	3	1	CFC	CD	DD
			134	137	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
603	Ic (Ic =)	Measurement	134	137	No	9	3	CFC	CD	DD
604	In (In =)	Measurement	134	137	No	9	4	CFC	CD	DD
605	I1 (positive sequence) (I1 =)	Measurement	-	-	-	-	-	CFC	CD	DD
606	I2 (negative sequence) (I2 =)	Measurement	-	-	-	-	-	CFC	CD	DD
621	Va (Va =)	Measurement	134	137	No	9	5	CFC	CD	DD
622	Vb (Vb =)	Measurement	134	137	No	9	6	CFC	CD	DD
623	Vc (Vc =)	Measurement	134	137	No	9	7	CFC	CD	DD
624	Va-b (Va-b=)	Measurement	160	145	Yes	3	2	CFC	CD	DD
			134	137	No	9	8			
625	Vb-c (Vb-c=)	Measurement	134	137	No	9	9	CFC	CD	DD
626	Vc-a (Vc-a=)	Measurement	134	137	No	9	10	CFC	CD	DD
627	VN (VN =)	Measurement	134	118	No	9	1	CFC	CD	DD
629	V1 (positive sequence) (V1 =)	Measurement	-	-	-	-	-	CFC	CD	DD
630	V2 (negative sequence) (V2 =)	Measurement	-	-	-	-	-	CFC	CD	DD
632	Vsync (synchronism) (Vsync =)	Measurement	-	-	-	-	-	CFC	CD	DD
641	P (active power) (P =)	Measurement	134	137	No	9	11	CFC	CD	DD
642	Q (reactive power) (Q =)	Measurement	134	137	No	9	12	CFC	CD	DD
644	Frequency (Freq=)	Measurement	134	137	No	9	13	CFC	CD	DD
645	S (apparent power) (S =)	Measurement	-	-	-	-	-	CFC	CD	DD
661	Threshold of Restart Inhibit (Θ REST. =)	Measurement	-	-	-	-	-	CFC	CD	DD
701	Resistive ground current in isol systems (INs Real)	Measurement	134	137	No	9	15	CFC	CD	DD
702	Reactive ground current in isol systems (INs Reac)	Measurement	134	137	No	9	16	CFC	CD	DD
805	Temperature of Rotor (Θ Rotor)	Measurement	-	-	-	-	-	CFC	CD	DD
807	Thermal Overload (Θ/Θtrip)	Measurement	-	-	-	-	-	CFC	CD	DD
809	Time untill release of reclose-blocking (T re-close=)	Measurement	-	-	-	-	-	CFC	CD	DD
830	INs Senstive Ground Fault Current (INs =)	Measurement	134	118	No	9	3	CFC	CD	DD
831	3Io (zero sequence) (3Io =)	Measurement	-	-	-	-	-	CFC	CD	DD
832	Vo (zero sequence) (Vo =)	Measurement	134	118	No	9	2	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
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 Minimum (QdMin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
848	Reactive Power Maximum (QdMax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
849	Apparent Power Minimum (SdMin=)	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
850	Apparent Power Maximum (SdMax=)	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
872	V neutral Min (Vn Min =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
873	V neutral Max (Vn Max =)	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
876	Active Power Minimum (Pmin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
877	Active Power Maximum (Pmax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
878	Reactive Power Minimum (Qmin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
879	Reactive Power Maximum (Qmax=)	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
884	Power Factor Maximum (PF Max=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
885	Power Factor Minimum (PF Min=)	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
901	Power Factor (PF =)	Measurement	134	137	No	9	14	CFC	CD	DD
924	Wp Forward (WpForward)	Energy	133	51	No	205	-	CFC	CD	DD
925	Wq Forward (WqForward)	Energy	133	52	No	205	-	CFC	CD	DD
928	Wp Reverse (WpReverse)	Energy	133	53	No	205	-	CFC	CD	DD
929	Wq Reverse (WqReverse)	Energy	133	54	No	205	-	CFC	CD	DD
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
991	Pressure (Press =)	Measurement	-	-	-	-	-	CFC	CD	DD
992	Temperature (Temp =)	Measurement	-	-	-	-	-	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
996	Transducer 1 (Td1=) (not for 7SJ64)	Measurement	134	137	No	9	0	CFC	CD	DD
997	Transducer 2 (Td2=) (not for 7SJ64)	Measurement	134	136	No	9	1	CFC	CD	DD
1058	Overload Meter Max (Θ/ΘTrpMax=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1059	Overload Meter Min (Θ/ΘTrpMin=)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
1068	Temperature of RTD 1 (Θ RTD 1 =)	Measurement	134	146	No	9	1	CFC	CD	DD
1069	Temperature of RTD 2 (Θ RTD 2 =)	Measurement	134	146	No	9	2	CFC	CD	DD
1070	Temperature of RTD 3 (Θ RTD 3 =)	Measurement	134	146	No	9	3	CFC	CD	DD
1071	Temperature of RTD 4 (Θ RTD 4 =)	Measurement	134	146	No	9	4	CFC	CD	DD
1072	Temperature of RTD 5 (Θ RTD 5 =)	Measurement	134	146	No	9	5	CFC	CD	DD
1073	Temperature of RTD 6 (Θ RTD 6 =)	Measurement	134	146	No	9	6	CFC	CD	DD
1074	Temperature of RTD 7 (Θ RTD 7 =)	Measurement	134	146	No	9	7	CFC	CD	DD
1075	Temperature of RTD 8 (Θ RTD 8 =)	Measurement	134	146	No	9	8	CFC	CD	DD
1076	Temperature of RTD 9 (Θ RTD 9 =)	Measurement	134	146	No	9	9	CFC	CD	DD
1077	Temperature of RTD10 (Θ RTD10 =)	Measurement	134	146	No	9	10	CFC	CD	DD
1078	Temperature of RTD11 (Θ RTD11 =)	Measurement	134	146	No	9	11	CFC	CD	DD
1079	Temperature of RTD12 (Θ RTD12 =)	Measurement	134	146	No	9	12	CFC	CD	DD
16004	Threshold Sum Current Exponentiation (ΣI^x>)	SetPoint(Stat)	-	-	-	-	-	CFC	CD	DD
16009	Lower Threshold of CB Residual Endurance (Resid.Endu. <)	SetPoint(Stat)	-	-	-	-	-	CFC	CD	DD
16017	Threshold Sum Squared Current Integral (ΣI^2t>)	SetPoint(Stat)	-	-	-	-	-	CFC	CD	DD
30701	Pa (active power, phase A) (Pa =)	Measurement	-	-	-	-	-	CFC	CD	DD
30702	Pb (active power, phase B) (Pb =)	Measurement	-	-	-	-	-	CFC	CD	DD
30703	Pc (active power, phase C) (Pc =)	Measurement	-	-	-	-	-	CFC	CD	DD
30704	Qa (reactive power, phase A) (Qa =)	Measurement	-	-	-	-	-	CFC	CD	DD
30705	Qb (reactive power, phase B) (Qb =)	Measurement	-	-	-	-	-	CFC	CD	DD
30706	Qc (reactive power, phase C) (Qc =)	Measurement	-	-	-	-	-	CFC	CD	DD
30707	Power Factor, phase A (PFa =)	Measurement	-	-	-	-	-	CFC	CD	DD
30708	Power Factor, phase B (PFb =)	Measurement	-	-	-	-	-	CFC	CD	DD
30709	Power Factor, phase C (PFc =)	Measurement	-	-	-	-	-	CFC	CD	DD

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Literature

/1/ SIPROTEC System Manual; E50417-H1176-C151-A5

/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-A3

/5/ Additional Information on the Protection of Explosion-Protected Motors of Protection Type Increased Safety “e”; C53000–B1174–C157

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 thus not generate any further signal changes. The function prevents overloading of the system when a fault arises.
Combination devices	Combination devices are bay devices with protection functions and a control display.
Combination matrix	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-Technischen-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) according to IEC 61850 are data packets which are cyclic transferred event-controlled via the Ethernet communication system. They serve for direct information exchange among the relays. This mechanism implements cross-communication between bay units.

GPS Global Positioning System. Satellites with atomic clocks on board orbit the earth twice a day 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 submodules 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.

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 clean up 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 SAS	Modular substation automation system based on the substation controller → SICAM SC and the SICAM WinCC operator control and monitoring system.
SICAM SC	Substation Controller. Modularly substation control system, based on the SIMATIC M7 automation system.
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.

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