SIPROTEC

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

V4.6

Manual


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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.

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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**

CE

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 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-*

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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.

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**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`***

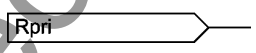
possible settings of text parameters, which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI®), are additionally written in italics. This also applies to header bars for selection menus.

„`Annunciations`“

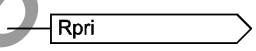
Designators for information, which may be output by the relay or required from other devices or from the switch gear, are marked in a monospace type style in quotation marks.

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

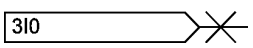
The following symbols are used in drawings:



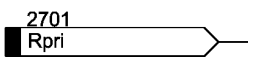
Device-internal logical input signal



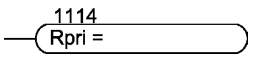
Device-internal logical output signal



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)

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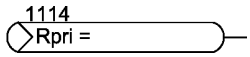
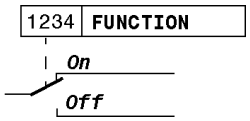
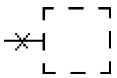



External binary output signal with number (device indication) used as input signal

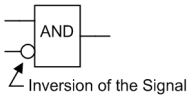



Example of a parameter switch designated **FUNCTION** with the address 1234 and the possible settings ON and OFF

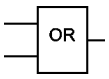
Besides these, graphical symbols are used according to IEC 60617-12 and IEC 60617-13 or symbols derived from these standards. Some of the most frequently used are listed below:



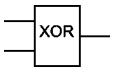
Input signal of an analog quantity



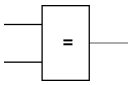

AND gate



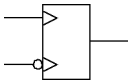

OR gate



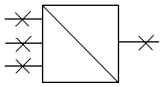

Exclusive–OR gate (antivalence): output is active, if only **one** of the inputs is active



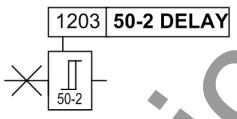

Equivalence: output is active, if **both** inputs are active or inactive at the same time



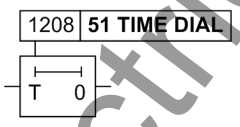
Dynamic inputs (edge–triggered) above with positive, below with negative edge



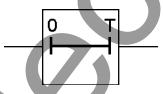
Formation of one analog output signal from a number of analog input signals



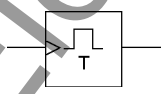

Limit stage with setting address and parameter designator (name)



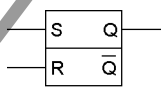

Timer (pickup delay T, example adjustable) with setting address and parameter designator (name)




Timer (dropout delay T, example non-adjustable)




Dynamic triggered pulse timer T (monoflop)




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

■

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# 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.


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## 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).

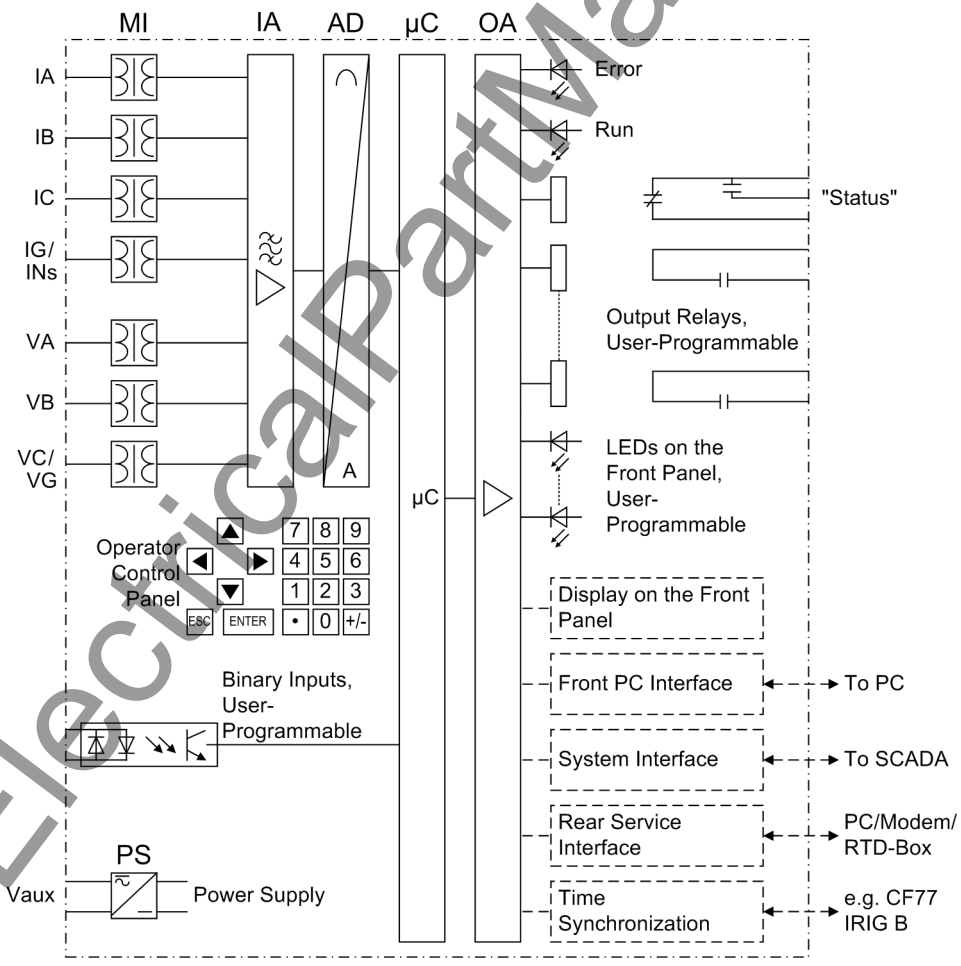


Figure 1-1 Hardware structure of the numerical multi-functional protection device 7SJ62 and 7SJ63

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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.

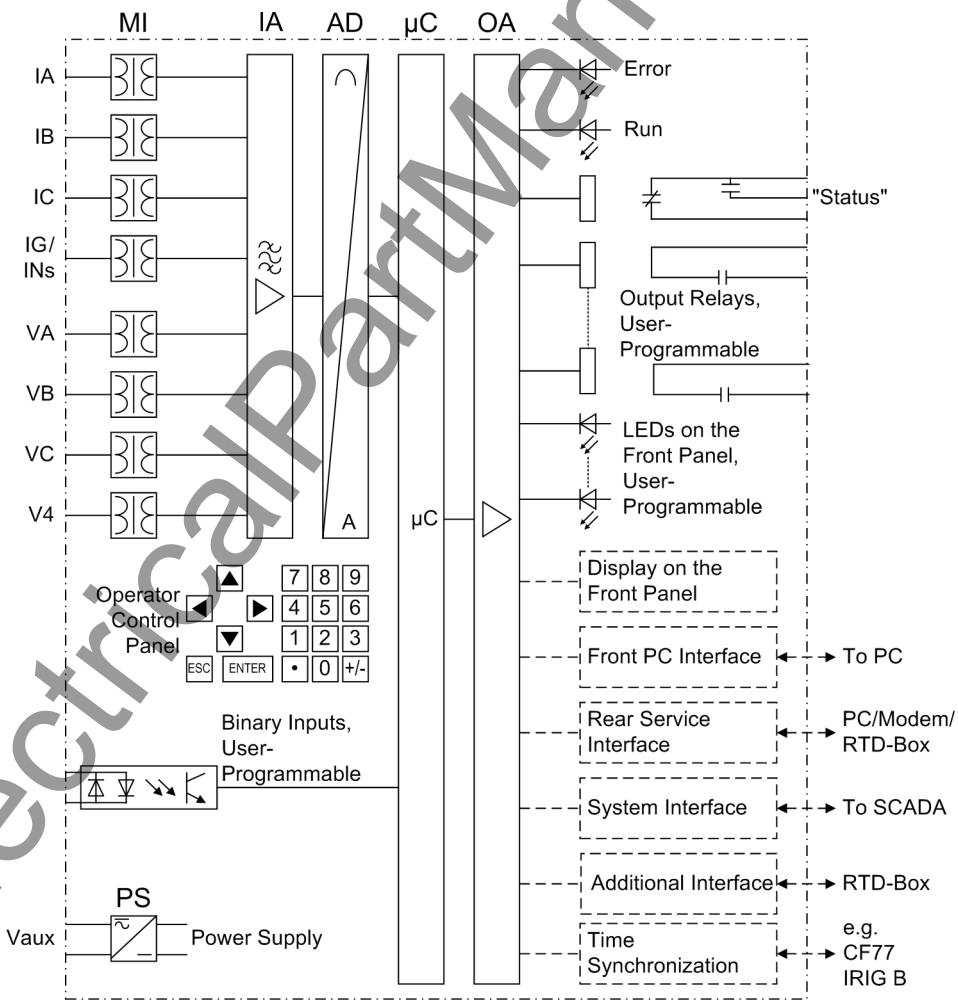


Figure 1-2 Hardware structure of the numerical multi-functional device 7SJ64

**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

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- 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.

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**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).

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## 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 con-

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trolled, 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 com-

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munication 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.

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## 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.

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**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.

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**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.

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**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 $\Delta V$, the phase angle difference $\Delta\varphi$ and the frequency difference $\Delta f$;
- 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.

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**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 ($\Sigma I$ procedure, $\Sigma I^x$ 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.

■

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# 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.


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# 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.

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**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***

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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 $\Sigma I^x$ **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<br>Enabled | Disabled | Setting Group Change Option |
| 104 | OSC. FAULT REC. | Disabled<br>Enabled | Disabled | Oscillographic Fault Records |
| 112 | Charac. Phase | Disabled<br>Definite Time<br>TOC IEC<br>TOC ANSI<br>User Defined PU<br>User def. Reset | Definite Time | 50/51 |
| 113 | Charac. Ground | Disabled<br>Definite Time<br>TOC IEC<br>TOC ANSI<br>User Defined PU<br>User def. Reset | Definite Time | 50N/51N |

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

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| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 170 | 50BF | Disabled<br>Enabled | Disabled | 50BF Breaker Failure Protection |
| 171 | 79 Auto Recl. | Disabled<br>Enabled | Disabled | 79 Auto-Reclose Function |
| 172 | 52 B.WEAR MONIT | Disabled<br>Ix-Method<br>2P-Method<br>I2t-Method | Disabled | 52 Breaker Wear Monitoring |
| 180 | Fault Locator | Disabled<br>Enabled | Disabled | Fault Locator |
| 182 | 74 Trip Ct Supv | Disabled<br>2 Binary Inputs<br>1 Binary Input | Disabled | 74TC Trip Circuit Supervision |
| 190 | RTD-BOX INPUT | Disabled<br>Port C | Disabled | External Temperature Input |
| 191 | RTD CONNECTION | 6 RTD simplex<br>6 RTD HDX<br>12 RTD HDX | 6 RTD simplex | Ext. Temperature Input Connection Type |
| - | FLEXIBLE FUNC. 1..20 | Flexible Function 01<br>Flexible Function 02<br>Flexible Function 03<br>Flexible Function 04<br>Flexible Function 05<br>Flexible Function 06<br>Flexible Function 07<br>Flexible Function 08<br>Flexible Function 09<br>Flexible Function 10<br>Flexible Function 11<br>Flexible Function 12<br>Flexible Function 13<br>Flexible Function 14<br>Flexible Function 15<br>Flexible Function 16<br>Flexible Function 17<br>Flexible Function 18<br>Flexible Function 19<br>Flexible Function 20 | Please select | Flexible Functions |

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## 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.

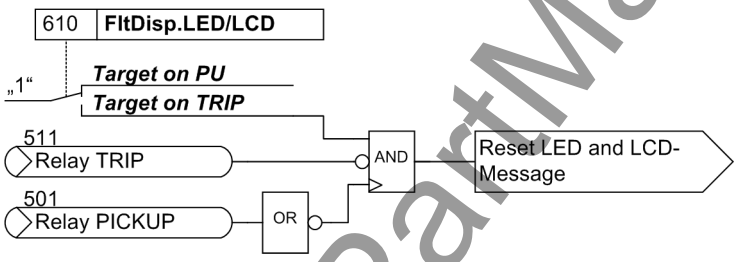


Figure 2-1 Creation of the reset command for the latched LED and LCD messages

**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.

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### 2.1.2.3 Settings

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

### 2.1.2.4 Information List

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| - | >Light on | SP | >Back Light on |
| - | Reset LED | IntSP | Reset LED |
| - | DataStop | IntSP | Stop data transmission |
| - | Test mode | IntSP | Test mode |
| - | Feeder gnd | IntSP | Feeder GROUNDED |
| - | Brk OPENED | IntSP | Breaker OPENED |
| - | HWTestMod | IntSP | Hardware Test Mode |
| - | SynchClock | IntSP_Ev | Clock Synchronization |
| - | 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 |

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| No. | Information | Type of Information | 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 |

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## 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 $I_{NS}$.

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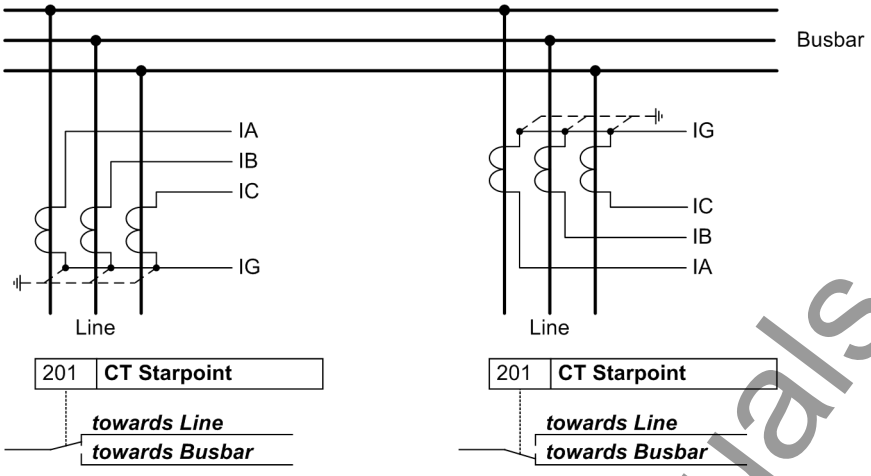


Figure 2-2 Polarity of current transformers

**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.

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**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.

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**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).

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### 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<br>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<br>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<br>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<br>Vab, Vbc, VGnd<br>Van,Vbn,Vcn,VGn<br>Van,Vbn,Vcn,VSy | Van, Vbn, Vcn | VT Connection, three-phase |
| 214 | Rated Frequency | | 50 Hz<br>60 Hz | 50 Hz | Rated Frequency |
| 215 | Distance Unit | | km<br>Miles | km | Distance measurement unit |
| 217 | Ignd-CT PRIM | | 1 .. 50000 A | 60 A | Ignd-CT rated primary current |
| 218 | Ignd-CT SEC | | 1A<br>5A | 1A | Ignd-CT rated secondary current |
| 235A | ATEX100 | | NO<br>YES | NO | Storage of th. Replicas w/o Power Supply |
| 240 | VT Connect. 1ph | | NO<br>Van<br>Vbn<br>Vcn<br>Vab<br>Vbc<br>Vca | NO | VT Connection, single-phase |
| 250A | 50/51 2-ph prot | | ON<br>OFF | OFF | 50, 51 Time Overcurrent with 2ph. prot. |

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| 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<br>Fahrenheit | Celsius | Unit of temperature measurement |
| 613A | Gnd O/Cprot. w. | | Ignd (measured)<br>3I0 (calcul.) | Ignd (measured) | Ground Overcurrent protection with |
| 614A | OP. QUANTITY 59 | | Vphph<br>V2 | Vphph | Opera. Quantity for 59 Overvolt. Prot. |
| 615A | OP. QUANTITY 27 | | V1<br>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 |

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### 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).

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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<br>Save w. TRIP<br>Start w. TRIP | Save w. Pickup | Waveform Capture |
| 402 | WAVEFORM DATA | Fault event<br>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 |

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## 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.

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### 2.1.5.3 Settings

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

### 2.1.5.4 Information List

| No. | Information | Type of Information | 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 |

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## 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, no 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.

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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:

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

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

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

where:

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

with

| | |
|---|---|
| $N_{CTR}$ | — Current transformer ratio |
| $N_{VTR}$ | — Voltage transformer ratio |

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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:

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

**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.

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### 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<br>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 |

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## 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) |

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## 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.

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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).

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

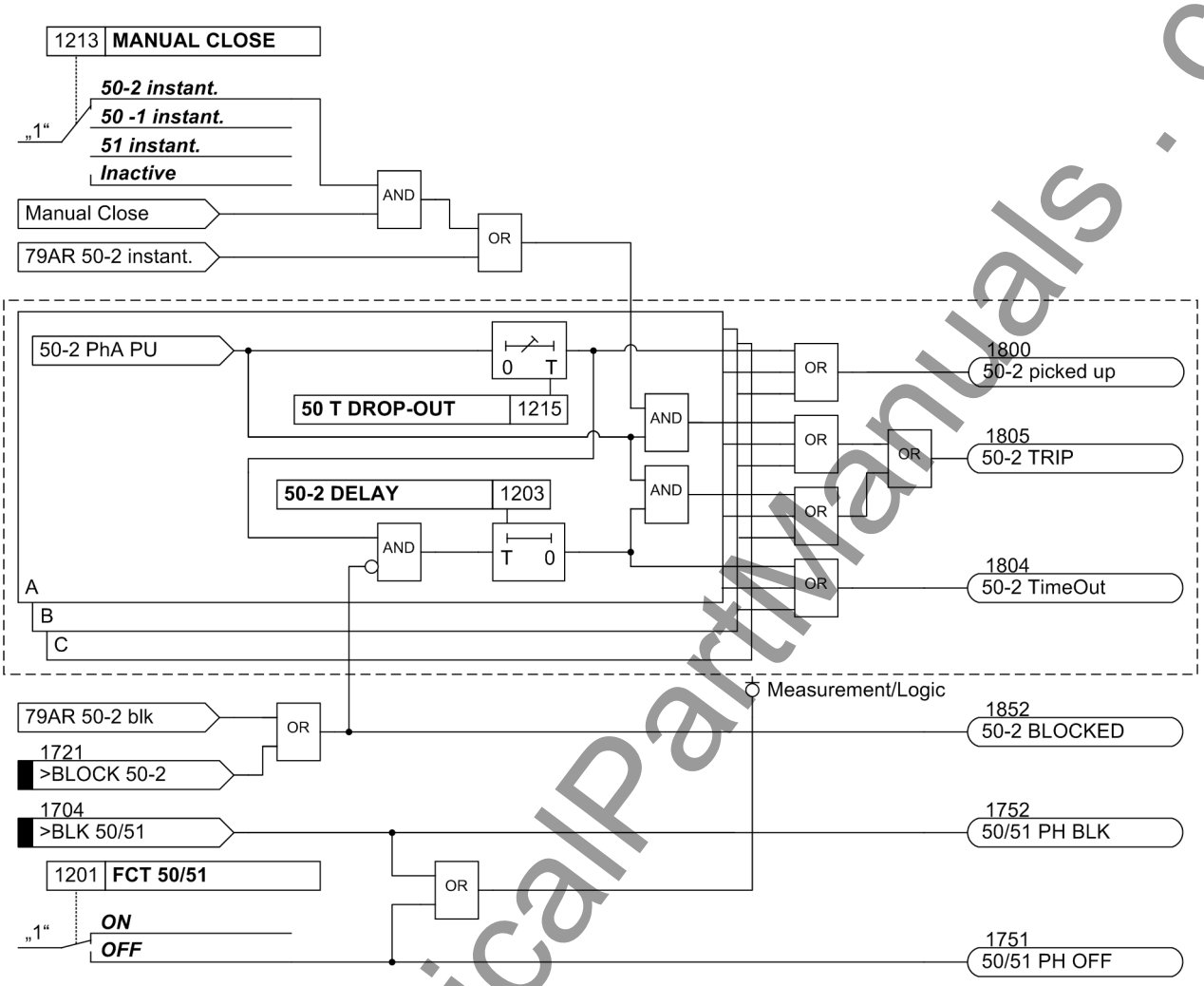


Figure 2-3 Logic diagram of the 50-2 high-current element for phases

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.

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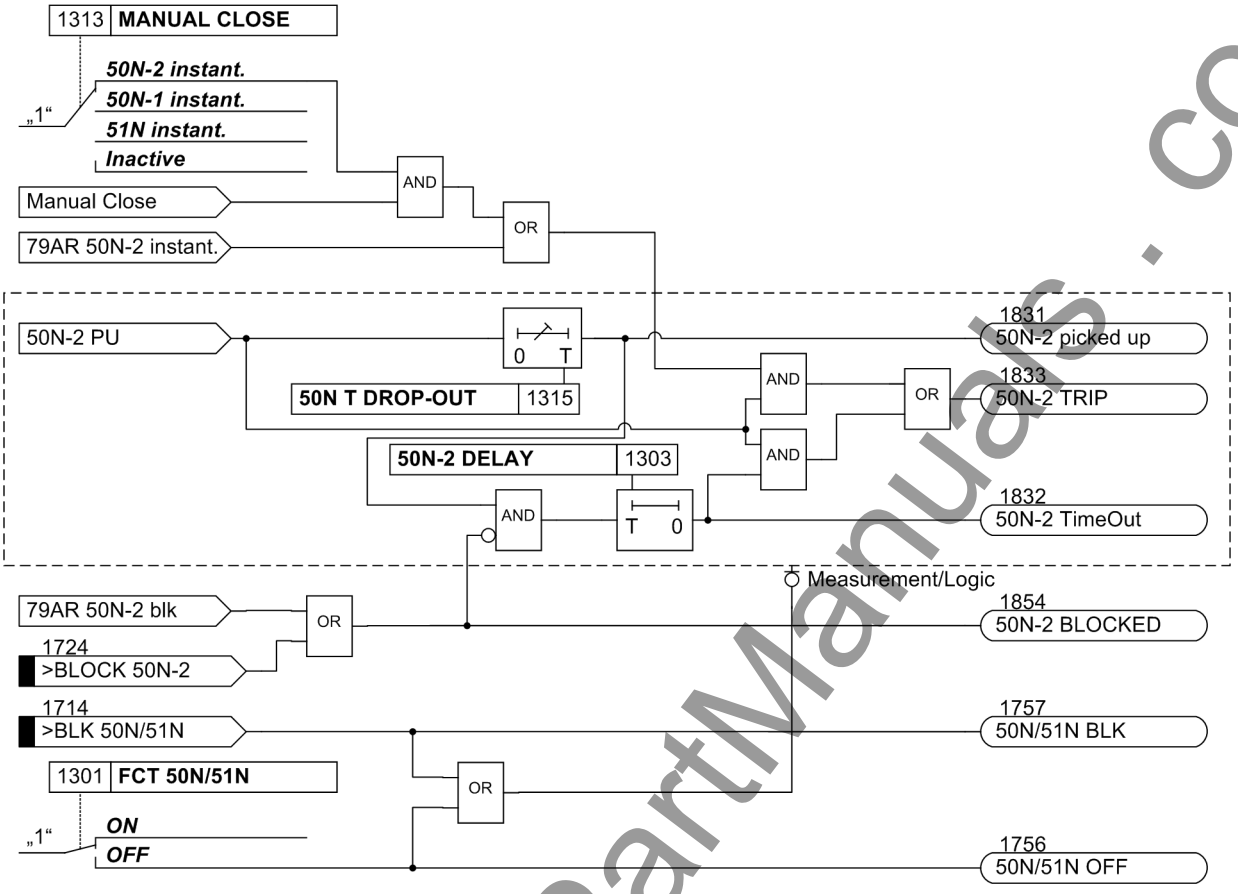


Figure 2-4 Logic diagram of the 50N-2 high-current element for ground

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.

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### 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).

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

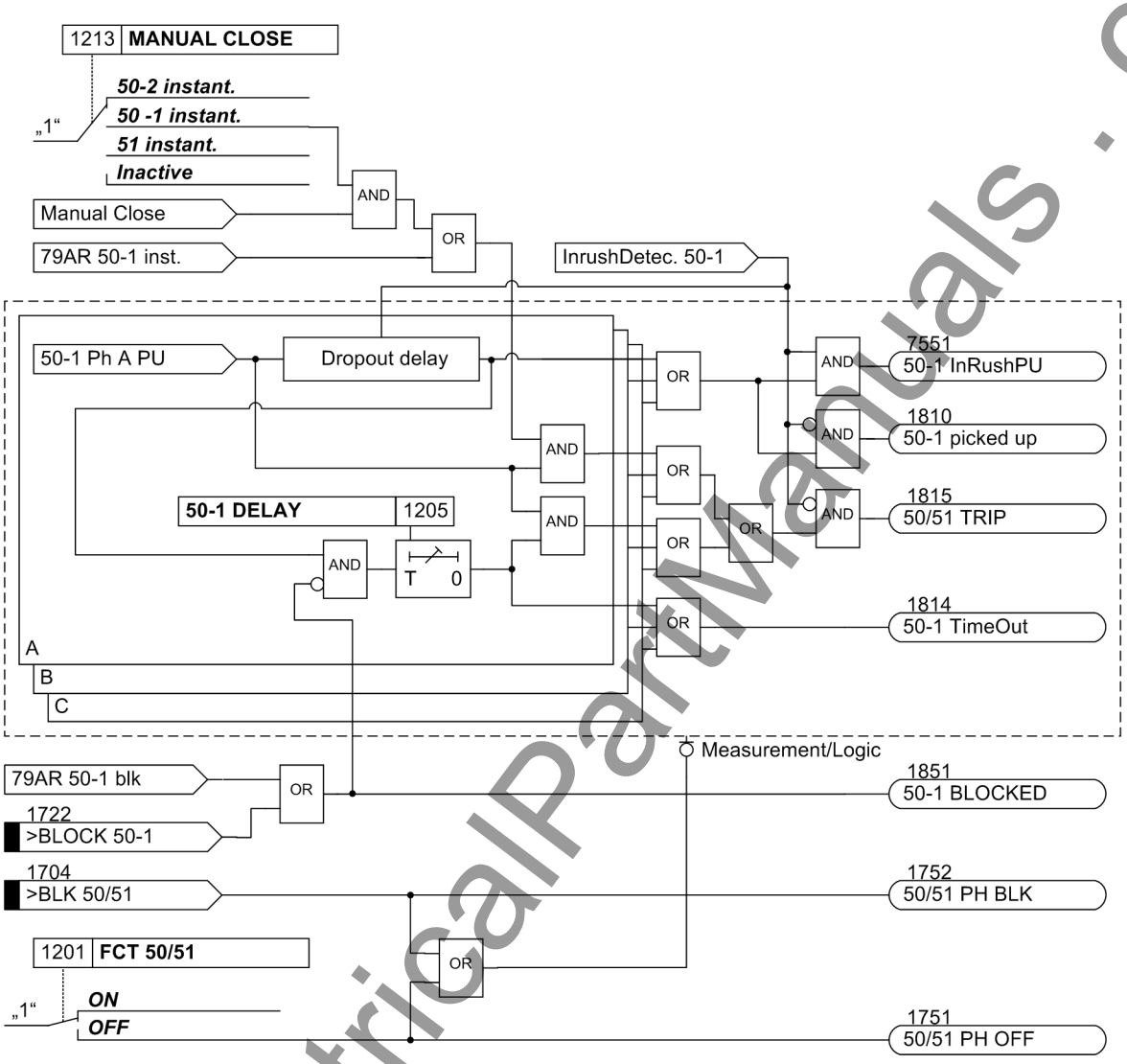


Figure 2-5 Logic diagram of the 50-1 current element for phases

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.

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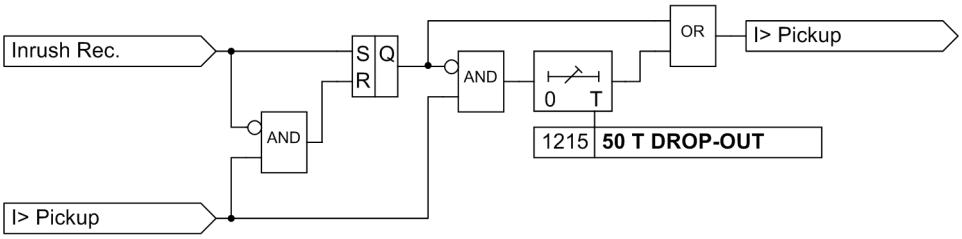


Figure 2-6 Logic of the dropout delay for 50-1 phase current element

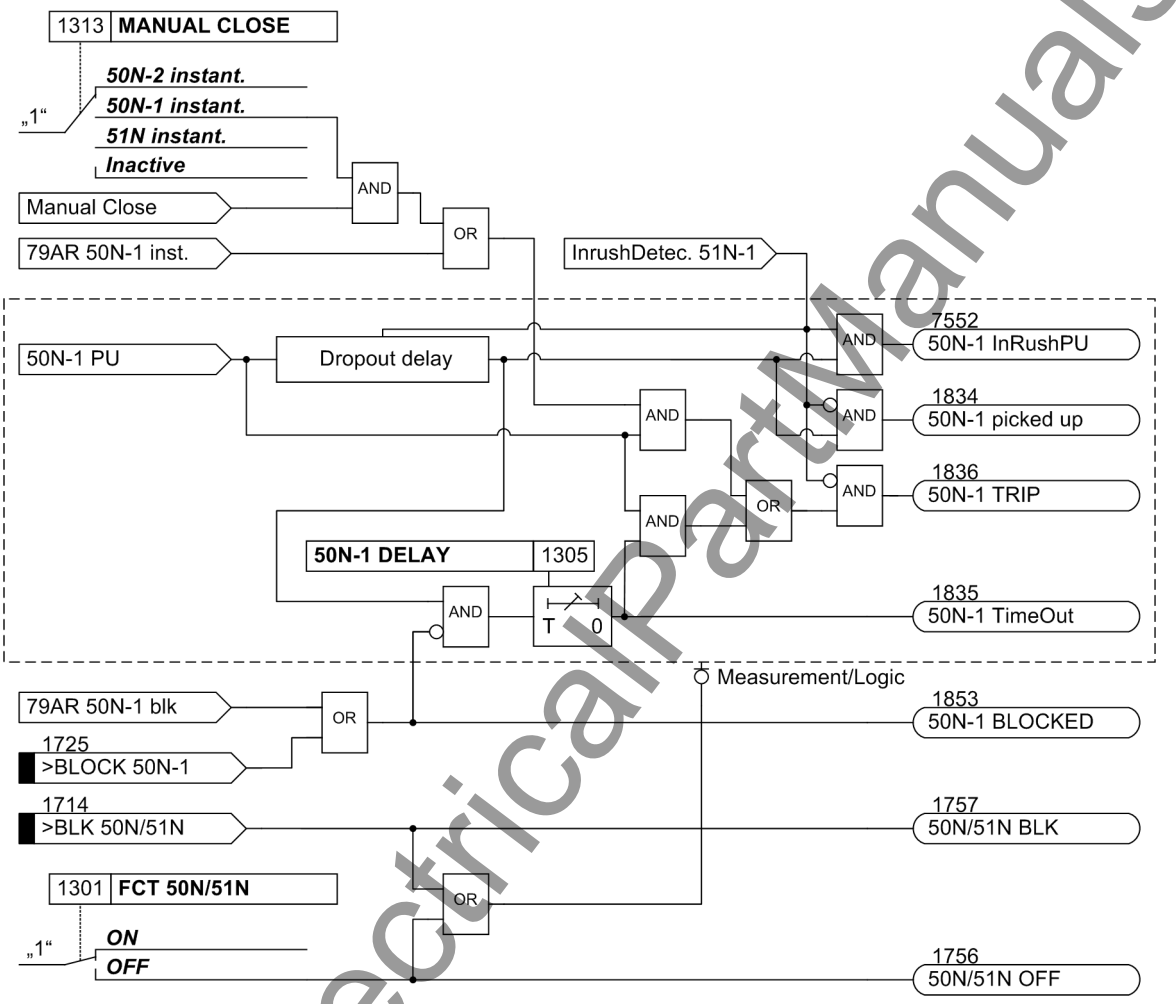


Figure 2-7 Logic diagram of the 50N-1 current element for ground

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.

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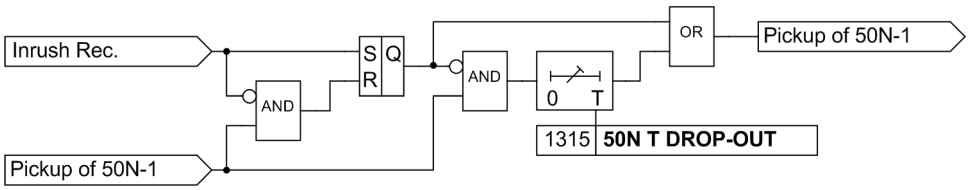


Figure 2-8 Logic of the dropout delay for 50N-1 ground current element

## 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.

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

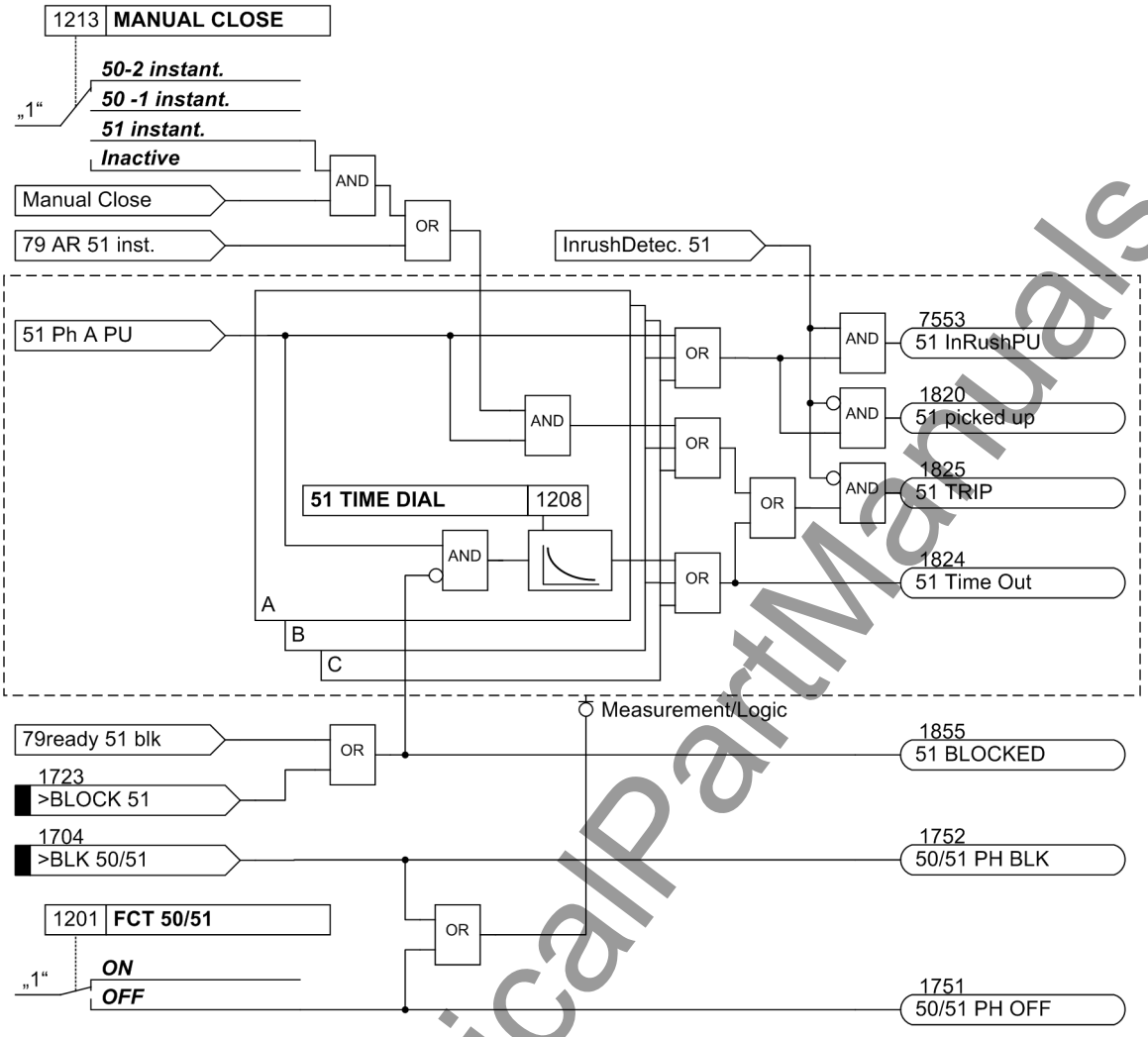


Figure 2-9 Logic diagram of the 51 current element for phases

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.

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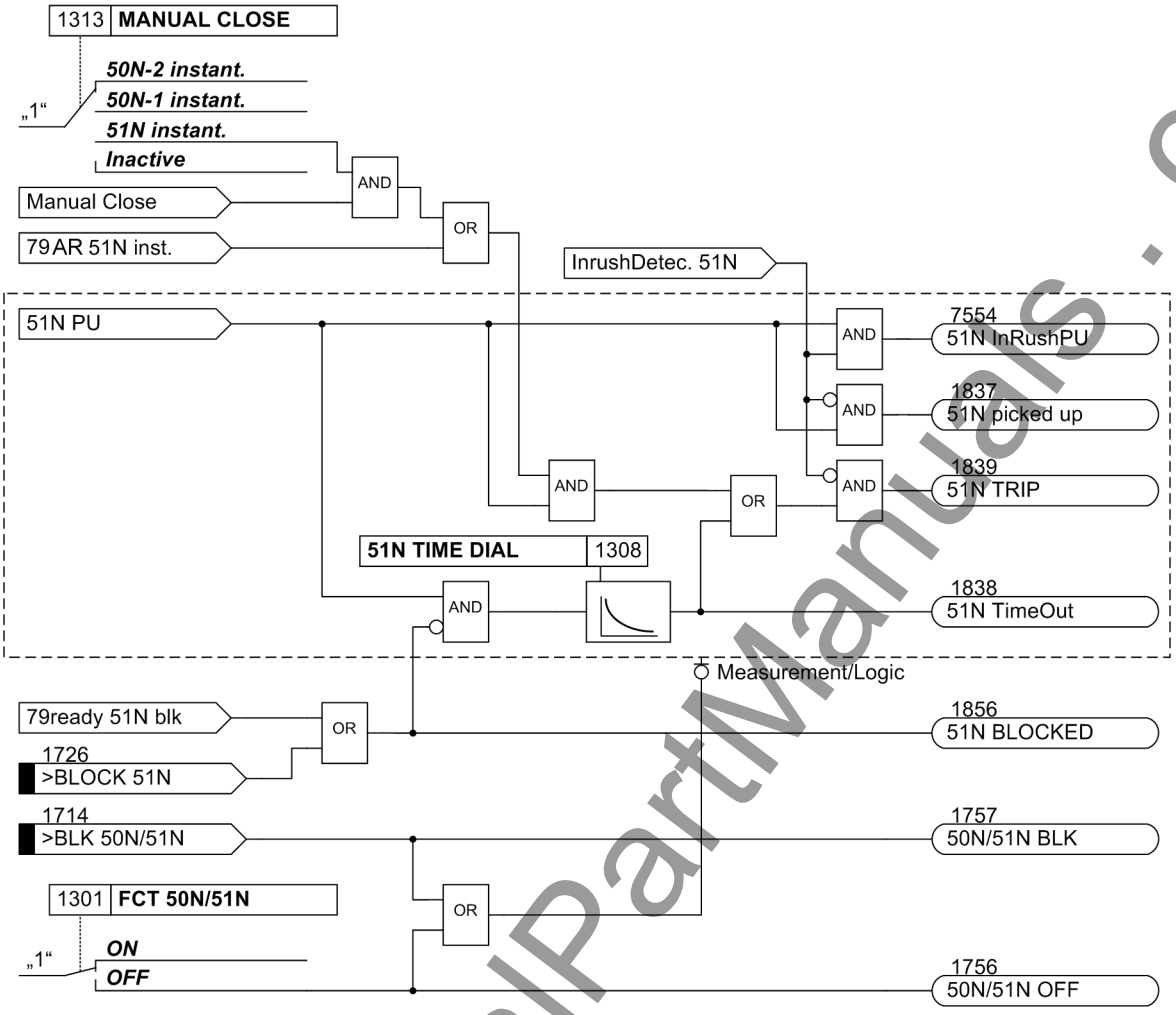


Figure 2-10 Logic diagram of the 51N current element for ground

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.

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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.

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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.

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

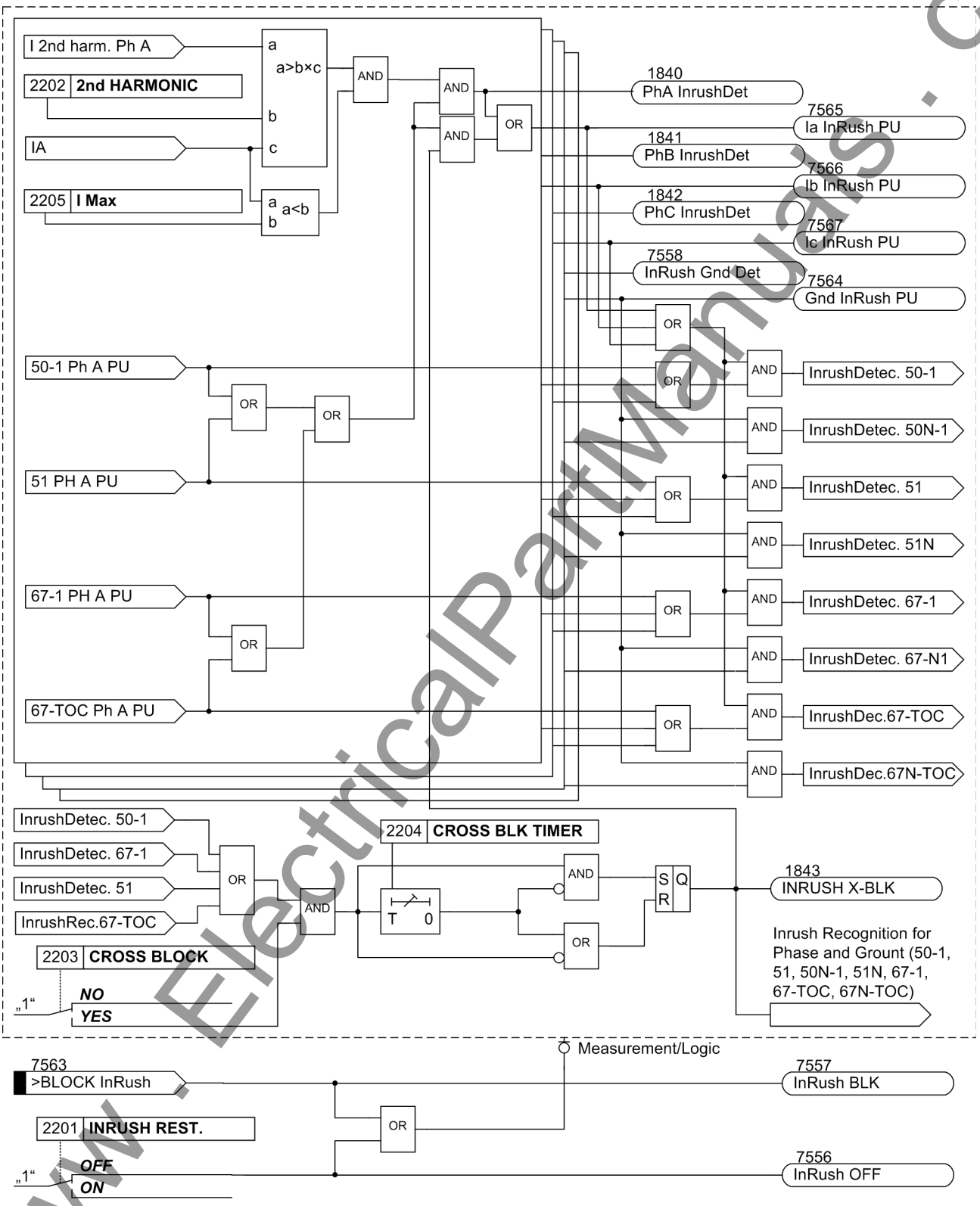


Figure 2-11 Logic diagram for inrush restraint

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### 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)<br>50-1 Ph A PU<br>51 Ph A PU | 2-3<br>2-5<br>2-9 | „50/51 Ph A PU“ | 1762 |
| 50-2 Ph B PU<br>50-1 Ph B PU<br>51 Ph B PU | 2-3<br>2-5<br>2-9 | „50/51 Ph B PU“ | 1763 |
| 50-2 Ph C PU<br>50-1 Ph C PU<br>51 Ph C PU | 2-3<br>2-5<br>2-9 | „50/51 Ph C PU“ | 1764 |
| 50N-2 PU<br>50N-1 PU<br>51N PU | 2-4<br>2-7<br>2-10 | „50N/51NPickedup“ | 1765 |
| 50-2 Ph A PU<br>50-2 Ph B PU<br>50-2 Ph C PU<br>50N-2 PU | 2-3<br>2-3<br>2-3<br>2-4 | „50-2 picked up“ | 1800 |
| 50-1 Ph A PU<br>50-1 Ph B PU<br>50-1 Ph C PU<br>50N-1 PU | 2-5<br>2-5<br>2-5<br>2-4 | „50-1 picked up“ | 1810 |
| 51 Ph A PU<br>51 Ph B PU<br>51 Ph C PU<br>51N PU | 2-9<br>2-9<br>2-9<br>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.

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### 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.

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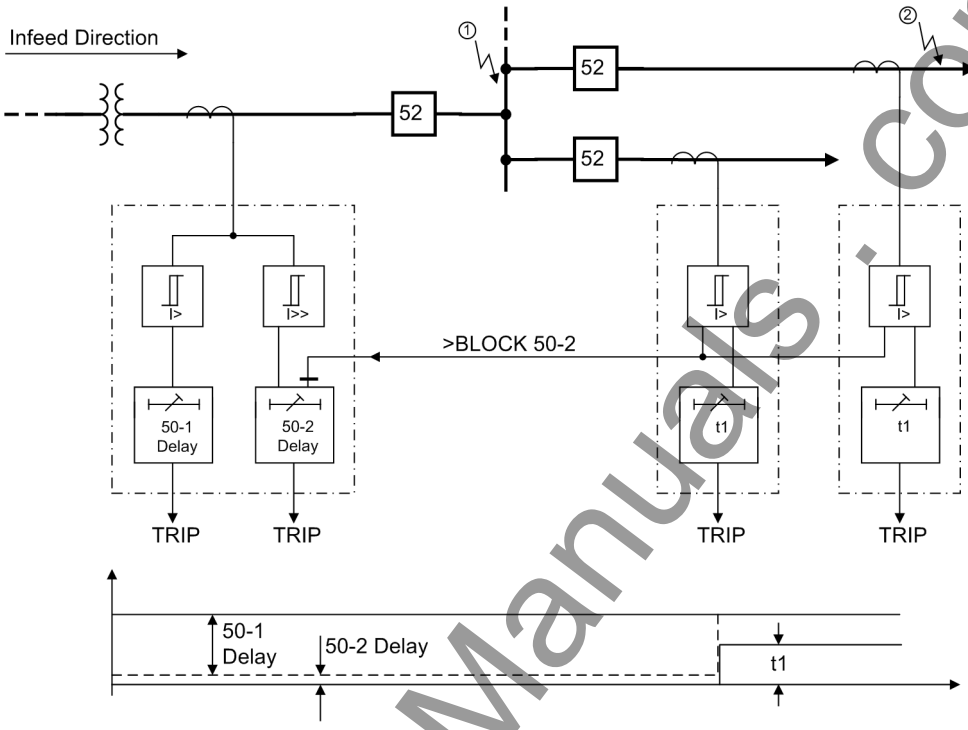


Fault Location ①: Tripping Time 50-2 Delay
Fault Location ②: Tripping Time t1
Backup Time 50-1 Delay

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.

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**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

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

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:

$1.6 \times I_{Startup} <$ 50-2 Pickup $< I_{\varphi\varphi\text{–Min}}$

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

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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.

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**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

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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.

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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 | | | | | | |

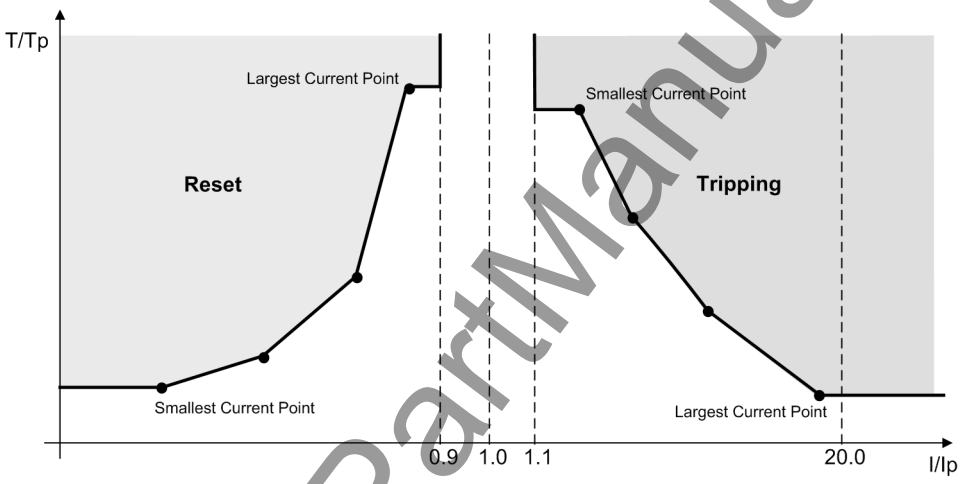


Figure 2-13 Using a user-defined curve

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 | | | | | | |

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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.

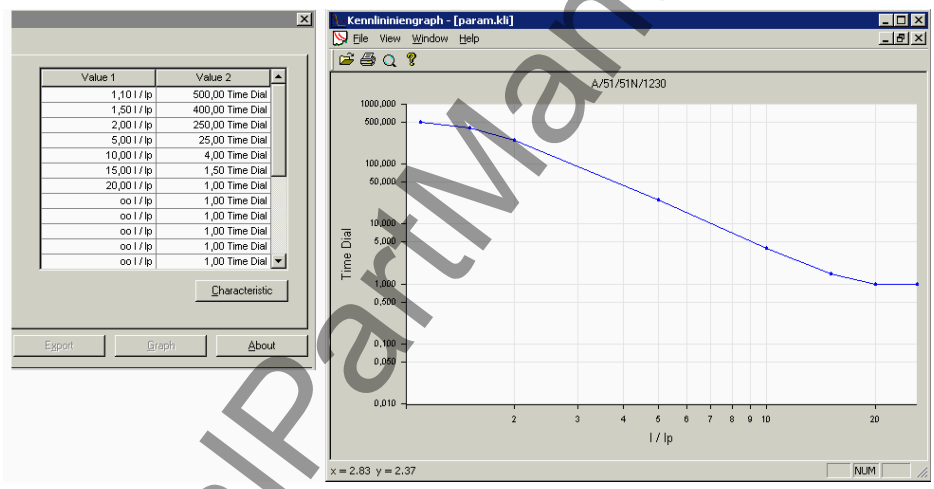


Figure 2-14 Inputting and visualizing a user-defined trip curve with DIGSI® – Example

**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).

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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).

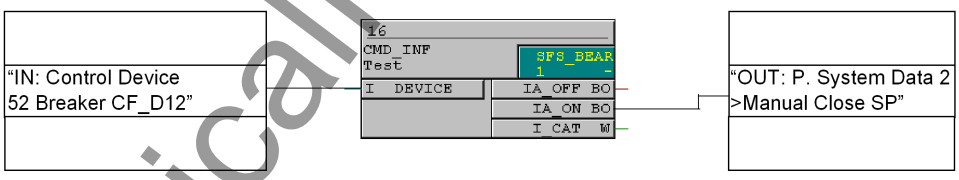


Figure 2-15 Example for manual close feature using the internal control function

**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.

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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<br>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<br>Disk Emulation | Disk Emulation | Drop-out characteristic |
| 1211 | 51 IEC CURVE | | Normal Inverse<br>Very Inverse<br>Extremely Inv.<br>Long Inverse | Normal Inverse | IEC Curve |

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| Addr. | Parameter | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|
| 1212 | 51 ANSI CURVE | | Very Inverse<br>Inverse<br>Short Inverse<br>Long Inverse<br>Moderately Inv.<br>Extremely Inv.<br>Definite Inv. | Very Inverse | ANSI Curve |
| 1213A | MANUAL CLOSE | | 50-2 instant.<br>50 -1 instant.<br>51 instant.<br>Inactive | 50-2 instant. | Manual Close Mode |
| 1214A | 50-2 active | | Always<br>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; ∞<br>0.01 .. 999.00 TD | | 51/51N |
| 1231 | MofPU Res T/Tp | | 0.05 .. 0.95 I/Ip; ∞<br>0.01 .. 999.00 TD | | Multiple of Pickup <-> T/Tp |
| 1301 | FCT 50N/51N | | ON<br>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<br>Disk Emulation | Disk Emulation | Drop-Out Characteristic |
| 1311 | 51N IEC CURVE | | Normal Inverse<br>Very Inverse<br>Extremely Inv.<br>Long Inverse | Normal Inverse | IEC Curve |
| 1312 | 51N ANSI CURVE | | Very Inverse<br>Inverse<br>Short Inverse<br>Long Inverse<br>Moderately Inv.<br>Extremely Inv.<br>Definite Inv. | Very Inverse | ANSI Curve |
| 1313A | MANUAL CLOSE | | 50N-2 instant.<br>50N-1 instant.<br>51N instant.<br>Inactive | 50N-2 instant. | Manual Close Mode |

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| Addr. | Parameter | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|
| 1314A | 50N-2 active | | Always<br>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; ∞<br>0.01 .. 999.00 TD | | 50N/51N |
| 1331 | MofPU Res T/TEp | | 0.05 .. 0.95 I/Ip; ∞<br>0.01 .. 999.00 TD | | Multiple of Pickup <-> T/TEp |
| 2201 | INRUSH REST. | | OFF<br>ON | OFF | Inrush Restraint |
| 2202 | 2nd HARMONIC | | 10 .. 45 % | 15 % | 2nd. harmonic in % of fundamental |
| 2203 | CROSS BLOCK | | NO<br>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 |

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| 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 |

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## 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.

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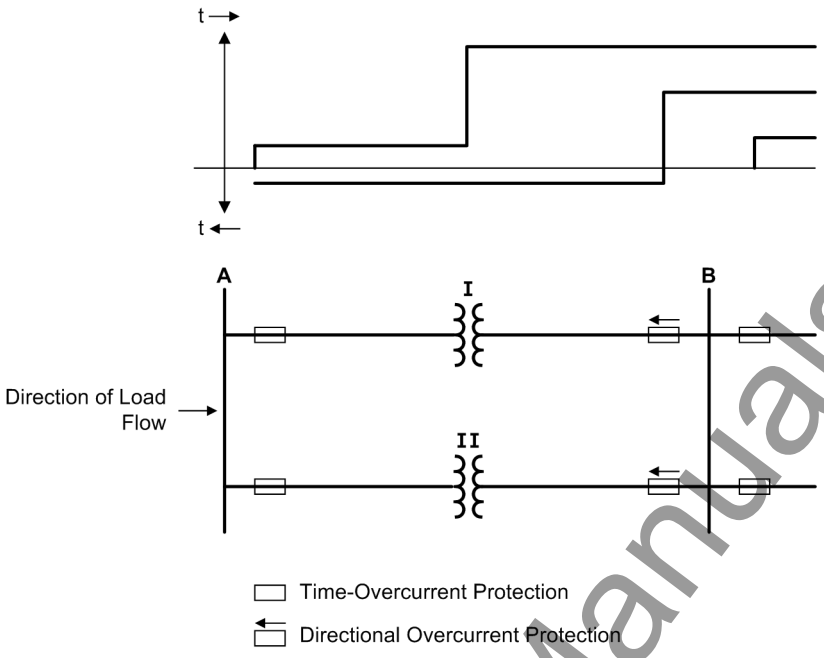


Figure 2-16 Overcurrent protection for parallel transformers

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.

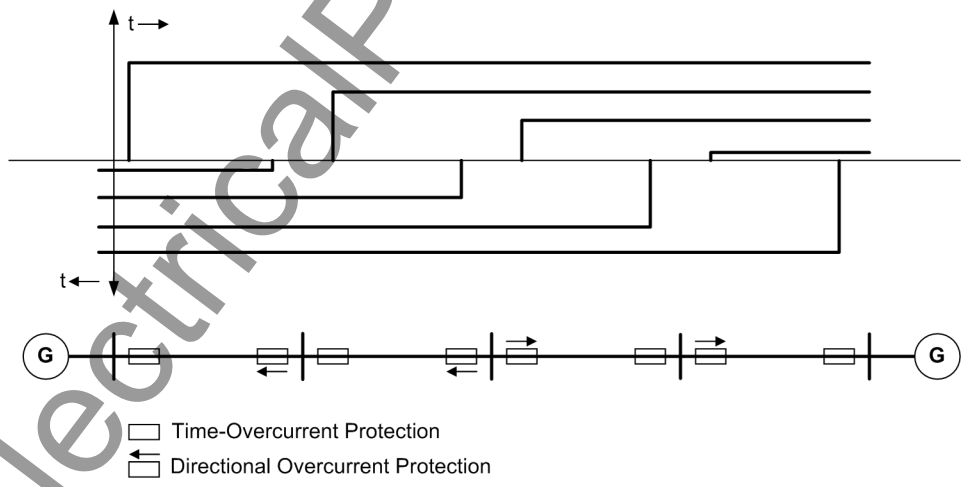


Figure 2-17 Transmission lines with sources at each end

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 overcur-

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rent 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 | • | • | • | • |

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### 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).

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

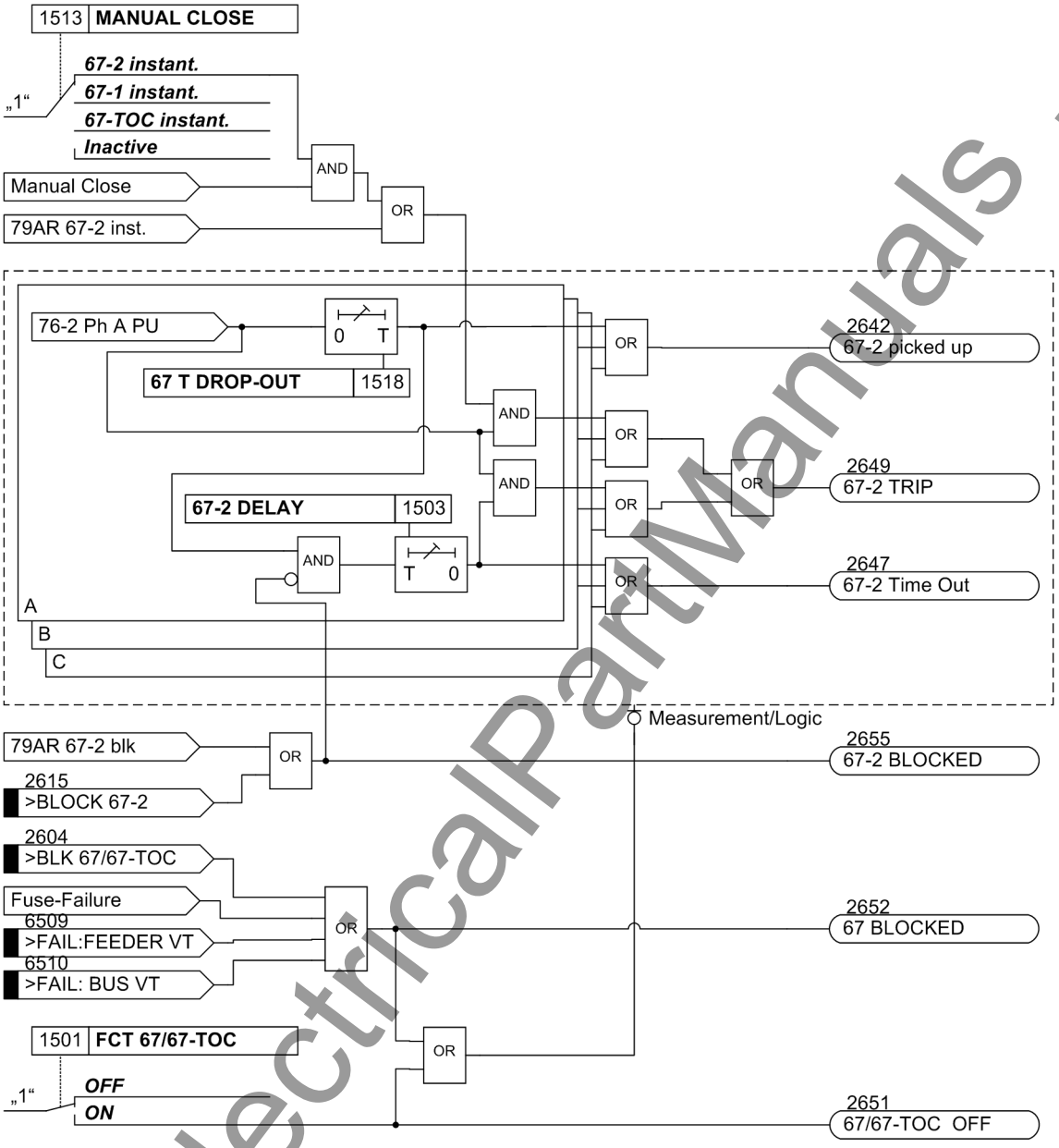


Figure 2-18 Logic diagram of the directional high-current element 67-2 for phases

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.

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### 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).

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

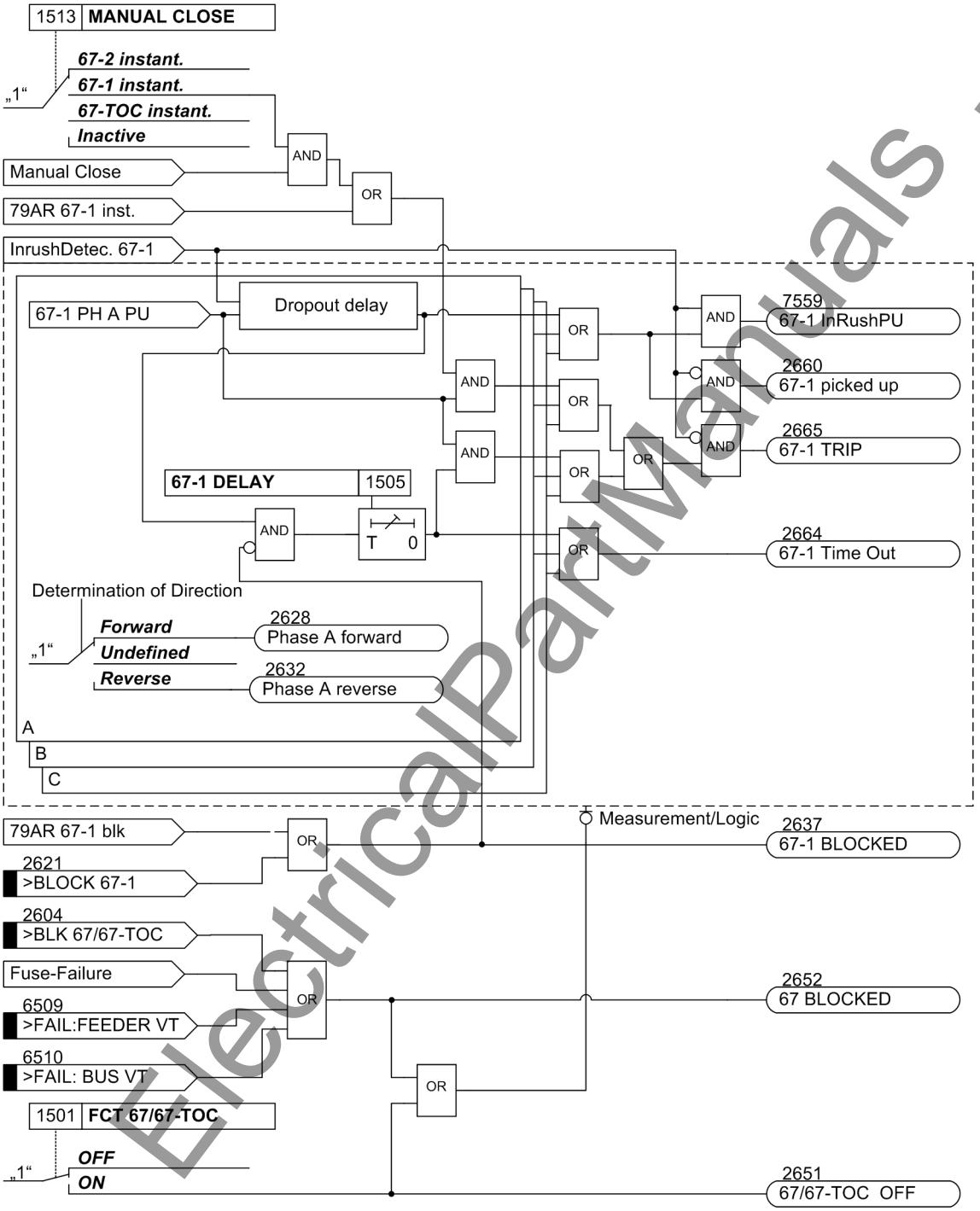


Figure 2-19 Logic diagram for the directional overcurrent element 67-1 for phases

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

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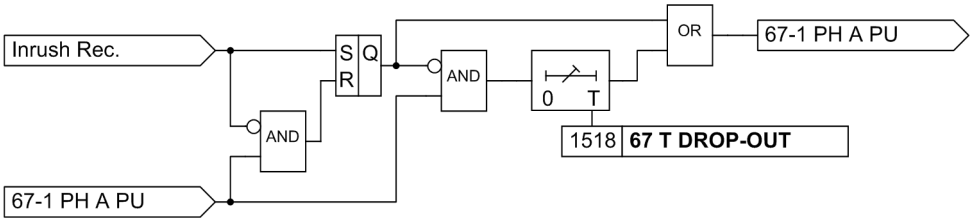


Figure 2-20 Logic of the dropout delay for 67-1

## 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.

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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.

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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.

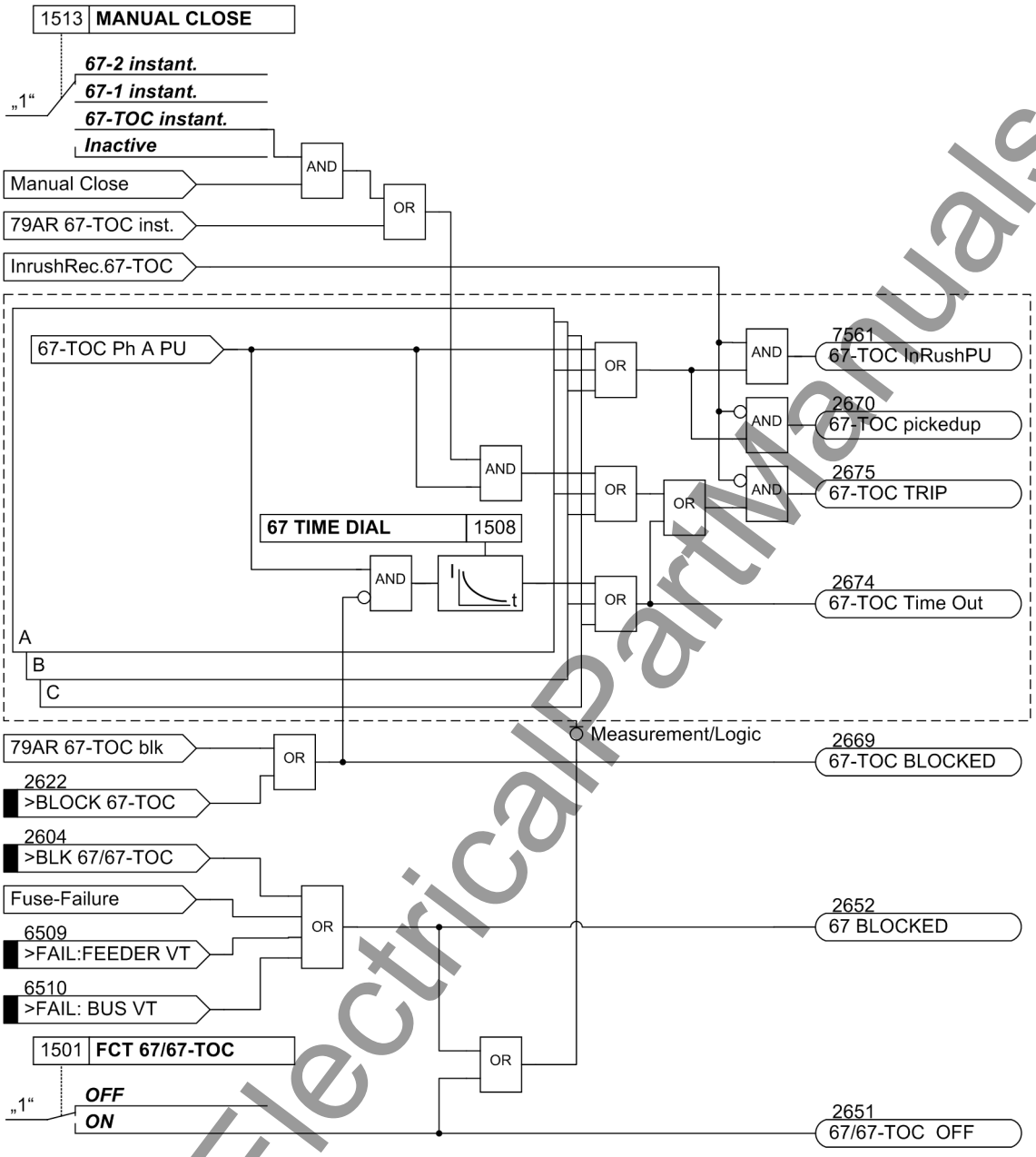


Figure 2-21 Logic diagram for the directional overcurrent protection: 67-TOC relay element

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### 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

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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.

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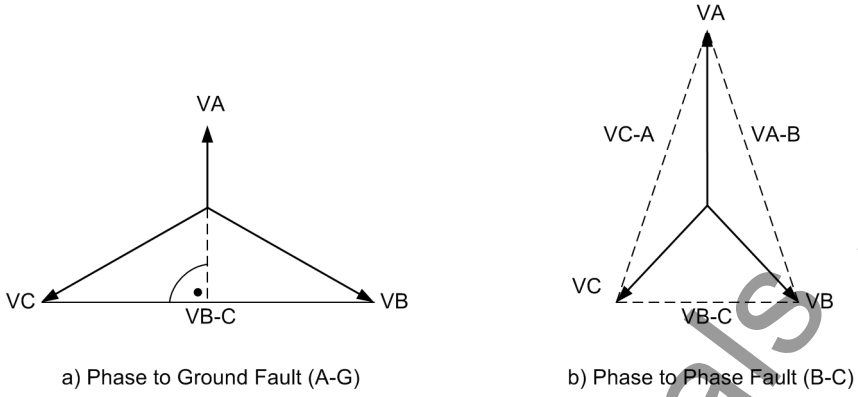


a) Phase to Ground Fault (A-G) b) Phase to Phase Fault (B-C)

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 $\varphi_{sc}$. The reference voltage, in this case $V_{BC}$ for the directional phase element A, is rotated through the

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setting value 1519 **ROTATION ANGLE**, positive counter-clockwise. In this case, a rotation of +45°.

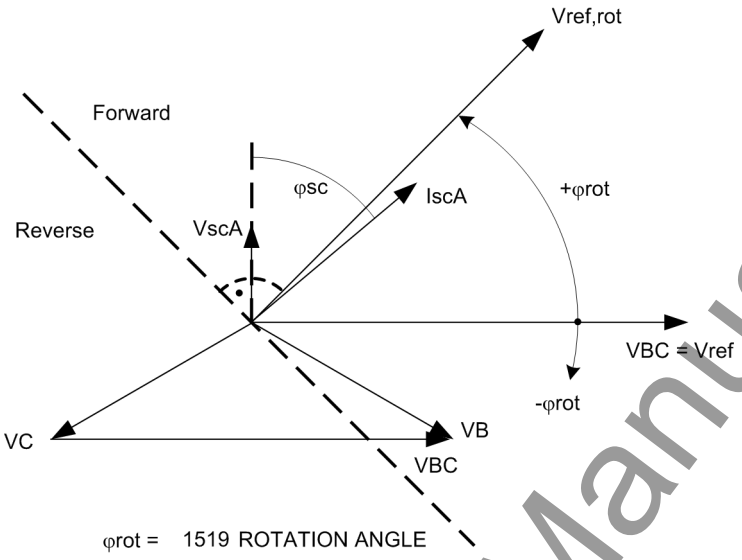


Figure 2-23 Rotation of the reference voltage, directional phase element

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.

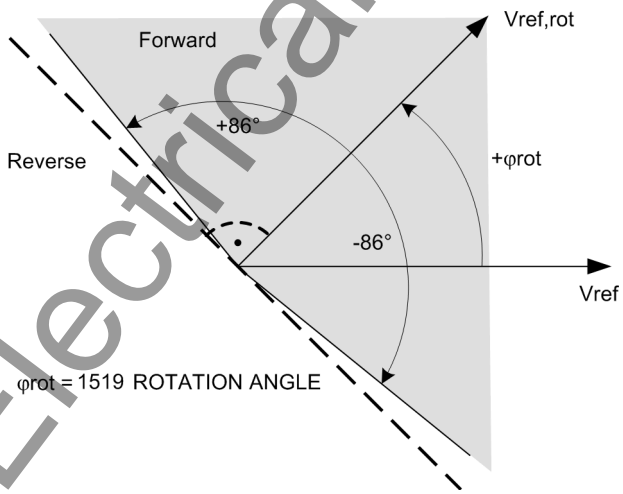


Figure 2-24 Forward characteristic of the directional function, directional phase element

**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

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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 $\varphi_{sc}$. The reference voltage is rotated through the setting value 1619 **ROTATION ANGLE**. In this case, a rotation of -45°.

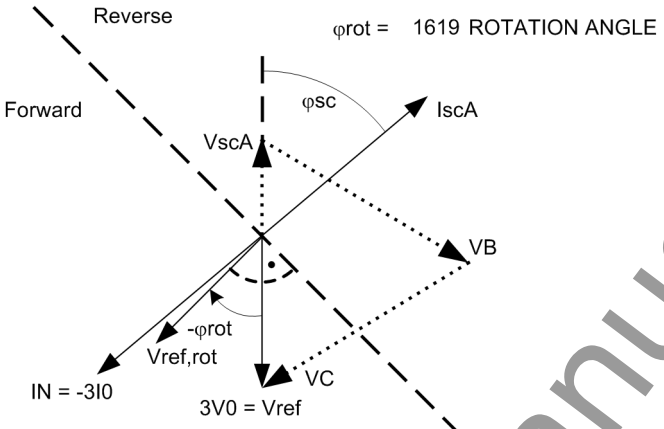


Figure 2-25 Rotation of the reference voltage, directional ground element with zero sequence values

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 $\varphi_{sc}$. The reference voltage is rotated through the setting value 1619 **ROTATION ANGLE**. In this case, a rotation of -45°.

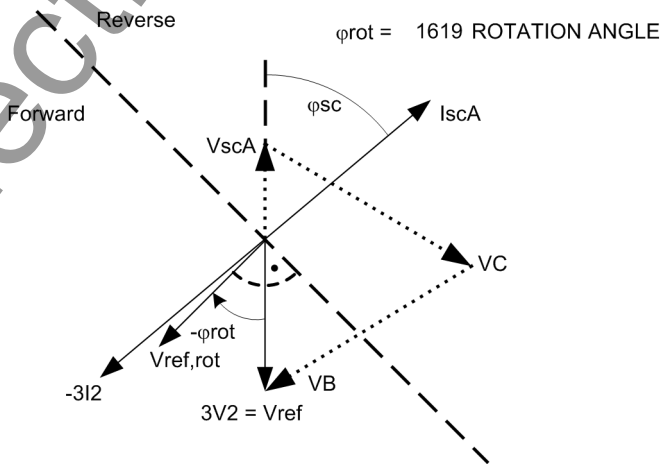


Figure 2-26 Rotation of the reference voltage, directional ground element with negative sequence values

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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.

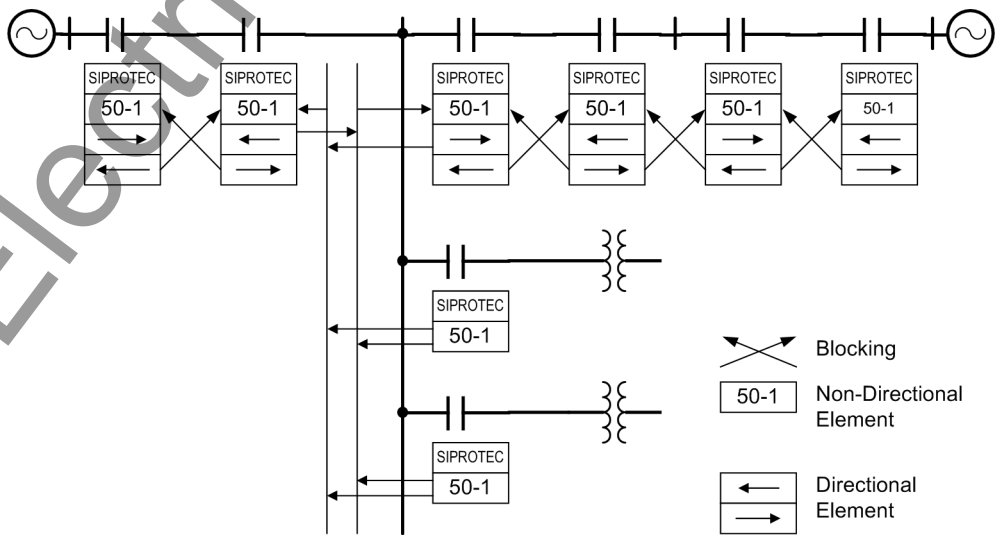


Figure 2-27 Reverse interlocking using directional elements

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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.

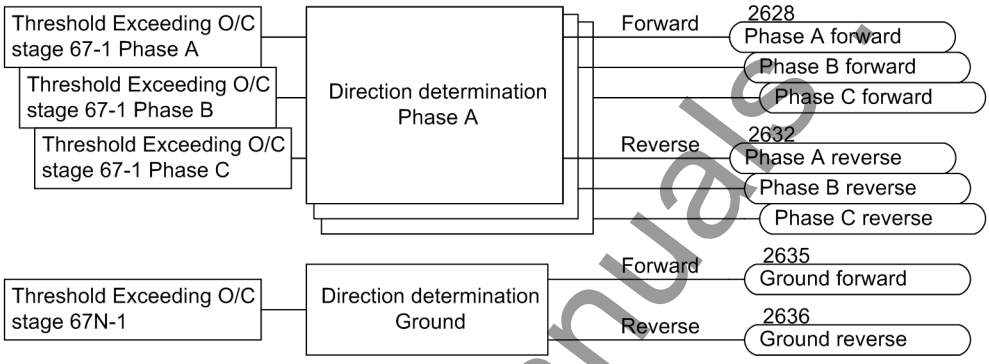


Figure 2-28 Logic diagram for the generation of fault direction signals.

## 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).

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**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).

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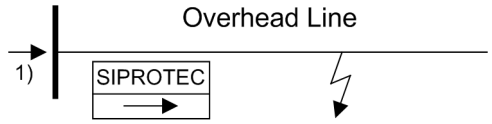
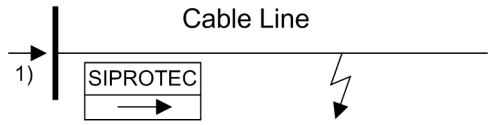
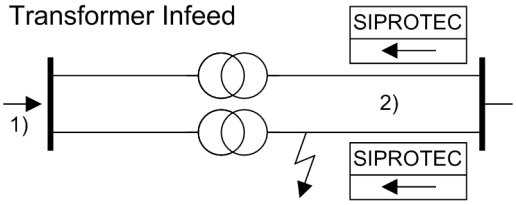
Table 2-7 Setting example

| Application | $\varphi_{sc}$ typical | Phase directional element setting<br>1519 ROTATION ANGLE | Ground directional element setting<br>1619 ROTATION ANGLE |
|---|---|---|---|
|  | 60° | Range 30°...0°<br>→ 15° | –60° |
|  | 30° | Range 60°...30°<br>→ 45° | –30° |
|  | 30° | Range 60°...30°<br>→ 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<br>Addr. 1519 | Ground directional element<br>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.

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**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.

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**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**.

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**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.

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**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.

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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 | | | | | | |

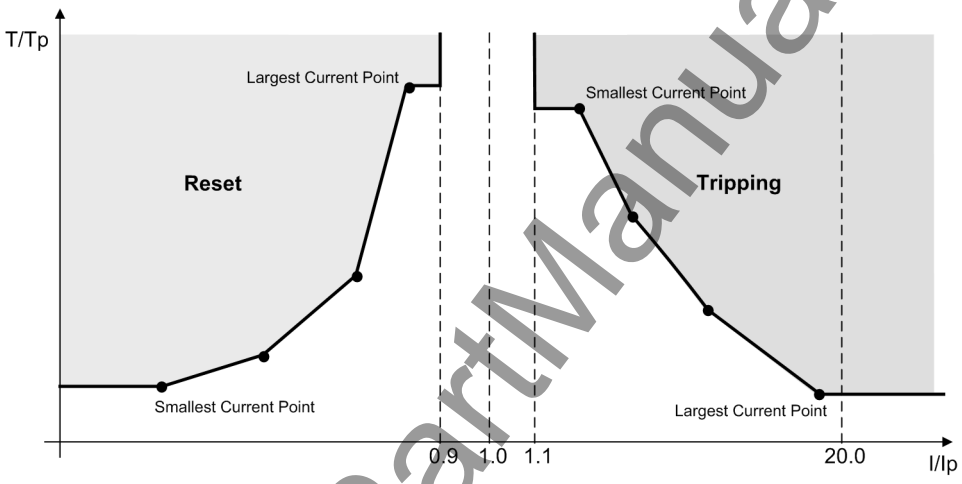


Figure 2-29 Using a user-defined curve

**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.

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**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.

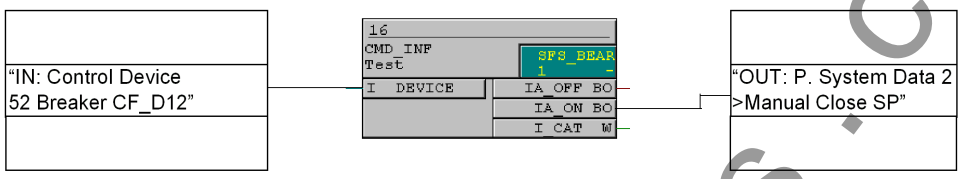


Figure 2-30 Example for manual close feature using the internal control function

**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).

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### 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<br>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<br>Disk Emulation | Disk Emulation | Drop-Out Characteristic |
| 1511 | 67- IEC CURVE | | Normal Inverse<br>Very Inverse<br>Extremely Inv.<br>Long Inverse | Normal Inverse | IEC Curve |
| 1512 | 67- ANSI CURVE | | Very Inverse<br>Inverse<br>Short Inverse<br>Long Inverse<br>Moderately Inv.<br>Extremely Inv.<br>Definite Inv. | Very Inverse | ANSI Curve |
| 1513A | MANUAL CLOSE | | 67-2 instant.<br>67-1 instant.<br>67-TOC instant.<br>Inactive | 67-2 instant. | Manual Close Mode |
| 1514A | 67 active | | with 79 active<br>always | always | 67 active |
| 1516 | 67 Direction | | Forward<br>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; ∞<br>0.01 .. 999.00 TD | | 67 |

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| Addr. | Parameter | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|
| 1531 | MofPU Res T/Tp | | 0.05 .. 0.95 I/Ip; ∞<br>0.01 .. 999.00 TD | | Multiple of Pickup <-> T/Tp |
| 1601 | FCT 67N/67N-TOC | | OFF<br>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<br>Disk Emulation | Disk Emulation | Drop-Out Characteristic |
| 1611 | 67N-TOC IEC | | Normal Inverse<br>Very Inverse<br>Extremely Inv.<br>Long Inverse | Normal Inverse | IEC Curve |
| 1612 | 67N-TOC ANSI | | Very Inverse<br>Inverse<br>Short Inverse<br>Long Inverse<br>Moderately Inv.<br>Extremely Inv.<br>Definite Inv. | Very Inverse | ANSI Curve |
| 1613A | MANUAL CLOSE | | 67N-2 instant.<br>67N-1 instant.<br>67N-TOC instant<br>Inactive | 67N-2 instant. | Manual Close Mode |
| 1614A | 67N active | | always<br>with 79 active | always | 67N active |
| 1616 | 67N Direction | | Forward<br>Reverse | Forward | Ground Direction |
| 1617 | 67N POLARIZAT. | | with VN and IN<br>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; ∞<br>0.01 .. 999.00 TD | | Multiples of PU Time-Dial |
| 1631 | I/IEp Rf T/TEp | | 0.05 .. 0.95 I/Ip; ∞<br>0.01 .. 999.00 TD | | 67N TOC |

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## 2.3.12 Information List

| No. | Information | Type of Information | 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 |

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| 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 |

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## 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

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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.

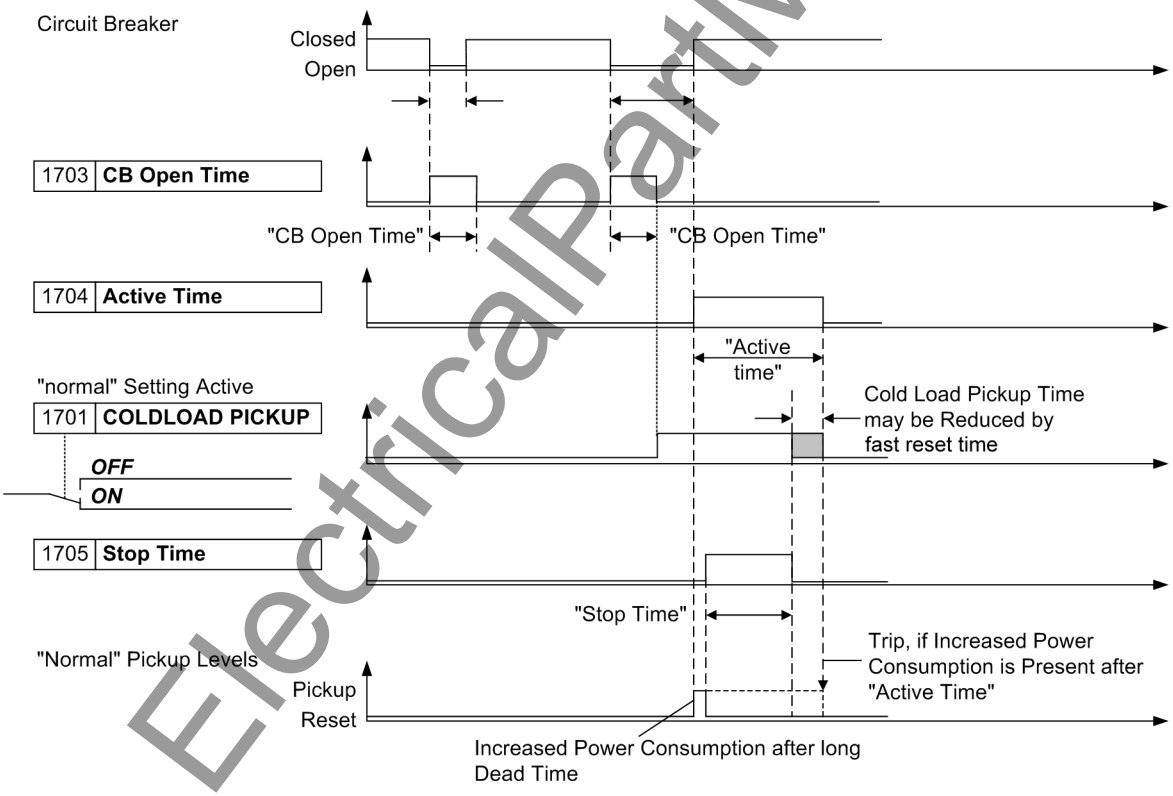


Figure 2-31 Timing charts of the dynamic cold load pickup function

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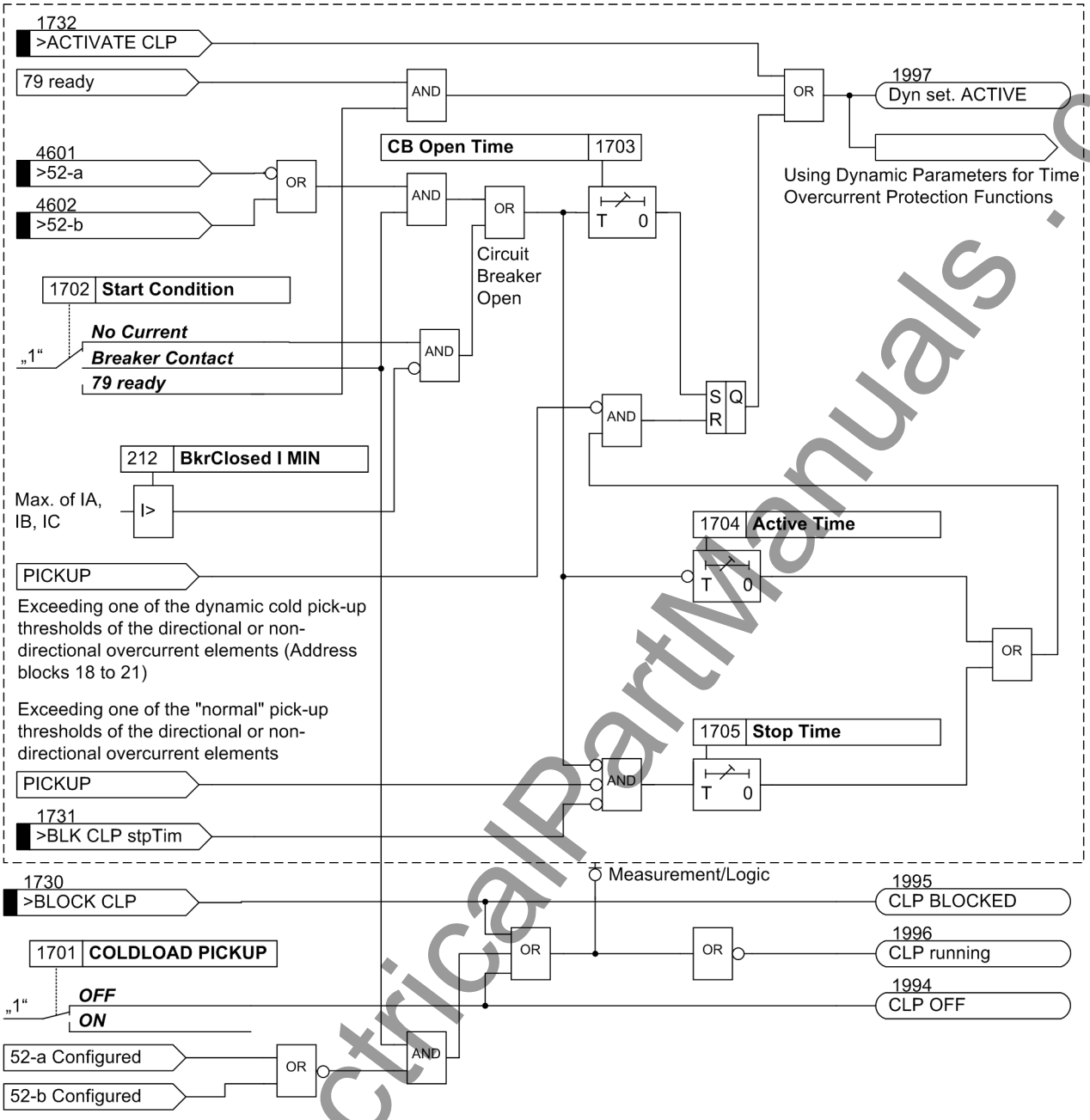


Figure 2-32 Logic diagram of the dynamic cold load pickup function (50c, 50Nc, 51c, 51Nc, 67c, 67Nc)

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### 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

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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<br>ON | OFF | Cold-Load-Pickup Function |
| 1702 | Start Condition | | No Current<br>Breaker Contact<br>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 |

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| 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 |

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## 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 $2 \cdot \sqrt{2}$.

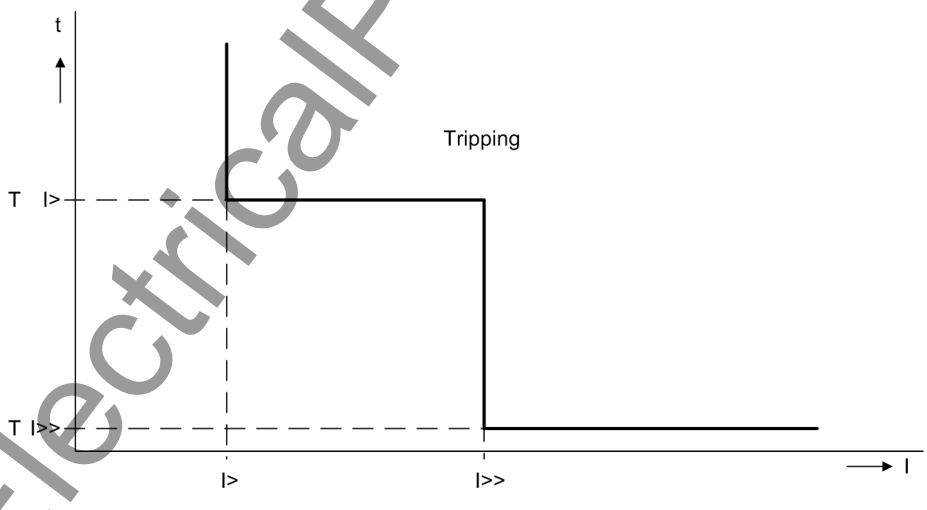


Figure 2-33 Two-stage characteristic of the single-phase time-overcurrent protection

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

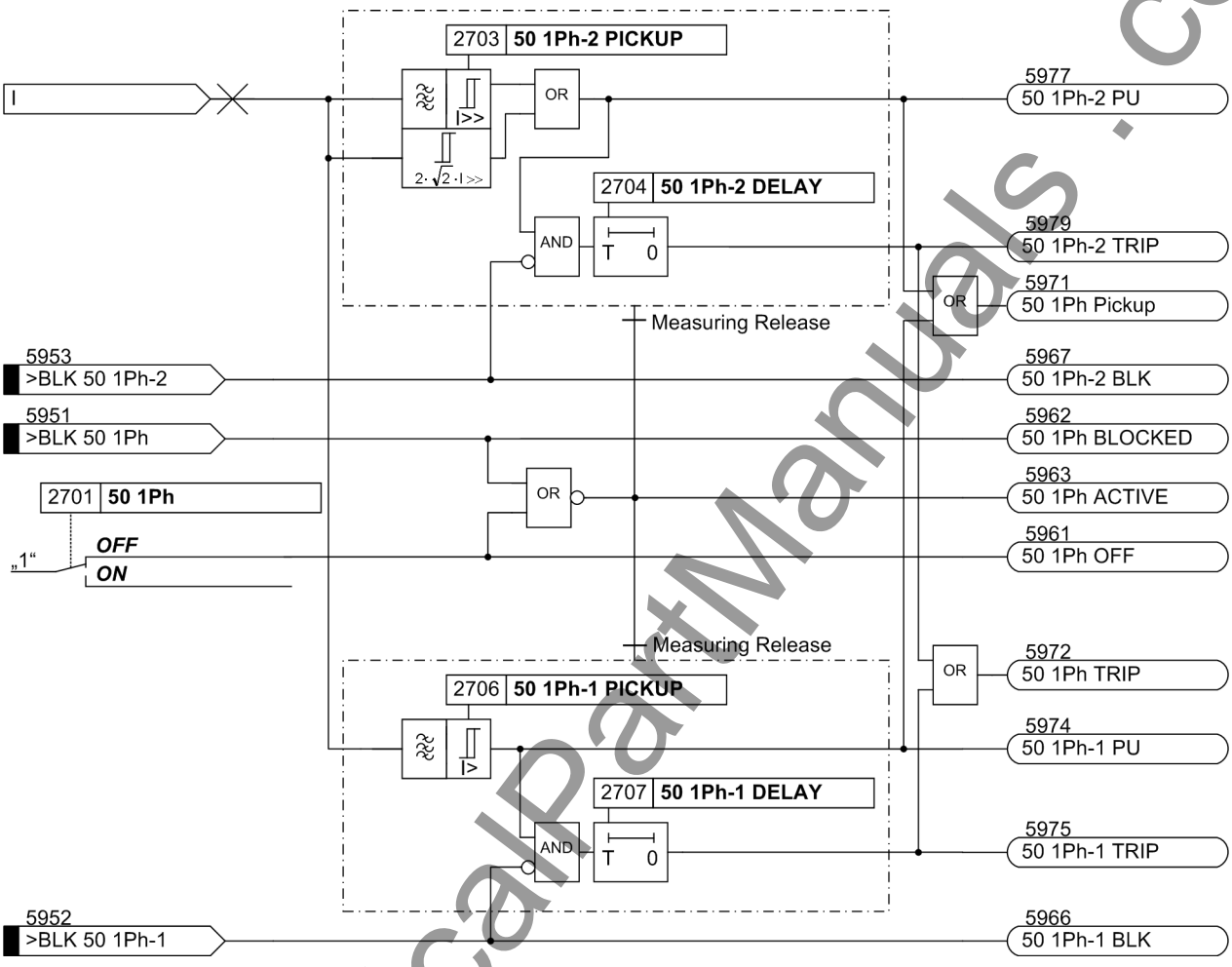


Figure 2-34 Logic diagram of the single-phase time-overcurrent protection

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## 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.

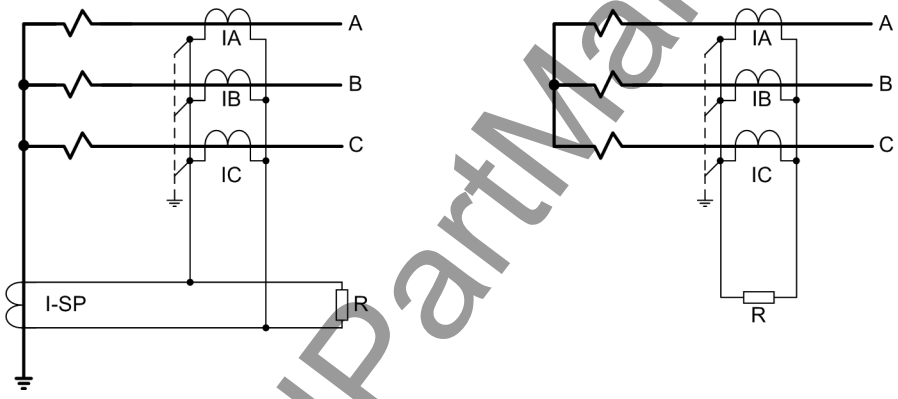


Figure 2-35 Ground fault protection according to the high-impedance principle

**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).

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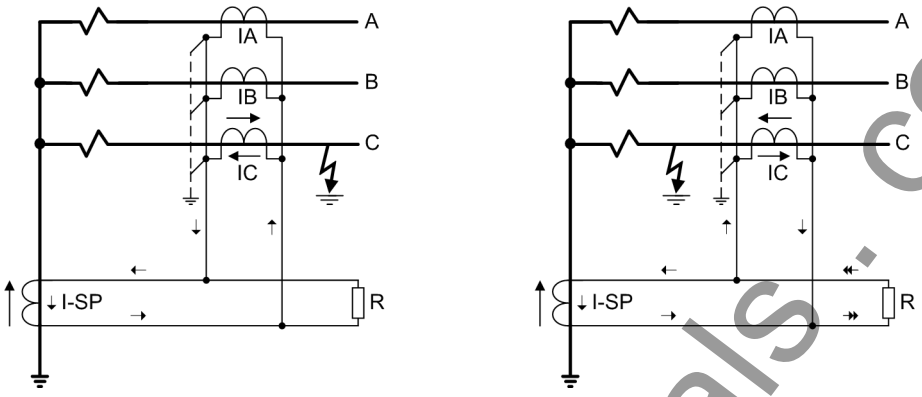


Figure 2-36 Principle of ground fault protection according to the high-impedance principle

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.

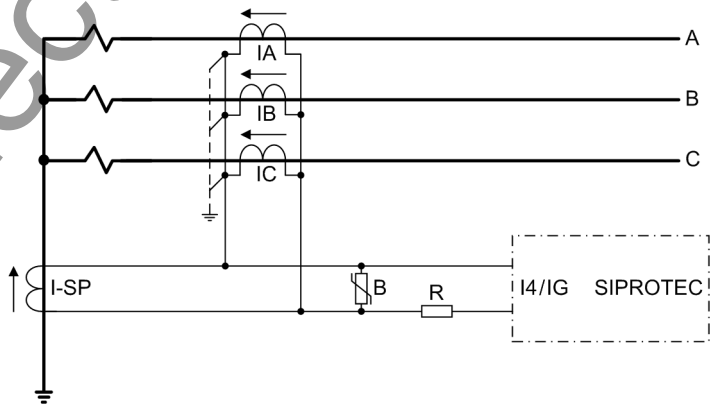


Figure 2-37 Connection diagram of the ground fault differential protection according to the high-impedance principle

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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.

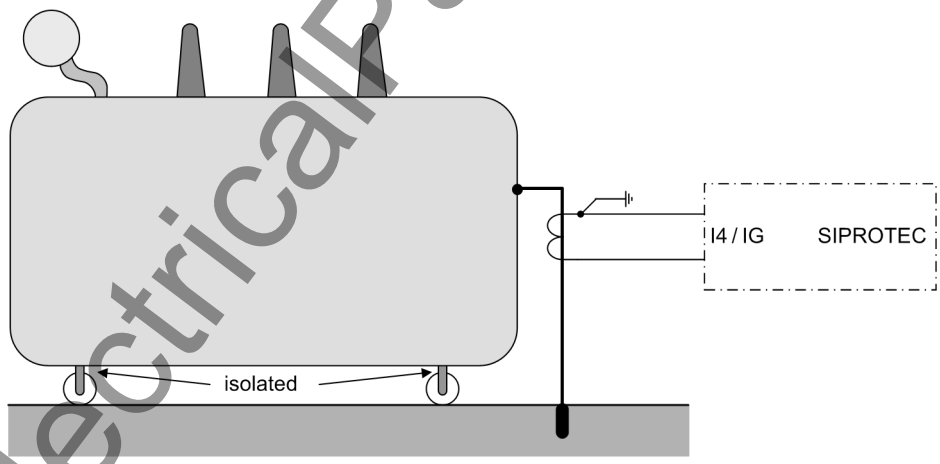


Figure 2-38 Principle of tank-leakage protection

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## 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 |

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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.

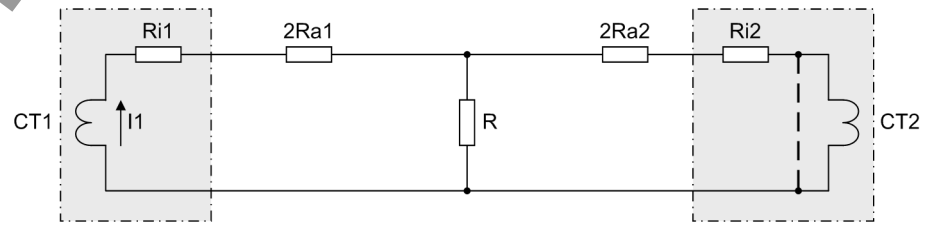


Figure 2-39 Simplified equivalent circuit of a circulating current system for high-impedance protection

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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

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

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

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

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:

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

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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:

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

$$P_R = \frac{V_{KPV}^2}{R} = \frac{(350\ V)^2}{3500\ \Omega} = 35\ W$$ 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.

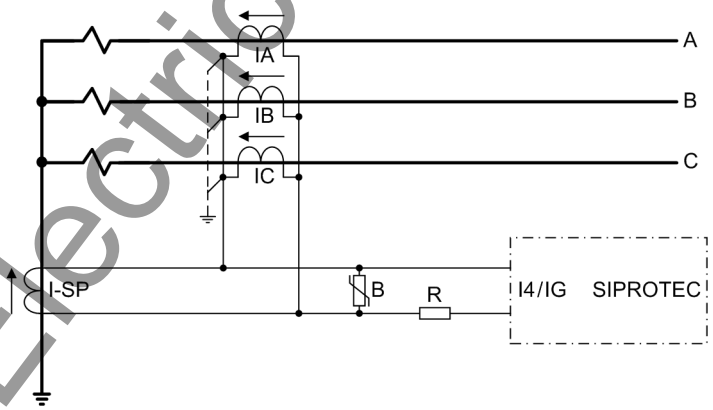


Figure 2-40 Connection diagram of the ground fault differential protection according to the high-impedance principle

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

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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, $\beta$ = 0.25)

600A/S1/S1088 (k = 900, $\beta$ = 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** = $\infty$ ).

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** = $\infty$ ).

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.

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### 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<br>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 |

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## 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

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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.

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## 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.

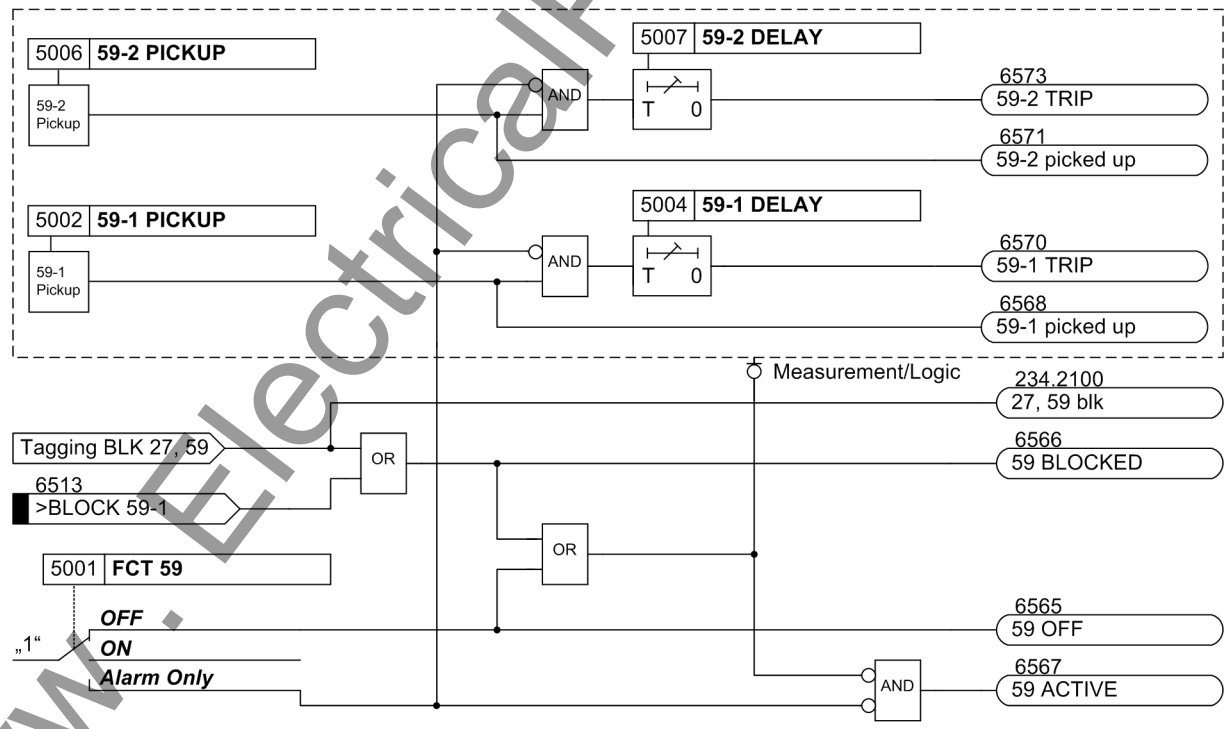


Figure 2-41 Logic diagram of the overvoltage protection

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### 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*** · $\sqrt{3}$ 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.

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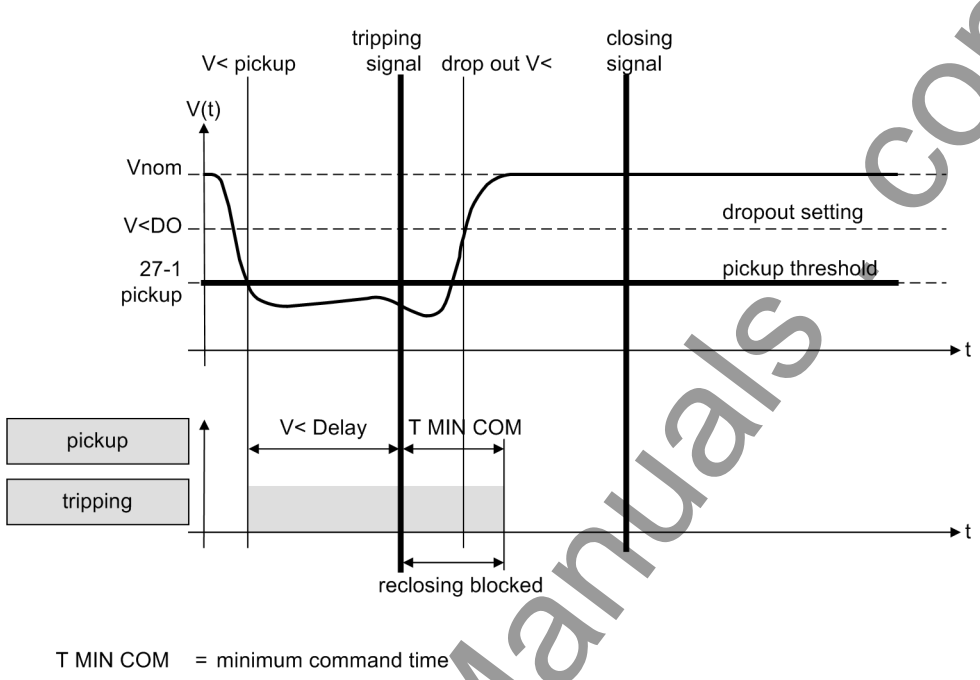


T MIN COM = minimum command time

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.

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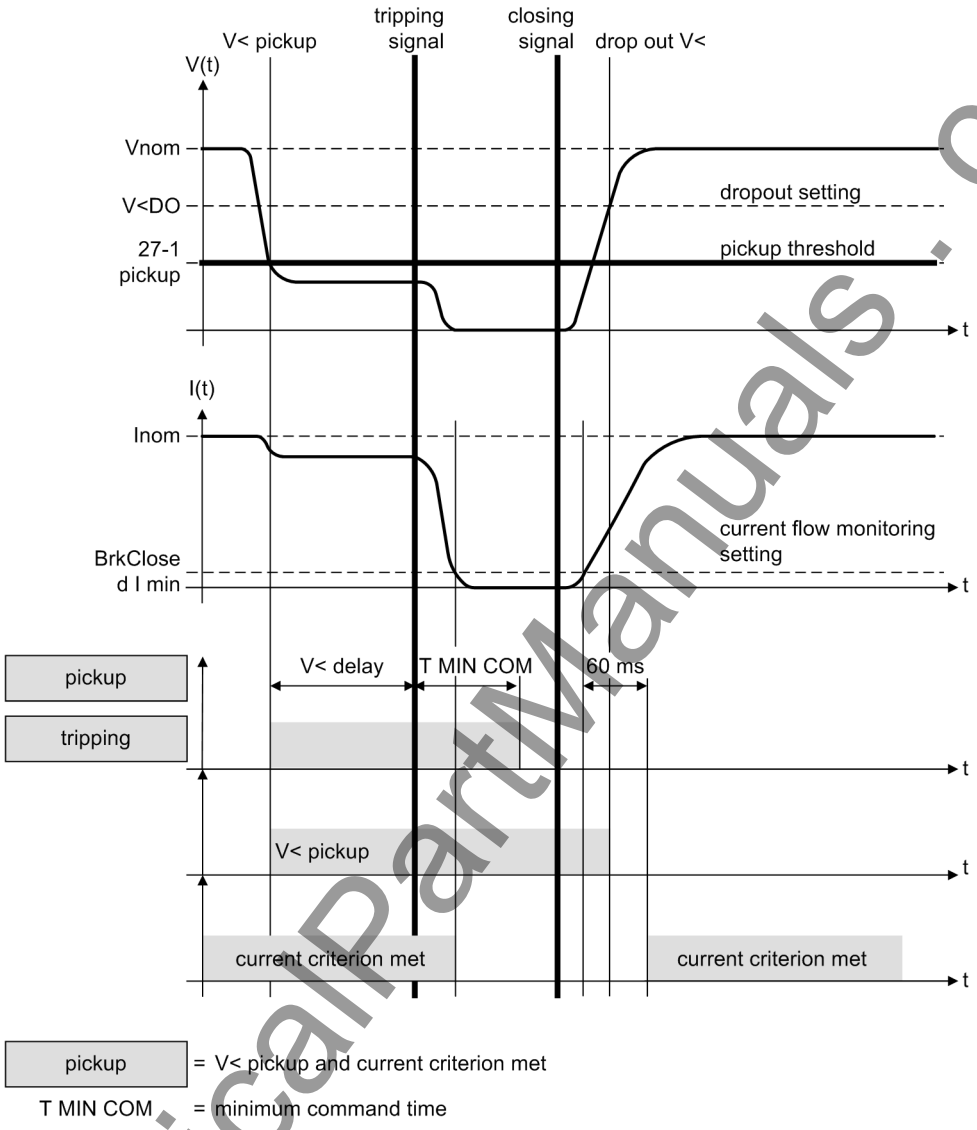


Figure 2-43 Typical fault profile for load side connection of the voltage transformers (with current supervision)

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.

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

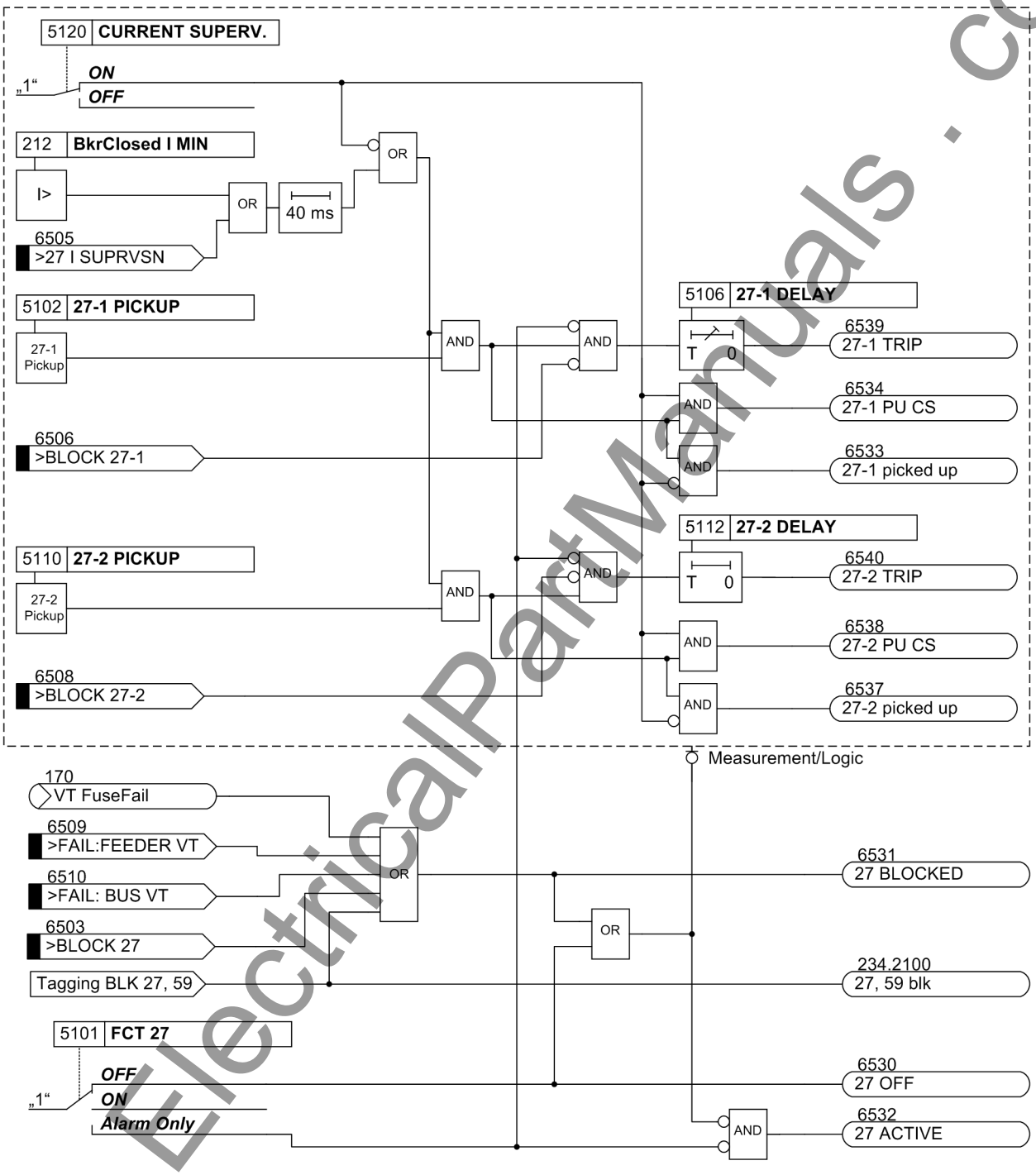


Figure 2-44 Logic diagram of the undervoltage protection

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### 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.

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**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:

$r \cdot$ (configured pickup threshold ) $\leq$ 150 V with connection of phase-to-phase voltages or

$r \cdot$ (configured pickup threshold ) $\leq$ 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.

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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,

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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<br>ON<br>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<br>ON<br>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 |

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| 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<br>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 |

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## 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.

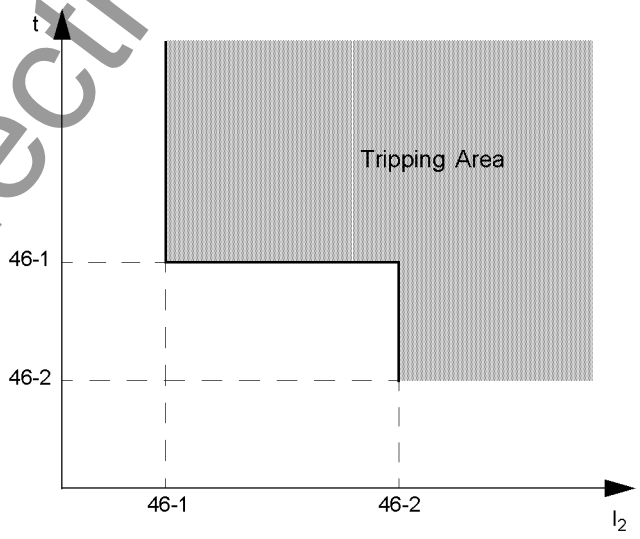


Figure 2-45 Definite time characteristic for negative sequence protection

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**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.

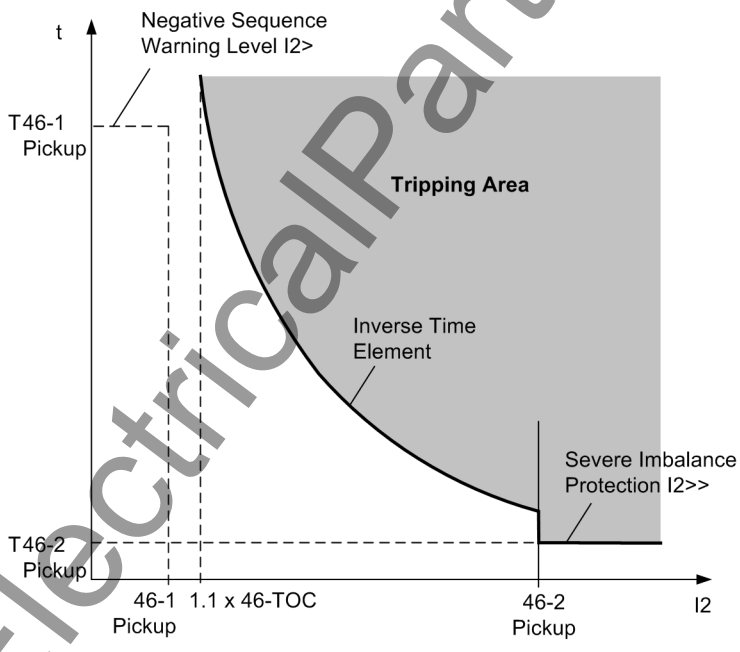


Figure 2-46 Inverse time characteristic for negative sequence protection

**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.

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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.

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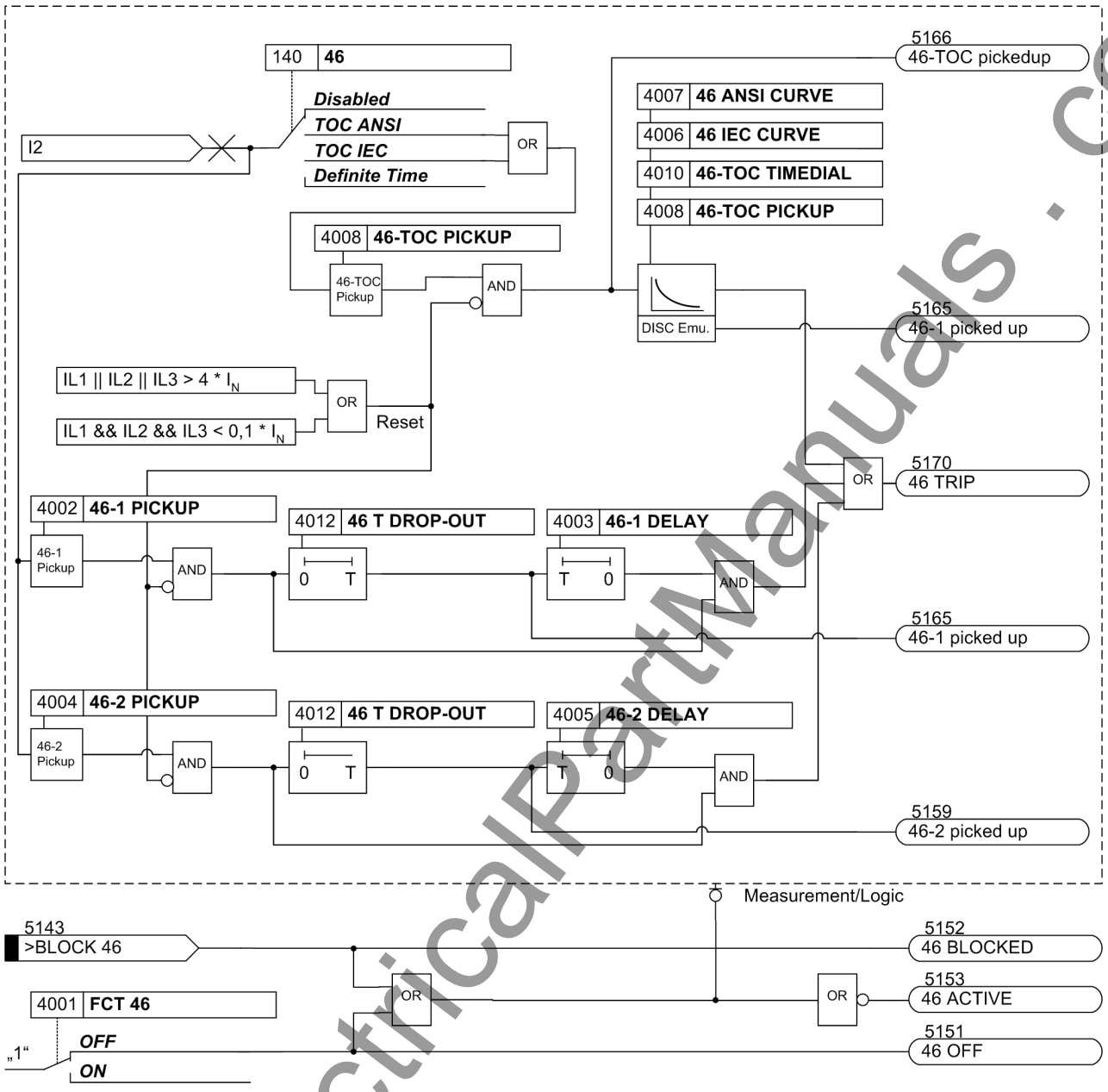


Figure 2-47 Logic diagram of the unbalanced load protection

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.

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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

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

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:

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

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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) |

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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).

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### 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<br>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<br>Very Inverse<br>Extremely Inv. | Extremely Inv. | IEC Curve |
| 4007 | 46 ANSI CURVE | | Extremely Inv.<br>Inverse<br>Moderately Inv.<br>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<br>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 |

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# 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**),

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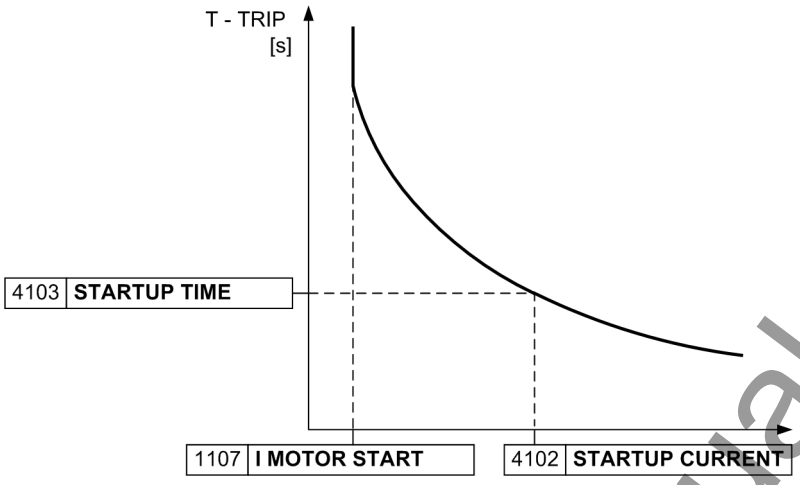


Figure 2-48 Inverse time tripping curve for motor starting current

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.

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**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.

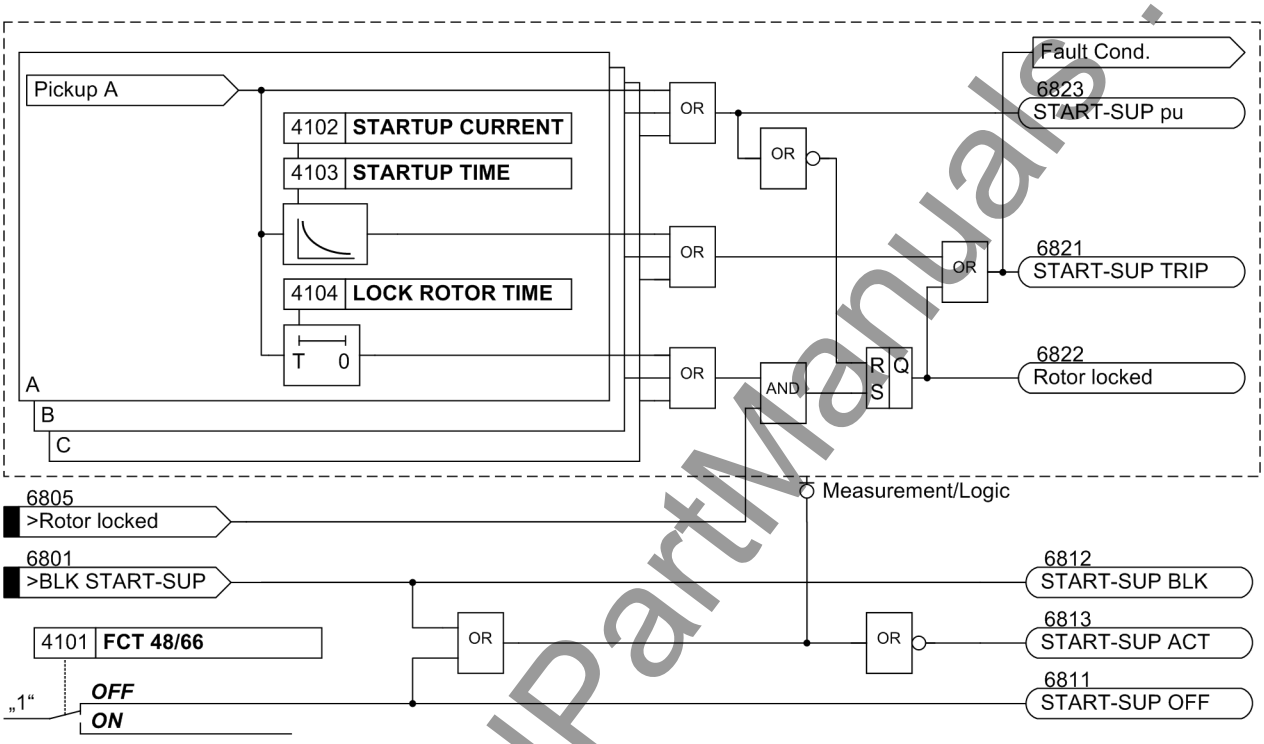


Figure 2-49 Logic diagram of the Motor Starting Time Supervision

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### 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 $0.8 \cdot I_{STARTUP} = 2.5$.

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:

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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.

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## 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 $\Theta_R$ 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.

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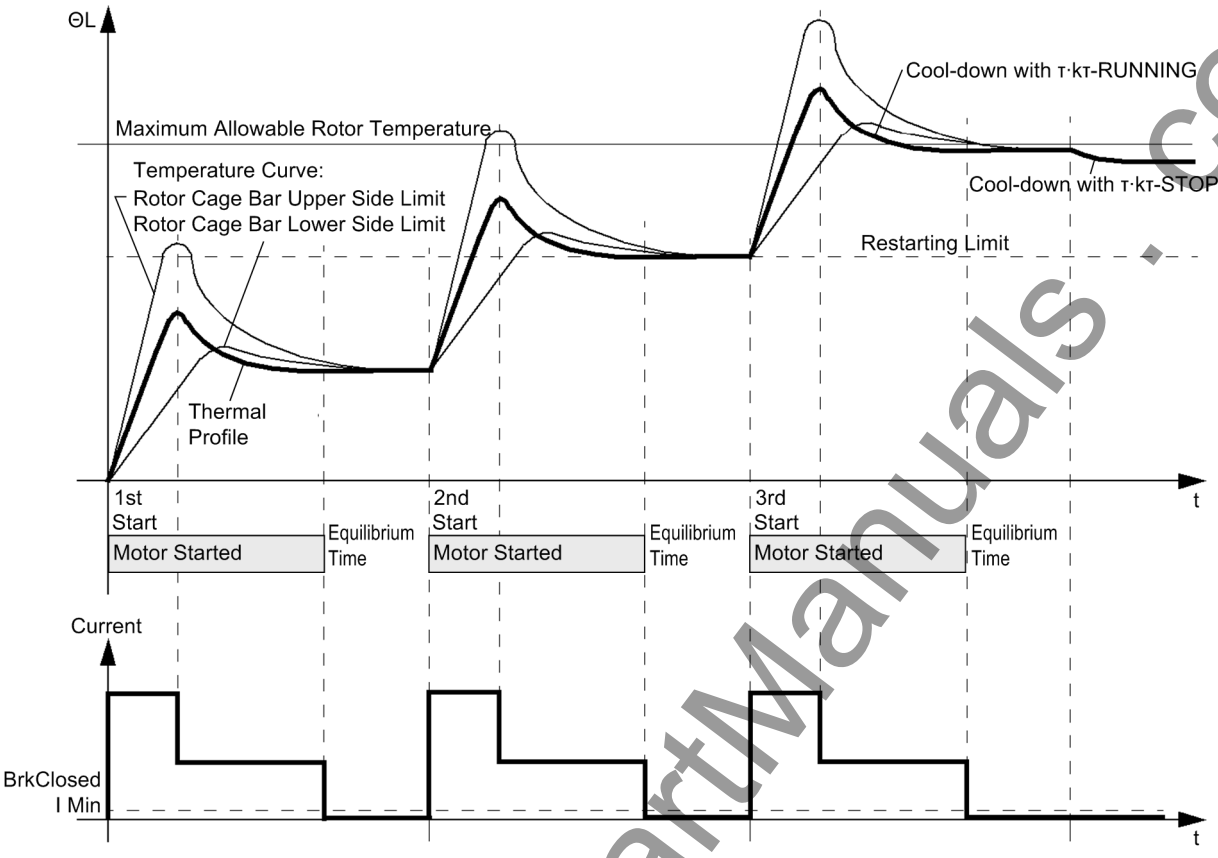


Figure 2-50 Temperature curve at the rotor and the thermal profile during repeated start-up attempts

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.

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**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 |
| $\tau_R$ | = | 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.

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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 $\tau_R$ calculated from the motor ratings, and the cool down calculated with the time constant $\tau_R$ 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:

$$T_{RESTART} = k_{\tau at\ STOP} \cdot \tau_R \cdot I_{Nom} \left[\frac{\Theta_{pre} \cdot n_{cold}}{n_{cold} - 1}\right] \quad \text{at Stop}$$

$$T_{RESTART} = k_{\tau at\ RUNNING} \cdot \tau_R \cdot I_{Nom} \left[\frac{\Theta_{pre} \cdot n_{cold}}{n_{cold} - 1}\right] \quad \text{at Running}$$

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

$\Theta_{pre}$ – thermal replica at the instant the motor is switched off (depends on operational condition)

$\tau_R$ – 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/.

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**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.

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**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.

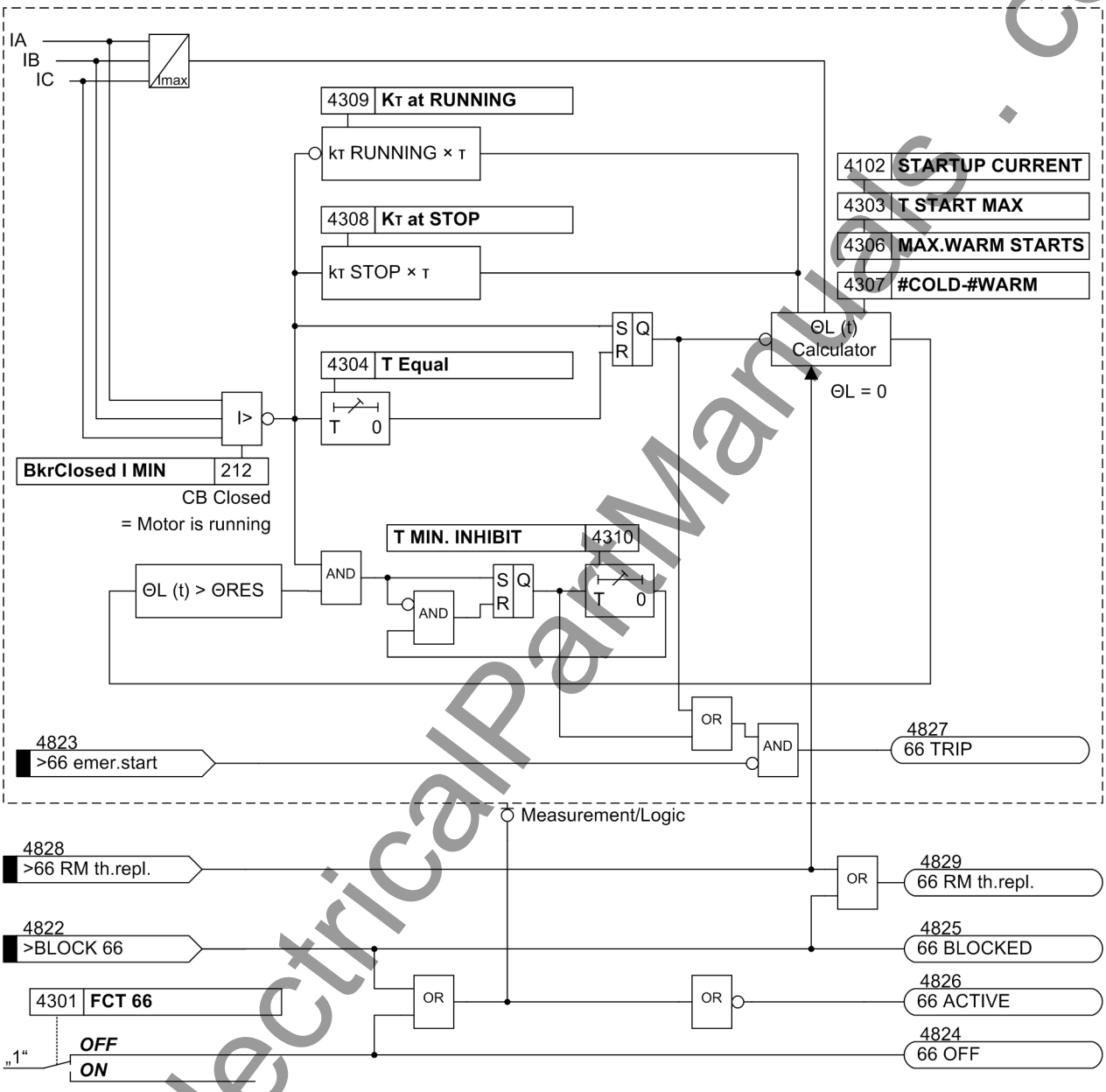


Figure 2-51 Logic diagram of the Restart Inhibit

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### 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 |

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The following settings are derived from these data:

$$I_{STARTUP}/I_{MOTnom} = \frac{624\ A}{126\ A} = 4.95$$

$$I_{MOTnom} = \frac{126\ A}{200\ A} = 0.62 \cdot I_{NomCTsec}$$

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).

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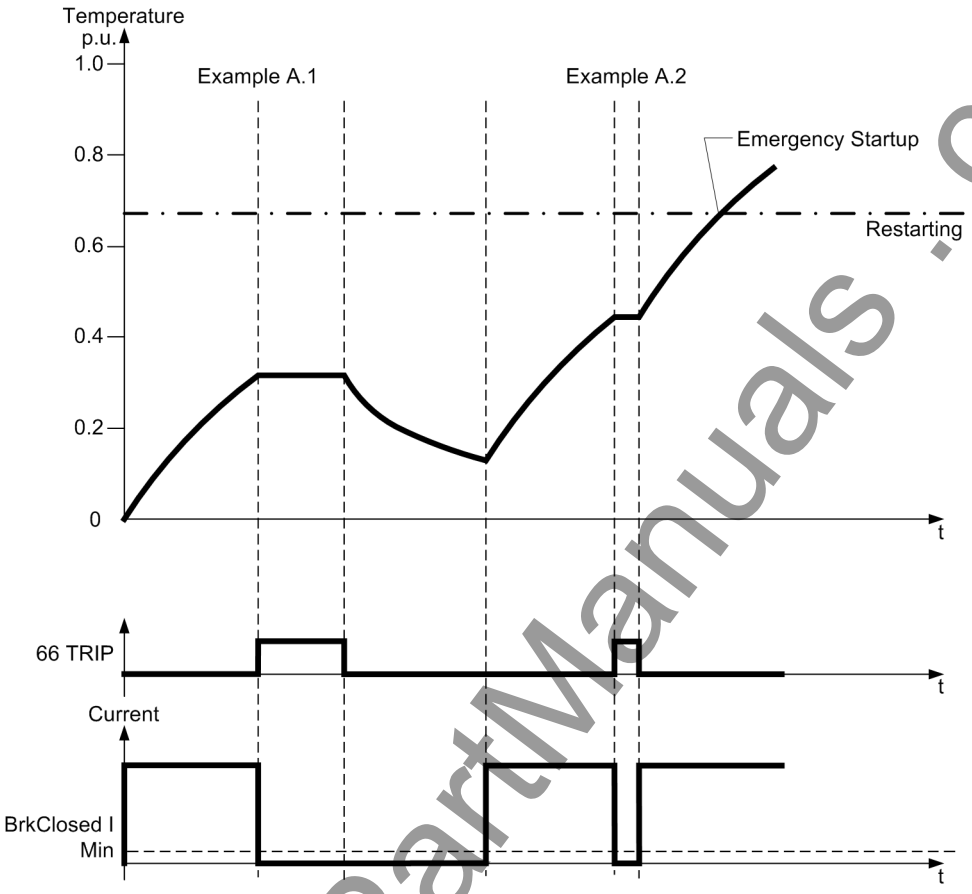


Figure 2-52 Startups according to examples A.1 and A.2

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).

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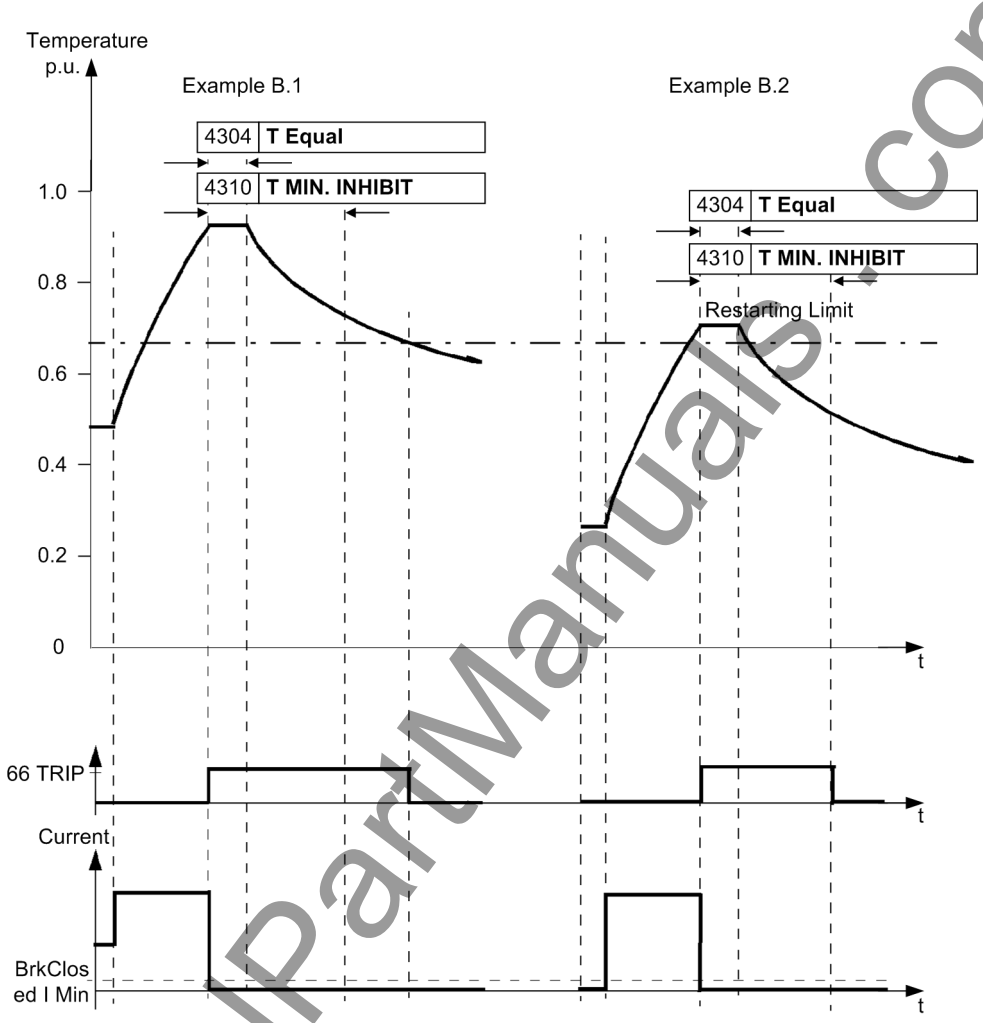


Figure 2-53 Starting up according to examples B.1 and B.2

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## 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<br>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<br>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 |

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### 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 |

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## 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.

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**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.

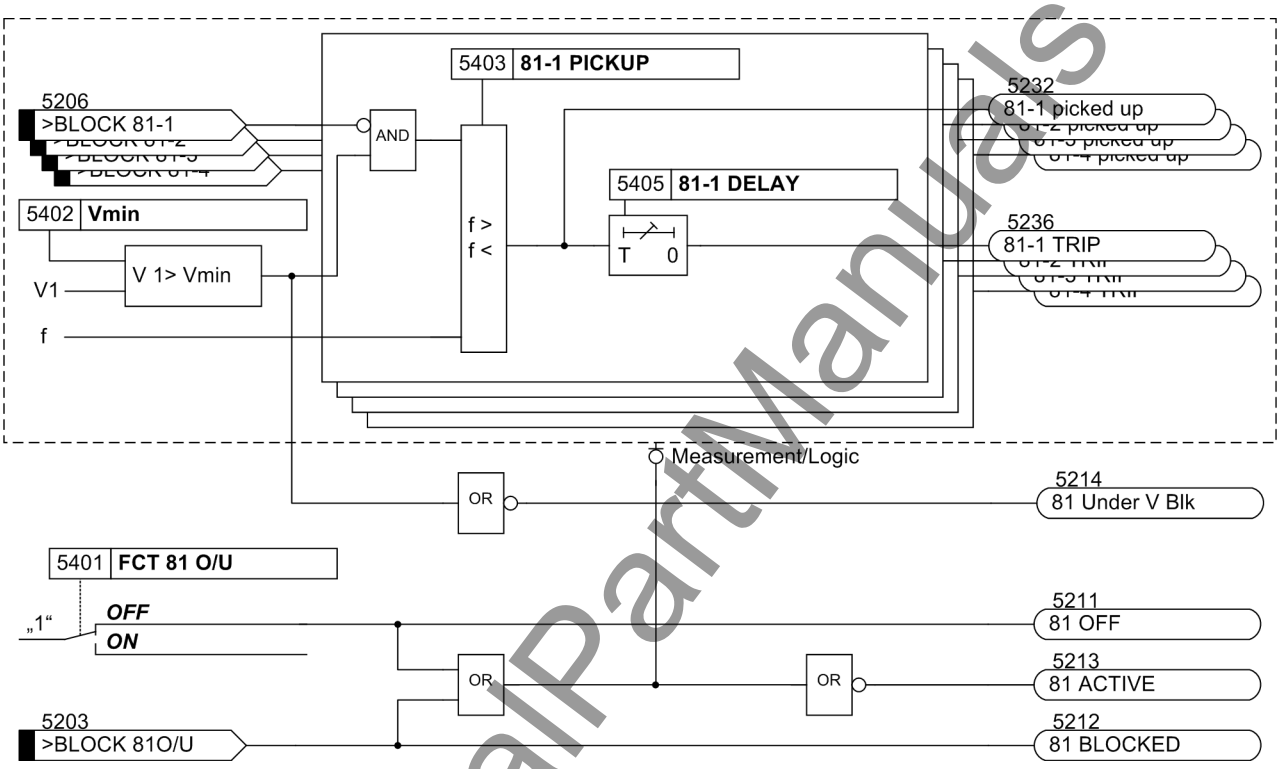


Figure 2-54 Logic diagram of the frequency protection

## 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

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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.

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### 2.9.3 Settings

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 5401 | FCT 81 O/U | OFF<br>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 |

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## 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

| | |
|---|---|
| $\Theta$ | Present overtemperature related to the final overtemperature at maximum allowed phase current $k \cdot I_{Nom\ Obj}$ |
| $\tau_{th}$ | 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

| | |
|---|---|
| $\Theta_u$ | Measured ambient temperature or coolant temperature |
| $\Theta_{Nom}$ | Temperature at object nominal current |

If the ambient or coolant temperature is not measured, a constant value of $\Theta_u$ = 40 °C or 104°F is assumed so that $\Theta_u$'= 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 thresh-

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old, 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** $\tau_{th}$ and the alarm temperature **49 Θ ALARM** (in percent of the trip temperature $\Theta_{TRIP}$) 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 $\Theta_u$ = 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 $\tau_{th}$ 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**

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**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/.

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

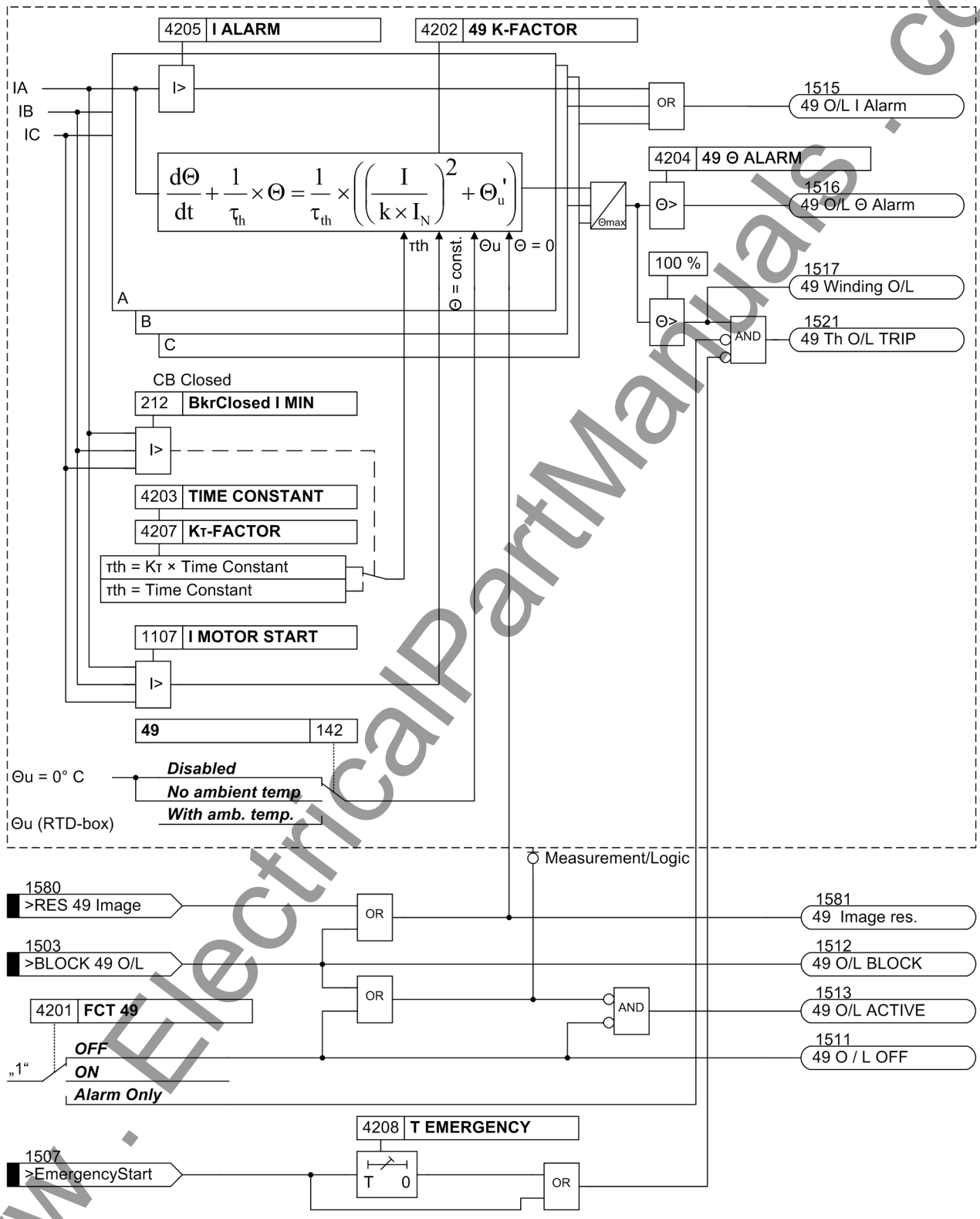


Figure 2-55 Logic diagram of the overload protection

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## 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 $I_{Nom\ Obj.}$ of the protected object (motor, transformer, cable) is used as a basis for overload detection. The thermally permissible continuous current $I_{max\ prim}$ allows to calculate a factor $k_{prim}$:

$$k_{prim} = \frac{I_{max\ prim}}{I_{Nom\ Obj.}}$$

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:

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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** $\tau_{th}$ (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.

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Example: Cable and current transformer with the following data:

Permissible Continuous Current $I_{max}$ = 500 A at $\Theta_u$ = 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:

$$k = \frac{I_{max}}{I_{Nom\ CT\ prim}} = \frac{500\ A}{600\ A} = 0.833$$

$$\tau_{th} = \frac{1}{60} \cdot \left(\frac{I_{1\ s}}{I_{max}}\right)^2 \cdot \frac{1}{60} \cdot 45^2 = 33.75\ min$$

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.

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**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.

$$\Theta_{\text{Nom sec}} = \Theta_{\text{Nom Mach}} \cdot \left(\frac{I_{\text{Nom prim CT}}}{I_{\text{Nom Mach}}}\right)^2$$

with

$\Theta_{\text{Nom sec}}$ Machine temperature with secondary nominal current = setting at the protective relay (address 4209 or 4210)

$\Theta_{\text{Nom mach}}$ Machine temperature with nominal machine current

$I_{\text{Nom CT prim}}$ Nominal Primary CT Current

$I_{\text{Nom mach}}$ 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

$\tau_{th}$ **TIME CONSTANT** (address 4203)

k **49 K-FACTOR** (address 4202)

$I_{\text{Nom}}$ Nominal device current in A

I Fault current through phase in A

$I_{\text{Pre}}$ Previous load current

$\Theta_{\text{Ut=0}}$ Coolant temperature input in °C with t=0

$\Theta_{\text{Nom}}$ Temperature with Nominal Current $I_{\text{Nom}}$(Address 4209 **49 TEMP. RISE I**)

$\Theta_u$ Coolant temperature input (scaling with address 4209 or 4210)

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Example:

Machine: $I_{Nom\ Mach}$ = 483 A

$I_{max\ Mach}$=1.15 $I_{Nom}$ at $\Theta_K$ = 104 °F or 40 °C

$\Theta_{Nom\ Mach}$ = 199.4° F or 93° C Temperature at $I_{Nom\ Mach}$

$\tau_{th}$ = 600 s (thermal time constant of the machine)

Current transformer: 500 A / 1 A

$$\mathbf{K\text{-}FACTOR} = 1.15 \cdot \frac{483\ A}{500\ A} \approx 1.11$$

(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.

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### 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<br>ON<br>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 |

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## 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.

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**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

$$I_F = | i_A + i_B + i_C + k_I \cdot i_N | > \Sigma \text{ I THRESHOLD} \cdot I_{Nom} + \Sigma \text{ I FACTOR} \cdot I_{max}$$

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):

$$k_I = \frac{\text{Ignd-CT PRIM} / \text{Ignd-CT SEC}}{\text{CT PRIMARY} / \text{CT SECONDARY}}$$

$\Sigma$ **I THRESHOLD** and $\Sigma$ **I FACTOR** are programmable settings. The component $\Sigma$ **I FACTOR** $\cdot$ 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`“.

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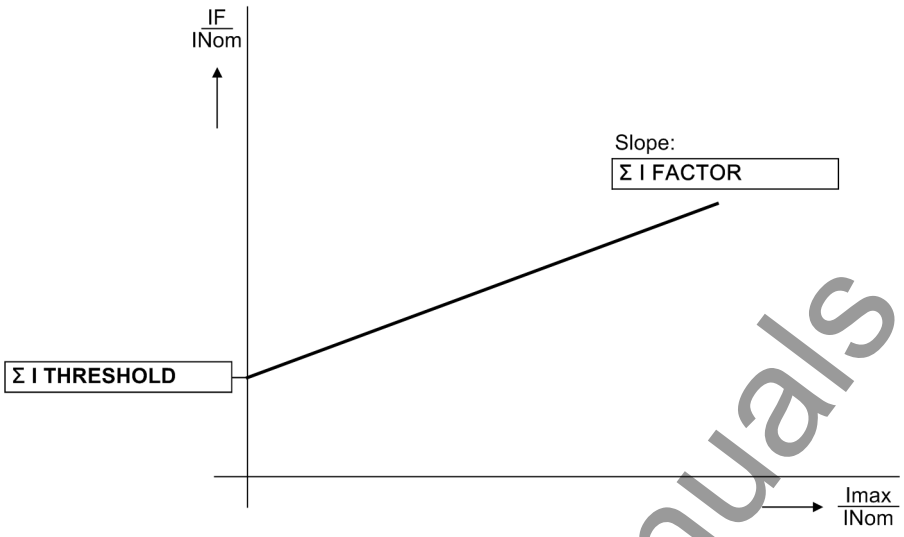


Figure 2-56 Current sum monitoring

**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 | Imin | / | Imax | < **BAL. FACTOR I** as long as Imax / $I_{Nom}$ > **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“.

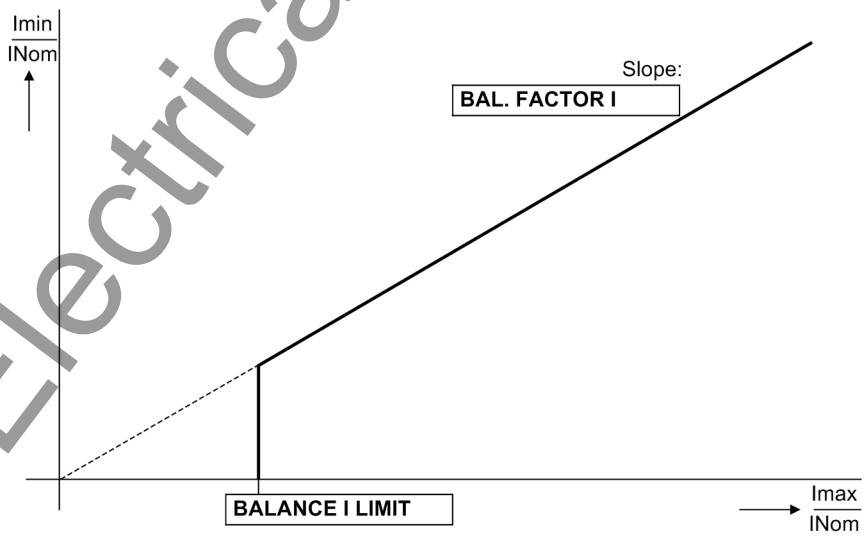


Figure 2-57 Current symmetry monitoring

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**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`“.

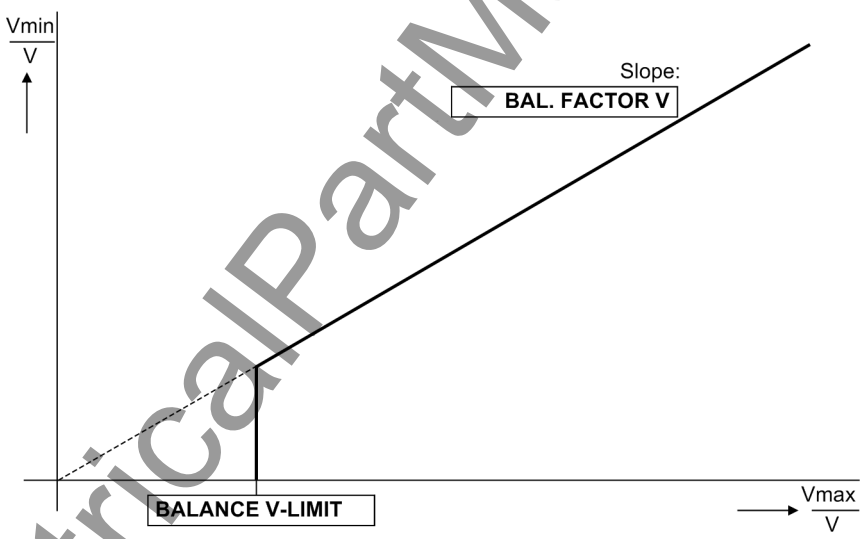


Figure 2-58 Voltage symmetry monitoring

**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 $\underline{I}_C$.

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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!

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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.

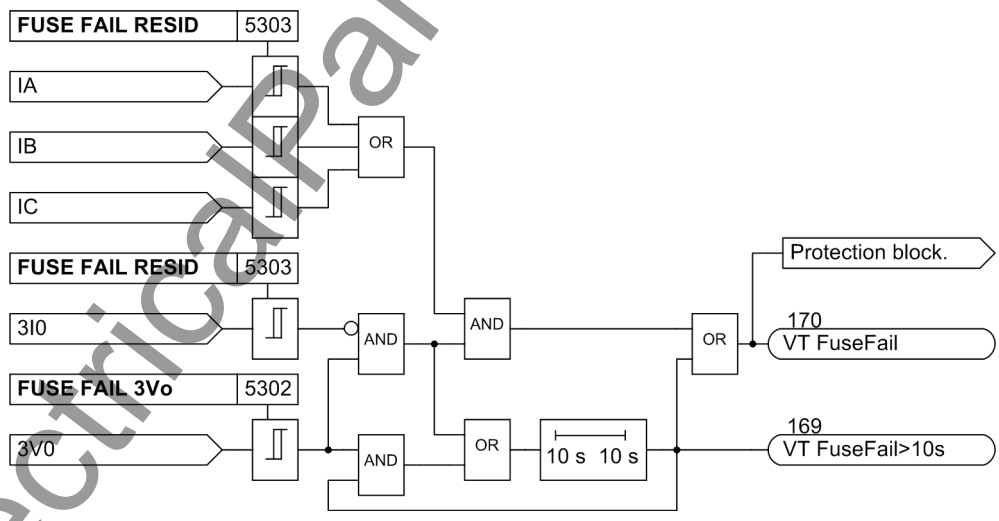


Figure 2-59 Logic diagram of the Fuse Failure Monitor

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### 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 not 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.

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**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<br>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<br>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 |

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#### 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.

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### 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.

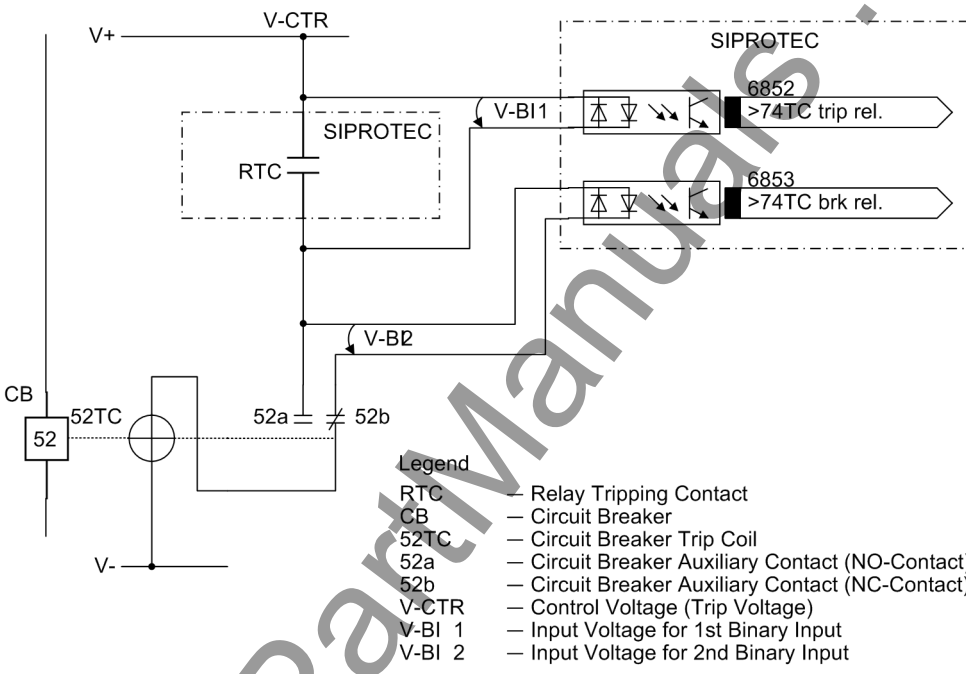


Figure 2-60 Principle of the trip circuit monitoring with two binary inputs

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 |

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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.

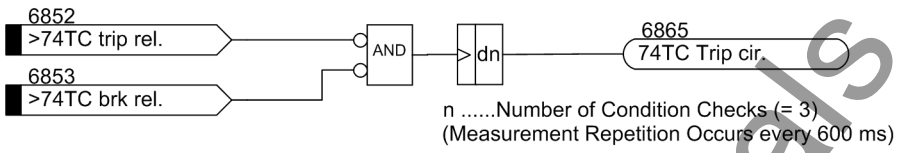


Figure 2-61 Logic diagram of the trip circuit supervision with two binary inputs

**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.

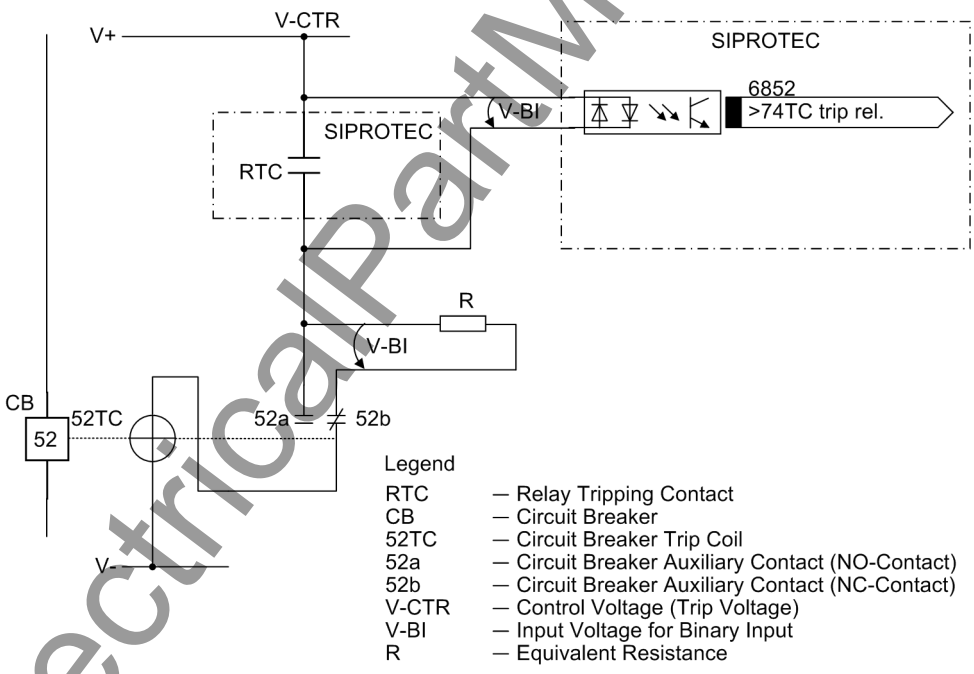


Figure 2-62 Trip circuit supervision with one binary input

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.

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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.

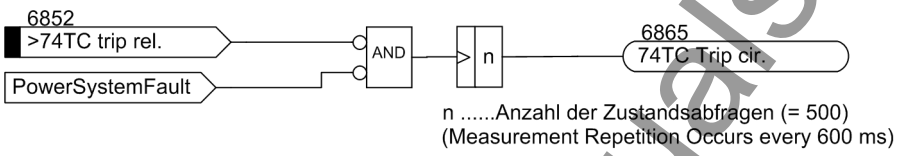


Figure 2-63 Logic diagram for trip circuit monitoring with one binary input

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.

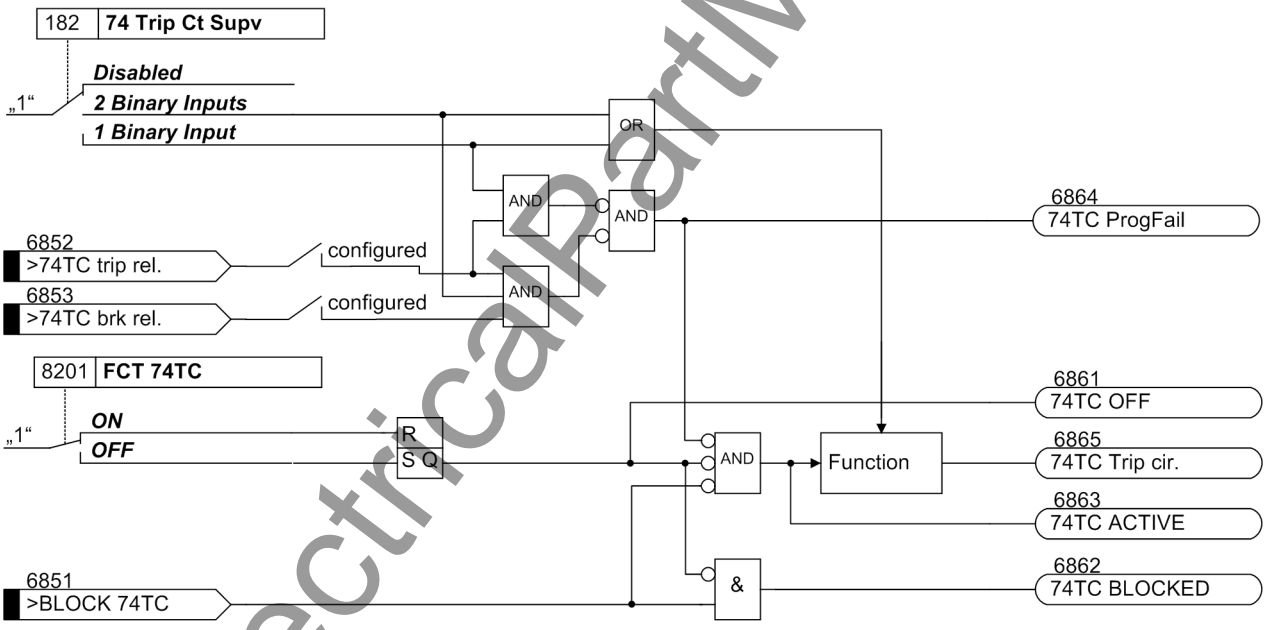


Figure 2-64 Message logic for the trip circuit monitor

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### 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<br>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 |

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## 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 |

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| 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)<br>„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.

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## 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**).

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**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.

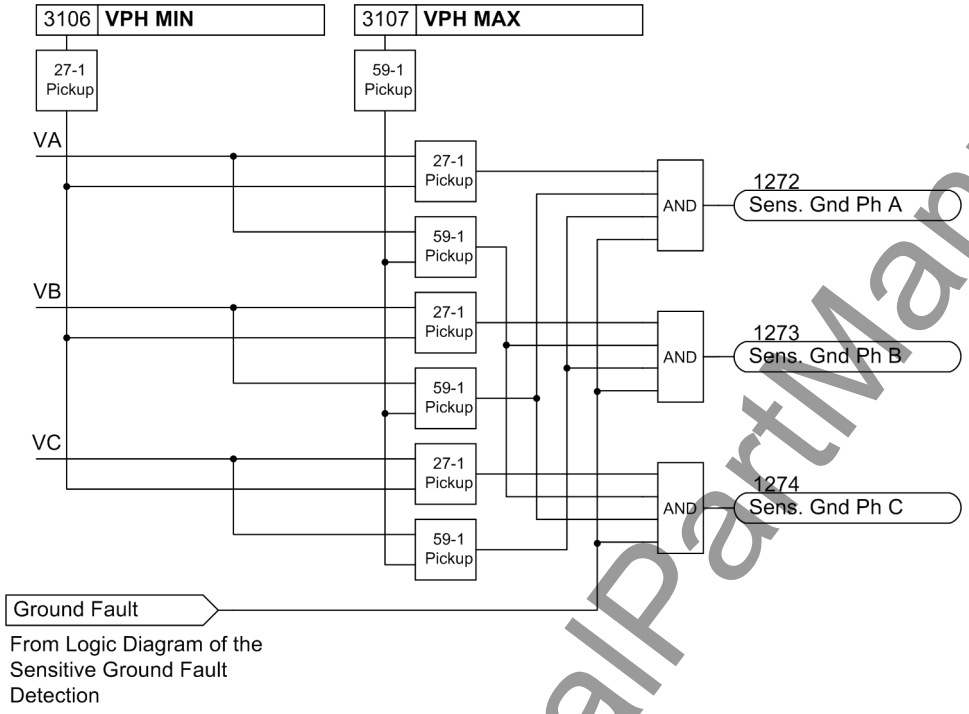


Figure 2-65 Determination of Grounded Phase

## 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**

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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 $3I0_{real}$.

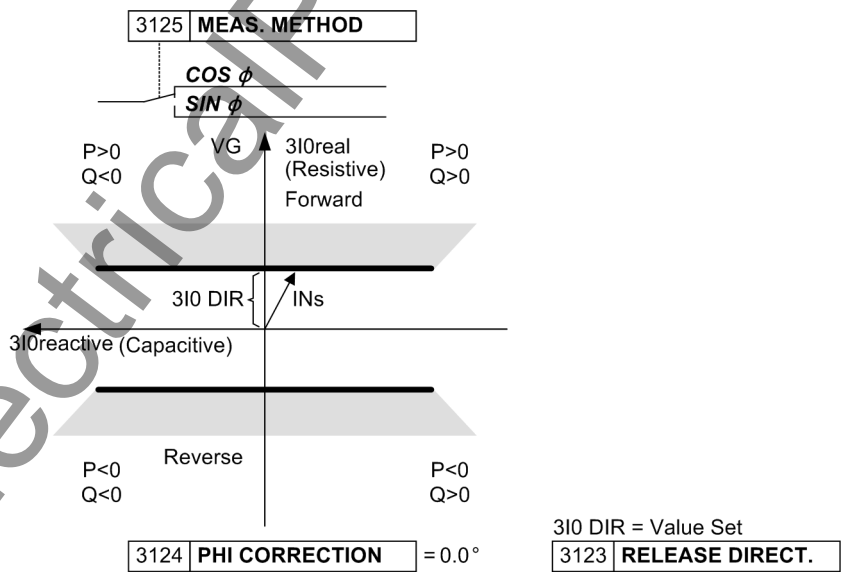


Figure 2-66 Directional characteristic for cos–φ–measurement

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.

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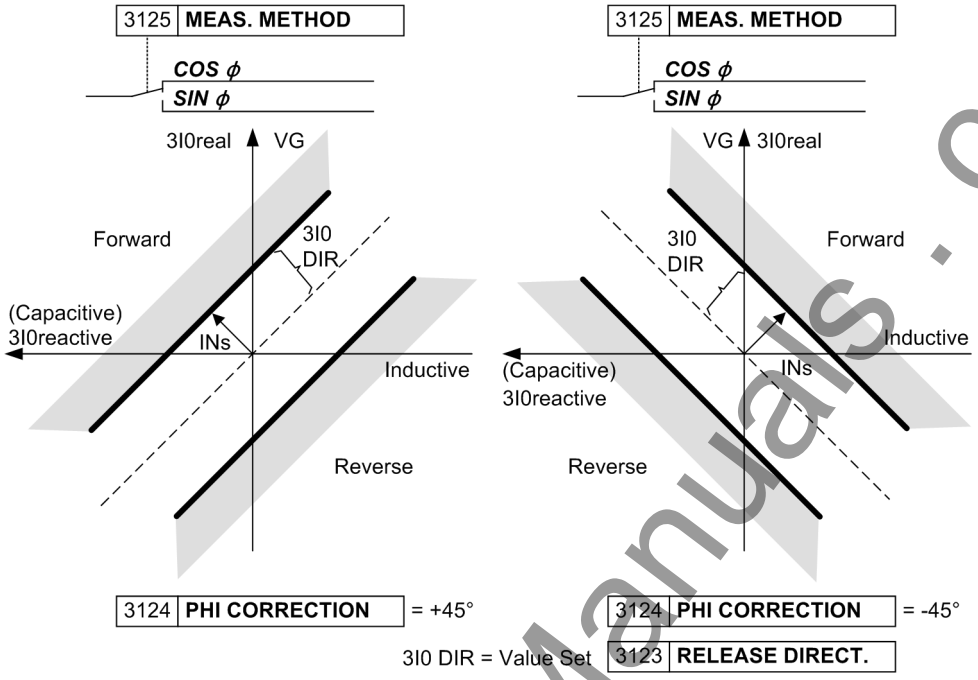


Figure 2-67 Directional characteristic for cos–φ–measurement

**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.

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**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.

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## 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.

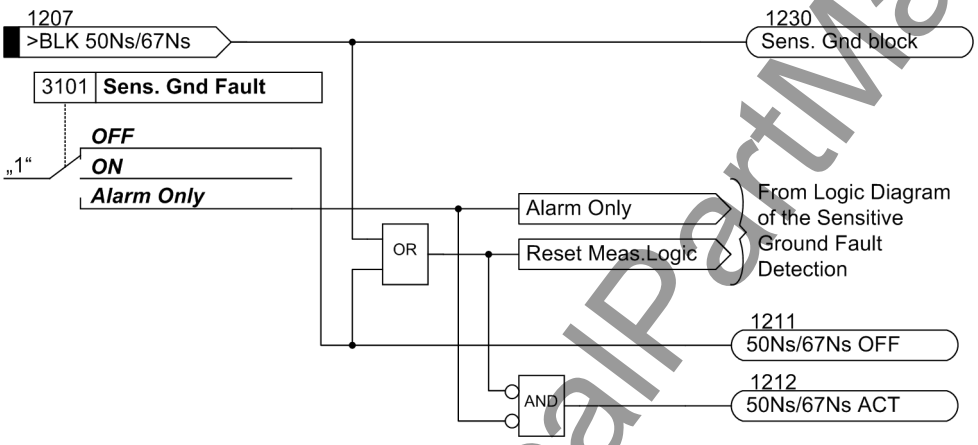


Figure 2-68 Activation of the sensitive ground current protection

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.

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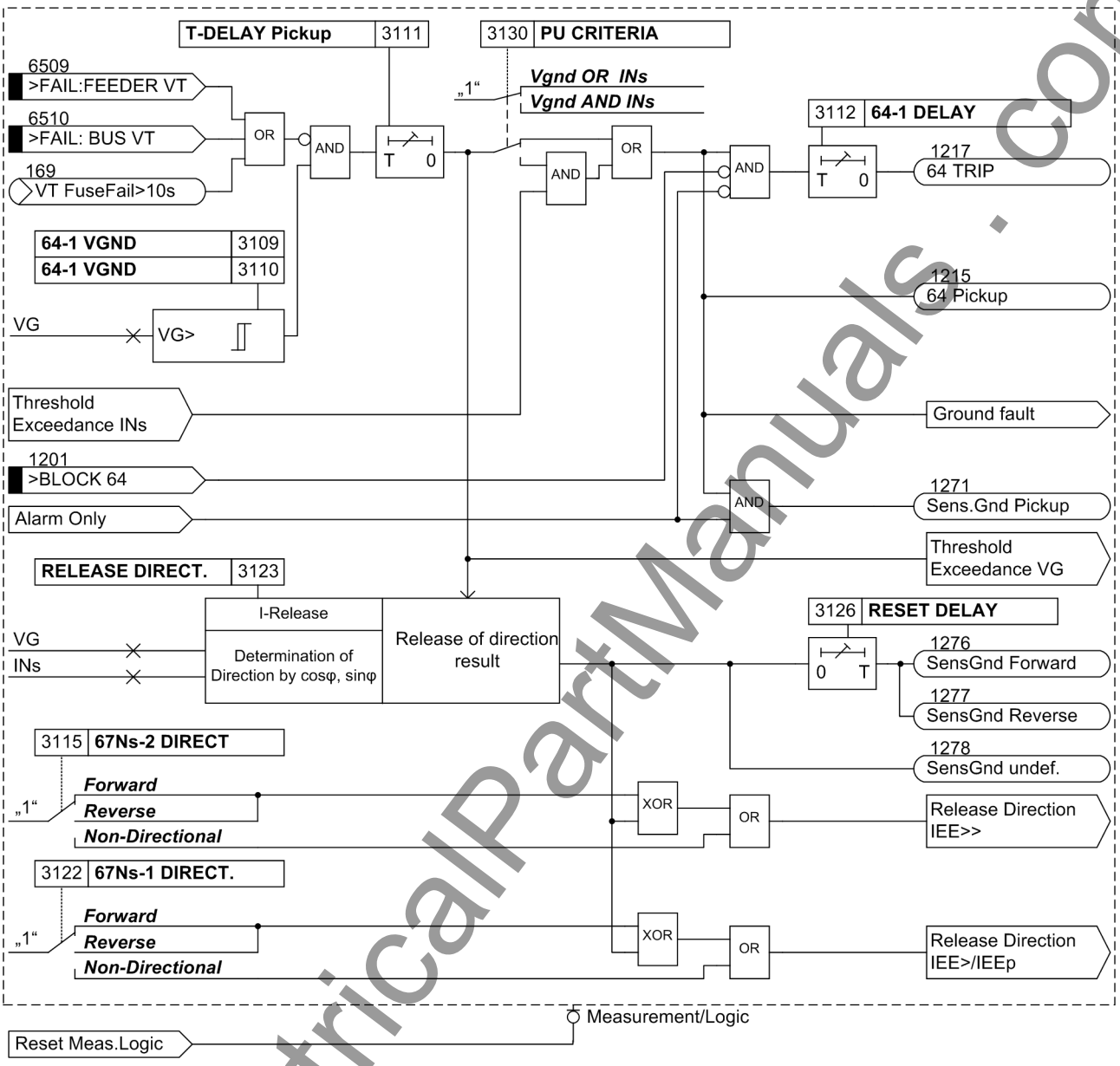


Figure 2-69 Logic diagram of the 64 element and determination of direction

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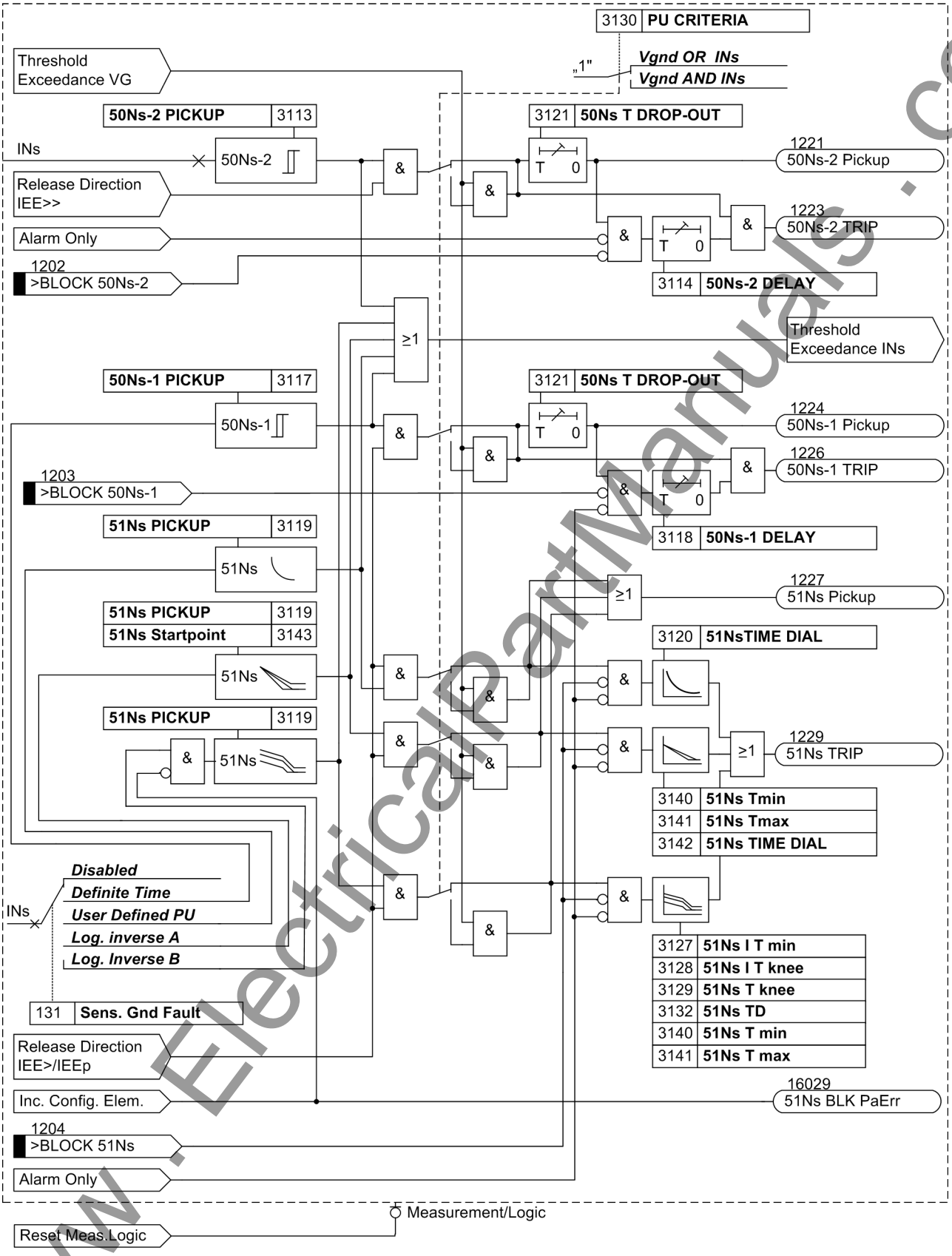


Figure 2-70 Logic diagram of the INs elements

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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.

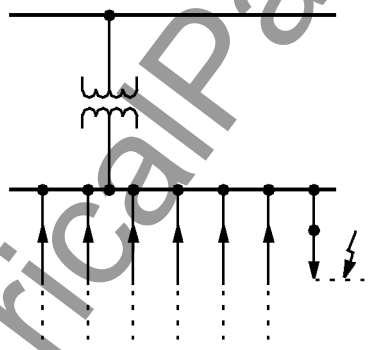

Figure 2-71 Location of ground faults in a radial network

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.

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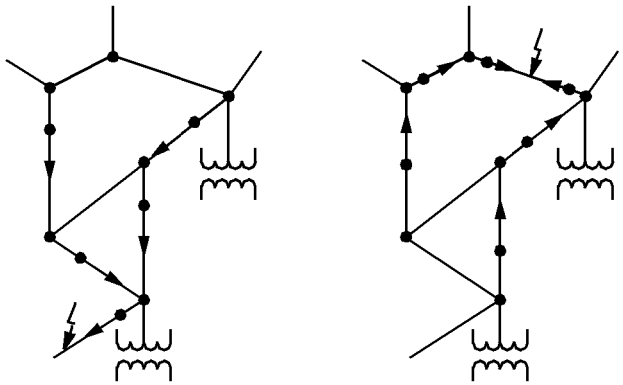

Figure 2-72 Determination of the ground fault location basing on directional indicators in the meshed system

## 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.

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**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 $t = 51Ns\ MAX.\ TIME\ DIAL - 51Ns\ TIME\ DIAL \cdot \ln(I/\mathbf{51Ns\ PICKUP})$

**Note:** For I/**51Ns PICKUP** > 35 the time applies for I/**51Ns PICKUP** = 35

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**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.

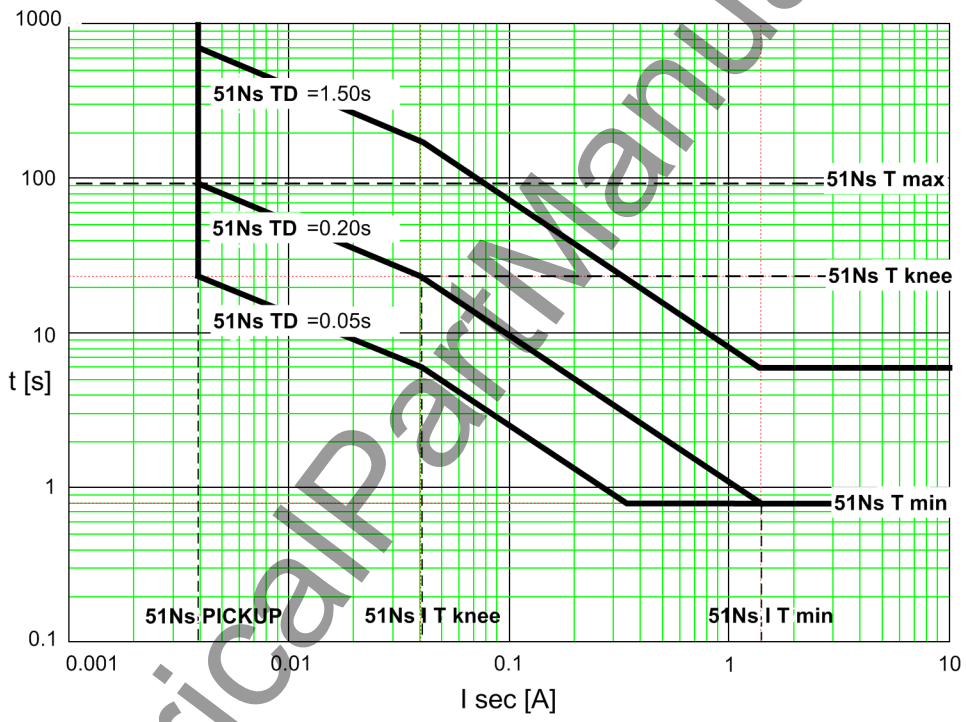


Figure 2-74 Trip-time characteristics of the inverse-time ground fault protection 51Ns with logarithmic inverse characteristic with knee point (example for 51Ns = 0.004 A)

**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.

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**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 | | | | | | |

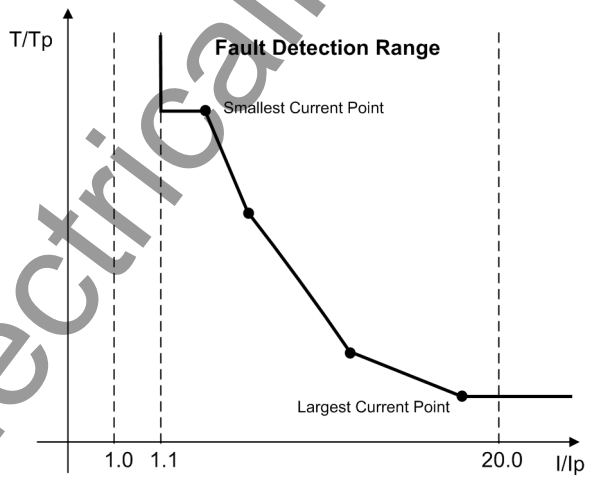


Figure 2-75 Use of a user-defined characteristic

**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

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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:

$$V_{N\,PRIM.} = Vph/Vdelta \cdot \frac{Vnom\ PRIMARY}{Vnom\ SECONDARY} \cdot V_{N\,SEC.}$$

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:

$$3V0_{PRIM.} = \frac{Vnom\ PRIMARY}{Vnom\ SECONDARY} \cdot 3V0_{SEC.}$$

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 |

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When changing to primary values, the following applies:

$$3109\ \text{VGND(measured)} = 1.73 \cdot \frac{12\ \text{kV}}{100\ \text{V}} = 8.3\ \text{kV}$$

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:

$$3110\ \ \text{VGND(calculated)} = \frac{12\ \text{kV}}{100\ \text{V}} = 4.8\ \text{kV}$$

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

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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).

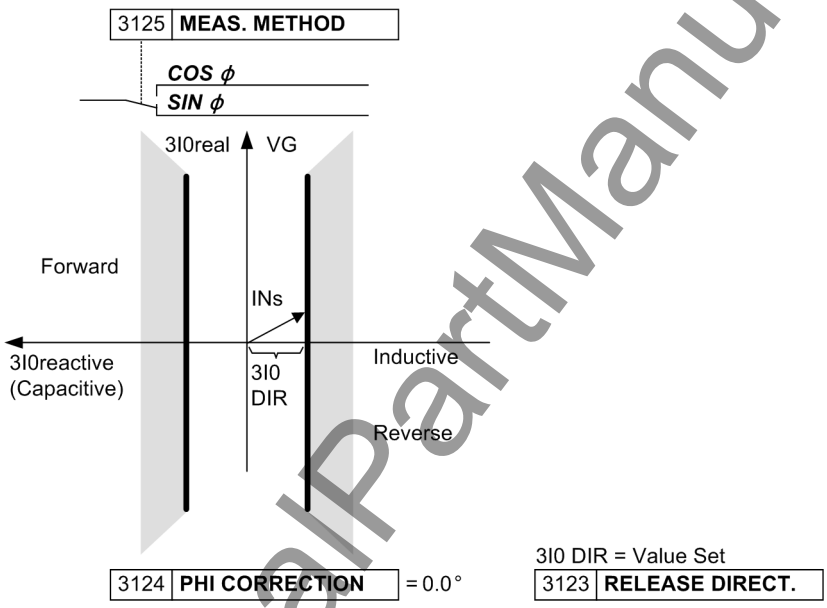


Figure 2-76 Directional characteristic for sin–φ–measurement

- 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.

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**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, $I_{Ns} \cos \varphi$. 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*** $\varphi$ 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*** $\varphi$ 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*** $\varphi$ 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.

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## 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<br>ON<br>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<br>Reverse<br>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 |

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| 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<br>Reverse<br>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<br>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<br>Vgnd AND INs | Vgnd OR INs | Sensitive Ground Fault PICKUP criteria |
| 3131 | M.of PU TD | | 1.00 .. 20.00 MofPU; ∞<br>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. |

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## 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 |

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## 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

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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.

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**Logic Diagram**

The following figure shows the logic diagram for the intermittent ground fault protection function.

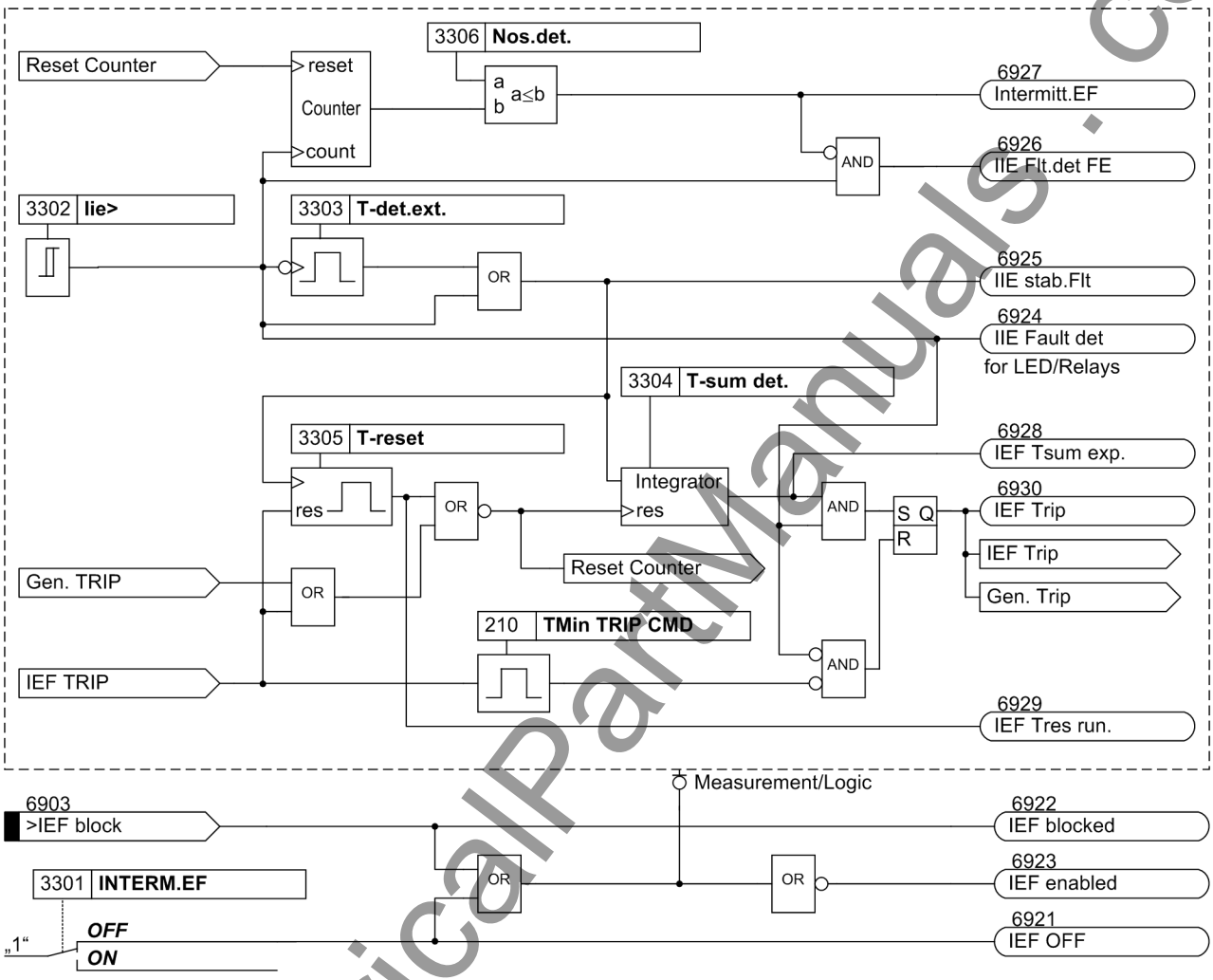


Figure 2-77 Logic diagram of the intermittent ground fault protection – principle

**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):

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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 |

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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.

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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.

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## 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 3IO 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.

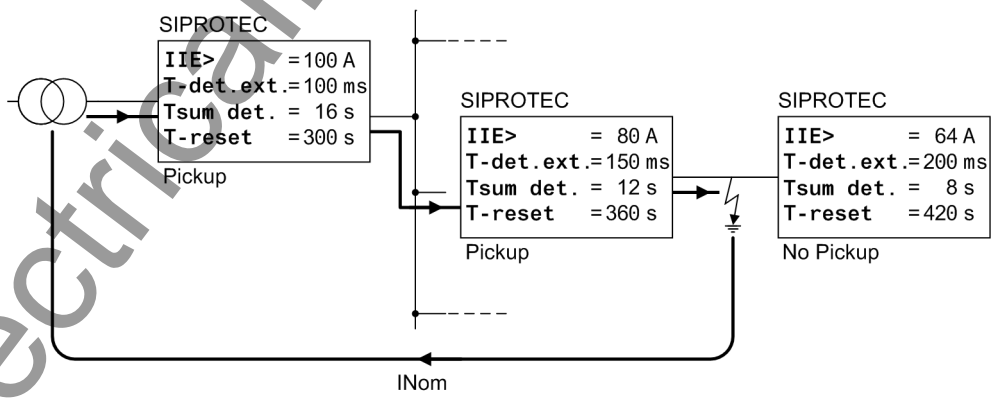


Figure 2-78 Example of selectivity criteria of the intermittent ground fault protection

Address 3306 **Nos.det.** specifies the number of pickups after which a ground fault is considered intermittent.

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### 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<br>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>= |

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## 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.

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### 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.

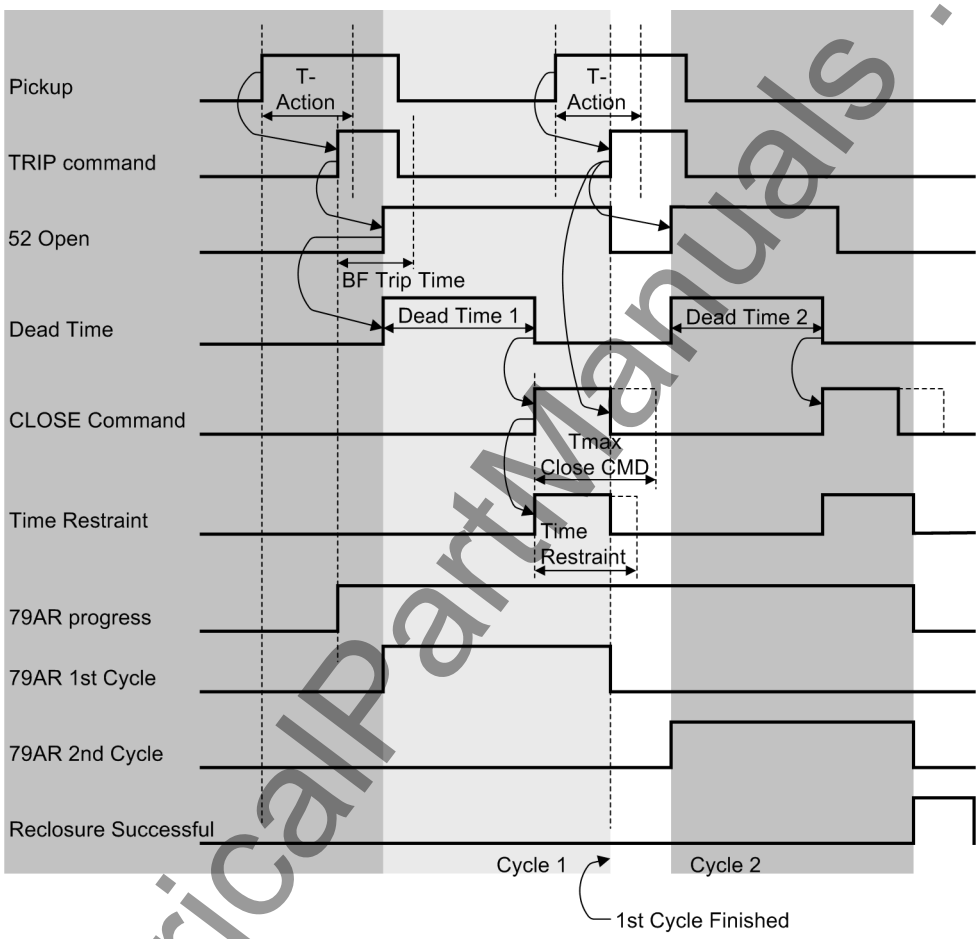


Figure 2-79 Timing diagram showing two reclosing shots, first cycle unsuccessful, second cycle successful

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.

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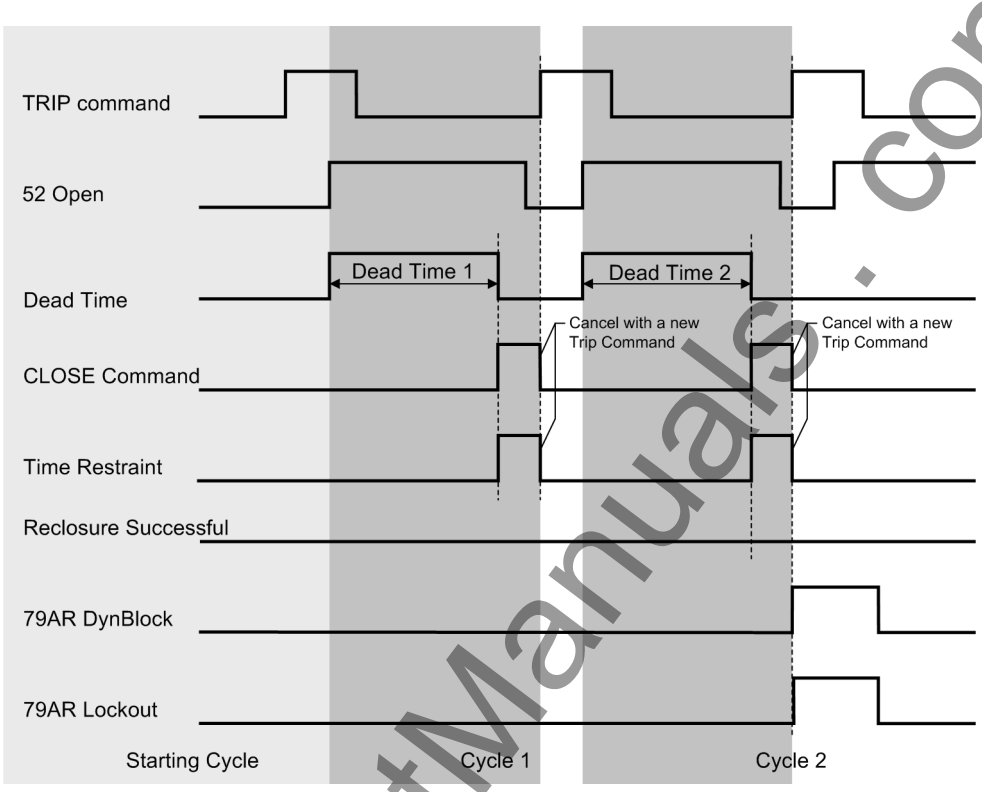


Figure 2-80 Timing diagram showing two unsuccessful reclosing shots

**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***.

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**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.

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**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

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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.

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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.

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### 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.

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**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.

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### 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.

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The following figure illustrates the control of the protective stages 50-2 and 50N-2.

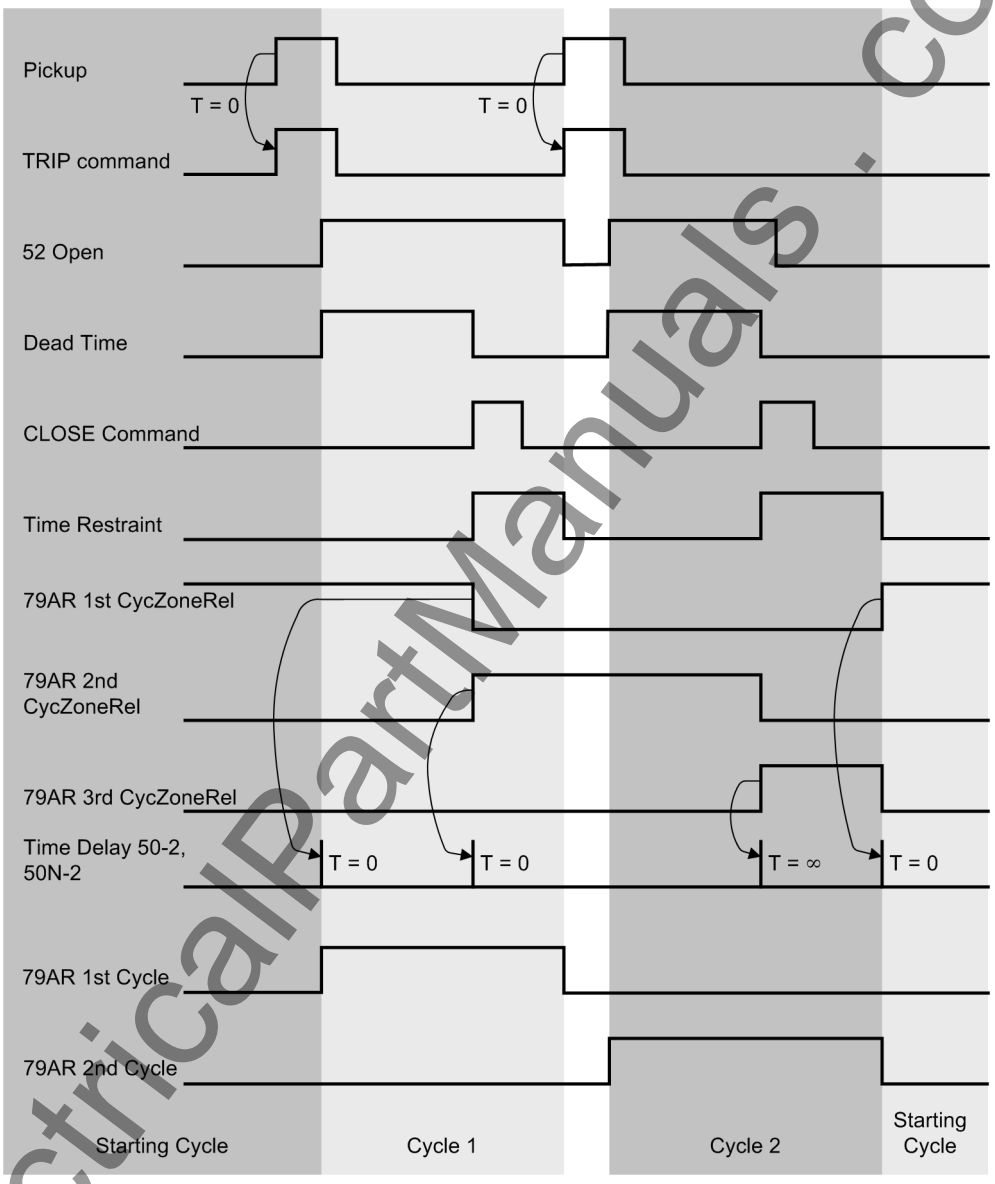


Figure 2-81 Control of protection elements for two-fold, successful auto-reclosure

**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.,

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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 se-

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quence coordination is not applied, element 50-1 is to be used only with the relative long time period (0.9 s).

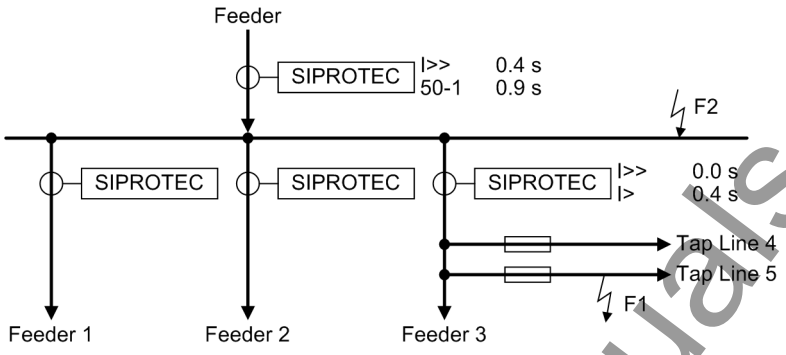


Figure 2-82 Zone sequencing with a fault occurring at Tap Line 2 and the busbar

## 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.

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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).

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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.

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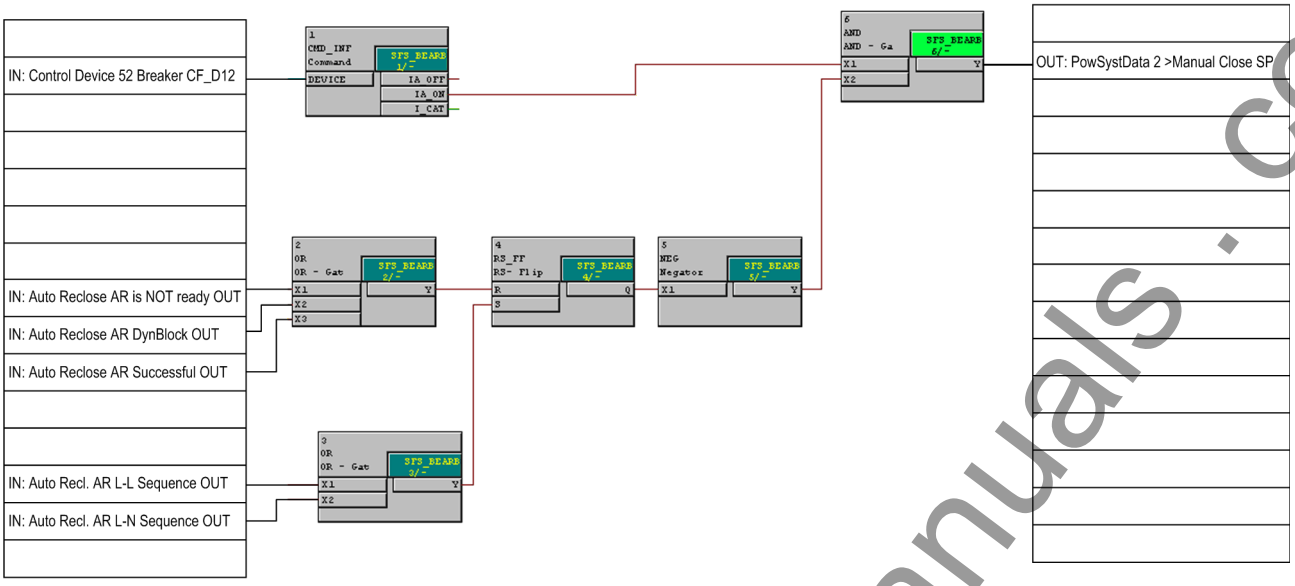


Figure 2-83 CFC Logic for ManCl with AR via Control

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 !

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**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 de-ionized 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.

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**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).

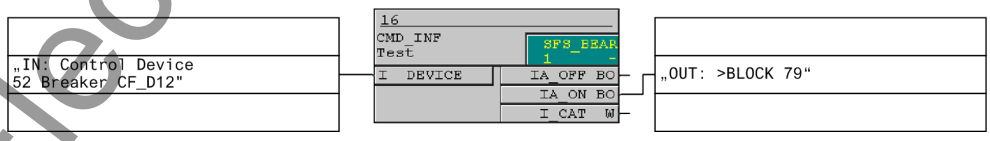


Figure 2-84 Blocking of the automatic reclose function using the internal control function

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**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.

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**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<br>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<br>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<br>NO | NO | External 25 synchronisation |
| 7140 | ZONE SEQ.COORD. | OFF<br>ON | OFF | ZSC - Zone sequence coordination |

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| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 7150 | 50-1 | No influence<br>Starts 79<br>Stops 79 | No influence | 50-1 |
| 7151 | 50N-1 | No influence<br>Starts 79<br>Stops 79 | No influence | 50N-1 |
| 7152 | 50-2 | No influence<br>Starts 79<br>Stops 79 | No influence | 50-2 |
| 7153 | 50N-2 | No influence<br>Starts 79<br>Stops 79 | No influence | 50N-2 |
| 7154 | 51 | No influence<br>Starts 79<br>Stops 79 | No influence | 51 |
| 7155 | 51N | No influence<br>Starts 79<br>Stops 79 | No influence | 51N |
| 7156 | 67-1 | No influence<br>Starts 79<br>Stops 79 | No influence | 67-1 |
| 7157 | 67N-1 | No influence<br>Starts 79<br>Stops 79 | No influence | 67N-1 |
| 7158 | 67-2 | No influence<br>Starts 79<br>Stops 79 | No influence | 67-2 |
| 7159 | 67N-2 | No influence<br>Starts 79<br>Stops 79 | No influence | 67N-2 |
| 7160 | 67 TOC | No influence<br>Starts 79<br>Stops 79 | No influence | 67 TOC |
| 7161 | 67N TOC | No influence<br>Starts 79<br>Stops 79 | No influence | 67N TOC |
| 7162 | sens Ground Flt | No influence<br>Starts 79<br>Stops 79 | No influence | (Sensitive) Ground Fault |
| 7163 | 46 | No influence<br>Starts 79<br>Stops 79 | No influence | 46 |
| 7164 | BINARY INPUT | No influence<br>Starts 79<br>Stops 79 | No influence | Binary Input |
| 7165 | 3Pol.PICKUP BLK | YES<br>NO | NO | 3 Pole Pickup blocks 79 |
| 7200 | bef.1.Cy:50-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 50-1 |

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| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 7201 | bef.1.Cy:50N-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 50N-1 |
| 7202 | bef.1.Cy:50-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 50-2 |
| 7203 | bef.1.Cy:50N-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 50N-2 |
| 7204 | bef.1.Cy:51 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 51 |
| 7205 | bef.1.Cy:51N | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 51N |
| 7206 | bef.1.Cy:67-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67-1 |
| 7207 | bef.1.Cy:67N-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67N-1 |
| 7208 | bef.1.Cy:67-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67-2 |
| 7209 | bef.1.Cy:67N-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67N-2 |
| 7210 | bef.1.Cy:67 TOC | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67 TOC |
| 7211 | bef.1.Cy:67NTOC | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67N TOC |
| 7212 | bef.2.Cy:50-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 50-1 |
| 7213 | bef.2.Cy:50N-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 50N-1 |
| 7214 | bef.2.Cy:50-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 50-2 |
| 7215 | bef.2.Cy:50N-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 50N-2 |
| 7216 | bef.2.Cy:51 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 51 |

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| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 7217 | bef.2.Cy:51N | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 51N |
| 7218 | bef.2.Cy:67-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67-1 |
| 7219 | bef.2.Cy:67N-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67N-1 |
| 7220 | bef.2.Cy:67-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67-2 |
| 7221 | bef.2.Cy:67N-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67N-2 |
| 7222 | bef.2.Cy:67 TOC | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67 TOC |
| 7223 | bef.2.Cy:67NTOC | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67N TOC |
| 7224 | bef.3.Cy:50-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 50-1 |
| 7225 | bef.3.Cy:50N-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 50N-1 |
| 7226 | bef.3.Cy:50-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 50-2 |
| 7227 | bef.3.Cy:50N-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 50N-2 |
| 7228 | bef.3.Cy:51 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 51 |
| 7229 | bef.3.Cy:51N | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 51N |
| 7230 | bef.3.Cy:67-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67-1 |
| 7231 | bef.3.Cy:67N-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67N-1 |
| 7232 | bef.3.Cy:67-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67-2 |

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| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 7233 | bef.3.Cy:67N-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67N-2 |
| 7234 | bef.3.Cy:67 TOC | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67 TOC |
| 7235 | bef.3.Cy:67NTOC | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67N TOC |
| 7236 | bef.4.Cy:50-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 50-1 |
| 7237 | bef.4.Cy:50N-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 50N-1 |
| 7238 | bef.4.Cy:50-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 50-2 |
| 7239 | bef.4.Cy:50N-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 50N-2 |
| 7240 | bef.4.Cy:51 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 51 |
| 7241 | bef.4.Cy:51N | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 51N |
| 7242 | bef.4.Cy:67-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67-1 |
| 7243 | bef.4.Cy:67N-1 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67N-1 |
| 7244 | bef.4.Cy:67-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67-2 |
| 7245 | bef.4.Cy:67N-2 | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67N-2 |
| 7246 | bef.4.Cy:67 TOC | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67 TOC |
| 7247 | bef.4.Cy:67NTOC | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67N TOC |

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## 2.14.8 Information List

| No. | Information | Type of Information | 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 |

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| 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 |

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## 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.

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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.

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## 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<br>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 |

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## 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).

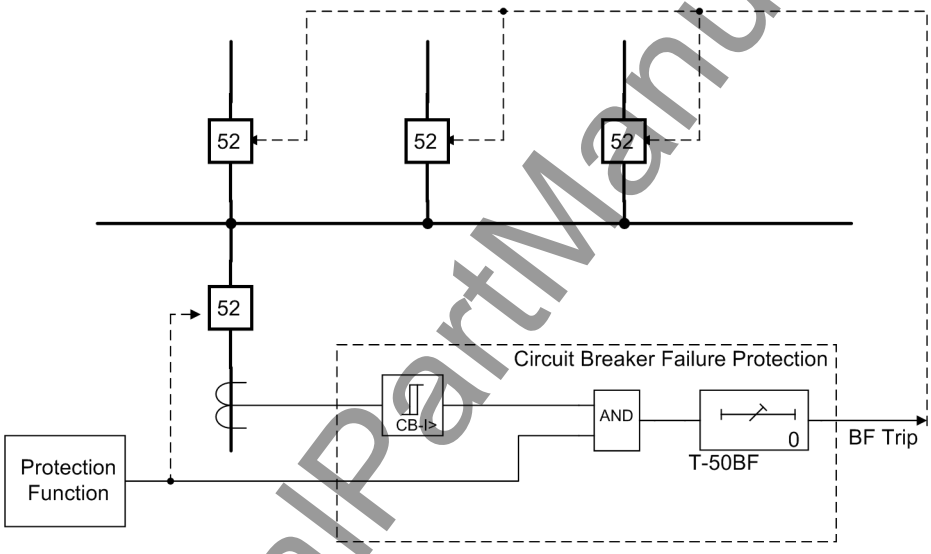


Figure 2-85 Functional principle of the breaker failure protection function

**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

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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.

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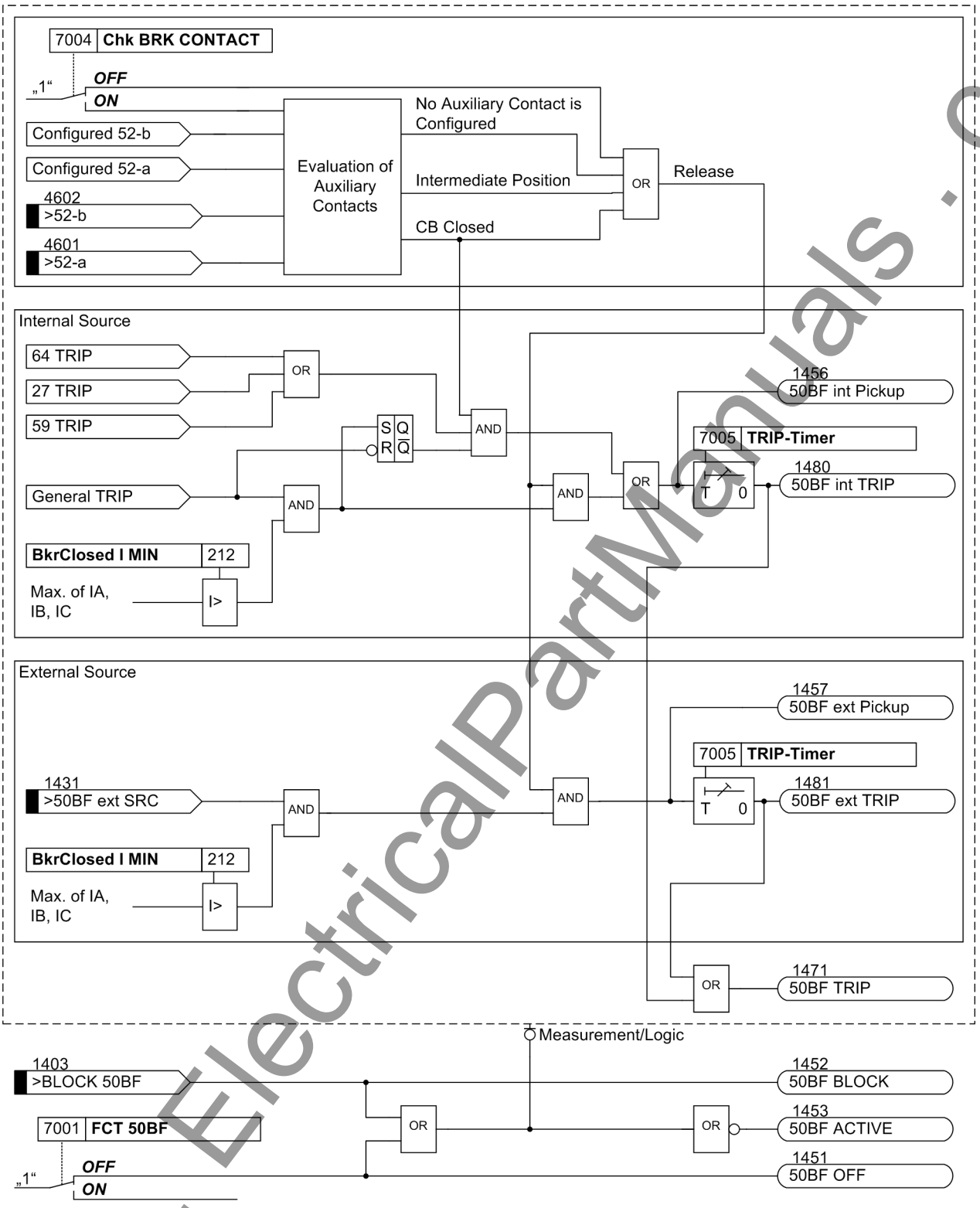


Figure 2-86 Logic diagram for breaker failure protection

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## 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.

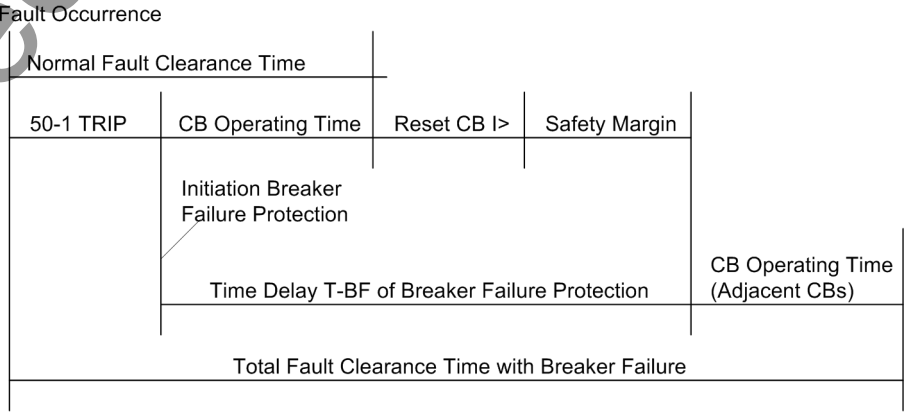


Figure 2-87 Timing for a Typical Breaker Failure Scenario

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### 2.16.3 Settings

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 7001 | FCT 50BF | OFF<br>ON | OFF | 50BF Breaker Failure Protection |
| 7004 | Chk BRK CONTACT | OFF<br>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 Information | 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 |

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# 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<br>-<br>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<br>- Displacement voltage | 27, 59, 59G | X | X |
| | $V_{rms}$ | True RMS (r.m.s. value) | - Voltage protection<br>- 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<br>- 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“.

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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.

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**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.

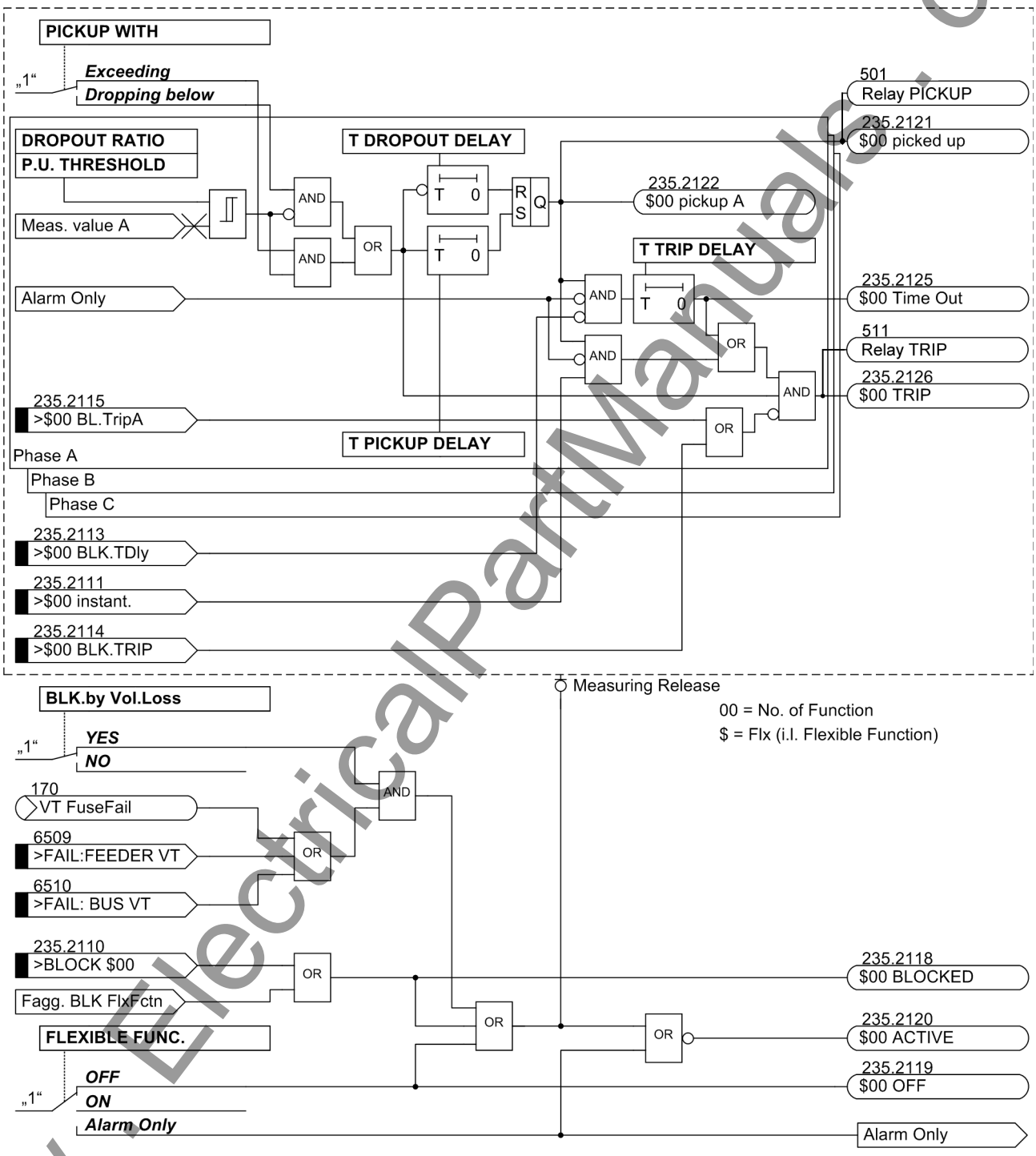


Figure 2-88 Logic diagram of the flexible protection functions

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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“).

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- 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.

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## 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**<br>Setting | Parameter **MEAS. QUANTITY**<br>Setting option |
|---|---|
| 1-phase,<br>3-phase | Current<br>Voltage<br>P forward<br>P reverse<br>Q forward<br>Q reverse<br>Power factor |
| without reference | Frequency<br>df/dt rising<br>df/dt falling<br>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.

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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:<br>- I2 (negative sequence protection)<br>- V2 (voltage asymmetry)<br><br>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.<br>**Attention**:The parameterization of the voltage threshold depends on the parameter **VOLTAGE SYSTEM**:<br>- **VOLTAGE SYSTEM** = Phase-to-phase:sym. component * $\sqrt{3}$<br>- **VOLTAGE SYSTEM** = Phase-to-ground:sym. component * 3 |
| | Voltage | Parameter **VOLTAGE SYSTEM** Setting option | |
| | | Phase-to-phase<br>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.<br><br>The parameter is hidden if phase-to-phase voltages are connected. |

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**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.

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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<br>Ib<br>Ic<br>IN<br>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<br>Vbc<br>Vca<br>Vag<br>Vbg<br>Vcg<br>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<br>Ib Vbg<br>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.

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**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.

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### 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<br>ON<br>Alarm Only | OFF | Flexible Function |
| 0 | OPERRAT. MODE | 3-phase<br>1-phase<br>no reference | 3-phase | Mode of Operation |
| 0 | MEAS. QUANTITY | Please select<br>Current<br>Voltage<br>P forward<br>P reverse<br>Q forward<br>Q reverse<br>Power factor<br>Frequency<br>df/dt rising<br>df/dt falling<br>Binray Input | Please select | Selection of Measured Quantity |
| 0 | MEAS. METHOD | Fundamental<br>True RMS<br>Positive seq.<br>Negative seq.<br>Zero sequence | Fundamental | Selection of Measurement Method |
| 0 | PICKUP WITH | Exceeding<br>Dropping below | Exceeding | Pickup with |
| 0 | CURRENT | Ia<br>Ib<br>Ic<br>In<br>In sensitive | Ia | Current |
| 0 | VOLTAGE | Please select<br>Va-n<br>Vb-n<br>Vc-n<br>Va-b<br>Vb-c<br>Vc-a<br>Vn | Please select | Voltage |
| 0 | POWER | Ia Va-n<br>Ib Vb-n<br>Ic Vc-n | Ia Va-n | Power |
| 0 | VOLTAGE SYSTEM | Phase-Phase<br>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 |

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| 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<br>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 |

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# 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<br>– detection of reverse energy supply from motors | |
| Q | forward | – monitoring of reactive power thresholds of equipment (transformers, lines)<br>– connecting a capacitor bank for reactive power compensation | |
| | reverse | – monitoring of reactive power thresholds of equipment (transformers, lines)<br>– 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.

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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.

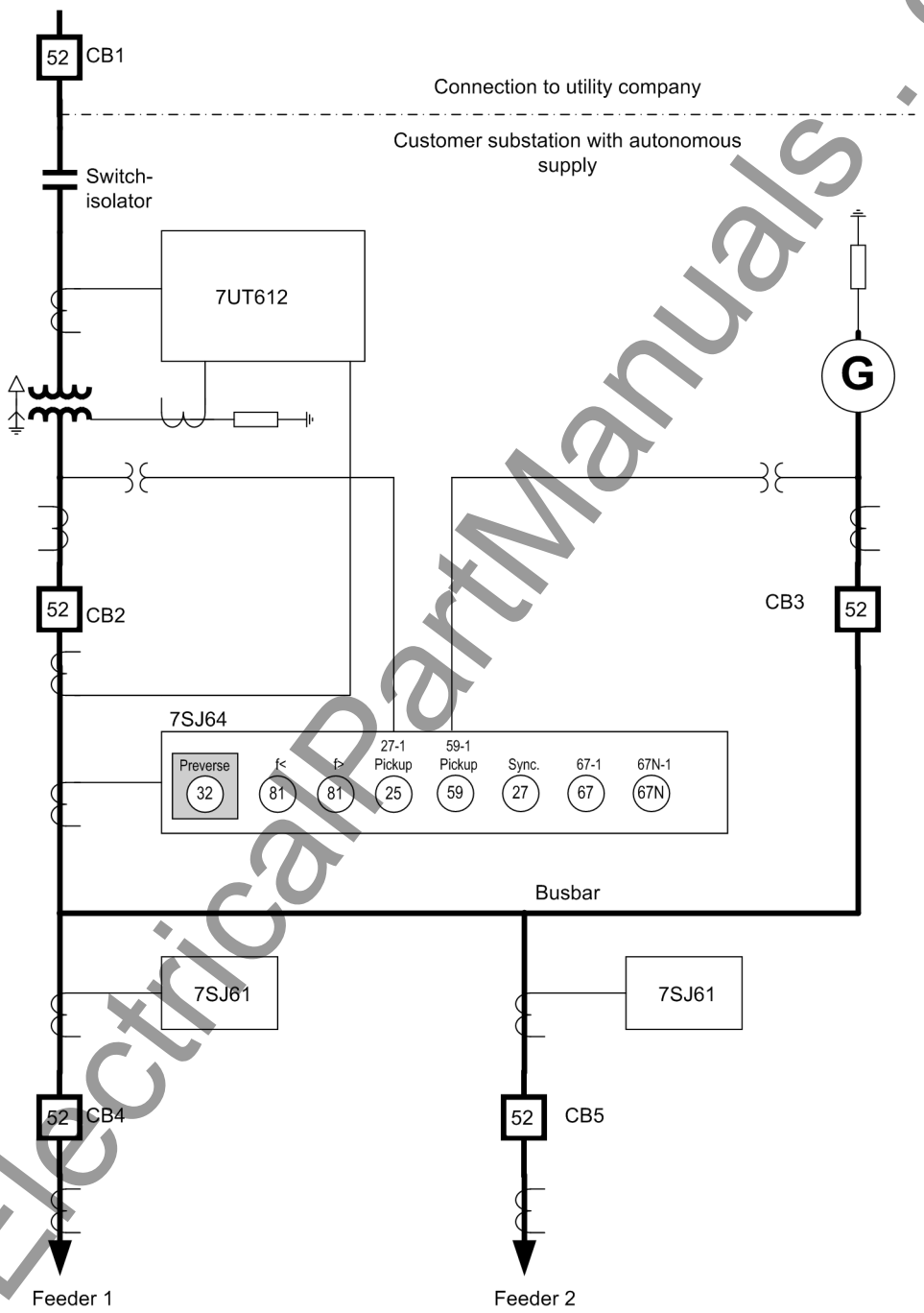


Figure 2-89 Example of a substation with autonomous generator supply

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**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).

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**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.

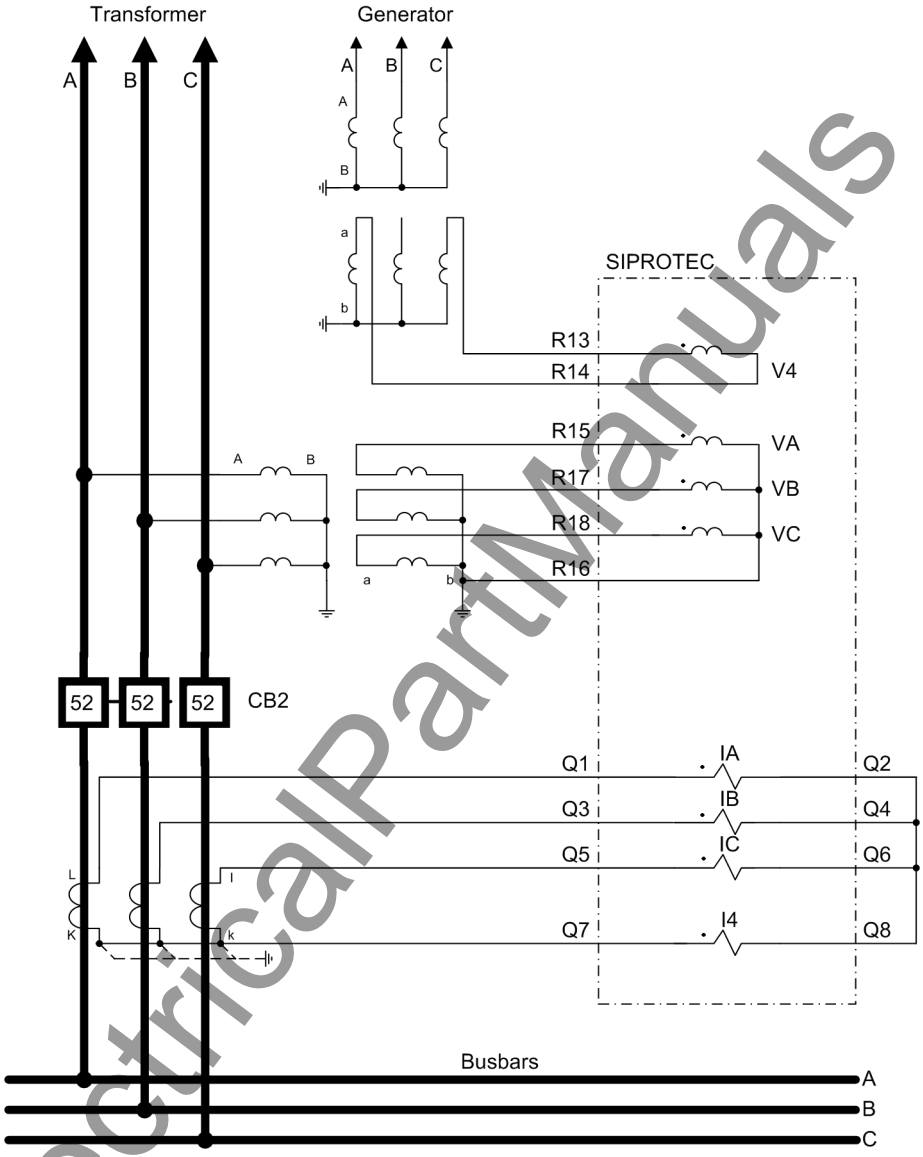


Figure 2-90 Wiring diagram for a 7SJ642 as reverse-power protection (flush-mounted case)

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## 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.

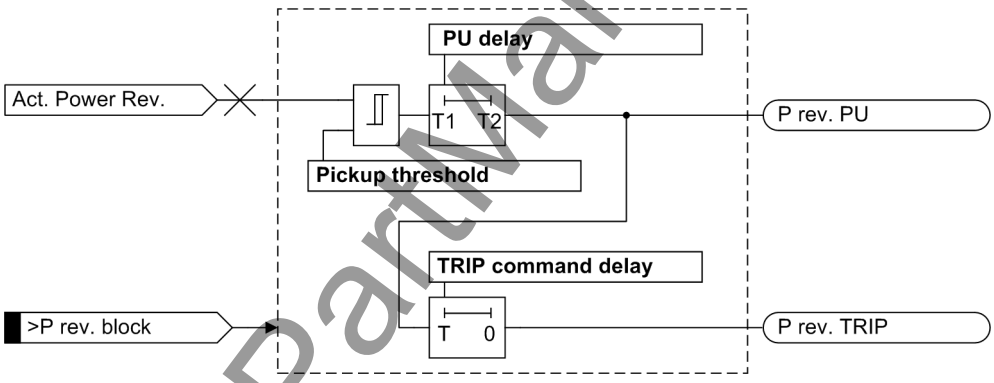


Figure 2-91 Logic diagram of the reverse-power determination with flexible protection function

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:

$$P_{sec} = P_{prim} \cdot \frac{V_{Nom,\,sec}}{V_{Nom,\,prim}} \cdot \frac{I_{Nom,\,sec}}{I_{Nom,\,prim}}$$

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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.

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### 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).

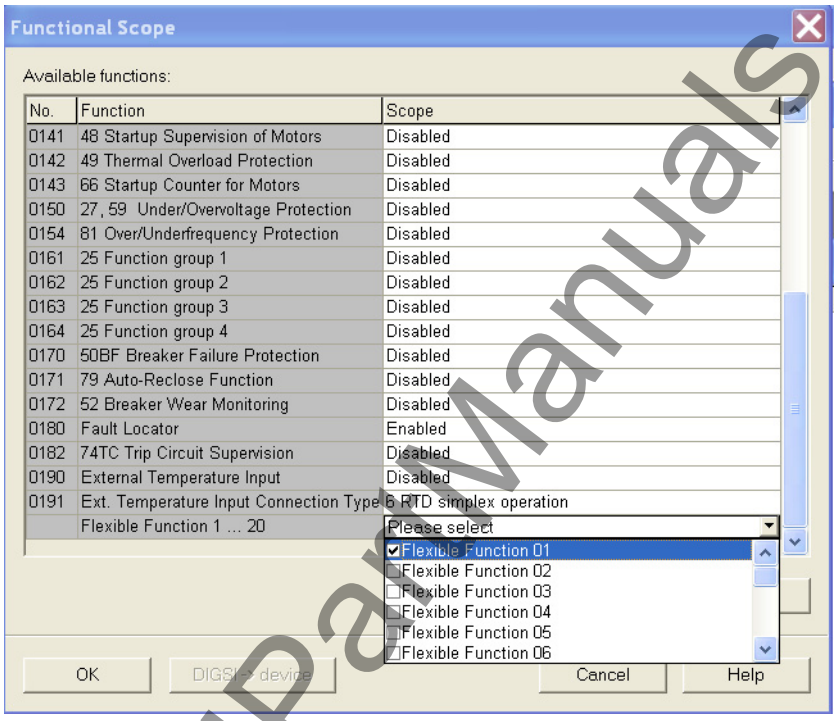


Figure 2-92 Configuration of a flexible protection function

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Select „Additional functions“ in the „Parameters“ menu to view the flexible function (figure 2-93).

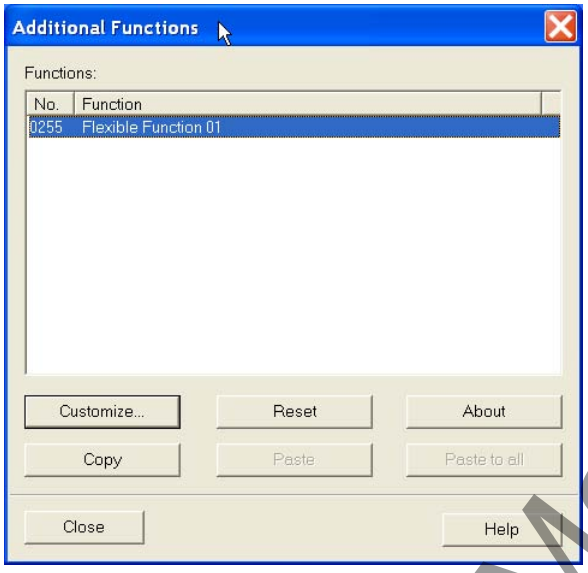


Figure 2-93 The flexible function appears in the function selection.

First activate the function at „Settings --> General“ and select the operating mode „3-phase“ (figure 2-94):

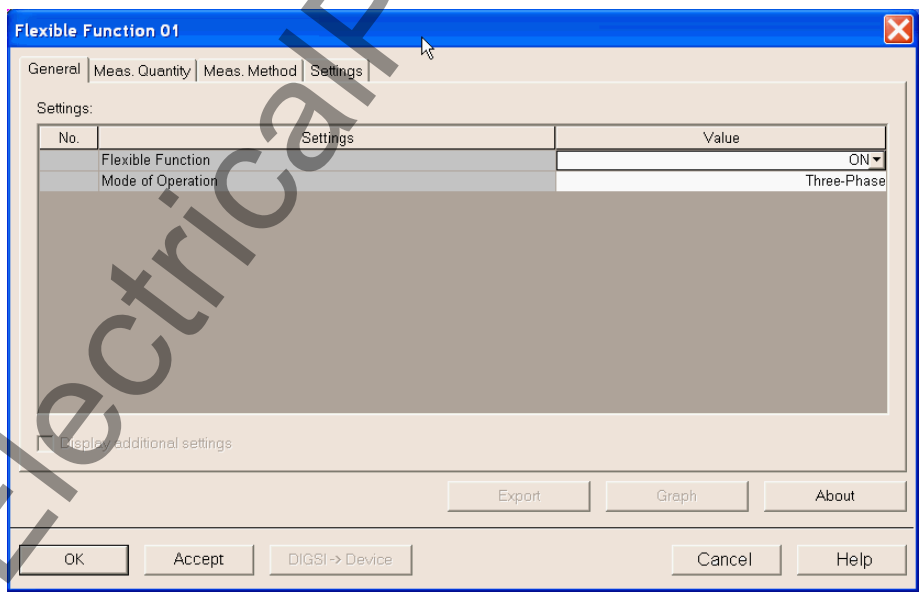


Figure 2-94 Selection of the three-phase operating mode

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.

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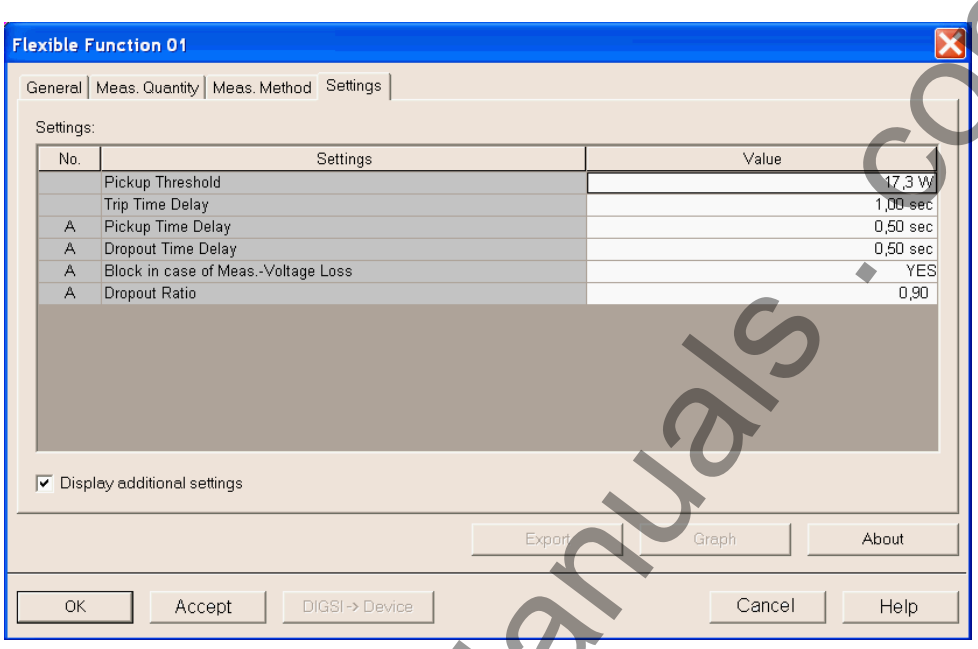


Figure 2-95 Setting options of the flexible function

**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.

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## 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.

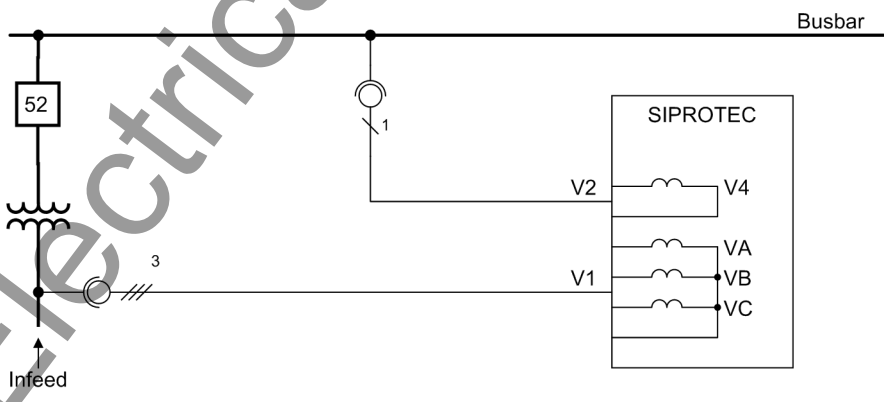


Figure 2-98 Infeed

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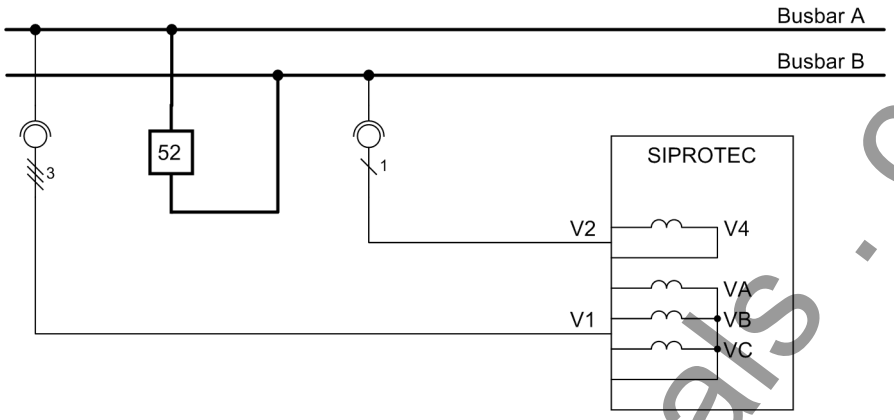


Figure 2-99 Bus coupler

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, Multiple-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 con-

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ditions 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)

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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 **d**$\alpha$ **SYNCHK** $\alpha$**2>**$\alpha$**1**?
- Is the angle difference $\alpha_1 - \alpha_2$ within the permitted threshold **d**$\alpha$ **SYNCHK** $\alpha$**2<**$\alpha$**1**?

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### 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 $f_{Nom} \pm 3$ 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 $f_{Nom} \pm 3$ 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**?

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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.

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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“).

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### 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).

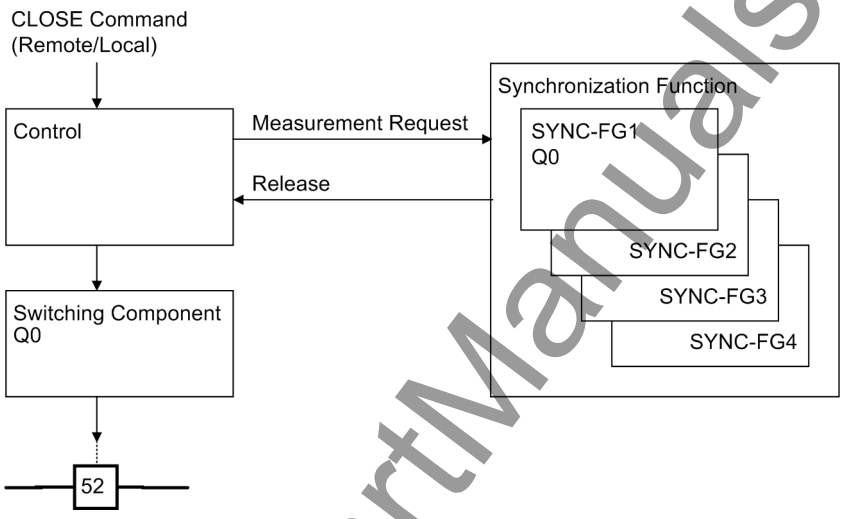


Figure 2-100 Interaction of control and synchrocheck

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**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).

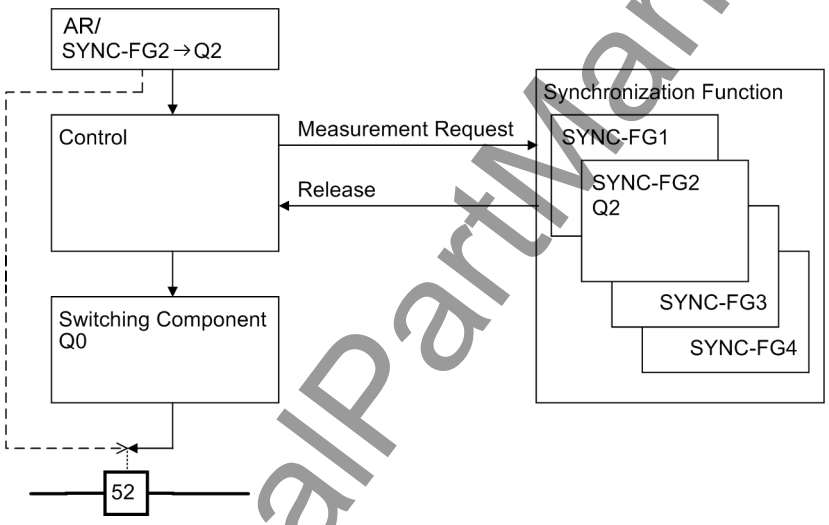


Figure 2-101 Connection of the automatic reclosing function to the synchrocheck

**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.

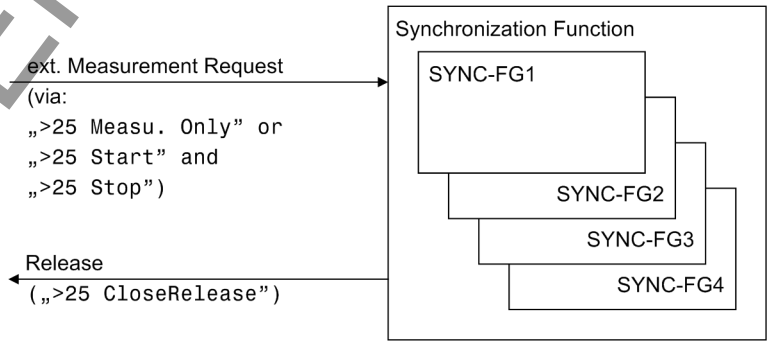


Figure 2-102 Interaction of synchronizing function and external control

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### 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 ($f_{Nom} \pm 3$ 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.

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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.

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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***.

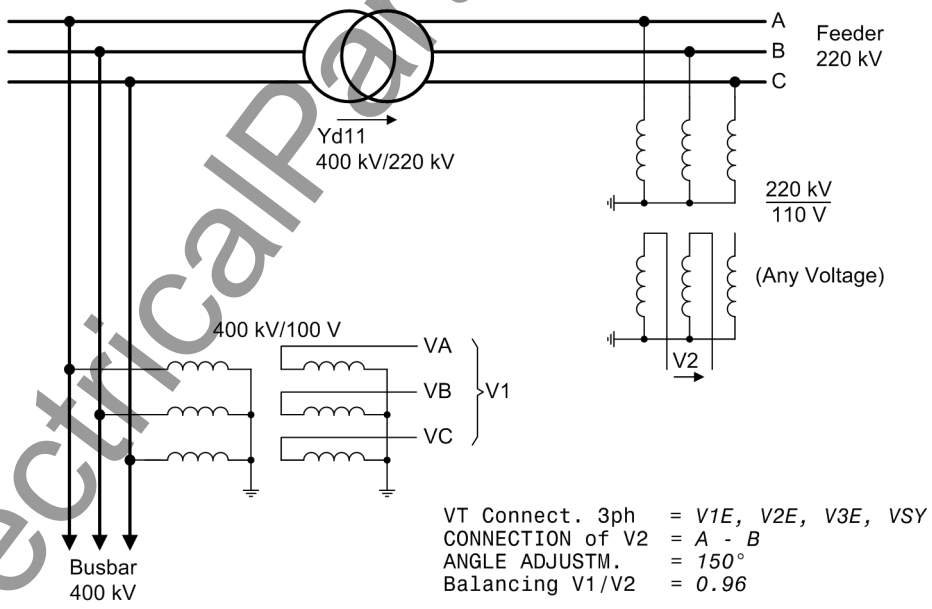


Figure 2-103 Busbar voltage measured accross transformer

**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

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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.

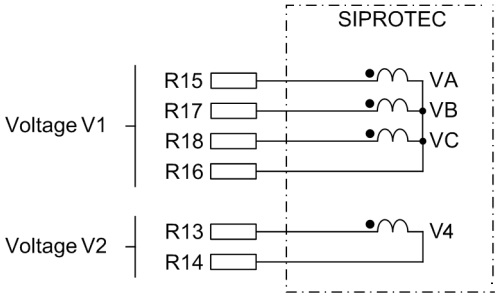


Figure 2-104 Connection of V1 and V2 at device

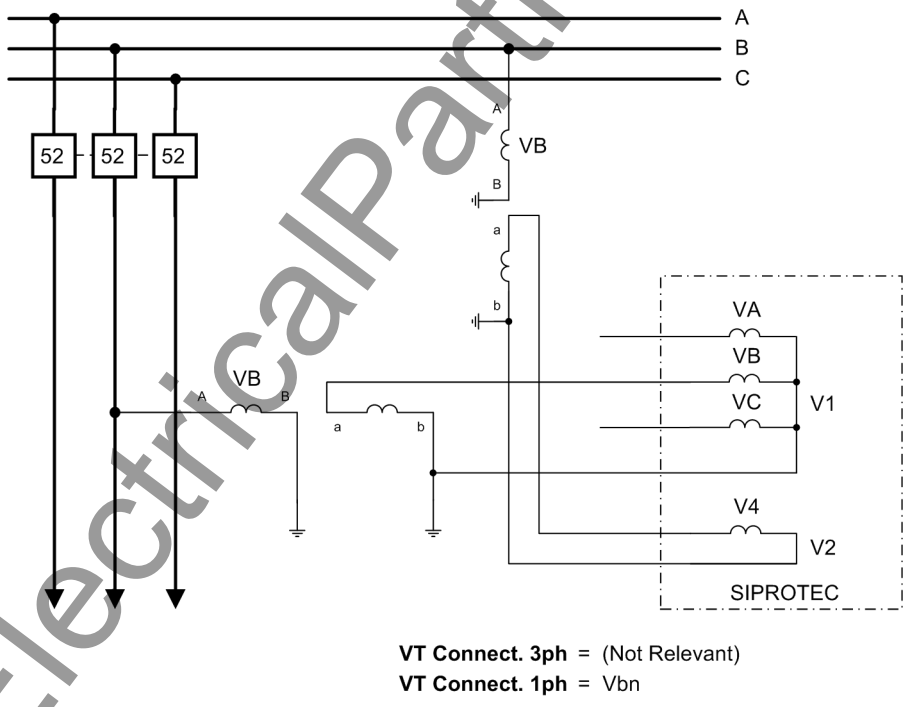


Figure 2-105 Single-phase connection (phase-ground) to side $V_1$

- 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.

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**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.

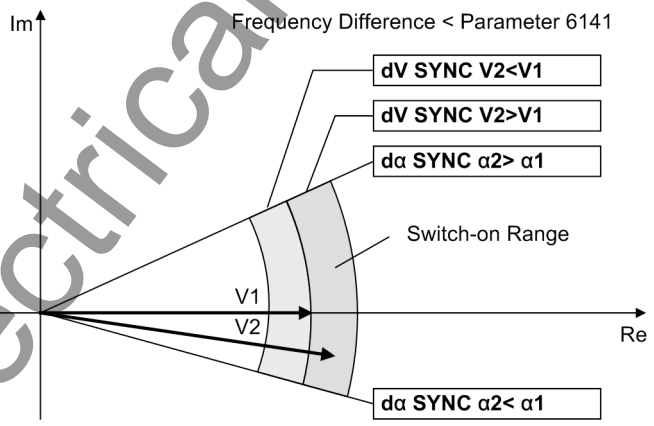


Figure 2-106 Switching under synchronous system conditions

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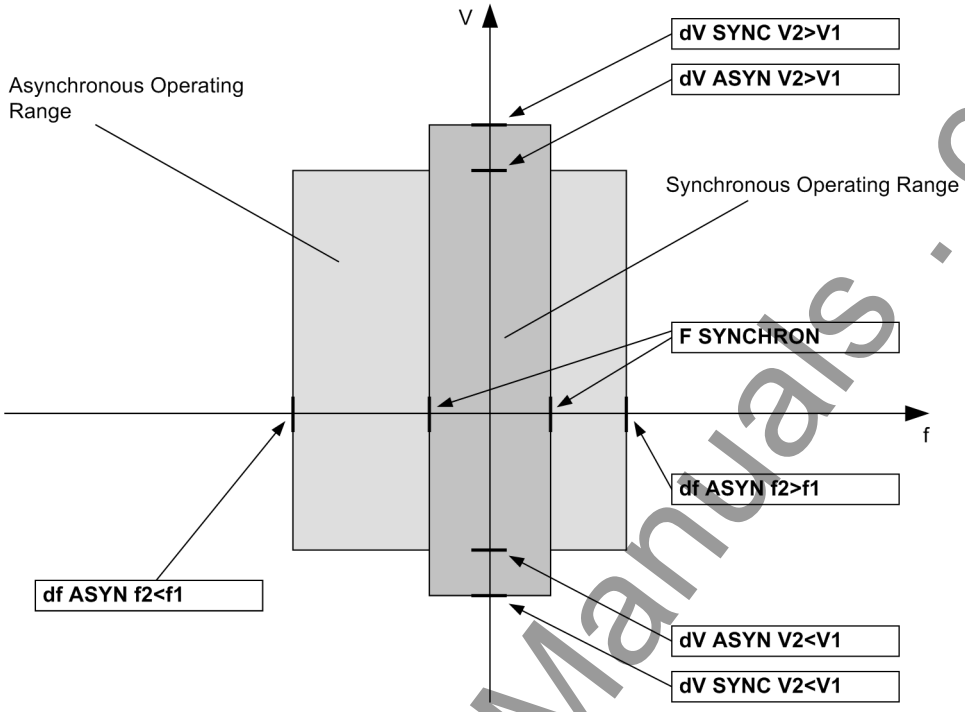


Figure 2-107 Operating range under synchronous and asynchronous conditions for voltage (V) and frequency (f)

**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**d**$\alpha$ **SYNCHK** $\alpha$**2>**$\alpha$**1** and 6x55**d**$\alpha$ **SYNCHK** $\alpha$**2<**$\alpha$**1** 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.

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### 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<br>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<br>NO | NO | ON-Command at V1< and V2> |
| 6108 | SYNC V1>V2< | YES<br>NO | NO | ON-Command at V1> and V2< |
| 6109 | SYNC V1<V2< | YES<br>NO | NO | ON-Command at V1< and V2< |
| 6110A | Direct CO | YES<br>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<br>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<br>B-G<br>C-G<br>A-B<br>B-C<br>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 |

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| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 6140 | SYNC PERMIS. | YES<br>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 |

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| No. | Information | Type of Information | 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 |

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## 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.

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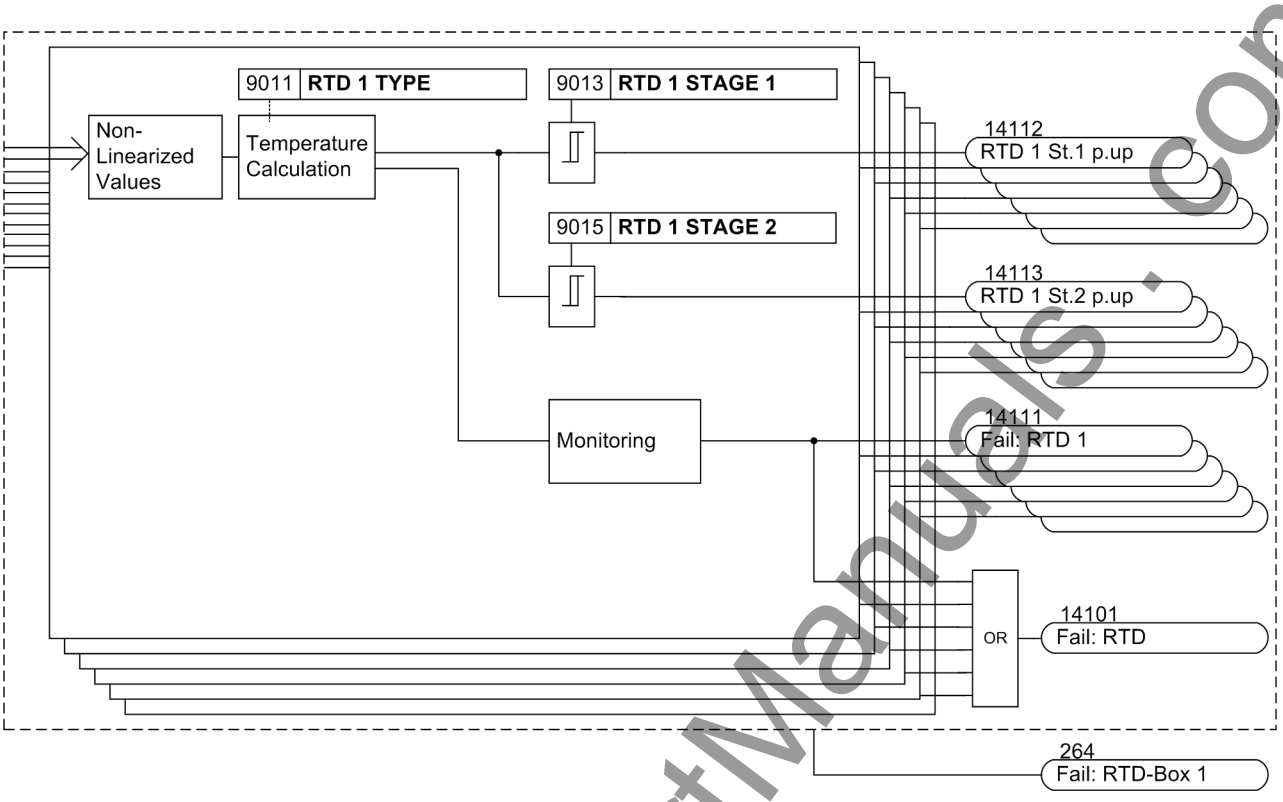


Figure 2-108 Logic diagram of the temperature processing for RTD-box 1

## 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**

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**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.

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### 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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Pt 100 Ω | RTD 1: Type |
| 9012A | RTD 1 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 2: Type |
| 9022A | RTD 2 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 3: Type |
| 9032A | RTD 3 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>Other | Other | RTD 3: Location |
| 9033 | RTD 3 STAGE 1 | -50 .. 250 °C; ∞ | 100 °C | RTD 3: Temperature Stage 1 Pickup |

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| 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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 4: Type |
| 9042A | RTD 4 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 5: Type |
| 9052A | RTD 5 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 6: Type |
| 9062A | RTD 6 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>Other | Other | RTD 6: Location |

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| 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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 7: Type |
| 9072A | RTD 7 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 8: Type |
| 9082A | RTD 8 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 9: Type |

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| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 9092A | RTD 9 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD10: Type |
| 9102A | RTD10 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD11: Type |
| 9112A | RTD11 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>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 |

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| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 9121A | RTD12 TYPE | Not connected<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD12: Type |
| 9122A | RTD12 LOCATION | Oil<br>Ambient<br>Winding<br>Bearing<br>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 |

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## 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 |

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# 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.

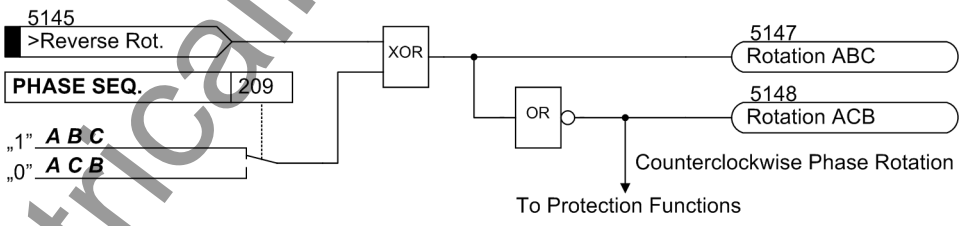


Figure 2-109 Message logic of the phase-sequence reversal

**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.

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### 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).

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## 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.

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

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

- Automatic 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

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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.

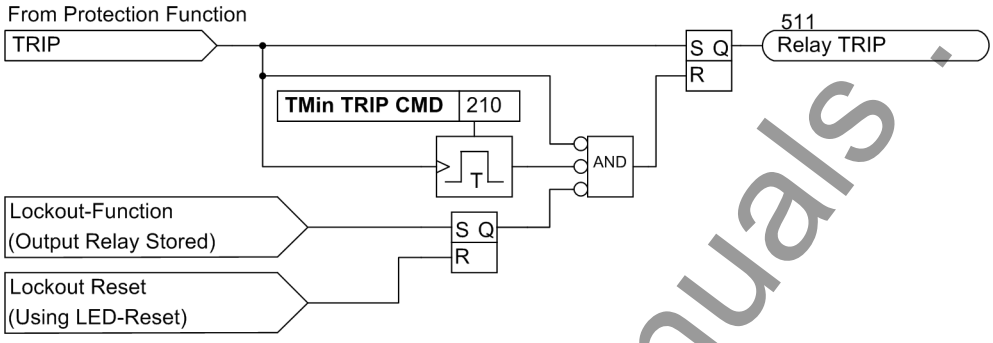


Figure 2-110 Terminating the Trip Signal

## 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.

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# 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).

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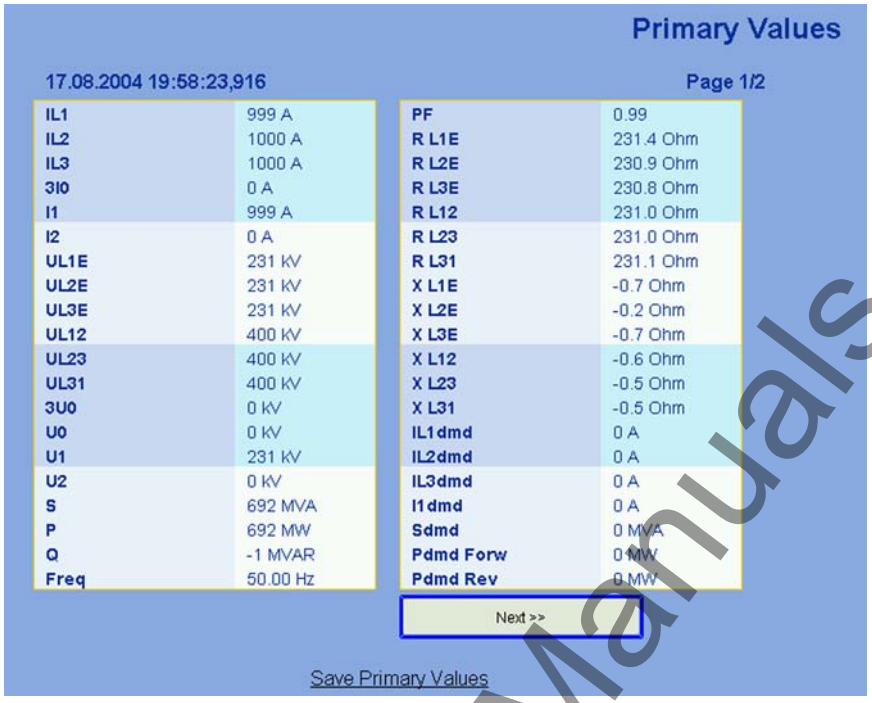


Figure 2-111 Measured values in the Web-Monitor — examples for measured values

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.

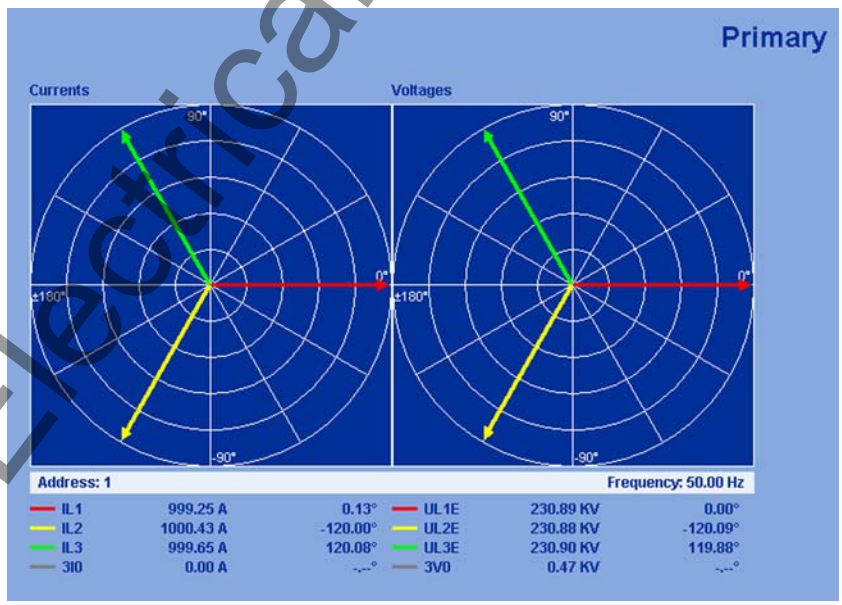


Figure 2-112 Phasor diagram of the primary measured values — Example

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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 ***.***.***.***.

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## 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.

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### 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

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**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.

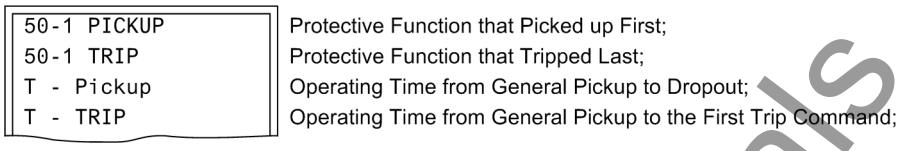


Figure 2-113 Display of spontaneous messages in the display – example

**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.

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## 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).

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### 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 ($\Sigma I^x$-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).

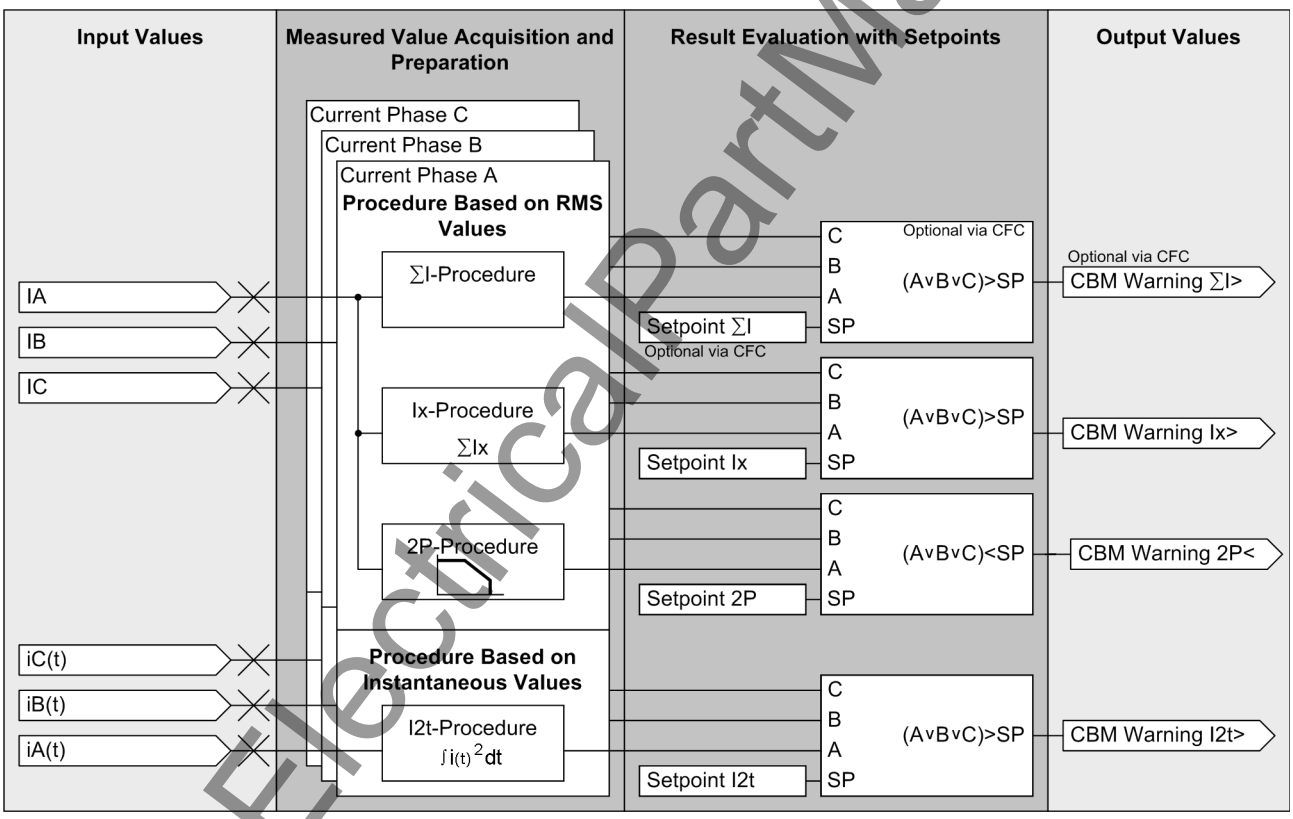


Figure 2-114 Diagram of CB maintenance procedures

Being a basic function, the ΣI-procedure is always enabled and active. The other procedures ($\Sigma I^x$, 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

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criteria for start and end. The procedures $\Sigma I^x$, 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.

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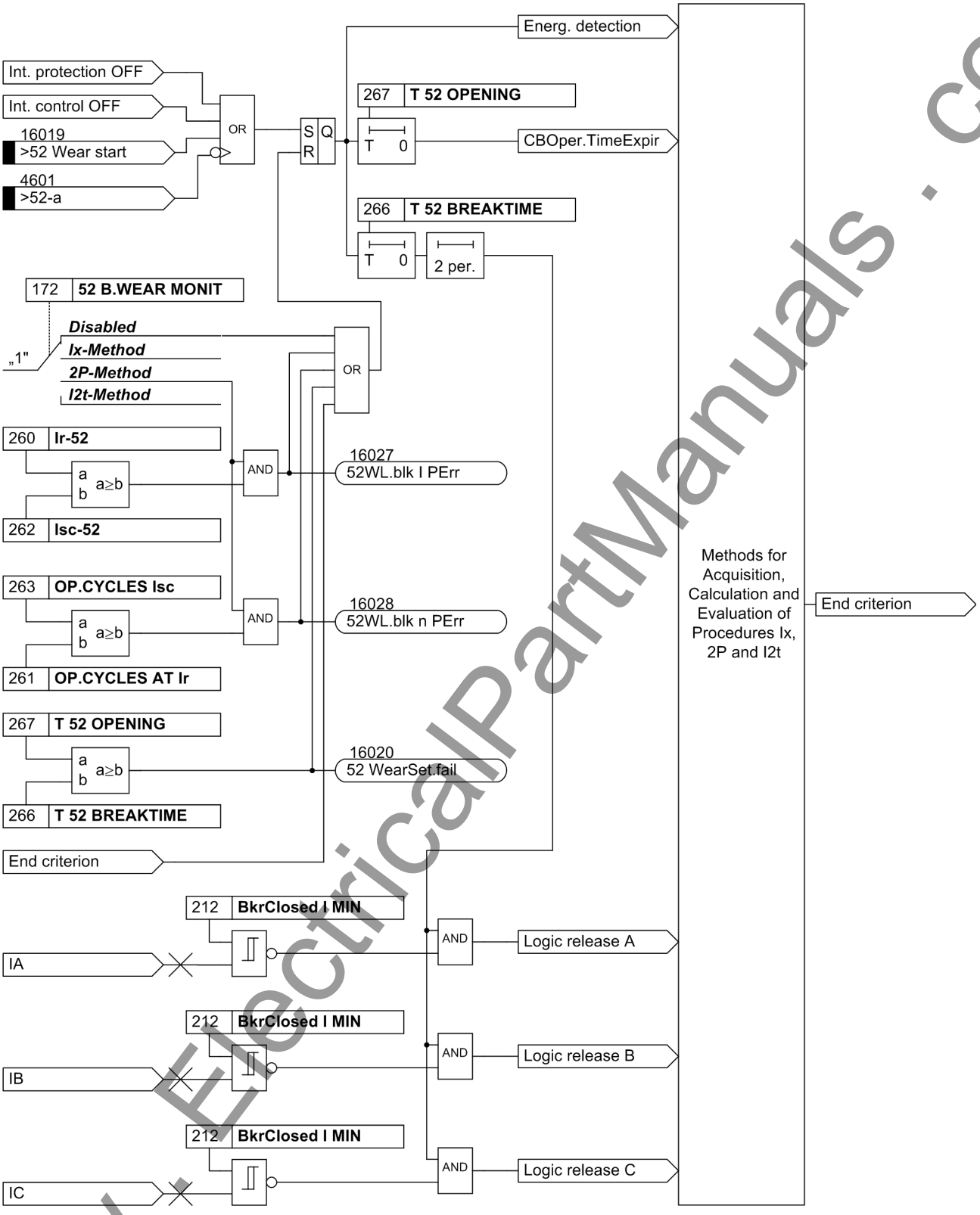


Figure 2-115 Logic of the start and end criterion

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**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 $\Sigma I^x$-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 $\Sigma I^x$-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 $\Sigma I^x$-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“,

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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.

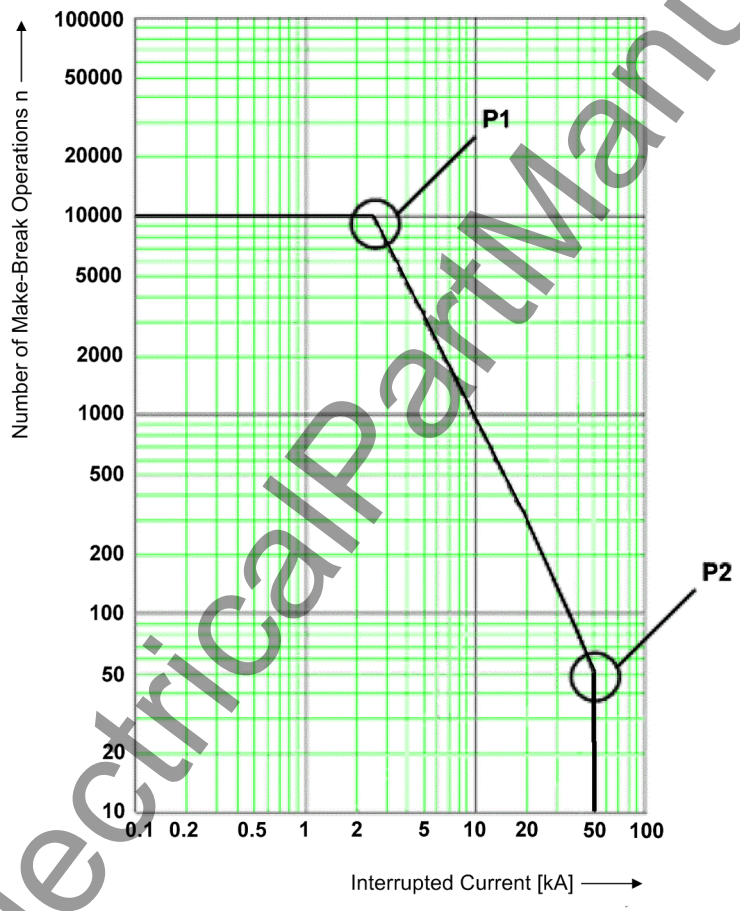


Figure 2-116 Diagram of operating cycles for the 2P procedure

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.

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**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.

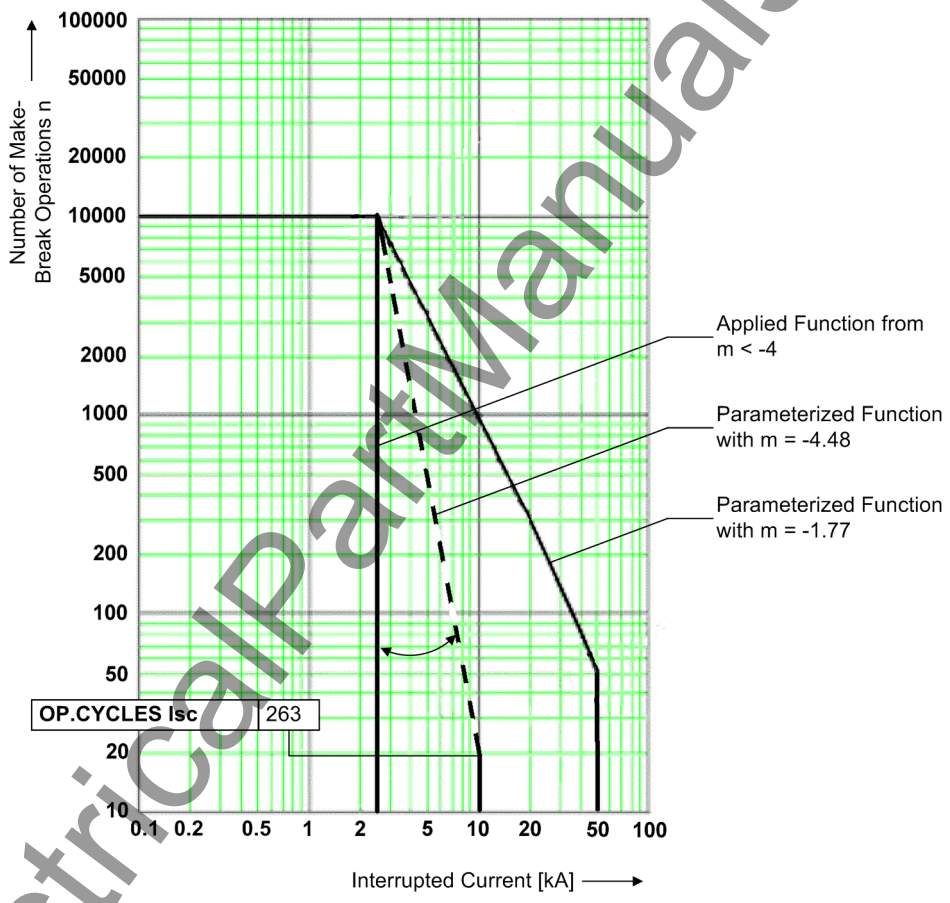


Figure 2-117 Value limitation of directional coefficient

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.

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**$I^2t$-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 $\Sigma I^x$-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**.

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The following diagram illustrates the relationship between these CB times.

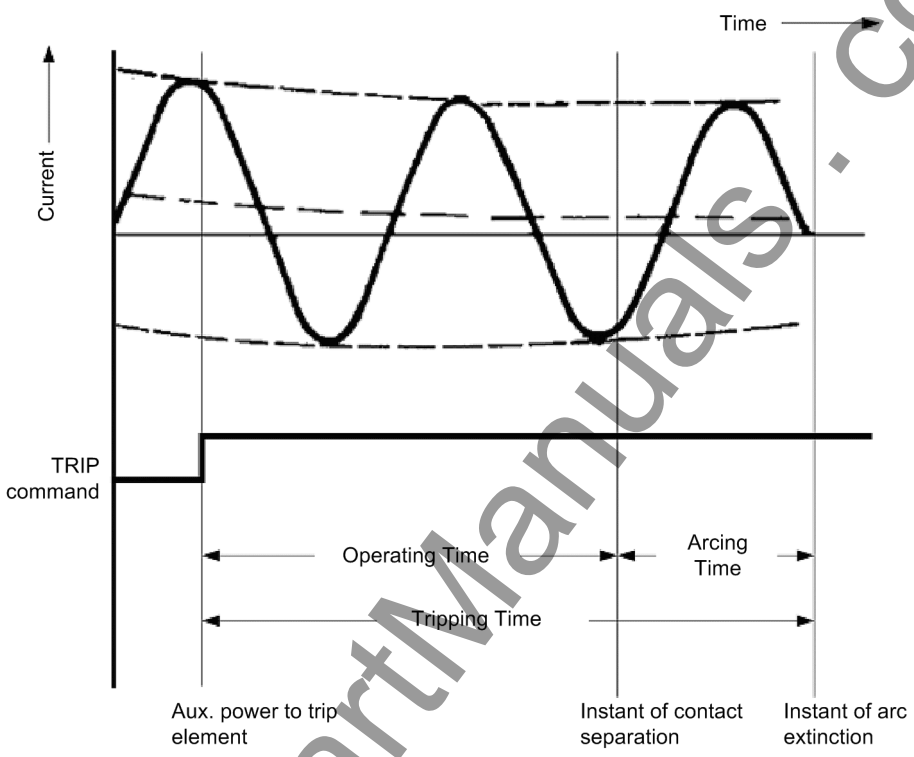


Figure 2-118 Illustration of the CB times

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 $\Sigma I^x$ 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 $\Sigma I^x$ 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**.

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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 |

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## 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) | $I_{N\,sec}$ | $\frac{\text{CT PRIMARY}}{\text{CT SECONDARY}} \cdot I_{N\,SEC.}$ | $\frac{I_{N\,prim.}}{\text{FullScaleCurr.}}$ |
| $I_N$ = measured value of $I_N$ input | $I_{N\,sec}$ | $\frac{\text{Ignd-CT PRIM}}{\text{Ignd-CT SEC}} \cdot I_{N\,SEC.}$ | $\frac{I_{N\,prim.}}{\text{FullScaleCurr.}}$ |
| $I_{Ns}$ ($I_{Ns}$, $I_{3I0real}$, $I_{3I0reactive}$ | $I_{Ns\,sec.}$ | $\frac{\text{Ignd-CT PRIM}}{\text{Ignd-CT SEC}} \cdot I_{Ns\,SEC.}$ | $\frac{I_{Ns\,prim.}}{\text{FullScaleCurr.}}$ |
| $V_A$, $V_B$, $V_C$, $V_0$, $V_1$, $V_2$, $V_4$ | $V_{Ph\text{-}N\,sec.}$ | $\frac{\text{Vnom PRIMARY}}{\text{Vnom SECONDARY}} \cdot V_{\phi g\,SEC.}$ | $\frac{V_{prim.}}{\text{FullScaleVolt.}/(\sqrt{3})}$ |
| $V_{A-B}$, $V_{B-C}$, $V_{C-A}$ | $V_{Ph\text{-}Ph\,sec.}$ | $\frac{\text{Vnom PRIMARY}}{\text{Vnom SECONDARY}} \cdot V_{\phi\phi\,SEC.}$ | $\frac{V_{prim.}}{\text{FullScaleVolt.}}$ |
| $V_N$ | $V_{N\,sec.}$ | $\text{Vph/Vdelta} \cdot \frac{\text{Vnom PRIMARY}}{\text{Vnom SECONDARY}} \cdot V_{N\,SEC.}$ | $\frac{V_{prim.}}{\sqrt{3} \cdot \text{FullScaleVolt.}}$ |

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| Measured Values | secondary | 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 Protection | f in Hz | f in Hz | $\frac{\text{f in Hz}}{f_{Nom}} \cdot 100$ |

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.

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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:

- $\Theta/\Theta_{Trip}$ **thermal measured value** of overload protection value for stator in % of the trip initiating overtemperature
- $\Theta/\Theta_{LTrip}$ **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 |

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| 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 |

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## 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<br>15 Min., 3 Subs<br>15 Min.,15 Subs<br>30 Min., 1 Sub<br>60 Min., 1 Sub<br>60 Min.,10 Subs<br>5 Min., 5 Subs | 60 Min., 1 Sub | Demand Calculation Intervals |
| 8302 | DMD Sync.Time | On The Hour<br>15 After Hour<br>30 After Hour<br>45 After Hour | On The Hour | Demand Synchronization Time |

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#### 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 $\Theta/\Theta_{off}$, the real power P, reactive power Q, and apparent power S, the frequency; and the power factor cos $\varphi$ 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**.

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### 2.23.6.3 Settings

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 8311 | MinMax cycRESET | NO<br>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 |

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| 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 |

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## 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.

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### 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

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| - | I Admd> | LV | I A dmd> |
| - | I Bdmd> | LV | I B dmd> |
| - | I Cdmd> | LV | I C dmd> |
| - | I1dmd> | LV | I1dmd> |
| - | \|Pdmd\|> | LV | \|Pdmd\|> |
| - | \|Qdmd\|> | LV | \|Qdmd\|> |
| - | \|Sdmd\|> | LV | \|Sdmd\|> |
| - | Press< | LVU | Pressure< |
| - | Temp> | LVU | Temp> |
| - | 37-1 | LV | 37-1 under current |
| - | \|PF\|< | LV | \|Power Factor\|< |
| 270 | SP. Pressure< | OUT | Set Point Pressure< |
| 271 | SP. Temp> | OUT | Set Point Temp> |
| 273 | SP. I A dmd> | OUT | Set Point Phase A dmd> |
| 274 | SP. I B dmd> | OUT | Set Point Phase B dmd> |
| 275 | SP. I C dmd> | OUT | Set Point Phase C dmd> |
| 276 | SP. I1dmd> | OUT | Set Point positive sequence I1dmd> |
| 277 | SP. \|Pdmd\|> | OUT | Set Point \|Pdmd\|> |
| 278 | SP. \|Qdmd\|> | OUT | Set Point \|Qdmd\|> |
| 279 | SP. \|Sdmd\|> | OUT | Set Point \|Sdmd\|> |
| 284 | SP. 37-1 alarm | OUT | Set Point 37-1 Undercurrent alarm |
| 285 | SP. PF(55)alarm | OUT | Set Point 55 Power factor alarm |

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## 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 |

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## 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<br>Factor 10<br>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 |

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## 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".

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**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".

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## 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.

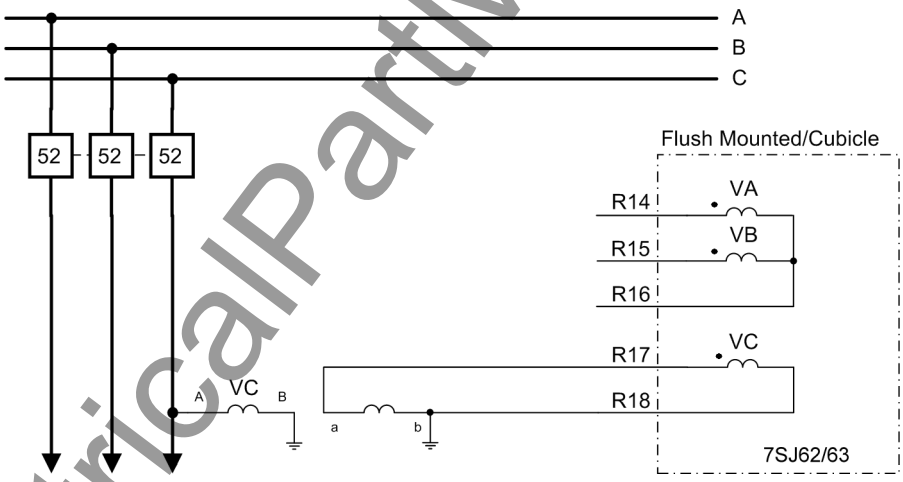


Figure 2-119 Connection example for single-phase voltage transformer for 7SJ62/63 with phase-to-ground-voltage $V_{C-N}$

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### 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.

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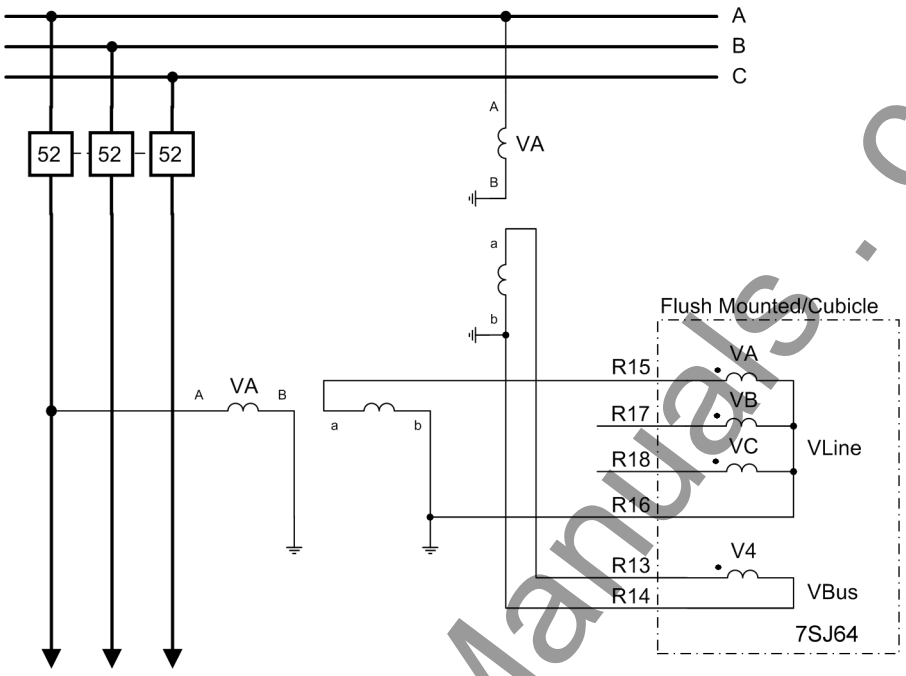


Figure 2-120 Connection example for single-phase voltage transformer for 7SJ64 (phase-to-ground voltages)

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.

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## 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 % $V_{Nom}$

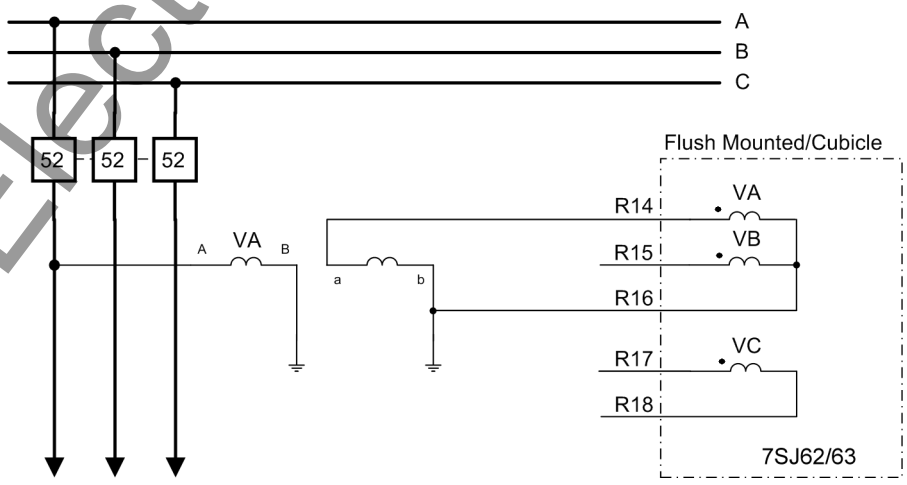


Figure 2-121 Example of a single-phase voltage transformer connection (Phase-ground)

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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:** $\frac{115\ \text{V}}{\sqrt{3}} \cdot 0.6 = 40\ \text{V}$

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## 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.

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The navigation keys ▲, ▼, ◀, ▶ are used to select the desired device in the Control Display. The I key or the 0 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 |

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| 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

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## 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)

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## 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+/– |

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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.

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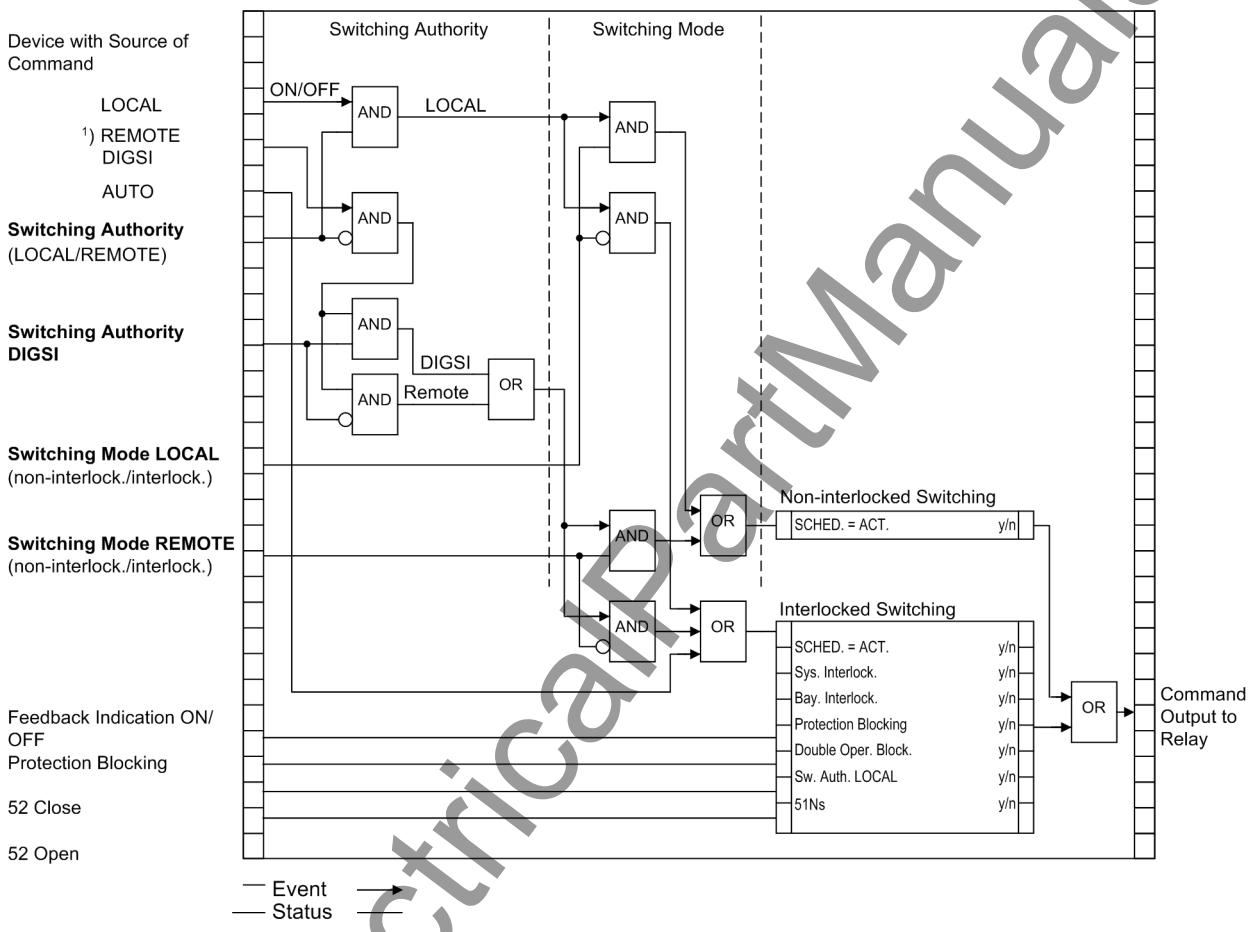
- Switching Authority DIGSI: Switching commands that are issued locally or remotely via DIGSI (command with command source DIGSI) are only allowed if remote control is admissible for the device (by key switch or configuration). If a DIGSI-PC communicates with the device, it deposits here its virtual 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

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The following figure shows the configuration of the interlocking conditions using DIGSI.

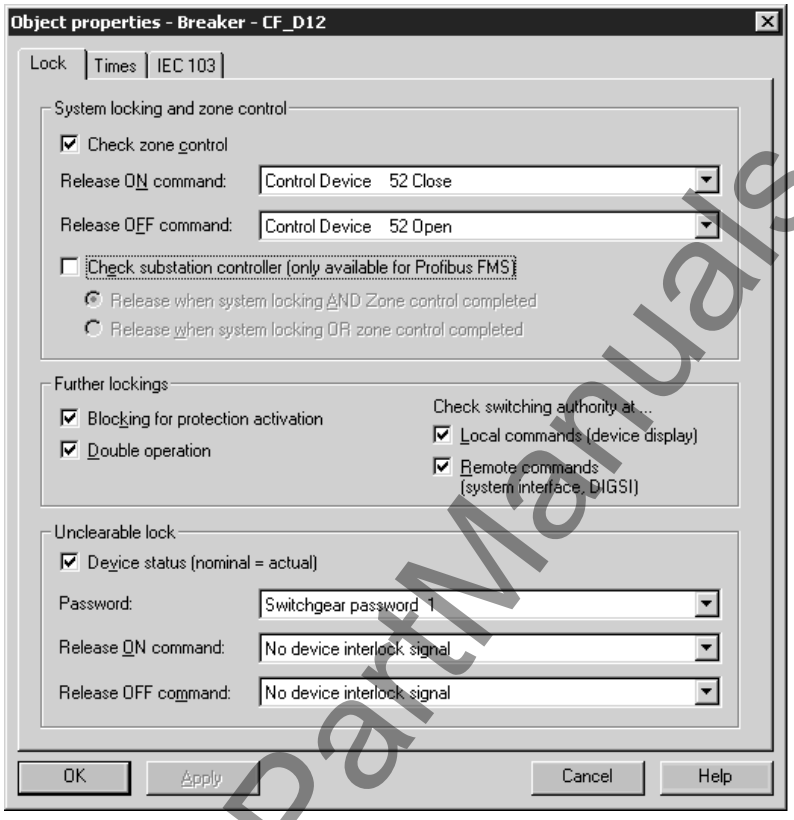


Figure 2-124 DIGSI®–dialog box for setting the interlocking conditions

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 |

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The following figure shows all interlocking conditions (which usually appear in the display of the device) for three switchgear items with the relevant abbreviations explained in the previous table. All parameterized interlocking conditions are indicated.

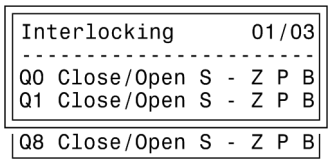


Figure 2-125 Example of configured interlocking conditions

**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 |

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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.

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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.

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**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").

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## 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/.

■

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# 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.


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## 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.

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**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.

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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 |

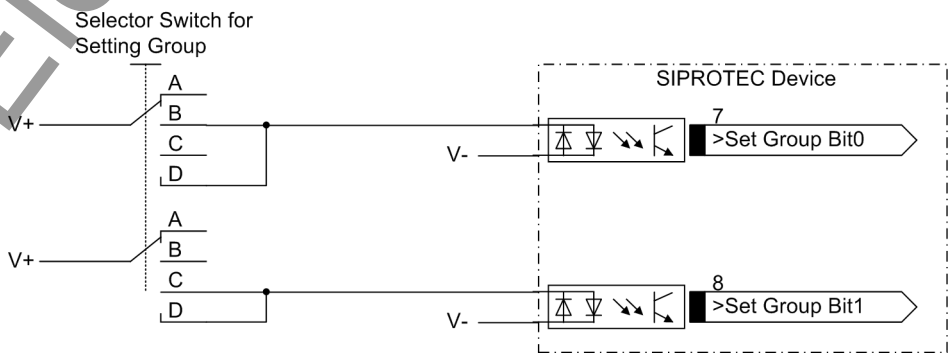


Figure 3-1 Connection diagram (example) for setting group switching using binary inputs

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**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.

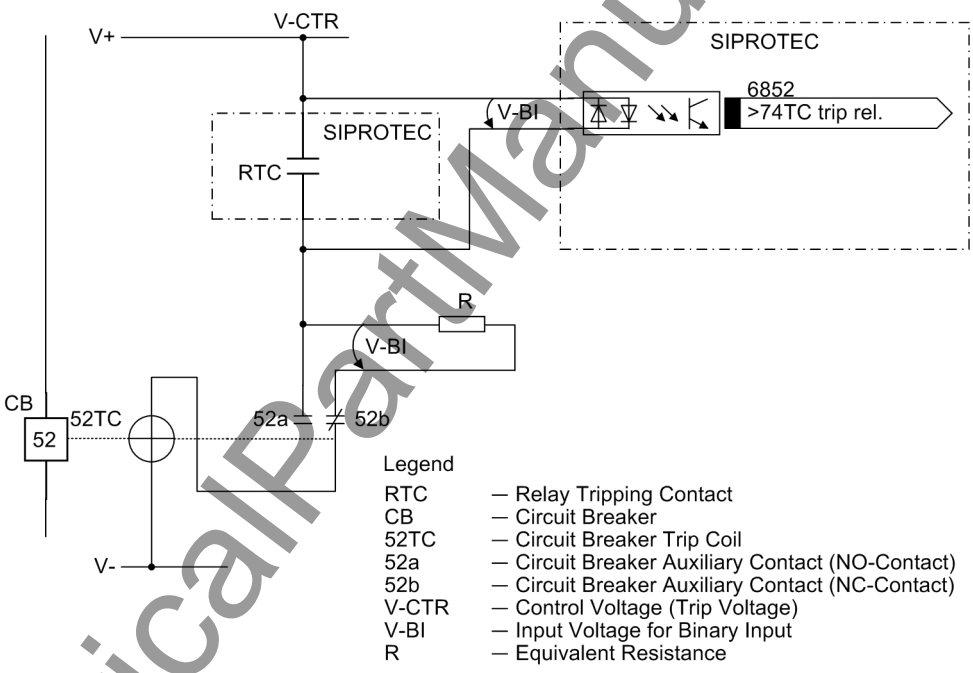


Figure 3-2 Trip circuit supervision with one binary input

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:

$$R = \frac{R_{max} + R_{min}}{2}$$

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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) |

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$$R_{max} = \left(\frac{110\ V - 19\ V}{1.8\ mA}\right) - 500\ \Omega = 50.1\ k\Omega$$

$$R_{min} = 500\ \Omega \cdot \left(\frac{110\ V - 2\ V}{2\ V}\right) = 27\ k\Omega$$

$$R = \frac{R_{max} + R_{min}}{2} = 38.6\ k\Omega$$

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.

**Auxiliary Voltage**

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.

**Live Status Contact**

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.

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**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 ar-

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rangement 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.

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- 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-subminiature 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.

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**Module Arrangement 7SJ62**

The arrangement of modules for device 7SJ62 is illustrated in the following figure.

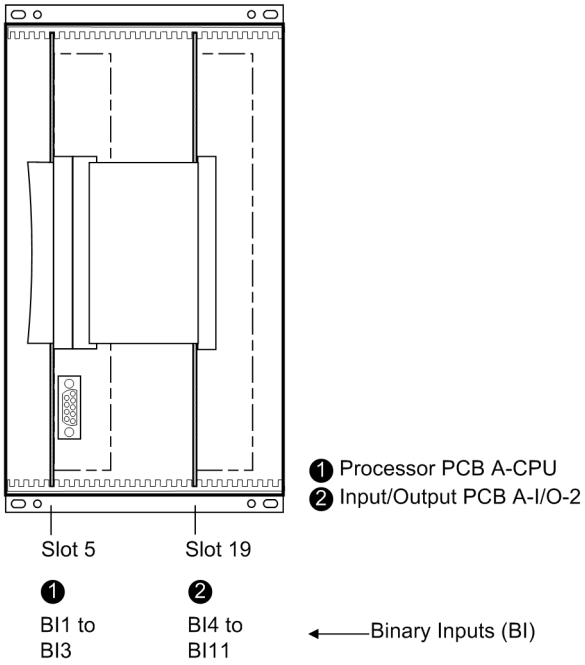


Figure 3-3 Front view of 7SJ62 after removal of the front cover (simplified and scaled down)

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**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 $^1/_1$.

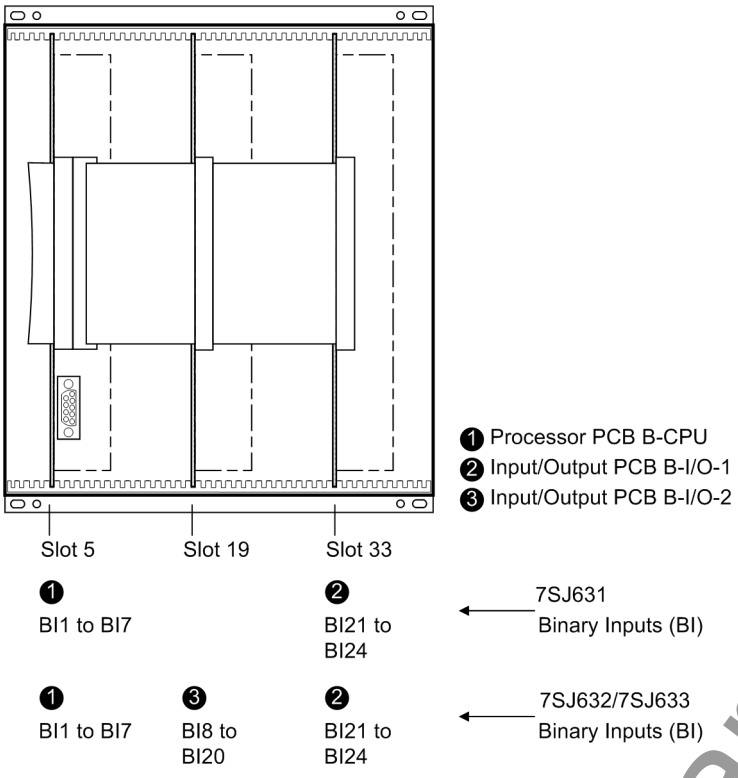


Figure 3-4 Front view of the 7SJ63 with housing size $^1/_2$ after removal of the front cover (simplified and scaled down)

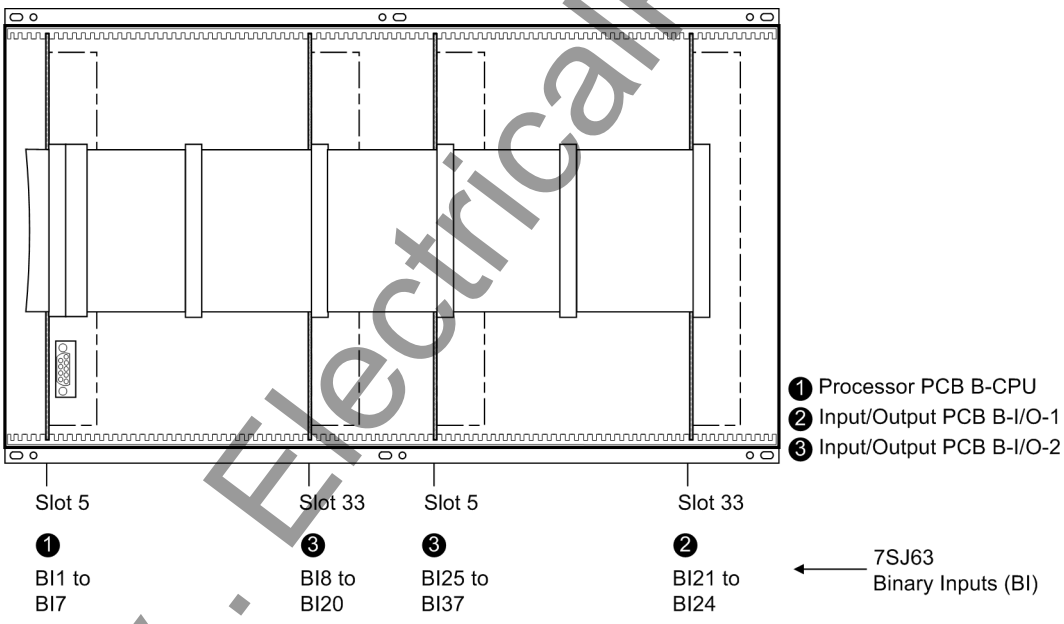


Figure 3-5 Front view of the 7SJ635 and 7SJ636 with housing size $^1/_1$ after removal of the front cover (simplified and scaled down)

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**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 $^1/_1$.

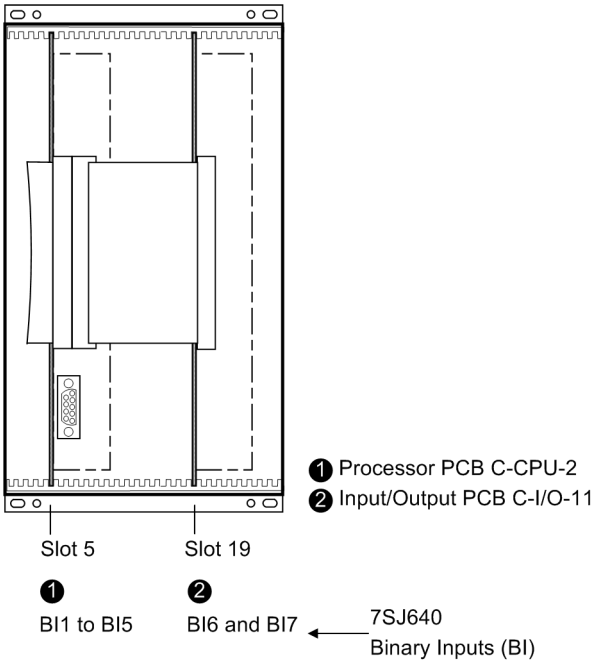


Figure 3-6 Front view with housing size $^1/_3$ after removal of the front cover (simplified and scaled down)

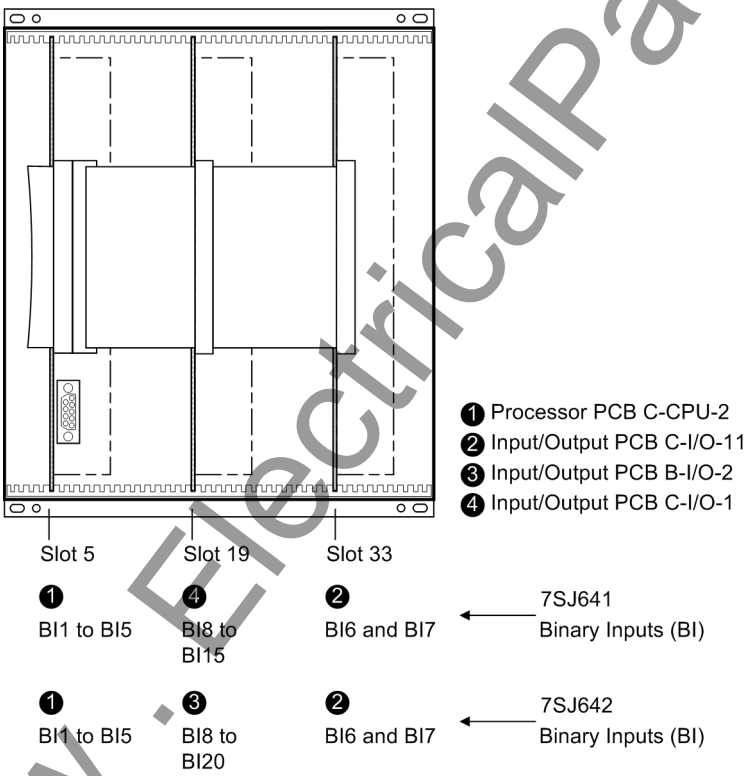


Figure 3-7 Front view of the 7SJ64 with housing size $^1/_2$ after removal of the front cover (simplified and scaled down)

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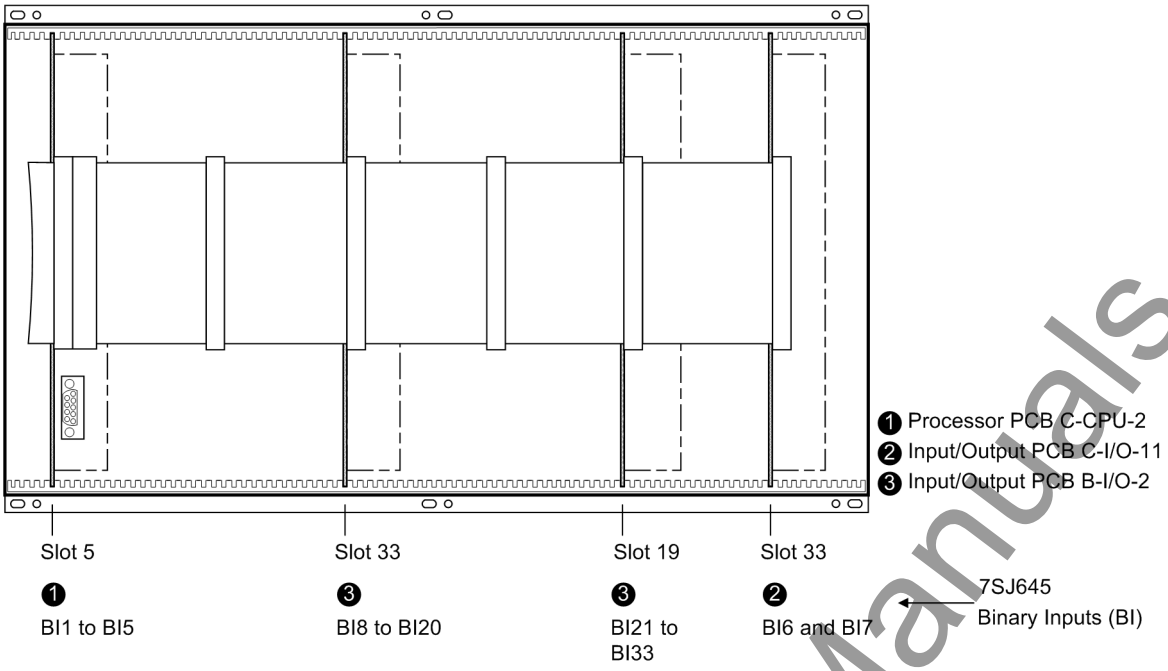


Figure 3-8 Front view of the 7SJ645 with housing size $^1/_1$ after removal of the front cover (simplified and scaled down)

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### 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.

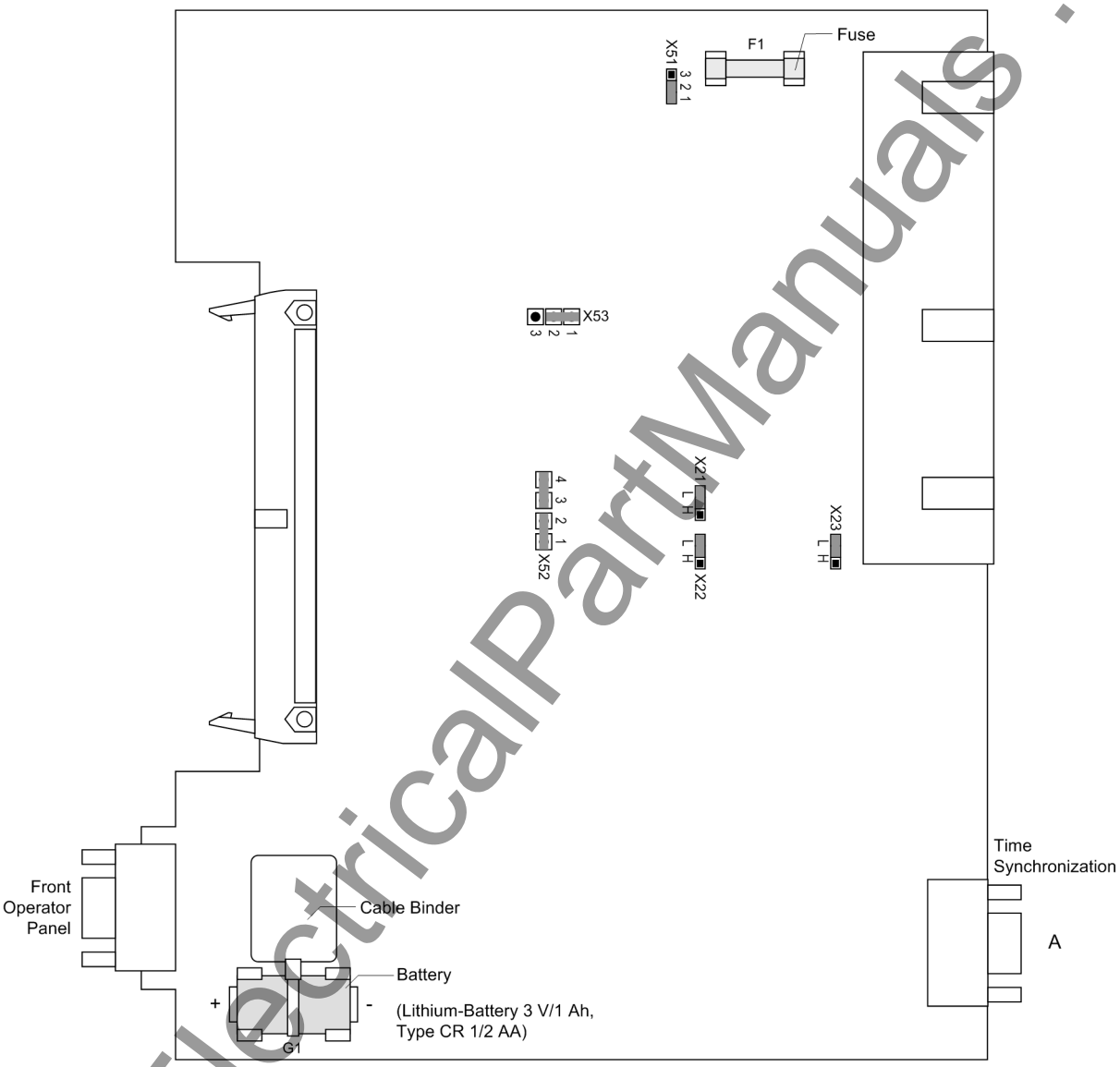


Figure 3-9 Processor printed circuit board A–CPU for devices up to release .../DD with jumpers settings required for the board configuration

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.

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**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

| Jumper | Rated Voltage | | | |
|---|---|---|---|---|
| | **60 to 125 VDC** | **110 to 250 VDC**<br>**115 VAC** | **24/48 VDC** | **230 VAC** |
| 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 | |

**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

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**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.

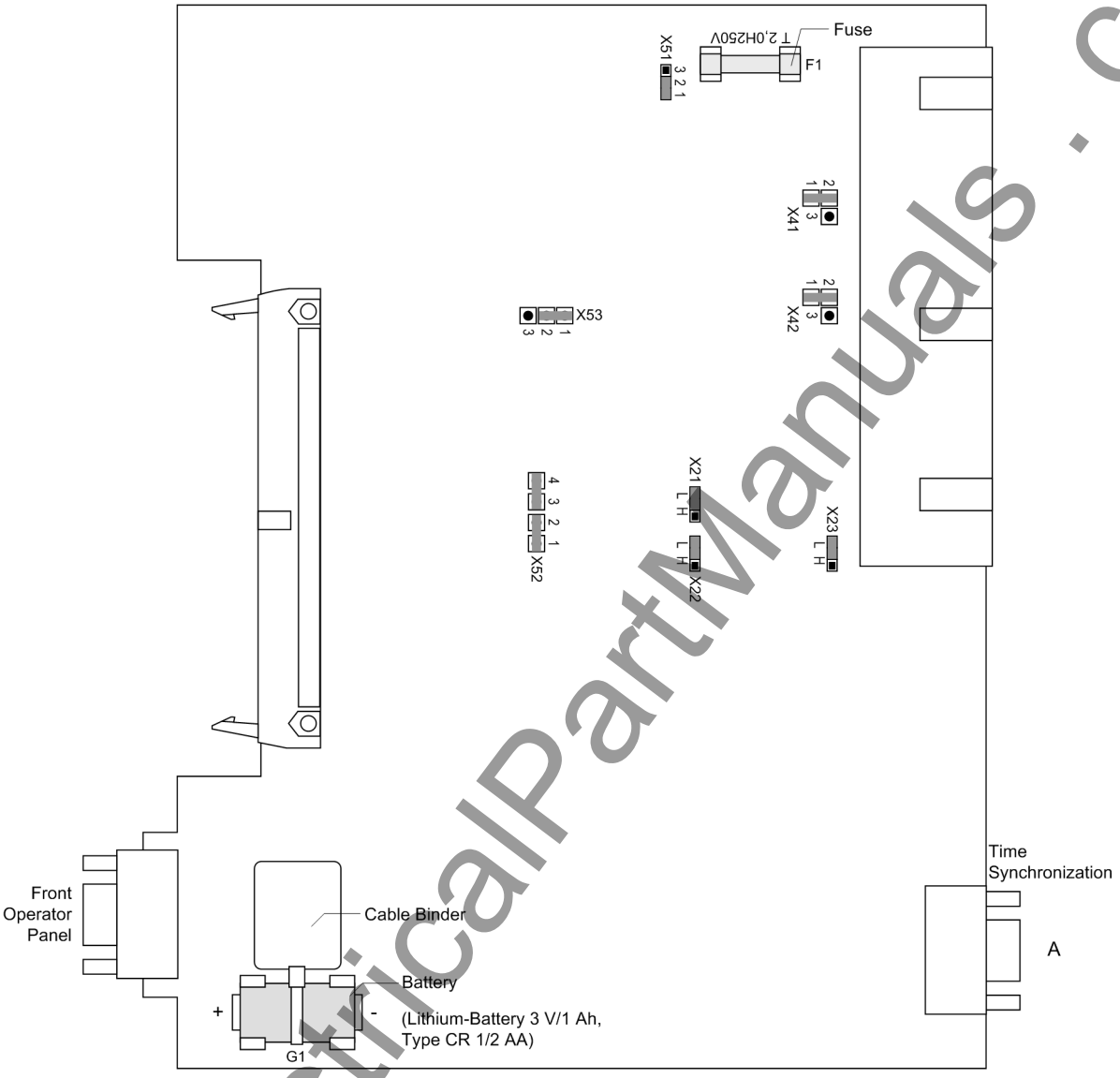


Figure 3-10 Processor printed circuit board A–CPU for devices .../EE and higher with jumpers settings required for the board configuration

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.

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**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**<br>**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 |

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**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.

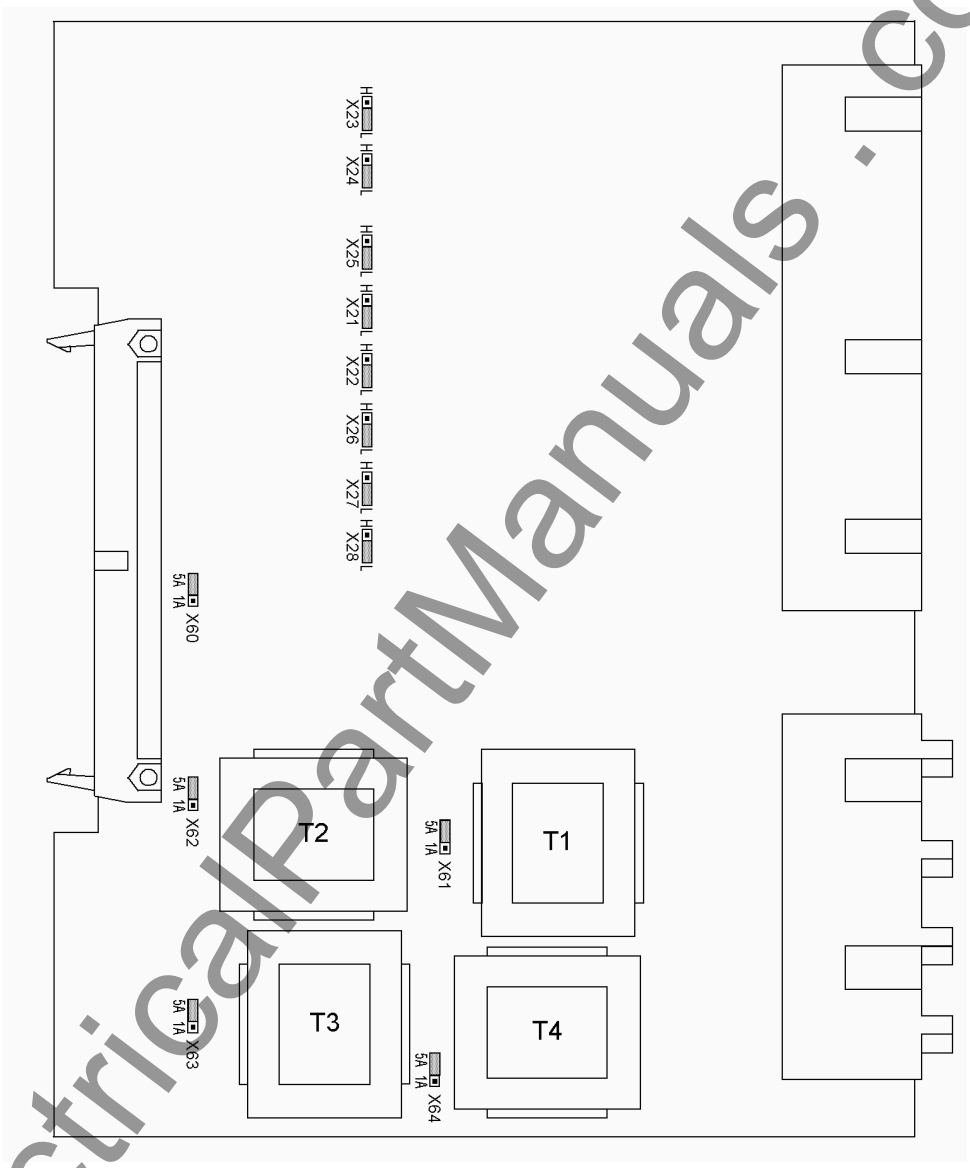


Figure 3-11 Input/output board A–I/O-2 with representation of the jumper settings required for the board configuration

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.

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**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

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### 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.

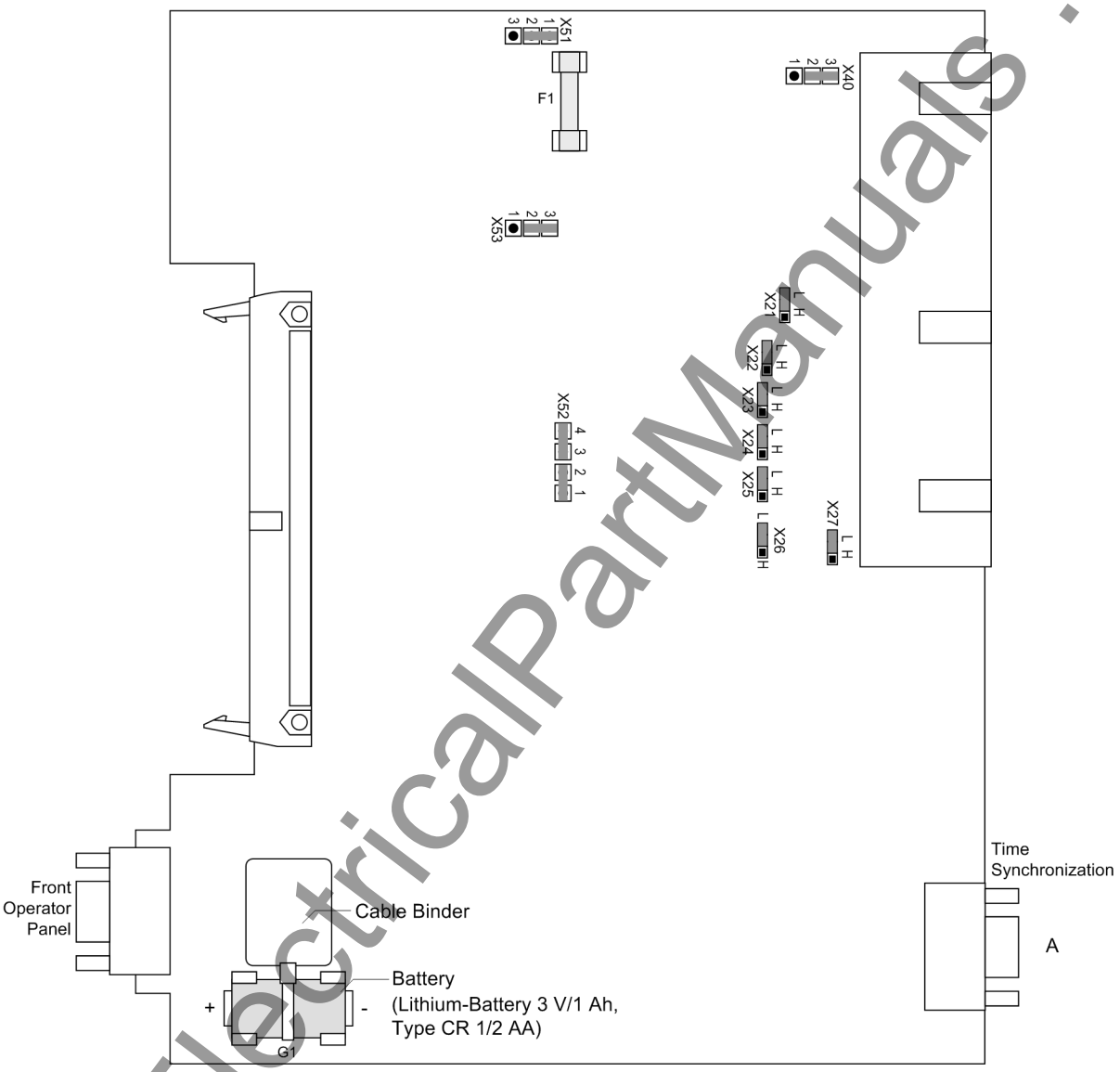


Figure 3-12 Processor printed circuit board B–CPU for devices up to release.../DD with jumpers settings required for the board configuration

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.

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**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

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**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.

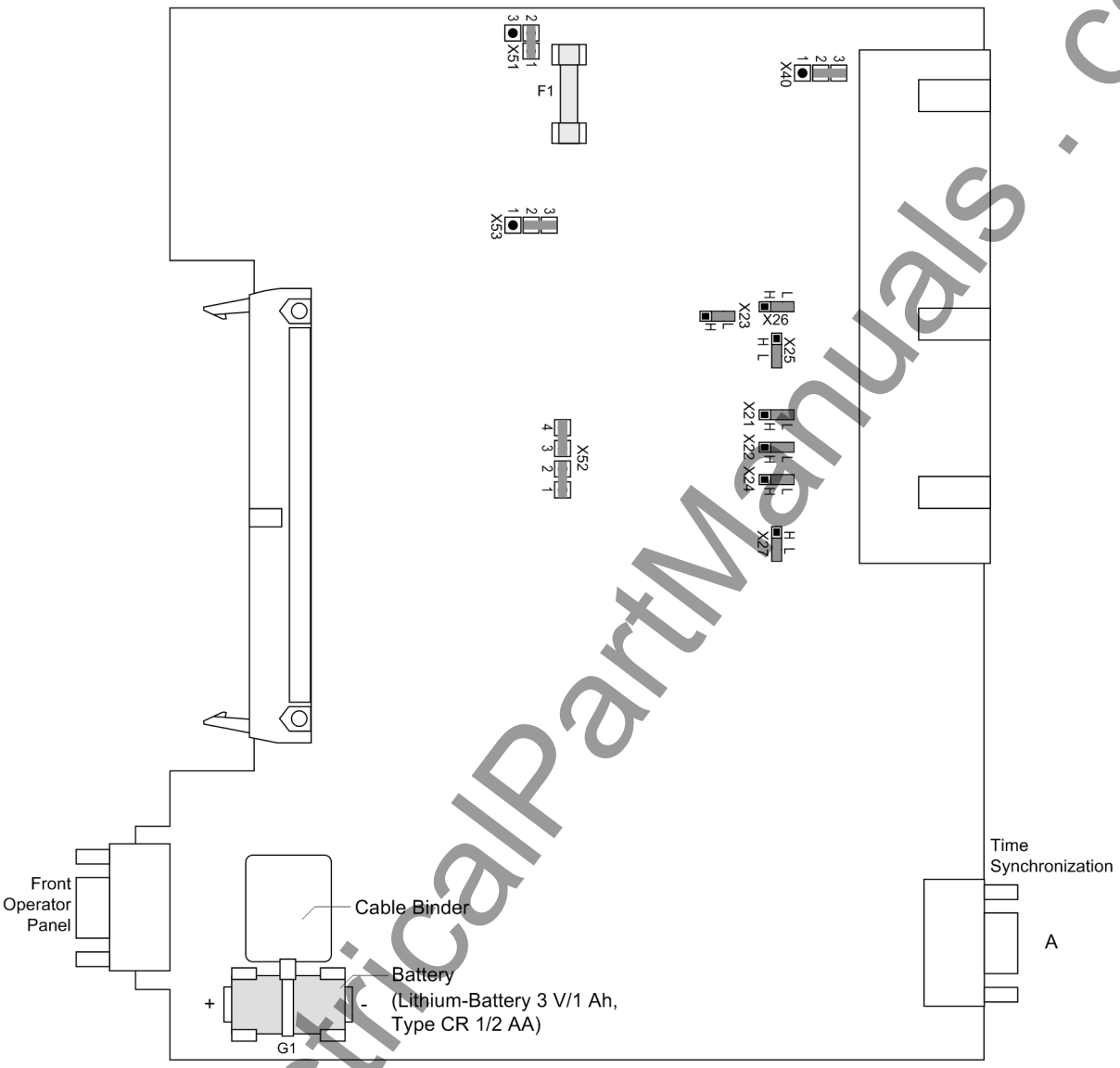


Figure 3-13 Processor printed circuit board B–CPU for devices .../EE and higher with jumpers settings required for the board configuration

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.

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**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**<br>**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

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**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.

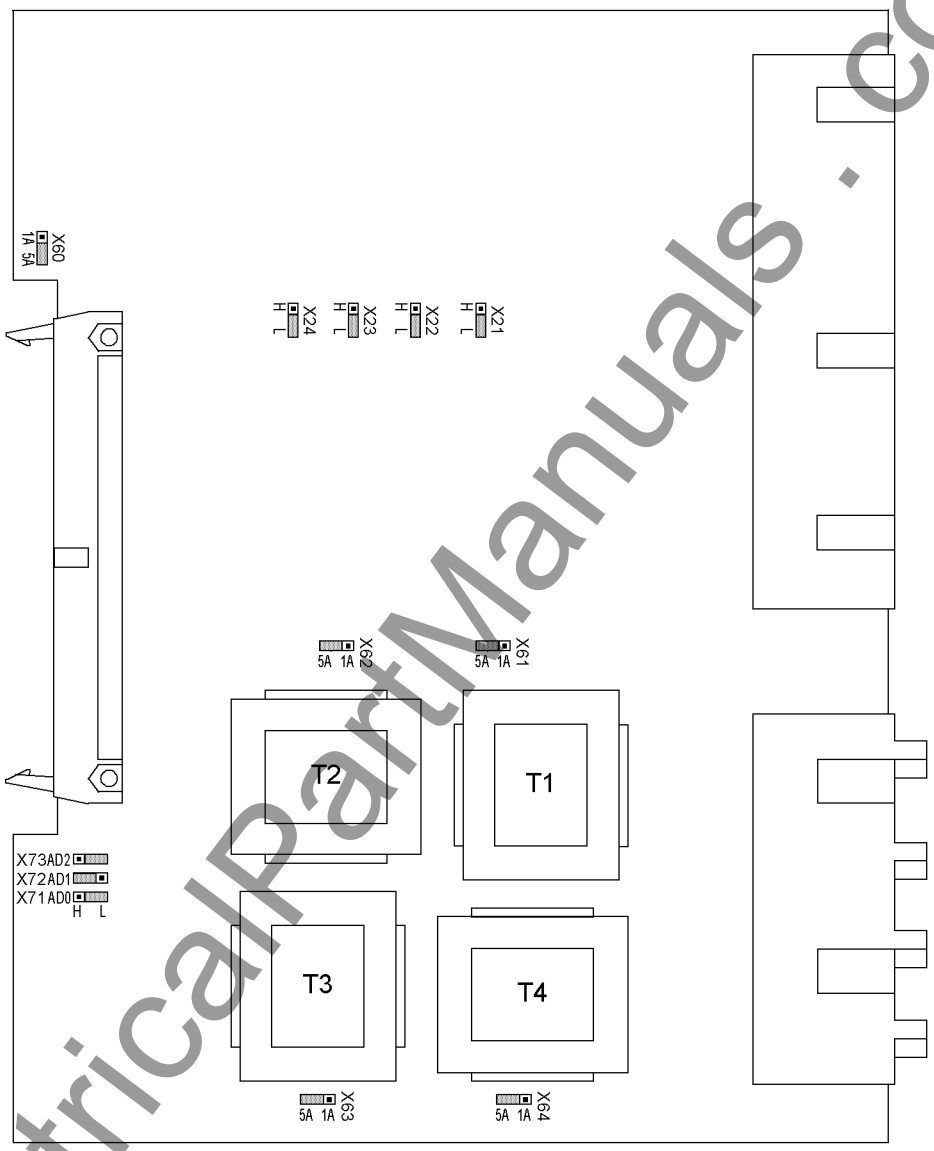


Figure 3-14 Input/output board B–I/O-1 with representation of the jumper settings required for the board configuration

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.

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**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 |

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**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

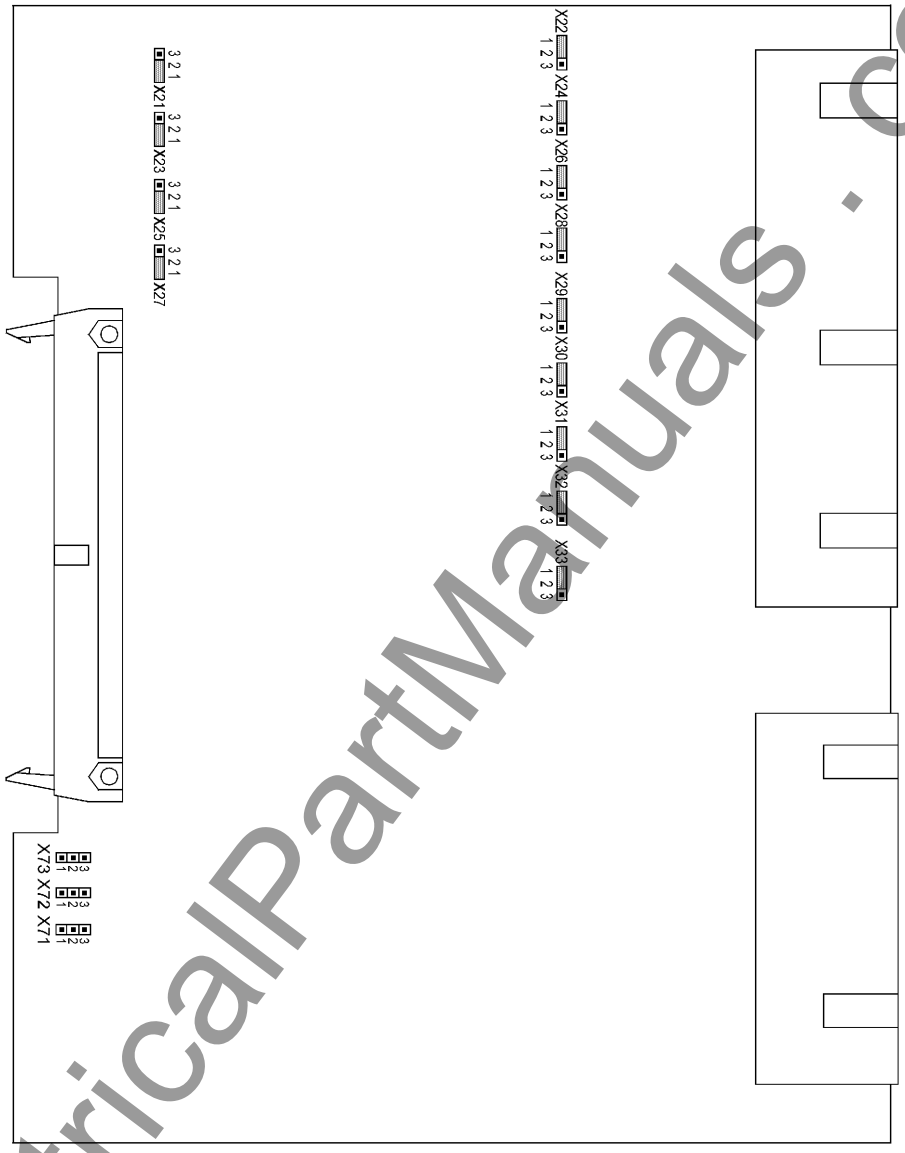


Figure 3-15 Input/output board B-I/O-2 with representation of the jumper settings required for the board configuration

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.

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**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 |

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### 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.

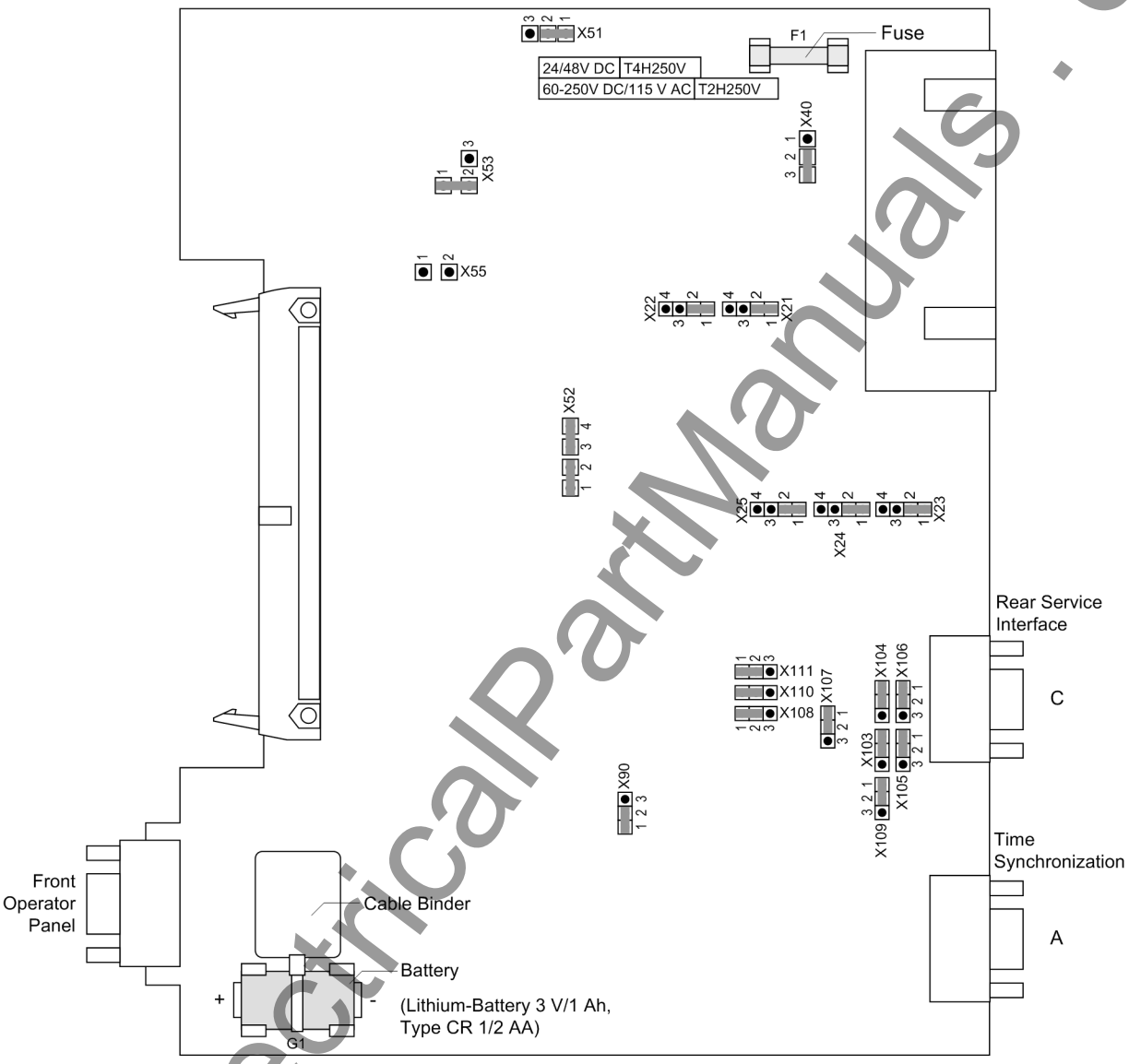


Figure 3-16 Processor printed circuit board C–CPU-2 with jumpers settings required for the board configuration

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.

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**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**<br>**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.

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### 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.

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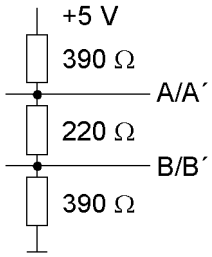


Figure 3-17 Termination of the RS485 interface (external)

**Input / Output Board C–I/O-11 (7SJ64)**

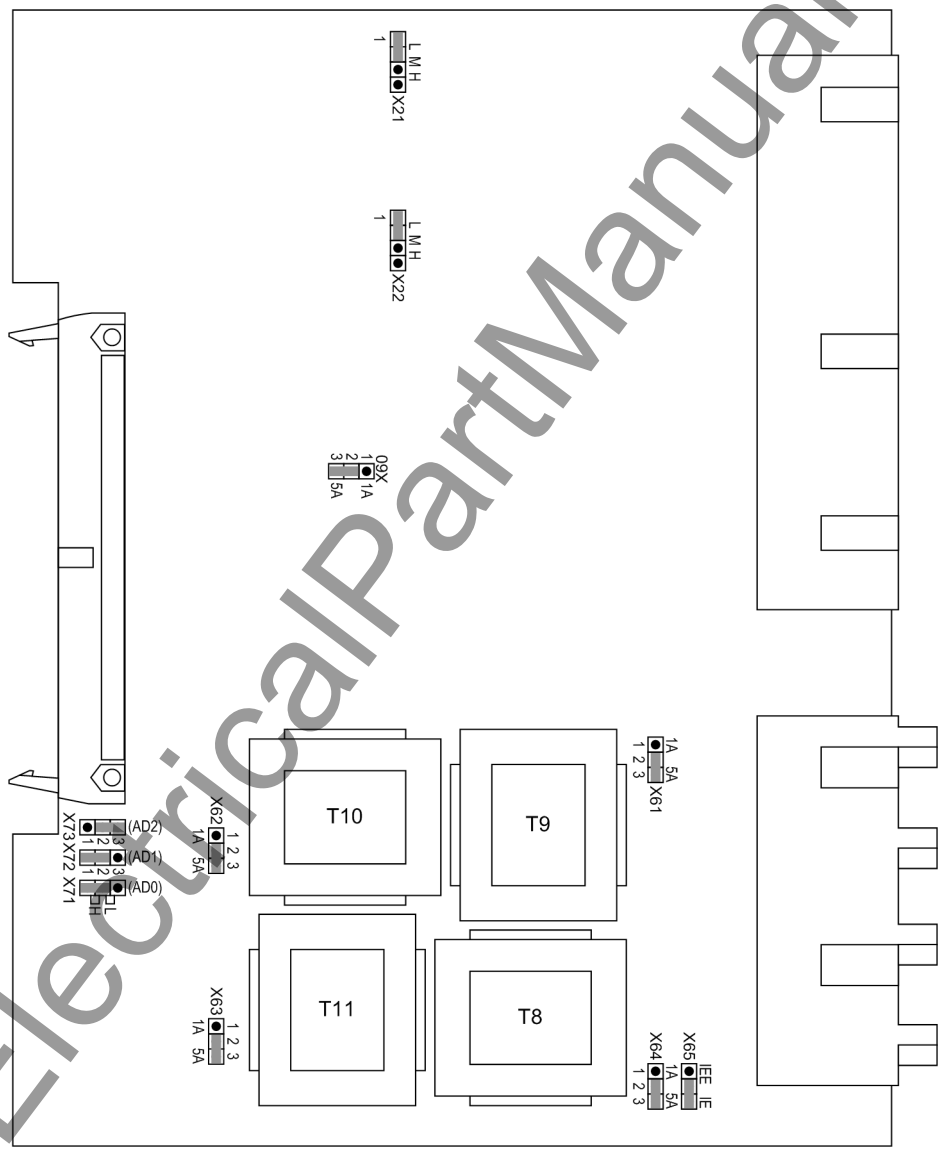


Figure 3-18 C-I/O-11 input/output board with representation of jumper settings required for checking configuration settings

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

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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) |

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**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.

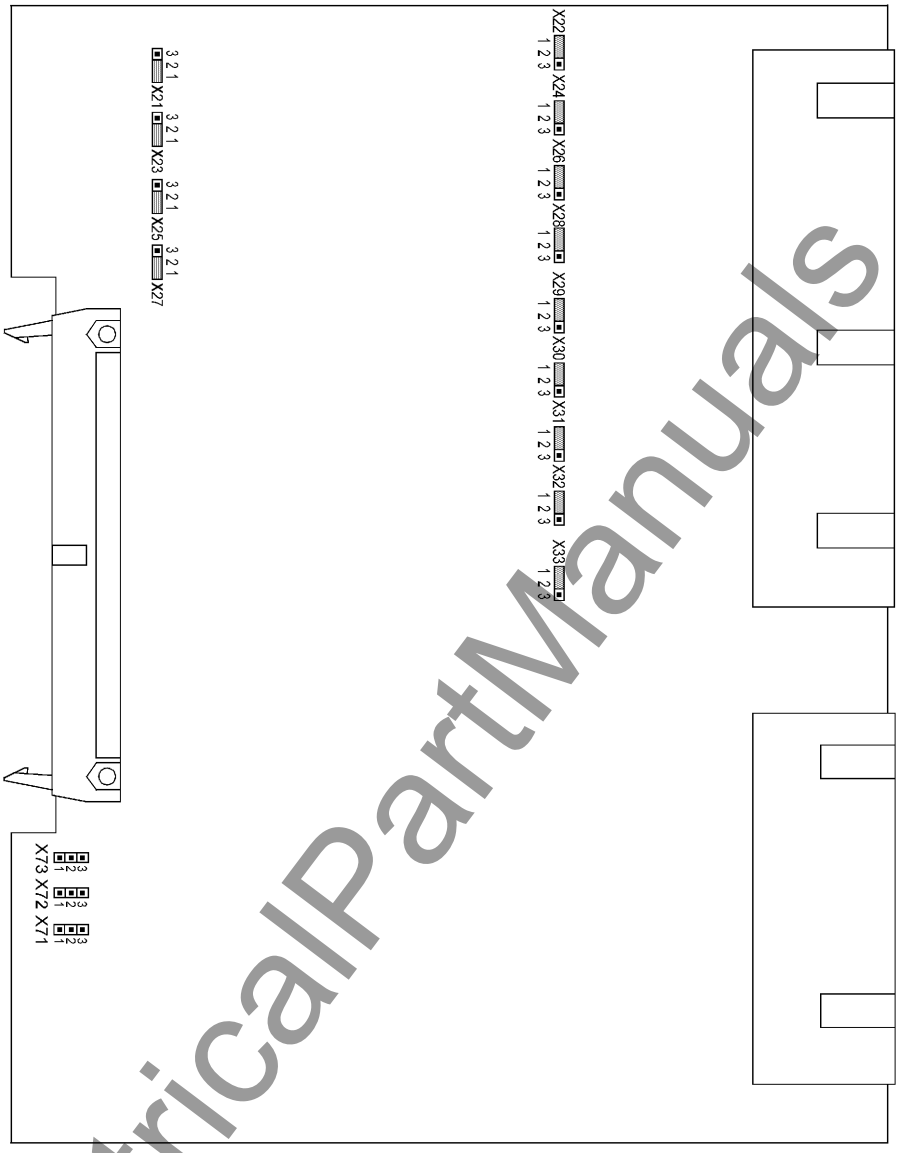


Figure 3-19 Input/output board B-I/O-2 with representation of the jumper settings required for the board configuration

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.

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**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.

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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 |

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**Input / Output Board C–I/O-1 (7SJ64)**

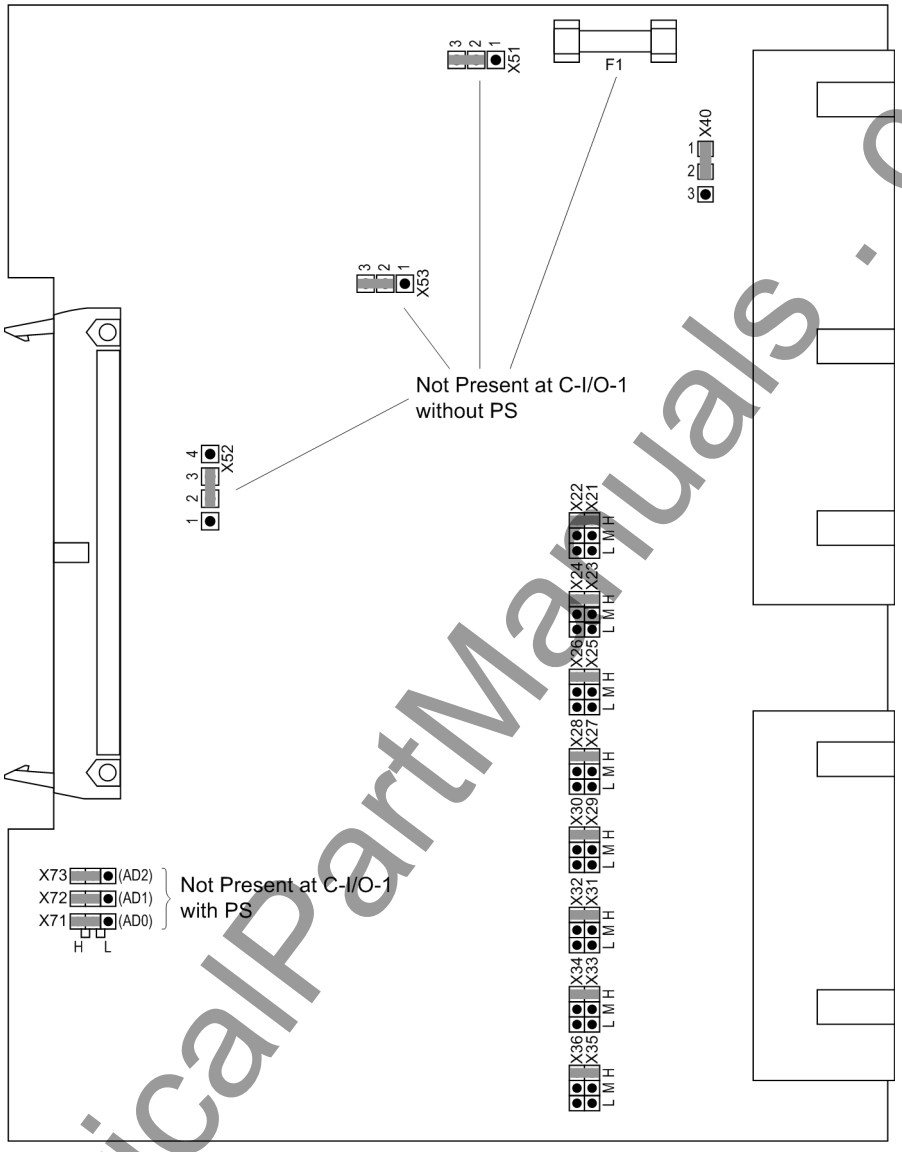


Figure 3-20 Input/output board C-I/O-1 with representation of the jumper settings required for the board configuration

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.

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**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 |

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### 3.1.2.6 Interface Modules

**Exchanging Interface Modules**

The following figure shows the processor board CPU and arrangement of the modules.

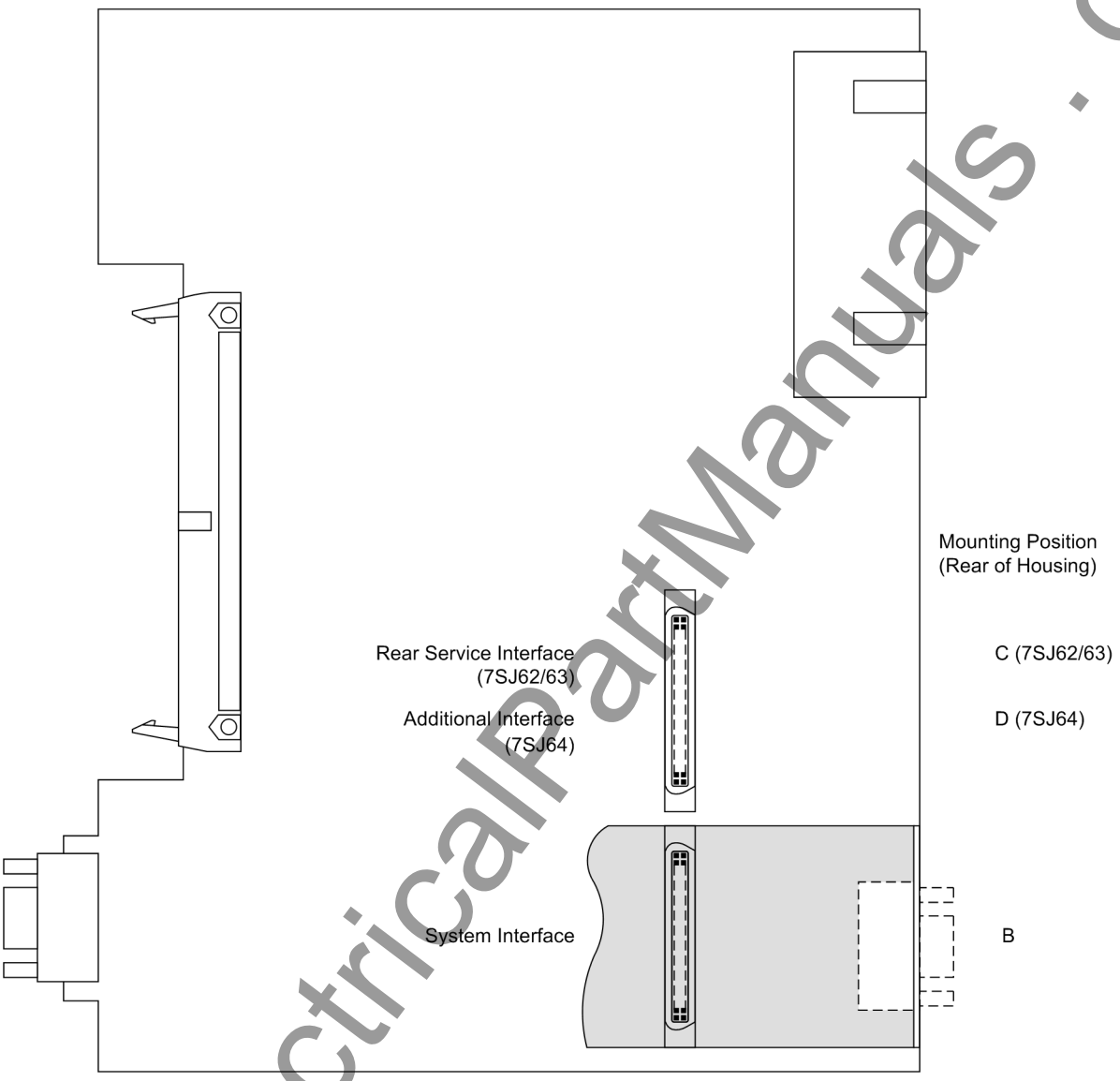


Figure 3-21 Processor board CPU with interface modules

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“.

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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.

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| Jumper | Terminating Resistors Disconnected |
|---|---|
| X3 | 1-2 *) |
| X4 | 1-2 *) |

*) Default Setting

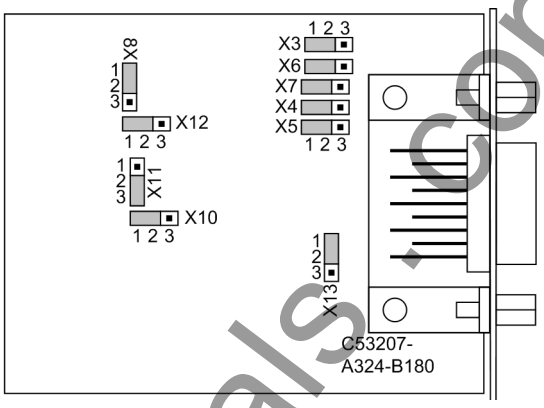


Figure 3-22 Location of the jumpers for configuration of RS232

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.

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| Jumper | Terminating Resistors | |
|---|---|---|
| | Connected | Disconnected |
| X3 | 2-3 | 1-2 *) |
| X4 | 2-3 | 1-2 *) |

*) Default Setting

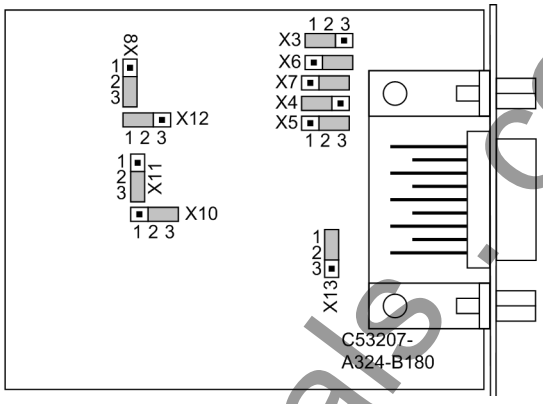


Figure 3-23 Position of terminating resistors and the plug-in jumpers for configuration of the RS485 interface

**Profibus (FMS/DP)**
**DNP3.0/Modbus**

| Jumper | Terminating Resistors | |
|---|---|---|
| | Connected | Disconnected |
| X3 | 1-2 | 2-3 *) |
| X4 | 1-2 | 2-3 *) |

*) Default Setting

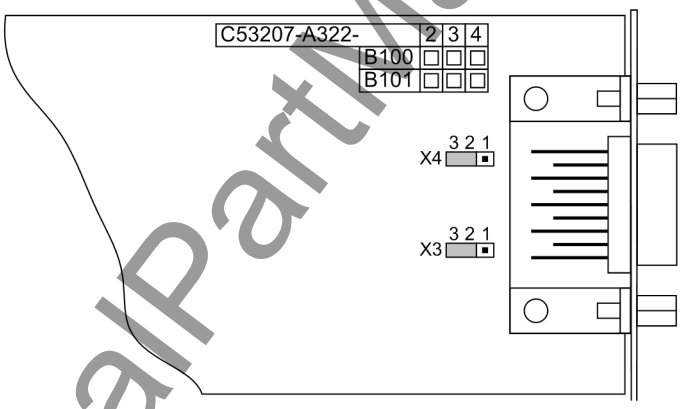


Figure 3-24 Position of the plug-in jumpers for the configuration of the terminating resistors at the Profibus (FMS and DP), DNP 3.0 and Modbus interfaces.

**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.

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#### 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.

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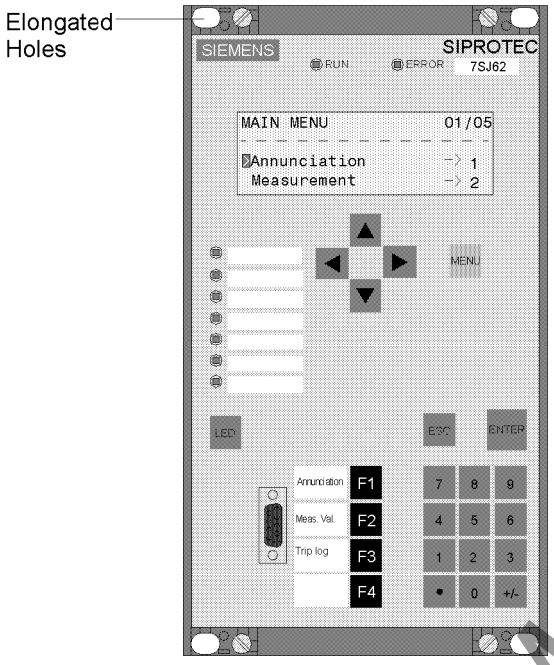


Figure 3-25 Panel flush mounting of a 7SJ62 and 7SJ640 (housing size $^1/_3$), as example

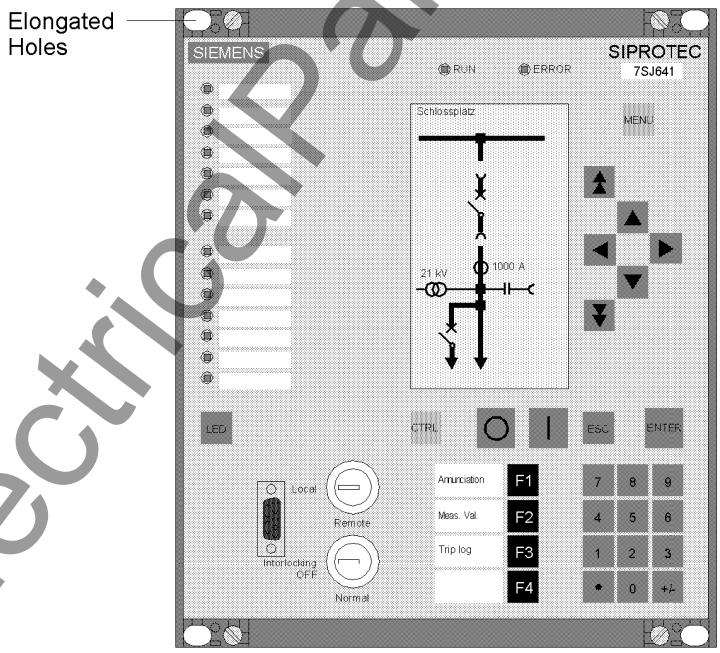


Figure 3-26 Panel flush mounting of a 7SJ632 and 7SJ641 (housing size $^1/_2$), as example

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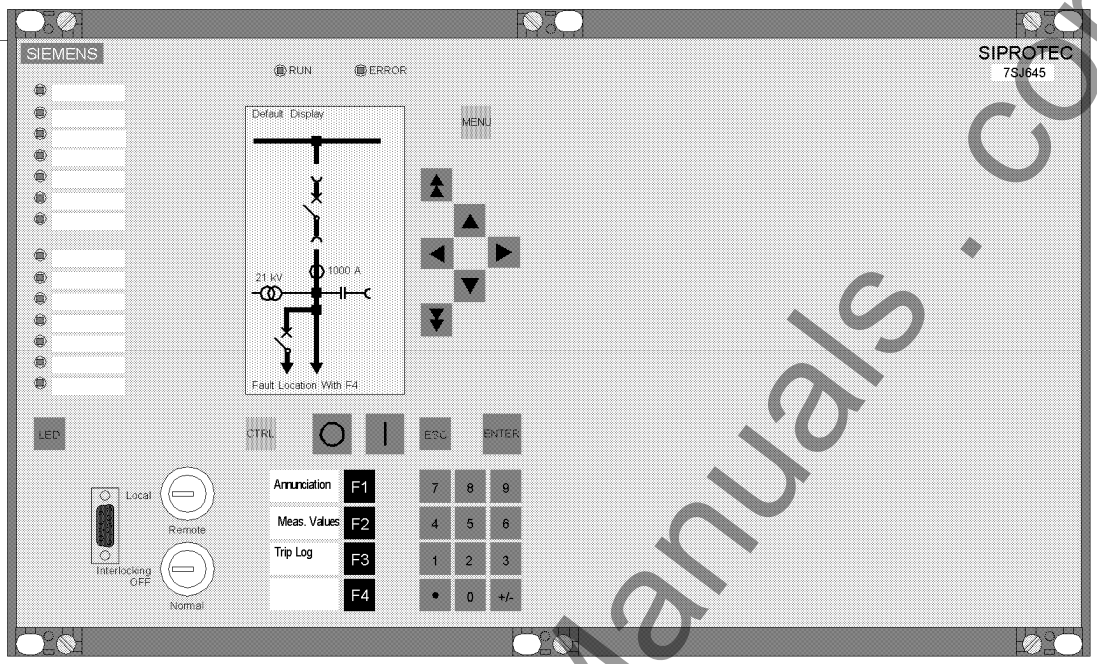


Figure 3-27 Panel flush mounting of a 7SJ635 and 7SJ645 (housing size $^1/_1$). as example

### 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.

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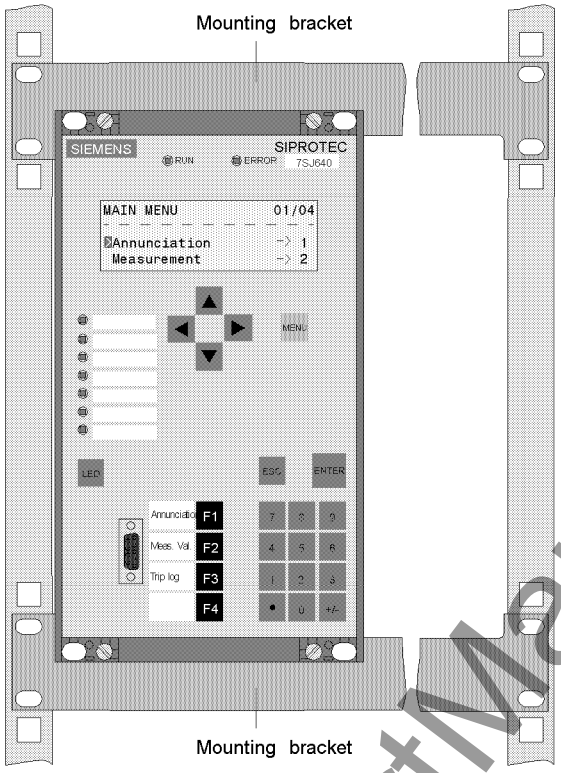


Figure 3-28 Installing a 7SJ62 and 7SJ640 in a rack or cubicle (housing size $^1/_3$), as example

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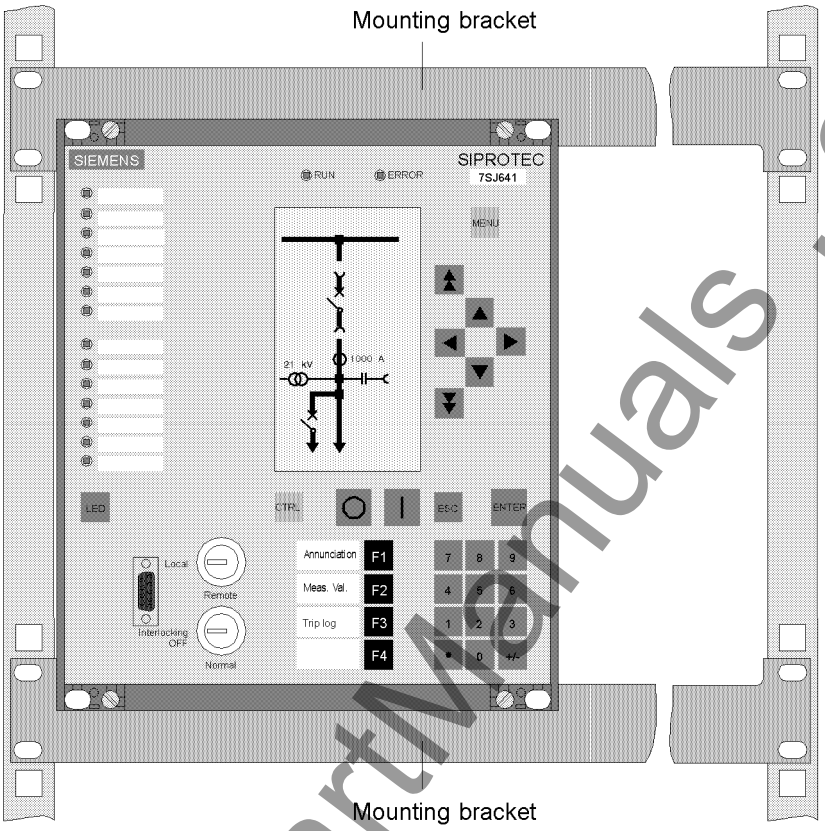


Figure 3-29 Installing a 7SJ632 and 7SJ641 in a rack or cubicle (housing size $^1/_2$), as example

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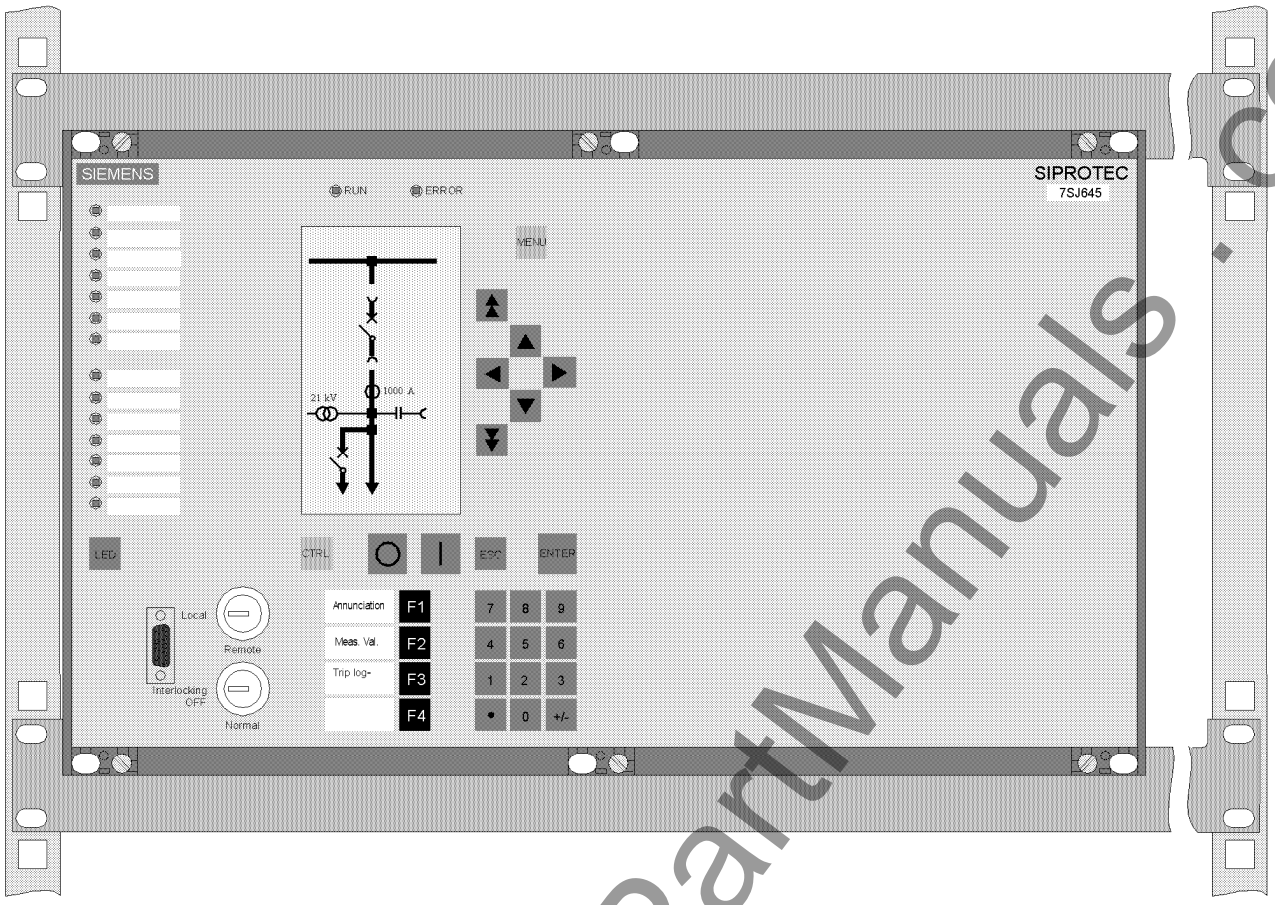


Figure 3-30 Installing a 7SJ635 and 7SJ645 in a rack or cubicle (housing size $^1/_1$), as example

### 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.

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### 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).

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### 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!

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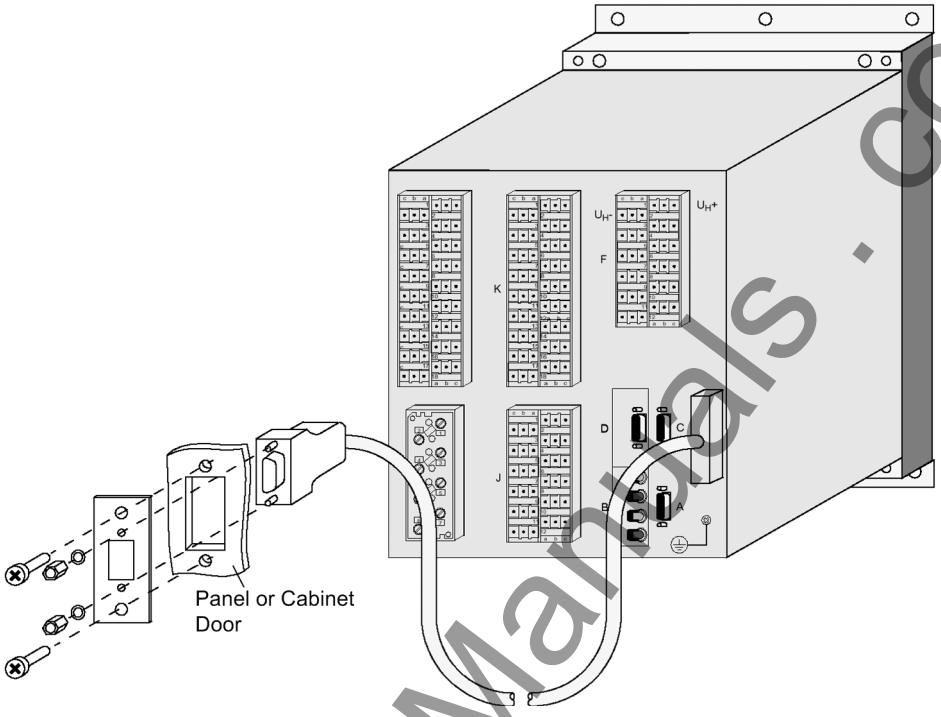


Figure 3-31 Plugging the subminiature connector of the dongle cable into the control panel or cabinet door (example housing size $^1/_2$)

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## 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.

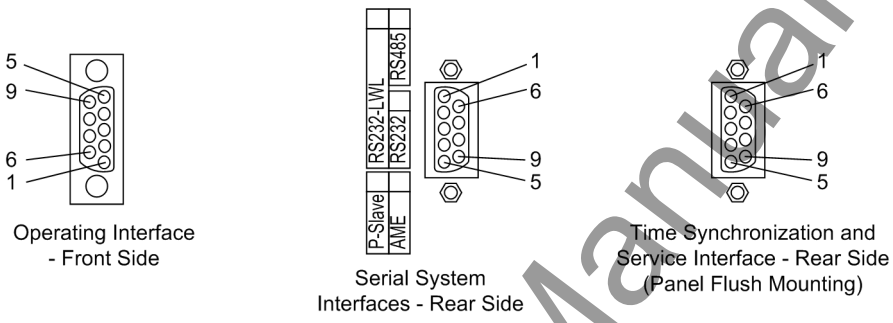


Figure 3-32 9-pin D-subminiature female connectors

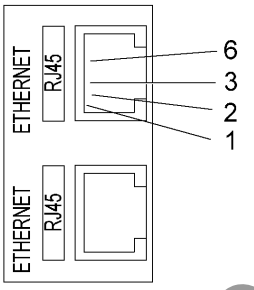


Figure 3-33 Ethernet connection

**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.

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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<br>PROFIBUS FMS Slave, RS485 | Modbus RS485<br>DNP3.0 RS485 | Ethernet EN 100 |
|---|---|---|---|---|---|
| 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.

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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.

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### 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)?

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- 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.

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## 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.

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## 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.

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**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.

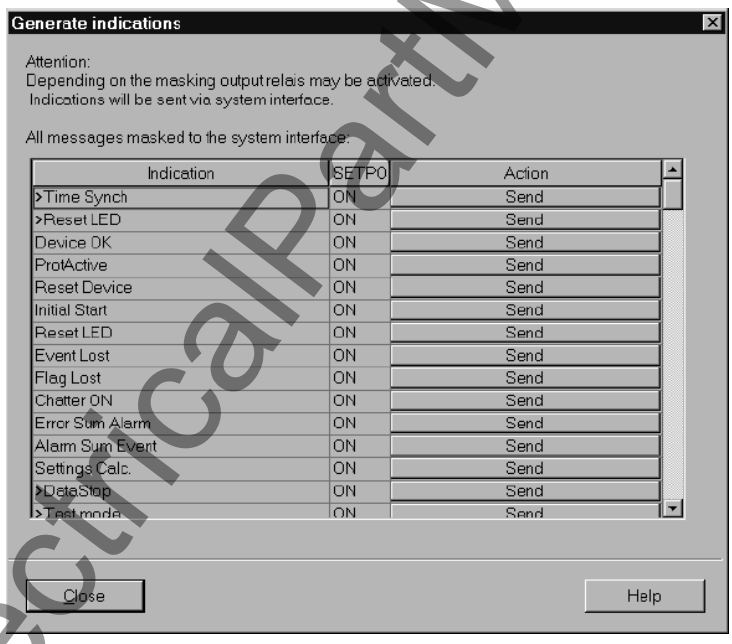


Figure 3-34 System interface test with dialog box: Generate annunciations — example

**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.

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**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.

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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.

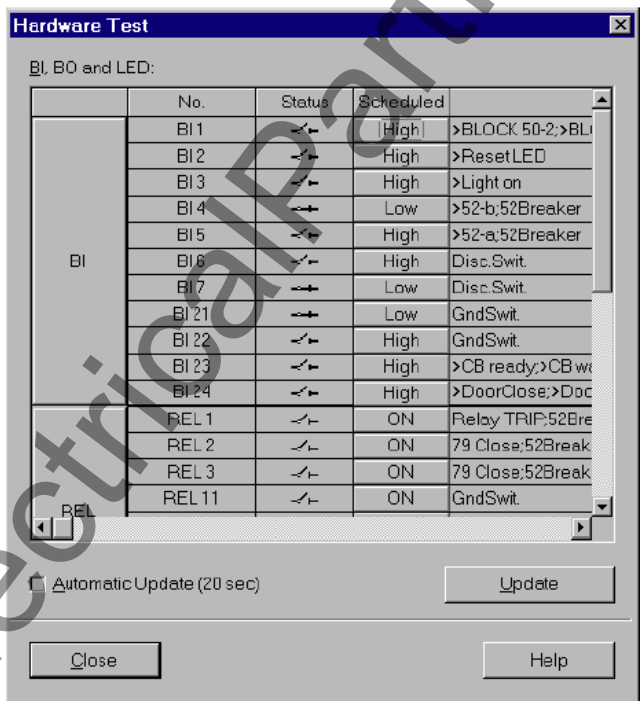


Figure 3-35 Test of the binary inputs and outputs — example

**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.

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**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.

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**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.

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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

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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.

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### 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

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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.

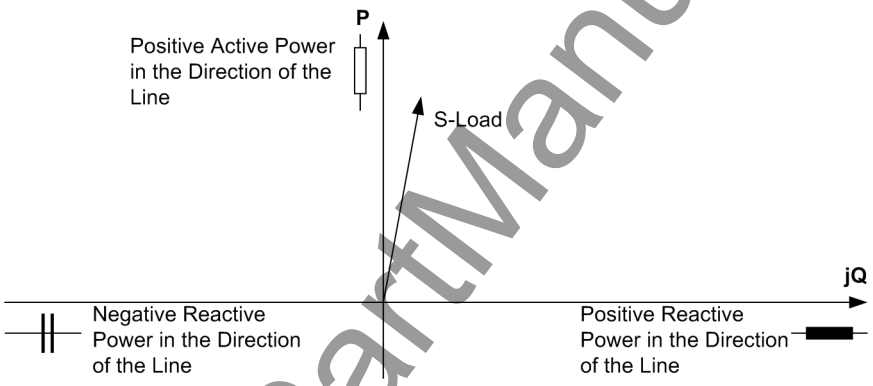


Figure 3-36 Apparent Load Power

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.

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**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 $\alpha$2>$\alpha$1“ and 170.2095 „25 $\alpha$2<$\alpha$1“ 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).

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- 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 $\alpha$2>$\alpha$1“ and 170.2095 „25 $\alpha$2<$\alpha$1“ 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 $\alpha$2>$\alpha$1“ or „25 $\alpha$2<$\alpha$1“ 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.

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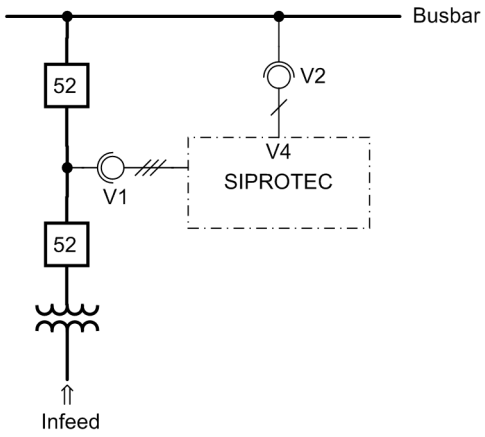


Figure 3-37 Measuring voltages for the synchro-check

### 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)

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- 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–

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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 !

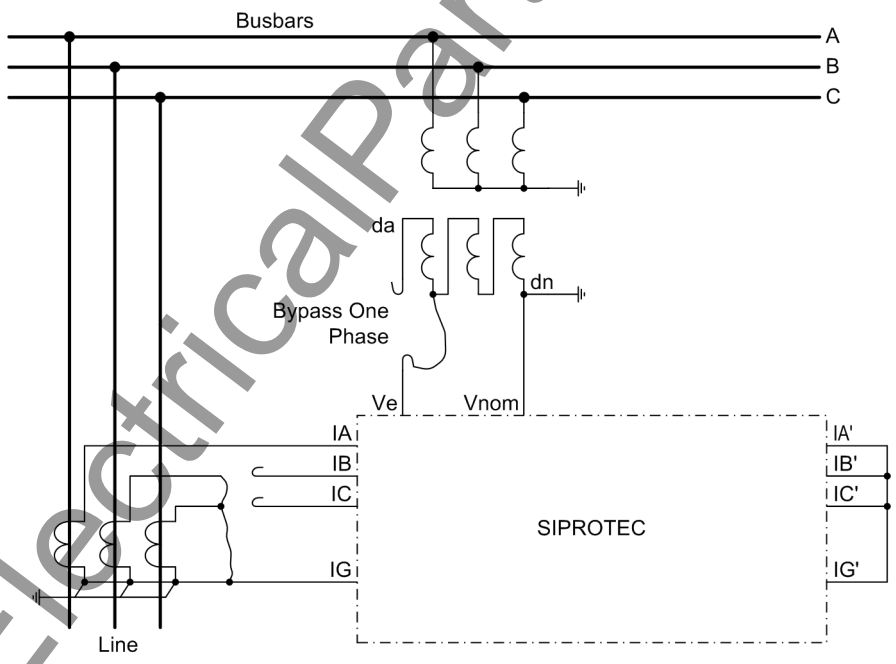


Figure 3-38 Polarity testing for $I_N$, example with current transformers configured in a Holmgreen-connection (VTs with broken delta connection -- e-n winding)

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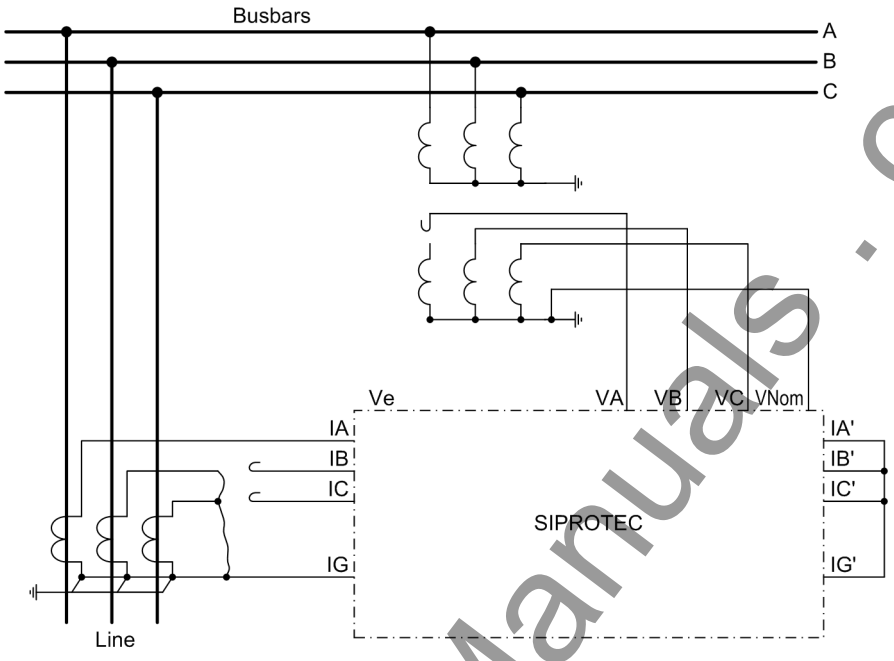


Figure 3-39 Polarity testing for $I_N$, example with current transformers configured in a Holmgreen-connection (VTs Wye-connected)

### 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 |

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| 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.

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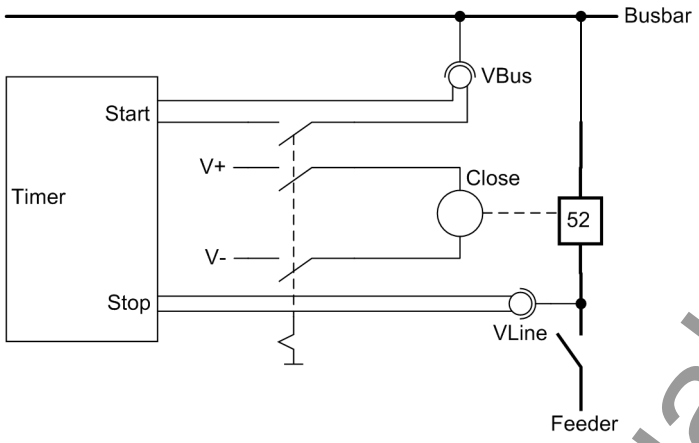


Figure 3-40 Measuring the circuit breaker closing time

### 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.

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### 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 OscillographicRecording**

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.

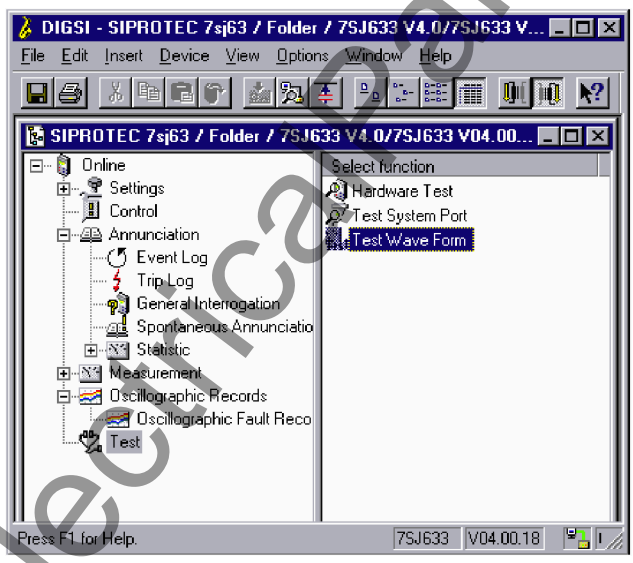


Figure 3-41 Triggering oscillographic recording with DIGSI®

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.

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## 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.

■

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# 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.


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# 4.1 General Device Data

## 4.1.1 Analog Inputs

### Current Inputs

| | | | |
|---|---|---|---|
| Nominal Frequency | $f_{Nom}$ | 50 Hz or 60 Hz | (adjustable) |
| 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<br>- at $I_{Nom}$ = 1 A<br>- at $I_{Nom}$ = 5 A<br>- for sensitive ground fault detection at 1 A | | <br>Approx. 0.05 VA<br>Approx. 0.3 VA<br>Approx. 0.05 VA | |
| Current overload capability<br>- Thermal (rms)<br><br><br>- Dynamic (peak value) | | <br>100· $I_{Nom}$ for 1 s<br>30· $I_{Nom}$ for 10 s<br>4· $I_{Nom}$ continuous<br>250· $I_{Nom}$ (half-cycle) | |
| Current overload capability for high-sensitivity input $I_{Ns}$ [1)] | | | |
| - Thermal (rms)<br><br><br>- Dynamic (peak value) | | 300 A for 1 s<br>100 A for 10 s<br>15 A continuous<br>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<br>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 |

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## 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,<br>Peak to Peak, IEC 60255-11 | 15 % of the auxiliary voltage | |

| Power Input | Quiescent | Energized |
|---|---|---|
| 7SJ621,<br>7SJ622 | Approx. 4 W | Approx. 7 W |
| 7SJ631 | Approx. 4 W | Approx. 10 W |
| 7SJ632,<br>7SJ633 | Approx. 5.5 W | Approx. 16 W |
| 7SJ635,<br>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,<br>IEC 60255–11<br>(in not energized operation) | ≥ 50 ms at V ≥ 110 V–<br>≥ 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,<br>7SJ622 | Approx. 3 VA | Approx. 9 VA |
| 7SJ631 | Approx. 3 VA | Approx. 12 VA |
| 7SJ632,<br>7SJ633 | Approx. 5 VA | Approx. 18 VA |
| 7SJ635,<br>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 | |

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### 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<br>V low ≤ 10 VDC |
| for Nominal Voltages | 110/125/220/250 VDC | V high ≥ 88 VDC<br>V low ≤ 44 VDC |
| for Nominal Voltages<br>(only for modules with 3 switching thresholds) | 220/250 VDC and<br>115/230 VAC | V high ≥ 176 VDC<br>V low ≤ 88 VDC |
| Maximum Permissible Voltage | 300 V DC | |
| Impulse Filter on Input | 220 nF at 220 V with recovery time > 60 ms | |

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### Output Relays

| Output Relay for Commands/Annunciations, Alarm Relay *)<br>High-duty Relay **) 2) | | | |
|---|---|---|---|
| Number and Information | According to the order variant (allocatable);<br>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<br>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<br>At 48 V to 250 V<br>At 24 V | – | | <br>1000 W<br>500 W |
| Permissible relative closing time | – | | 1 % |
| | | | |
| AC Load<br>(it has to be taken into consideration for the dimensions of external circuits) | | | |
| Value of the ANSI capacitor:<br>$4{,}70 \cdot 10^{-9}$ F ± 20% | Frequency | Impedance | |
| | 50 Hz | $6{,}77 \cdot 10^{5}\ \Omega \pm 20\%$ | |
| | 60 Hz | $5{,}64 \cdot 10^{5}\ \Omega \pm 20\%$ | |
| | | | |
| *) 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 FLA[1)]) | |
| | 240 VAC | 1/2 hp (4.9 FLA[1)]) | |
| **) UL–listed with the Following Nominal Values: | | | |

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| | | |
|---|---|---|
| | 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) |

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### 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 | $\lambda$ = 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

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**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 | $\lambda$ = 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“ |

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**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 | $\lambda$ = 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<br>500 m or 1,640 ft at ≤ 187.5 kBd<br>200 m or 330 ft at ≤ 1.5 MBd |

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| | | |
|---|---|---|
| PROFIBUS FO (FMS and DP) | | |
| | FO connector type | ST connector<br>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<br>≤ 57 600 Bd at detached operator panel |
| | Optical Wavelength | $\lambda$ = 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 | $\lambda$ = 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) |

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| | | |
|---|---|---|
| Ethernet electrical (EN 100) for IEC61850 and DIGSI | | |
| | Connection for flush-mounted case | rear side, mounting location „B“<br>2 x RJ45 socket contact<br>100BaseT acc. to IEEE802.3 |
| | Connection for panel surface-mounted housing | available<br>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<br>(Telegram Format IRIG-B000) |
| Connection for flush-mounted case | Rear panel, mounting location „A“<br>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 |

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## 4.1.5 Electrical Tests

### Specifications

| | |
|---|---|
| Standards: | IEC 60255 (product standards)<br>ANSI/IEEE Std C37.90.0/.1/.2<br>UL 508<br>DIN 57435 Part 303<br>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;<br>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),<br>EN 50082-2 (Generic standard)<br>DIN 57435 Part 303 |
| High Frequency Test<br>IEC 60255-22-1, Class III and VDE 0435 Part 303, Class III | | 2.5 kV (Peak); 1 MHz; $\tau$ = 15 μs; 400 surges per s; test duration 2 s; $R_i$ = 200 Ω |
| Electrostatic Discharge<br>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<br>IEC 60255-22-3 (report), Class III | | 10 V/m; 27 MHz to 500 MHz |
| Irradiation with HF field, amplitude modulated<br>IEC 61000-4-3, Class III | | 10 V/m; 80 MHz to 1000 MHz; 80 % AM; 1 kHz |
| Irradiation with HF field, pulse modulated<br>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<br>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),<br>IEC 61000-4-5 Installation Class 3 | | Impulse: 1.2/50 μs |
| | Auxiliary voltage | common mode: 2 kV; 12 Ω; 9 μF<br>diff. mode:1 kV; 2 Ω; 18 μF |
| | Measuring Inputs, Binary Inputs, Relay Outputs | common mode: 2 kV; 42 Ω; 0.5 μF<br>diff. mode: 1 kV; 42 Ω; 0.5 μF |

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| | |
|---|---|
| HF on lines, amplitude-modulated<br>IEC 61000-4-6, Class III | 10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz |
| Power System Frequency Magnetic Field<br>IEC 61000-4-8; class IV<br>IEC 60255-6 | 30 A/m continuous; 300 A/m for 3 s; 50 Hz 0.5 mT; 50 Hz |
| Oscillatory Surge Withstand Capability<br>IEEE Std C37.90.1 | 2.5 kV (peak value); 1 MHz; $\tau$ = 15 µs; 400 surges per s; Test Duration 2 s; $R_i$ = 200 Ω |
| Fast Transient Surge Withstand Cap.<br>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<br>IEEE Std C37.90.2 | 35 V/m; 25 MHz to 1000 MHz |
| Damped Oscillations<br>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<br>IEC-CISPR 22 | 150 kHz to 30 MHz<br>Limit Class B |
| Interference field strength<br>IEC-CISPR 22 | 30 MHz to 1000 MHz Limit Class B |
| Harmonic Currents on the Network Lead at 230 VAC<br>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<br>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<br>IEC 60255-21-1, Class II;<br>IEC 60068-2-6 | Sinusoidal<br>10 Hz to 60 Hz: ± 0.075 mm Amplitude; 60 Hz to 150 Hz: 1 g acceleration<br>frequency sweep rate 1 Octave/min 20 cycles in 3 orthogonal axes. |
| Shock<br>IEC 60255-21-2, Class I;<br>IEC 60068-2-27 | Semi-sinusoidal<br>5 g acceleration, duration 11 ms, each 3 shocks (in both directions of the 3 axes) |
| Seismic Vibration<br>IEC 60255-21-3, Class I;<br>IEC 60068-3-3 | Sinusoidal<br>1 Hz to 8 Hz: ± 3.5 mm amplitude (horizontal vectors)<br>1 Hz to 8 Hz: ± 1.5 mm Amplitude (vertical axis)<br>8 Hz to 35 Hz: 1 g acceleration (horizontal axis)<br>8 Hz to 35 Hz: 0.5 g acceleration (vertical axis)<br>frequency sweep rate 1 octave/min,<br>1 cycle in 3 orthogonal axes |

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**Vibration and Shock Stress During Transport**

| | |
|---|---|
| Standards: | IEC 60255-21 and IEC 60068 |
| Oscillation<br>IEC 60255-21-1, Class II;<br>IEC 60068-2-6 | Sinusoidal<br>5 Hz to 8 Hz: ±7.5 mm amplitude;<br>8 Hz to 150 Hz: 2 g acceleration<br>frequency sweep 1 octave/min<br>20 cycles in 3 orthogonal axes |
| Shock<br>IEC 60255-21-2, Class I;<br>IEC 60068-2-27 | Semi-sinusoidal<br>15 g acceleration, duration 11 ms,<br>each 3 shocks (in both directions of the 3 axes) |
| Continuous Shock<br>IEC 60255-21-2, Class I;<br>IEC 60068-2-29 | Semi-sinusoidal<br>10 g acceleration, duration 16 ms,<br>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<br>+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. | |

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### 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 |

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| 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“ |

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## 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<br>– Current = 2 x Pickup Value<br>– Current = 10 x Pickup Value | <br>approx. 30 ms<br>approx. 20 ms |
| Dropout Times<br>50-1, 50-2, 50N-1, 50N-2 | <br>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<br>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<br>$-5\ °C \leq \Theta_{amb} \leq 55\ °C$ | 0.5 %/10 K |
| Frequency in range $0.95 \leq f/f_{Nom} \leq 1.05$ | 1 % |

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| | |
|---|---|
| Harmonics<br>Up to 10 % 3rd harmonic<br>Up to 10 % 5th harmonic | <br>1 %<br>1 % |
| Transient overreach for $\tau$ > 100 ms (with complete asymmetry) | <5 % |

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## 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<br>IEC curves | | 0.05 s to 3.20 s or ∞ (disabled)<br>(disabled) | Increments 0.01 s |
| Time multipliers D for 51, 51N<br>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 · $I_p$ |

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### 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 $0.05 \leq (I/Ip) \leq 0.90$

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 |
| 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<br>or 50 mA for $I_{Nom}$ = 5 A |
| Pickup time for $2 \leq I/I_p \leq 20$ | 5 % of reference (calculated) value + 2 %<br>current tolerance, respectively 30 ms |
| Dropout ratio for $I/I_p \leq 0.90$ | 5 % of reference (calculated) value + 2 %<br>current tolerance, 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<br>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 % |

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| | |
|---|---|
| Harmonics<br>Up to 10 % 3rd harmonic<br>Up to 10 % 5th harmonic | <br>1 %<br>1 % |
| Transient overreach for $\tau$ > 100 ms (with complete asymmetry) | <5 % |

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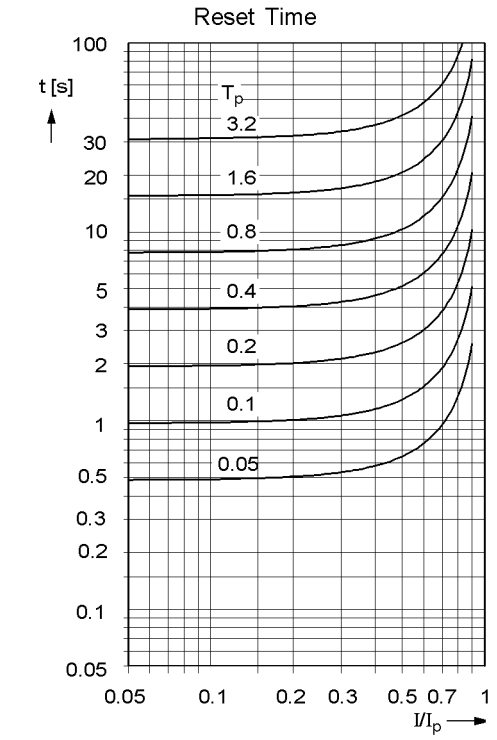
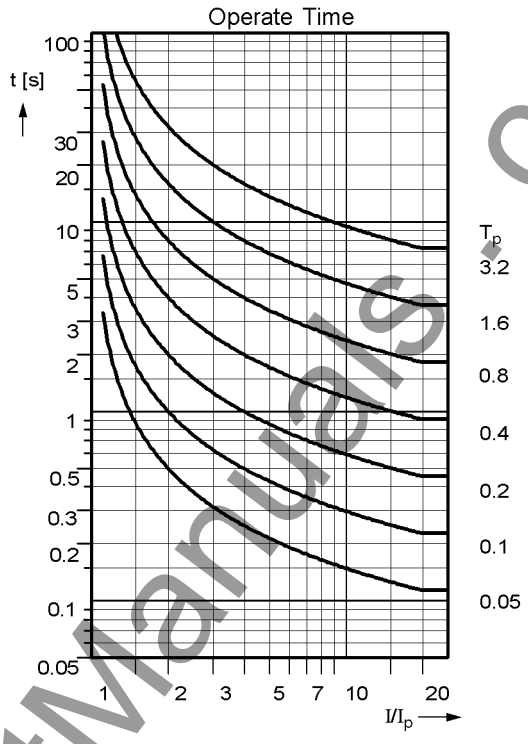
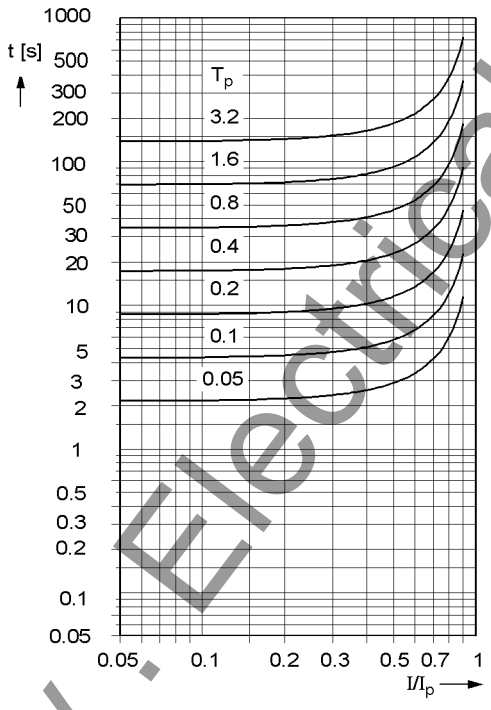


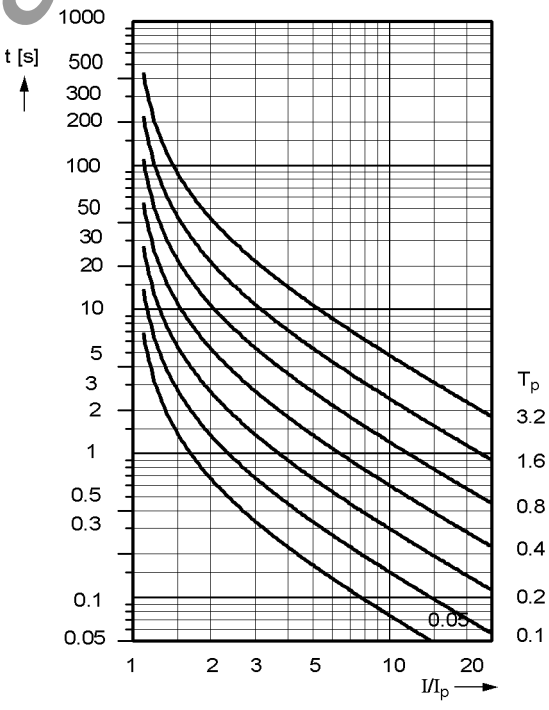

**Reset Normal inverse: (Type A)** $t = \frac{9.7}{(I/I_p)^2 - 1} \cdot T_p$ [s]




**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

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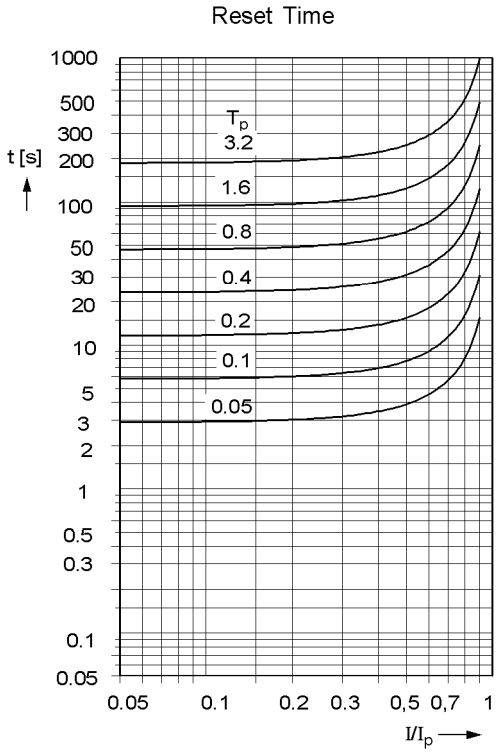
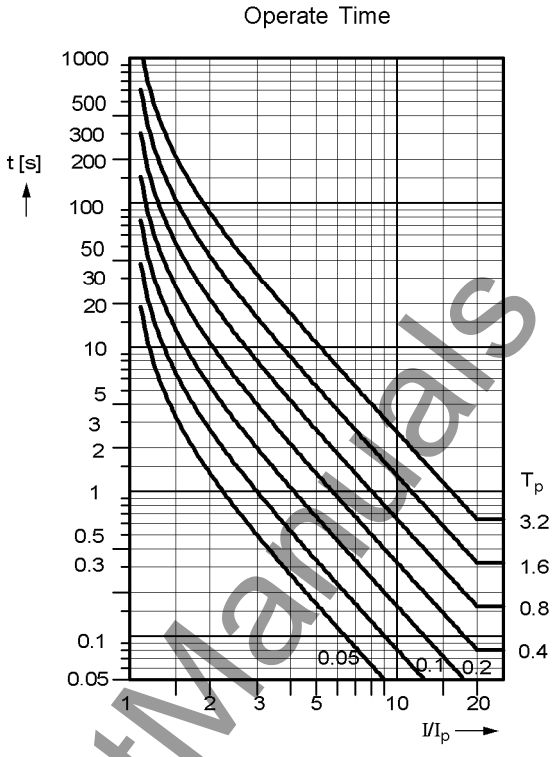
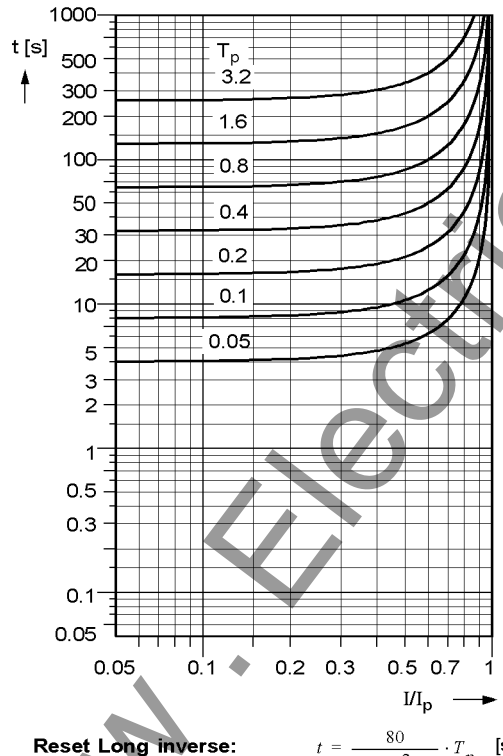


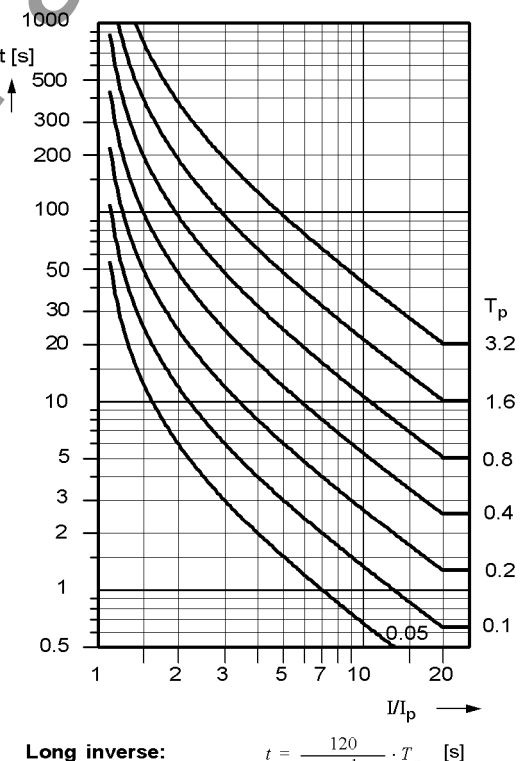

**Reset Extremely inverse: (Type C)** $t = \frac{58.2}{(I/I_p)^2 - 1} \cdot T_p$ [s]




**Extremely inverse: (Type C)** $t = \frac{80}{(I/I_p)^2 - 1} \cdot T_p$ [s]




**Reset Long inverse: (Type B)** $t = \frac{80}{(I/I_p)^2 - 1} \cdot T_p$ [s]




**Long inverse: (Type B)** $t = \frac{120}{(I/I_p)^1 - 1} \cdot T_p$ [s]

Figure 4-2 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to IEC

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### Trip Time Curves acc. to ANSI

Acc. to ANSI/IEEE (see also Figures 4-3 to 4-6)

| | |
|---|---|
| **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 |

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. $1.10 \cdot I_p$ |

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### Dropout Time Characteristics with Disk Emulation acc. to ANSI/IEEE

Acc. to ANSI/IEEE (see also Figures 4-3 to 4-6)

| | |
|---|---|
| **ANSI INVERSE** | $t_{Reset} = \left(\frac{8.8}{(I/I_p)^{2.0938} - 1}\right) \cdot D \ [s]$ |
| **ANSI SHORT INVERSE** | $t_{Reset} = \left(\frac{0.831}{(I/I_p)^{1.2969} - 1}\right) \cdot D \ [s]$ |
| **ANSI LONG INVERSE** | $t_{Reset} = \left(\frac{12.9}{(I/I_p)^{1} - 1}\right) \cdot D \ [s]$ |
| **ANSI MODERATELY INV.** | $t_{Reset} = \left(\frac{0.97}{(I/I_p)^{2} - 1}\right) \cdot D \ [s]$ |
| **ANSI VERY INVERSE** | $t_{Reset} = \left(\frac{4.32}{(I/I_p)^{2} - 1}\right) \cdot D \ [s]$ |
| **ANSI EXTREMELY INV.** | $t_{Reset} = \left(\frac{5.82}{(I/I_p)^{2} - 1}\right) \cdot D \ [s]$ |
| **ANSI DEFINITE INV.** | $t_{Reset} = \left(\frac{1.03940}{(I/I_p)^{1.5625} - 1}\right) \cdot D \ [s]$ |
| for $0.05 < (I/I_p) \leq 0.90$ | For all Characteristics<br>$t_{RESET}$ = Reset time<br>D = Setting value of the time multiplier<br>I = Fault Current<br>$I_p$ = Setting value of the pickup current |
| The dropout time curves apply for the range (I/Ip) ≤ 0.90 | |
| For zero-sequence current read 3I0p instead of $I_p$ and $T_{3I0p}$ instead of $T_p$;<br>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 ≤ 0.90 | 5 % of reference (calculated) value + 2 %, respectively 30 ms |

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### 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<br>$23.00\ °F\ (-5\ °C) \leq \Theta_{amb} \leq 131.00\ °F\ (55\ °C)$ | 0.5 %/10 K |
| Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$ | 1 % |
| Harmonics<br>- up to 10 % 3rd harmonic<br>- up to 10 % 5th harmonic | <br>1%<br>1% |
| Transient overreach for $\tau > 100$ ms (with complete asymmetry) | <5 % |

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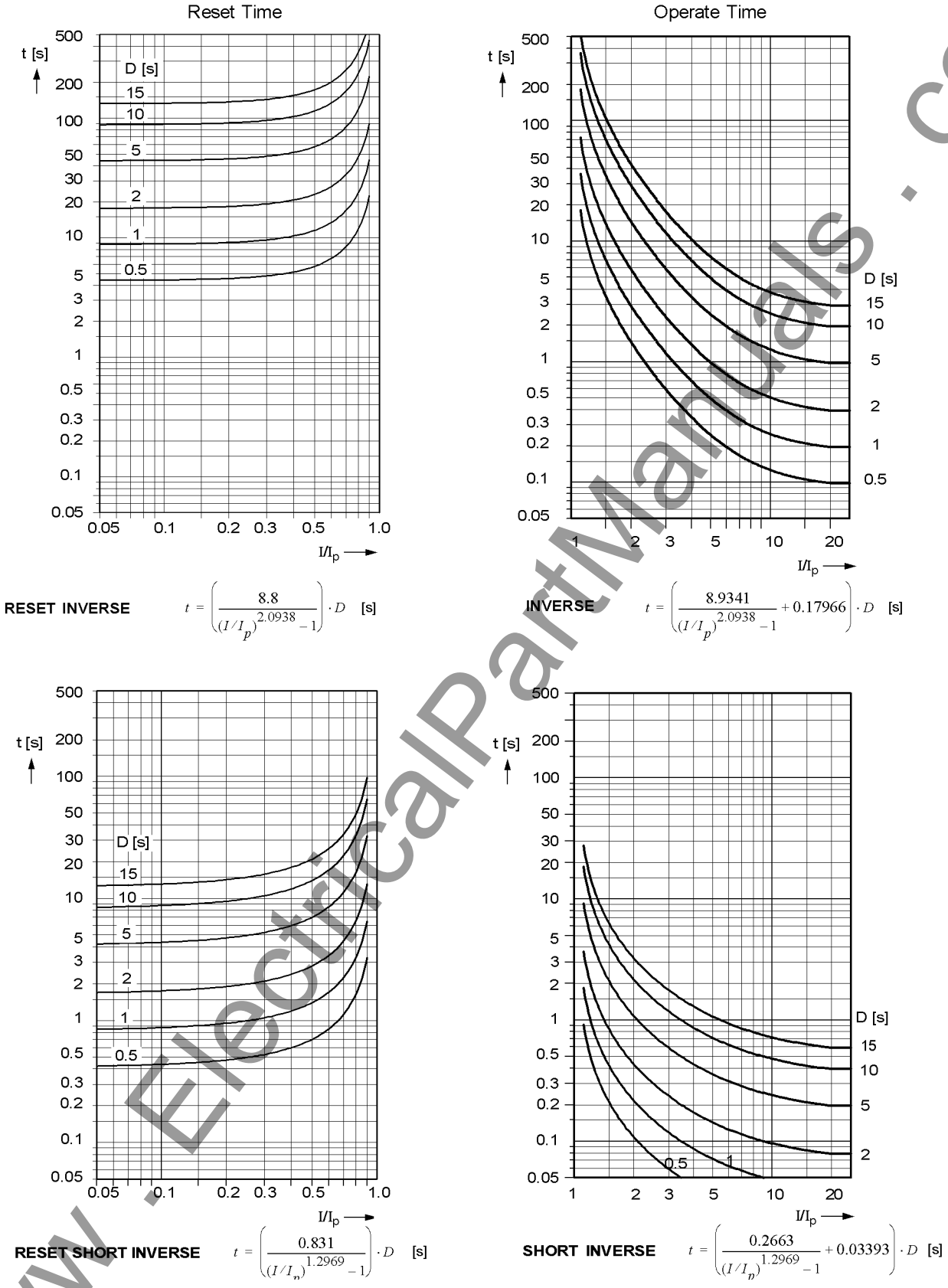


Figure 4-3 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to ANSI/IEEE

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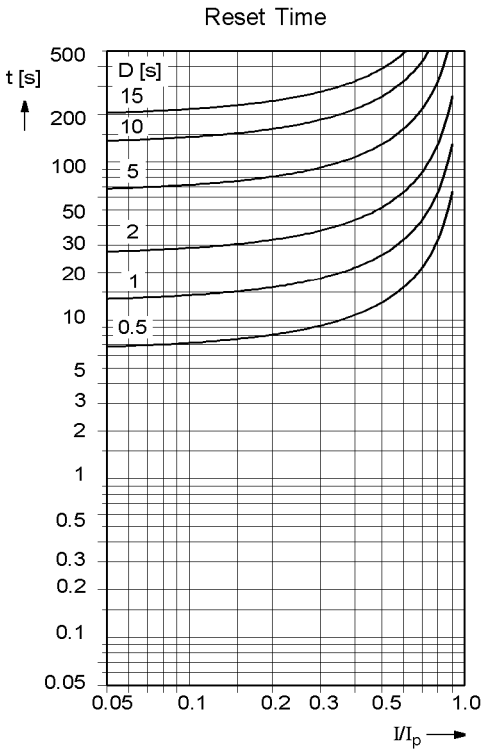
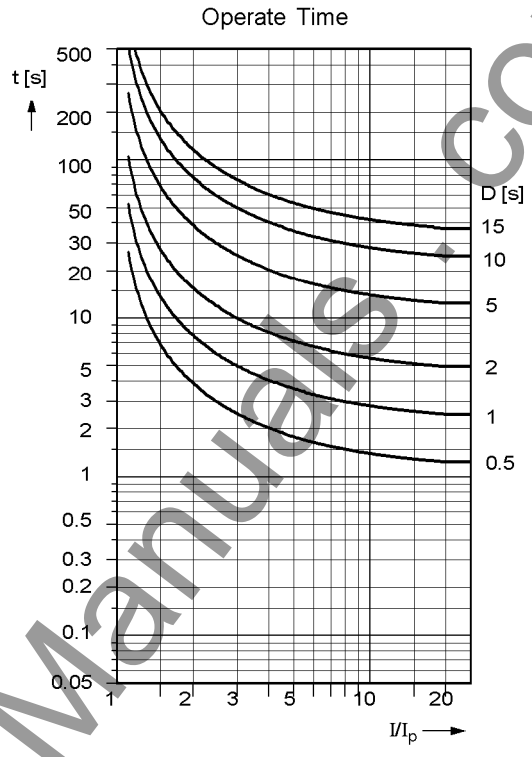
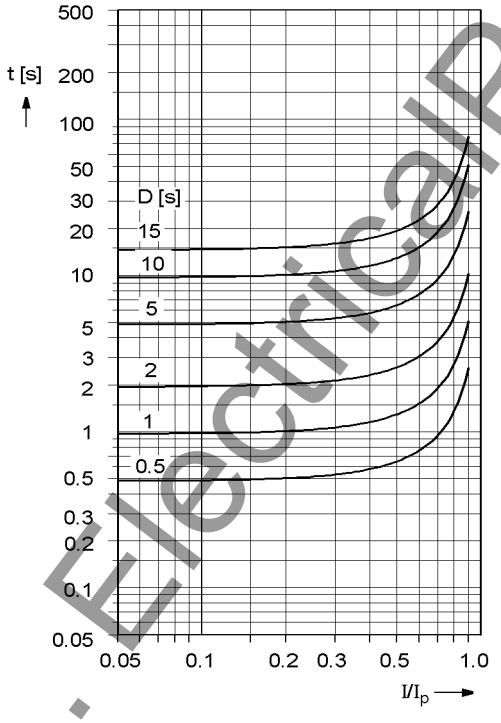


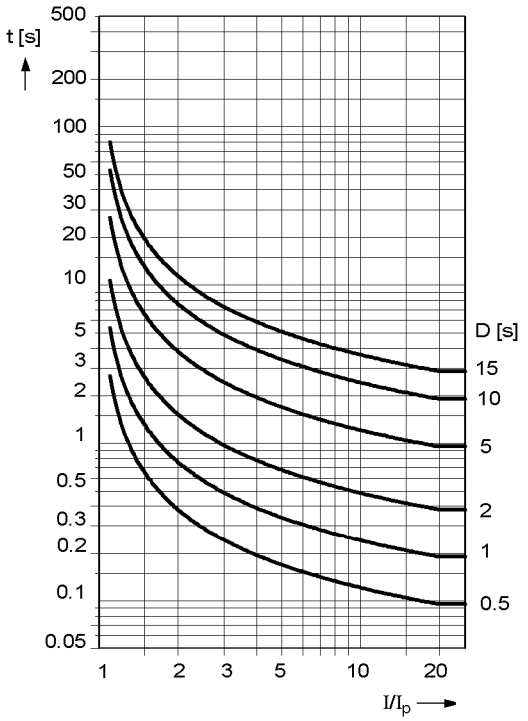

**RESET LONG INVERSE** $t = \left( \frac{12.9}{(I/I_p)^1 - 1} \right) \cdot D$ [s]




**LONG INVERSE** $t = \left( \frac{5.6143}{(I/I_p) - 1} + 2.18592 \right) \cdot D$ [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 4-4 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to ANSI/IEEE

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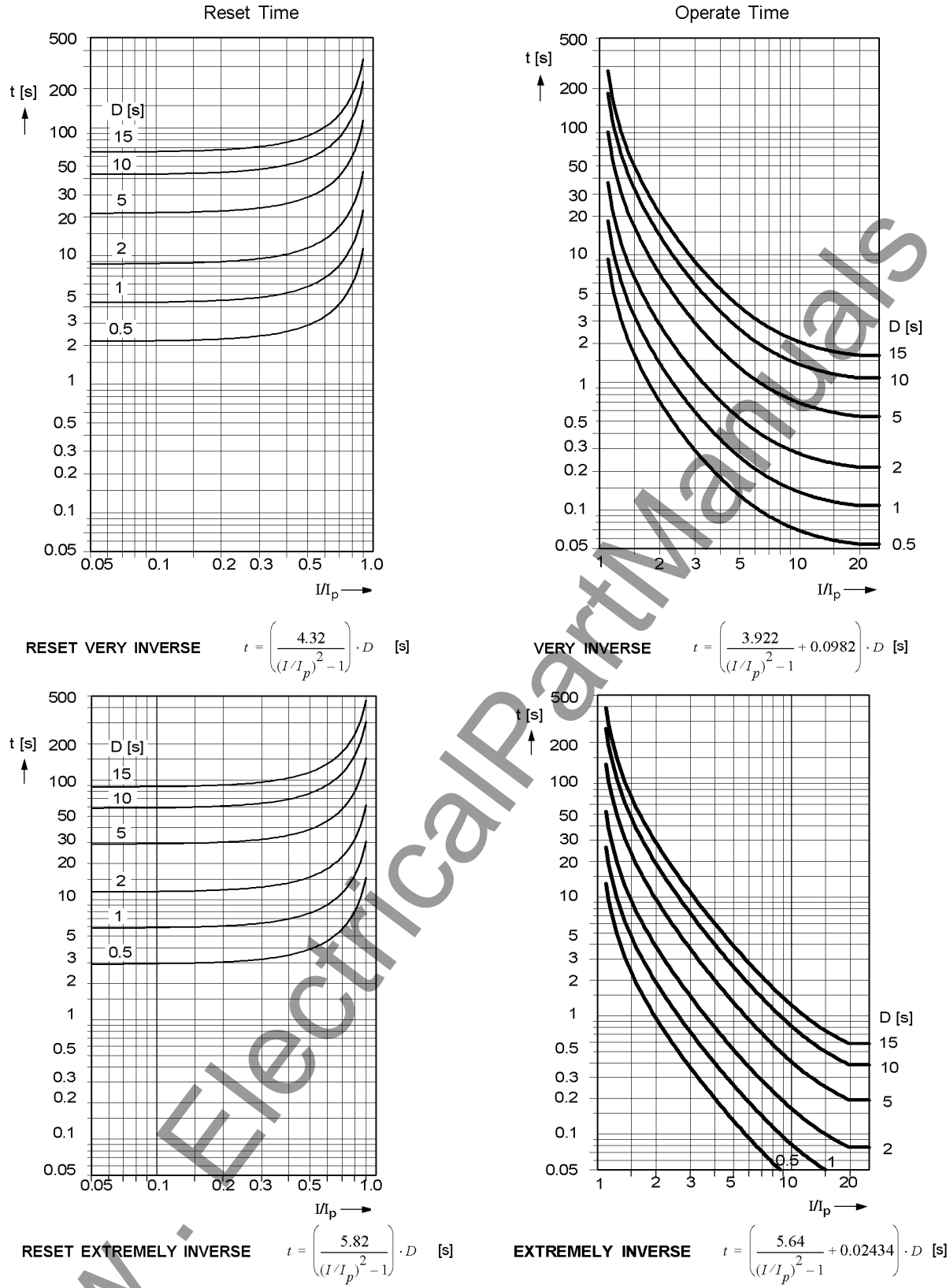


Figure 4-5 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to ANSI/IEEE

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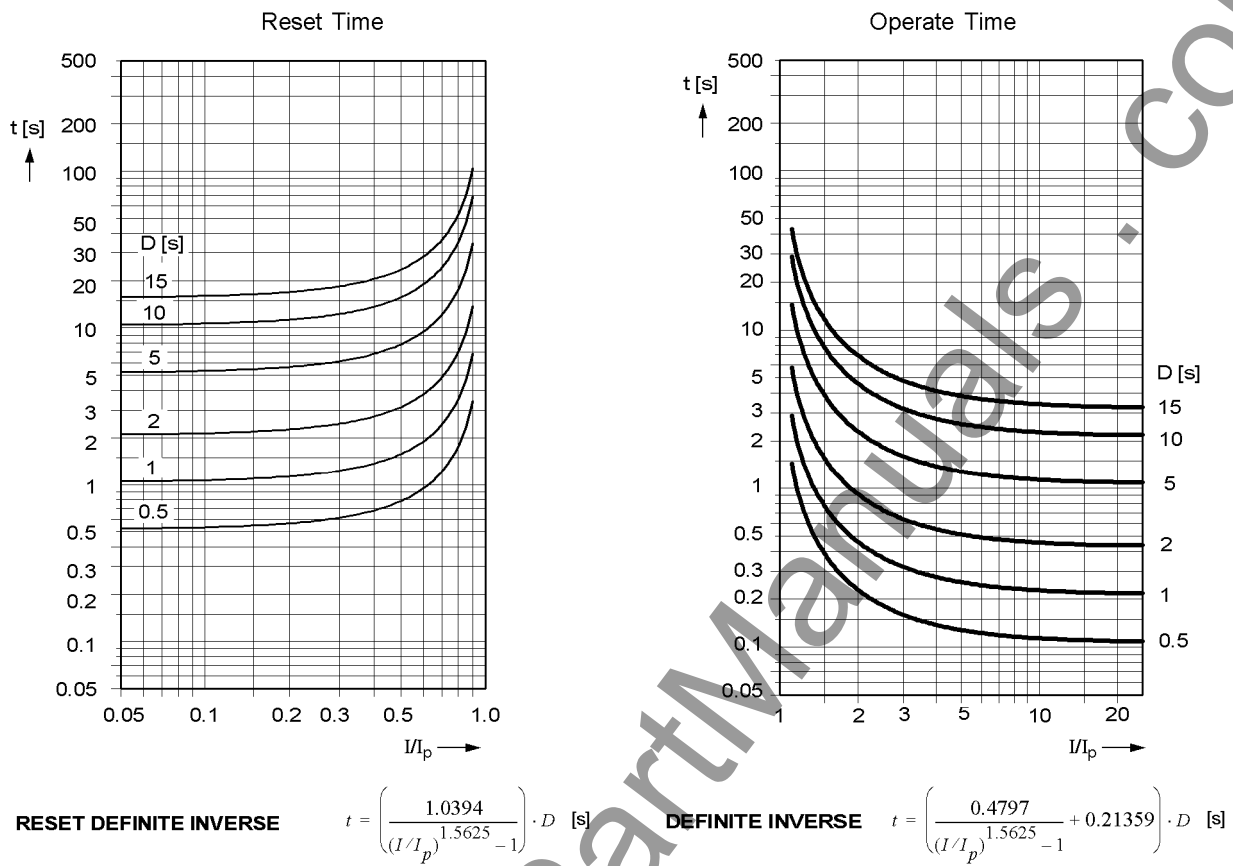


Figure 4-6 Dropout time and trip time curve of the inverse time overcurrent protection, acc. to ANSI/IEEE

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## 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;<br>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°<br>Increments 1° |
| Dropout difference | 2° |
| Directional sensitivity | Unlimited for single and two phase faults<br>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°<br>Increments 1° |
| Dropout difference | 2° |
| Directional Sensitivity | $V_0 \approx 2.5$ V zero voltage, measured<br>$3V_0 \approx 5$ 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°<br>Increments 1° |
| Dropout difference | 2° |
| Directional Sensitivity | $3V_2 \approx 5$ V negative sequence voltage<br>$3I_2 \approx 45$ mA negative sequence current with $I_{Nom} = 1$ A<br>$3I_2 \approx 225$ mA negative sequence current with $I_{Nom} = 5$ A |

### Times

| |
|---|
| Pickup times (without inrush restraint, with restraint add 10 ms) |

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| | |
|---|---|
| 50-1, 50-2, 50N-1, 50N-2<br>– Current = 2 times pickup value<br>– Current = 10 times pickup value | <br>approx. 45 ms<br>approx. 40 ms |
| Dropout Times<br>50-1, 50-2, 50N-1, 50N-2 | <br>approx. 40 ms |

### Tolerances

| | |
|---|---|
| Angle faults for phase and ground faults | ±3° electrical |

### Influencing Variables

| | |
|---|---|
| Frequency Influence<br>– With no memory voltage | <br>approx.1° in range $0.95 < f/f_{Nom} < 1.05$ |

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## 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 $\geq 0{,}25 * I_N$ |
| lower function limit ground | | Earth current $\geq 0{,}25 * I_N$ |
| 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 |

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## 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 | |

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## 4.7 Single-Phase Overcurrent Protection 50

### Current Elements

| | | | |
|---|---|---|---|
| High-set current elements | 50-2 | 0.05 A to 35.00 A [1]<br>0.003 A to 1.500 A [2]<br>or ∞ (element disabled) | Increments 0.01 A<br>Increments 0.001 A |
| | $T_{50-2}$ | 0.00 s to 60.00 s<br>or ∞ (no trip) | Increments 0.01 s |
| Definite-Time Current Element | 50-1 | 0.05 A to 35.00 A [1]<br>0.003 A to 1.500 A [2]<br>or ∞ (element disabled) | Increments 0.01 A<br>Increments 0.001 A |
| | $T_{50-1}$ | 0.00 s to 60.00 s<br>or ∞ (no trip) | Increments 0.01 s |
| The set times are pure delay times.<br>[1] Secondary values for $I_{Nom}$ = 1 A; with $I_{Nom}$ = 5 A multiply currents by 5<br>[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<br>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<br>23.00 °F (–5 °C) ≤ $\Theta_{amb}$ ≤ 131.00 °F (55 °C) | 0.5 %/10 K |
| Frequency in range $0.95 \leq f/f_{Nom} \leq 1.05$ | 1 % |
| Harmonics<br>- up to 10 % 3rd harmonic<br>- up to 10 % 5th harmonic | <br>1 %<br>1 % |

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## 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<br>max. 210 V for phase–to–ground voltage<br>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 |
| | 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<br>max. 260 V for phase–to–ground voltage<br>Minimum hysteresis 0.6 V | |
| Time delay 59-Delay | | 0.00 s to 100.00 s | Increments 0.01 s |

1) $r = V_{dropout}/V_{pickup}$

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### Times

| Pickup Times | |
|---|---|
| - Undervoltage 27-1, 27-2, 27-1 $V_1$, 27-2 $V_1$<br>- Overvoltage 59-1, 59-2<br>- Overvoltage 59-1 $V_2$, 59-2 $V_2$ | Approx. 50 ms<br>Approx. 50 ms<br>Approx. 60 ms |
| Dropout Times | |
| - Undervoltage 27-1, 27-2, 27-1 $V_1$, 27-2 $V_1$<br>- Overvoltage 59-1, 59-2<br>- Overvoltage 59-1 $V_2$, 59-2 $V_2$ | Approx. 50 ms<br>Approx. 50 ms<br>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<br>$0.8 \leq V_H/V_{PSNom} \leq 1.15$ | 1 % |
| Temperature in Range<br>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<br>$f_{Nom} \pm 5$ Hz | Increased tolerances, tending to overfunction with undervoltage protection |
| Harmonics<br>- Up to 10 % 3rd harmonic<br>- Up to 10 % 5th harmonic | <br>1 %<br>1 % |

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## 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 | Approx. 35 ms |
| Dropout Times | 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) ≤ $\Theta_{amb}$ ≤ 131 °F (55 °C) | 0.5 %/10 K |
| Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$ | 1 % |
| Harmonics<br>- Up to 10 % 3rd harmonic<br>- Up to 10 % 5th harmonic | <br>1 %<br>1 % |
| Transient overreach for $\tau$ > 100 ms (with complete asymmetry) | <5 % |

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## 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. $1.10 \cdot I_{2p}$ |

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### 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<br>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 |

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### 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:<br>$t_{Reset}$ trip time<br>$D_{I2p}$ setting value of the time multiplier<br>$I_2$ negative sequence currents<br>$I_{2p}$ 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 $I_{2p}$<br><br>Time for $I_2/I_{2p} \leq 0.90$ | 2 % of set value or 10 mA for $I_{Nom}$ = 1 A<br>or 50 mA for $I_{Nom}$ = 5 A<br>5 % of reference (calculated) value + 2 %<br>current tolerance, respectively 30 ms |

### Influencing Variables for Pickup Values

| | |
|---|---|
| Power Supply DC Voltage in Range<br>$0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$ | 1 % |
| Temperature in range<br>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<br>- Up to 10 % 3rd harmonic<br>- Up to 10 % 5th harmonic | <br>1 %<br>1 % |
| Transient overreach for $\tau > 100$ ms (with complete asymmetry) | <5 % |

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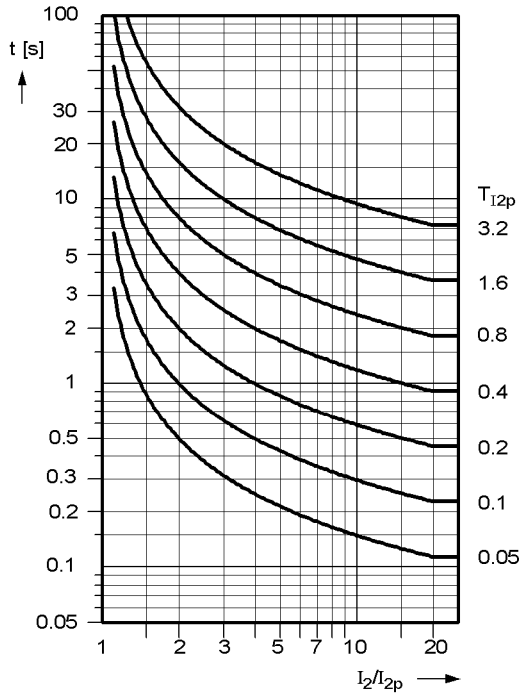
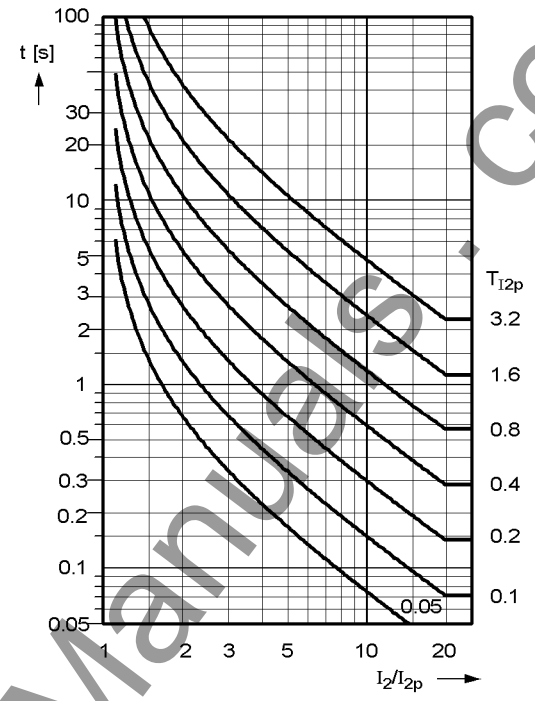
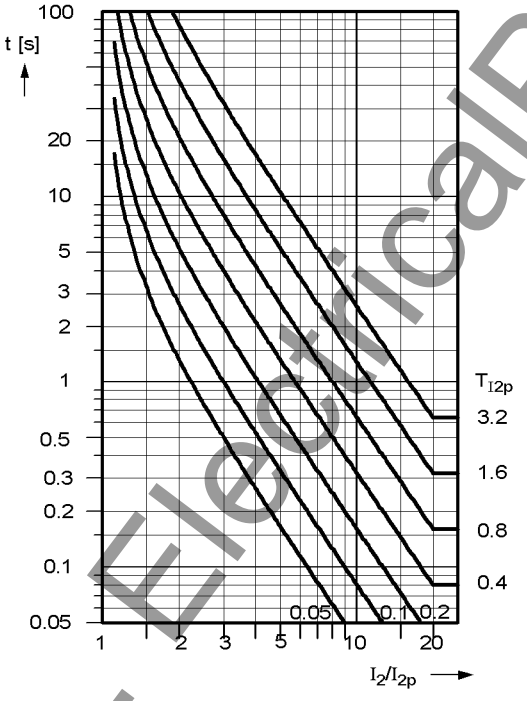



**IEC NORMAL INVERSE:** $t = \dfrac{0.14}{(I_2/I_{2p})^{0.02} - 1} \cdot T_{I2p}$ [s]




**IEC VERY INVERSE:** $t = \dfrac{13.5}{(I_2/I_{2p})^{1} - 1} \cdot T_{I2p}$ [s]




**IEC EXTREMELY INVERSE:** $t = \dfrac{80}{(I_2/I_{2p})^{2} - 1} \cdot T_{I2p}$ [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

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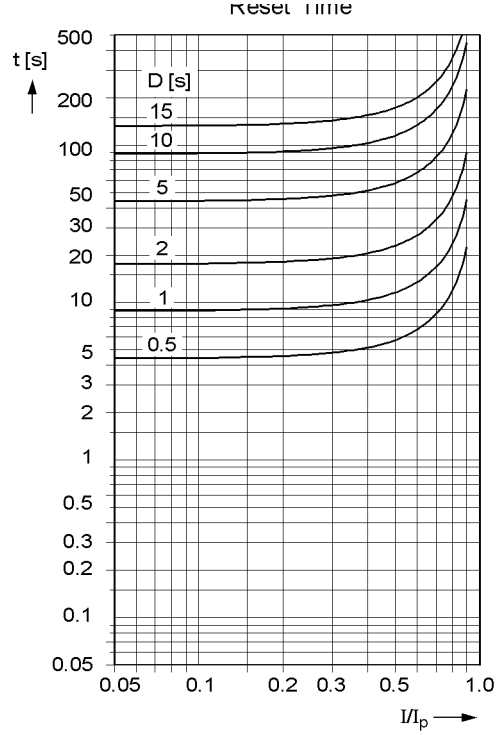
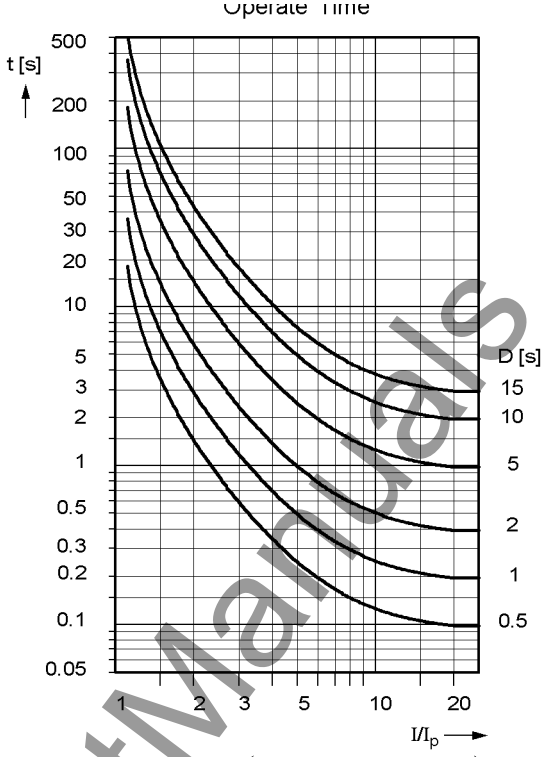
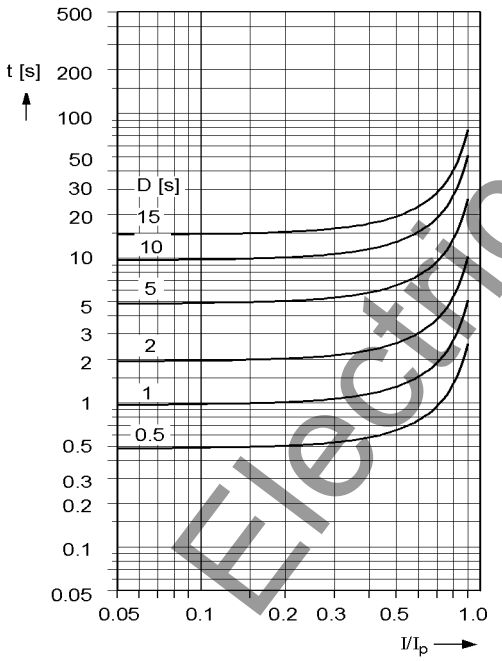


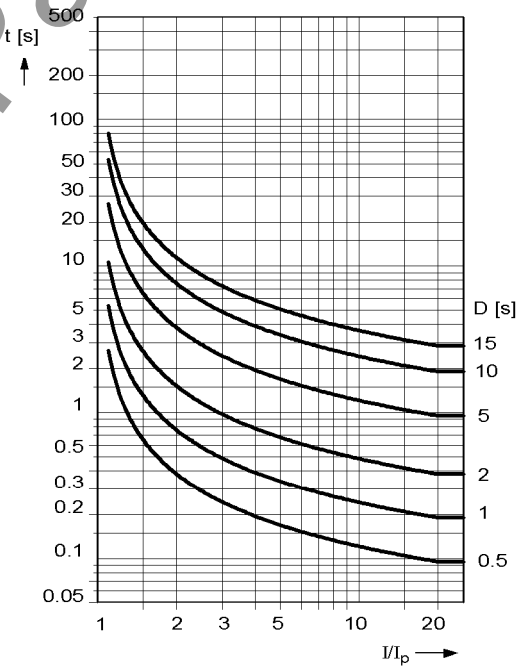

**RESET INVERSE** $t = \left( \frac{8.8}{(I/I_p)^{2.0938} - 1} \right) \cdot D$ [s]




**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

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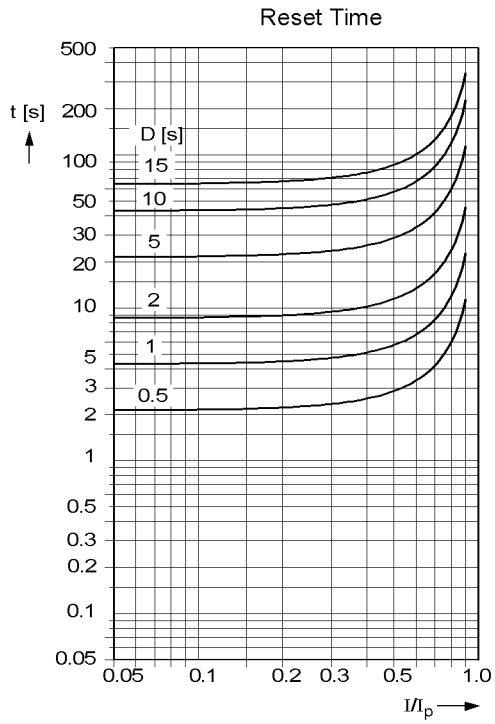
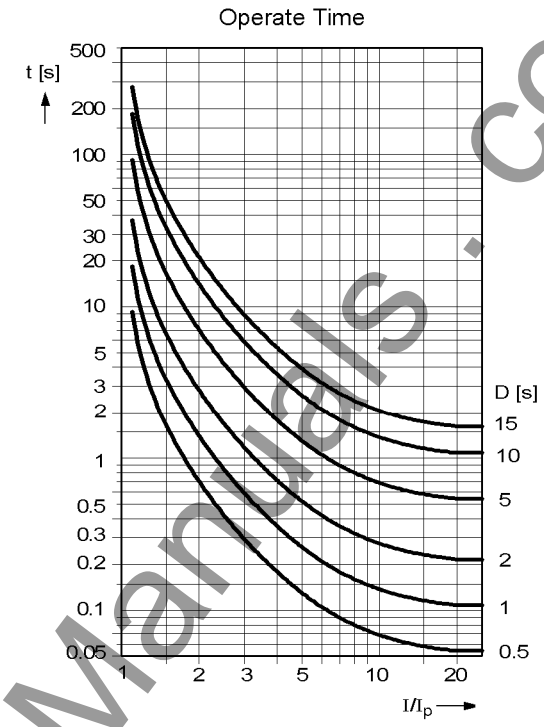
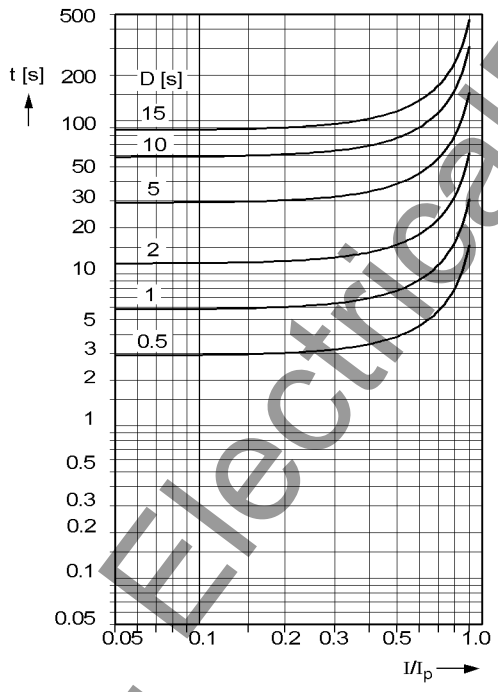


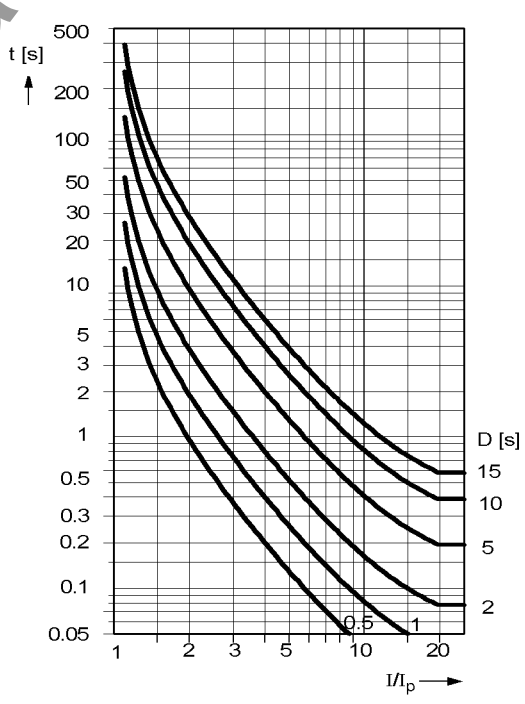

**RESET VERY INVERSE** $t = \left( \frac{4{,}32}{(I/I_p)^2 - 1} \right) \cdot D$ [s]




**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

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## 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<br>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) ≤ $\Theta_{amb}$ ≤ 131.00 °F (55 °C) | 0.5 %/10 K |
| Frequency in Range $0.95 \le f/f_{Nom} \le 1.05$ | 1 % |
| Harmonics<br>- Up to 10 % 3rd harmonic<br>- Up to 10 % 5th harmonic | <br>1 %<br>1 % |

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## 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<br>$k_R$ = k-factor for rotor<br>$I_{Start}$ = Startup current<br>$I_B$ = Basic current<br>$T_{start\ max}$ = Max. startup time<br>$\tau_R$ = Thermal rotor time constant<br>$n_{cold}$ = 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 |

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## 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<<br>with $f_{Nom}$ = 50 Hz | 45.50 Hz to 54.50 Hz | Increments 0.01 Hz |
| Pickup Frequency f> or f<<br>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<br>with Three-phase Connection: Positive Sequence Component $V_1$<br>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)<br>approx. 80 ms (7SJ64) |
| Dropout times f>, f< | approx. 150 ms (7SJ62/63)<br>approx. 80 ms (7SJ64) |

### Dropout Frequency

| | |
|---|---|
| $\Delta f$ = 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<br>Undervoltage Blocking<br>Time Delays 81/O or 81/U | 10 mHz (with V = $V_{Nom}$, f = $f_{Nom}$)<br>3 % of setting value or 1 V<br>1 % of setting value or 10 ms |

### Influencing Variables

| | |
|---|---|
| Power Supply DC Voltage in Range<br>$0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$ | 1 % |
| Temperature in Range<br>23.00 °F (–5 °C) ≤ $\Theta_{amb}$ ≤ 131.00 °F (55 °C) | 0.5 %/10 K |
| Harmonics<br>Up to 10 % 3rd harmonic<br>Up to 10 % 5th harmonic | <br>1 %<br>1 % |

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# 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 $\tau_{th}$ | | 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 $(I/ k \cdot I_{Nom}) \leq 8$

$$t = \tau \cdot \ln \frac{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - \left(\frac{I_{pre}}{k \cdot I_{Nom}}\right)^2}{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - 1} \quad [min]$$

Where:

| | |
|---|---|
| t | Trip time in minutes |
| $\tau$ | 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

| | |
|---|---|
| $\Theta/\Theta_{Trip}$ | Drops out with $\Theta_{Alarm}$ |
| $\Theta/\Theta_{Alarm}$ | 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<br>3 % or 1 s for $I/(k \cdot I_{Nom}) > 1.25$;<br>3 % class according to IEC 60255-8 |

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### Influencing Variables Referring to $k \cdot I_{Nom}$

| | |
|---|---|
| Power Supply DC Voltage in Range<br>$0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$ | 1 % |
| Temperature in Range<br>23 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131 °F (55 °C) | 0.5 %/10 K |
| Frequency in Range fN $\pm$ 5 Hz | 1 % |
| Frequency out of Range<br>$f_{Nom} \pm 5$ Hz | Increased Tolerances |

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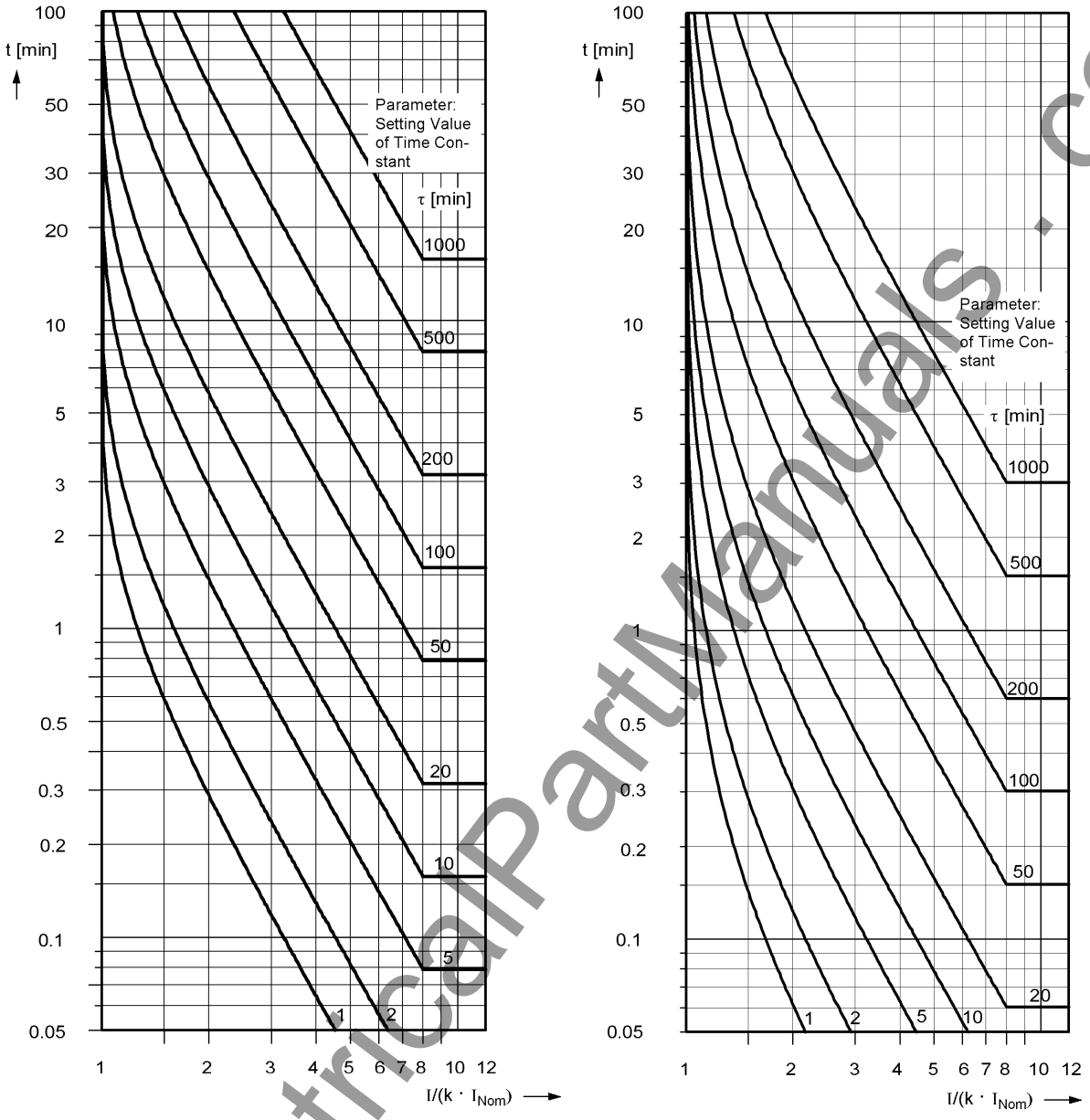


$$t = \tau \cdot \ln \frac{\left(\frac{I}{k \cdot I_{Nom}}\right)^2}{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - 1} \quad [\text{min}]$$

$$t = \tau \cdot \ln \frac{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - \left(\frac{I_{pre}}{k \cdot I_{Nom}}\right)^2}{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 - 1} \quad [\text{min}]$$

Figure 4-10 Trip time curves for the thermal overload protection (49)

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## 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)<br>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<br>$V_N$> (measured)<br>3V0> (calculated) | <br>3 % of setting value or 0.3 V<br>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<br>for sensitive transformer<br>for normal 1-A transformer<br>for normal 5-A transformer | <br>0.001 A to 1.500 A<br>0.05 A to 35.00 A<br>0.25 A to 175.00 A | <br>Increments 0.001 A<br>Increments 0.01 A<br>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<br>for sensitive transformer<br>for normal 1-A transformer<br>for normal 5-A transformer | <br>0.001 A to 1.500 A<br>0.05 A to 35.00 A<br>0.25 A to 175.00 A | <br>Increments 0.001 A<br>Increments 0.01 A<br>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)<br>≤ 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 | |

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### 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<br>for sensitive transformer<br>for normal 1-A transformer<br>for normal 5-A transformer | <br>0.001 A to 1.400 A<br>0.05 A to 4.00 A<br>0.25 A to 20.00 A | <br>Increments 0.001 A<br>Increments 0.01 A<br>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 · $I_{51Ns}$ | |
| Dropout ratio | Approx. 1.05 · $I_{51Nsp}$ 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 ≤ $I/I_{51Ns}$ ≤ 20 + 2 % current tolerance, or 70 ms | |

### Ground Fault Pickup for All Types of Ground Faults (Inverse Time Characteristic Logarithmic inverse)

| | | | |
|---|---|---|---|
| Pickup Current 50Ns<br>For sensitive transformer<br>For normal 1-A transformer<br>For normal 5-A transformer | | <br>0.001 A to 1.400 A<br>0.05 A to 4.00 A<br>0.25 A to 20.00 A | <br>Increments 0.001 A<br>Increments 0.01 A<br>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<br>Times | inv. | 5 % ± 15 ms for 2 ≤ $I/I_{51Ns}$ ≤ 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<br>for sensitive transformer<br>for normal 1-A transformer<br>for normal 5-A transformer | | <br>0.003 A to 0.500 A<br>0.05 A to 4.00 A<br>0.25 A to 20.00 A | <br>Increments 0.001 A<br>Increments 0.01 A<br>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<br>for sensitive transformer<br>for normal 1-A transformer<br>for normal 5-A transformer | | <br>0.003 A to 1.400 A<br>0.05 A to 20.00 A<br>0.25 A to 100.00 A | <br>Increments 0.001 A<br>Increments 0.01 A<br>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<br>for sensitive transformer<br>for normal 1-A transformer<br>for normal 5-A transformer | | <br>0.003 A to 0.650 A<br>0.05 A to 17.00 A<br>0.25 A to 85.00 A | <br>Increments 0.001 A<br>Increments 0.01 A<br>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<br>Times | inv. | 5 % ± 15 ms | |
| | def. | 1 % of setting value or 10 ms | |

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### Influencing Variables

| | |
|---|---|
| Power Supply DC Voltage in Range<br>$0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$ | 1 % |
| Temperature in Range<br>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<br>- Up to 10 % 3rd harmonic<br>- Up to 10 % 5th harmonic | <br>1 %<br>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<br>– $3 \cdot I_0$ and $3 \cdot V_0$ calculated | |
| Measuring Principle | Real/reactive power measurement | |
| Measuring release $I_{RELEASE\ DIR.}$<br>(current component perpendicular (90°) to direction phasor)<br>for sensitive transformer<br>for normal 1-A transformer<br>for normal 5-A transformer | <br><br>0.001 A to 1.200 A<br>0.05 A to 30.00 A<br>0.25 A to 150.00 A | <br><br>Increments 0.001 A<br>Increments 0.01 A<br>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<br>(for resonant-grounded system) | 0.0° to 5.0° | Increments 0.1° |
| Current value I1, I2 for the angle correction<br>for sensitive transformer<br>for normal 1-A transformer<br>for normal 5-A transformer | <br>0.001 A to 1.600 A<br>0.05 A to 35.00 A<br>0.25 A to 175.00 A | <br>Increments 0.001 A<br>Increments 0.01 A<br>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. | | |

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### Logarithmic inverse trip time characteristic

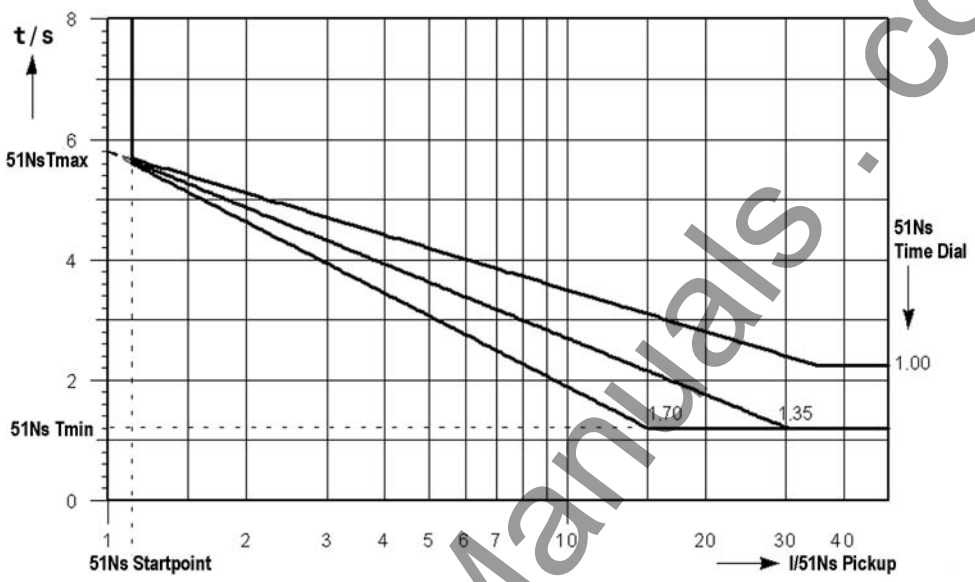


Figure 4-11 Trip time characteristics of inverse time ground fault protection with logarithmic inverse characteristic

Logarithmic inverse $t = \mathbf{51Ns\ Tmax} - \mathbf{51Ns\ TIME\ DIAL} \cdot \ln(I/\mathbf{51Ns\ PICKUP})$

**Note:** For $I/\mathbf{51Ns\ PICKUP} > 35$ the time applies for $I/\mathbf{51Ns\ PICKUP} = 35$; for $t < \mathbf{51Ns\ Tmin}$ the time **51Ns Tmin** applies.

### Logarithmic inverse trip time characteristic with knee point

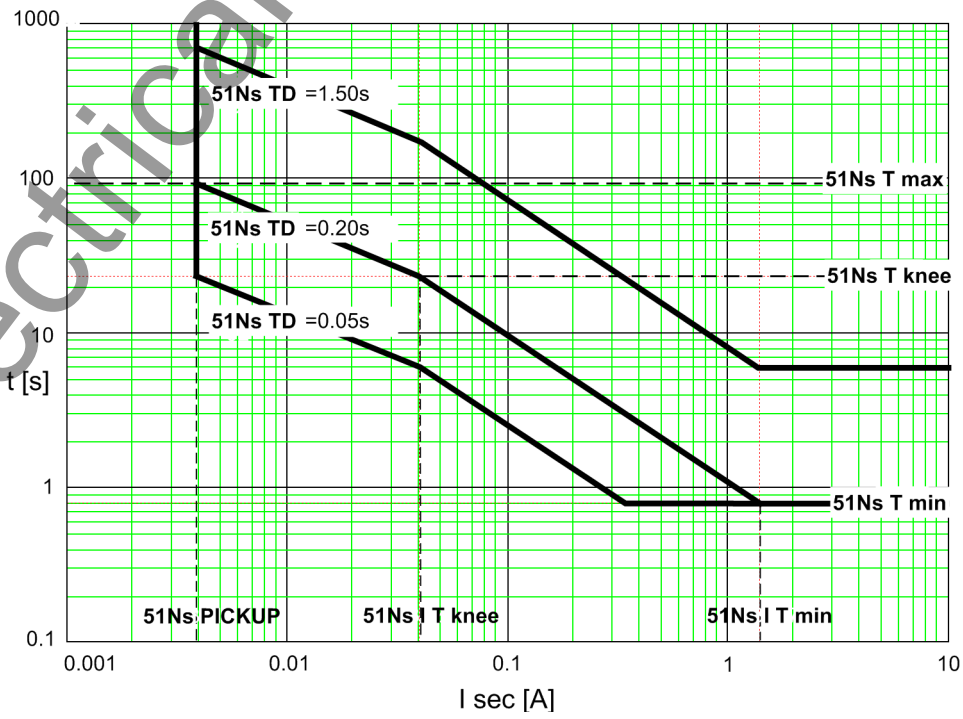


Figure 4-12 Trip-time characteristics of the inverse-time ground fault protection 51Ns with logarithmic inverse characteristic with knee point (example for 51Ns = 0.004 A)

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## 4.16 Intermittent Ground Fault Protection

### Setting Ranges / Increments

| | | | |
|---|---|---|---|
| Pickup Threshold<br>with IN<br><br>with 3I0<br><br>with INs | <br>for $I_{Nom}$ = 1 A<br>for $I_{Nom}$ = 5 A<br>for $I_{Nom}$ = 1 A<br>for $I_{Nom}$ = 5 A | <br>0.05 A to 35.00 A<br>0.25 A to 175.00 A<br>0.05 A to 35.00 A<br>0.25 A to 175.00 A<br>0.005 A to 1.500 A | <br>Increments 0.01 A<br>Increments 0.01 A<br>Increments 0.01 A<br>Increments 0.01 A<br>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<br>– Current = 1.25 x Pickup Value<br>– for ≥ 2 · Pickup Value<br>Dropout Time (without extension time) | <br>Approx. 30 ms<br>Approx. 22 ms<br>Approx. 22 ms |

### Tolerances

| | |
|---|---|
| Pickup threshold I | 3 % of set value or 10 mA for $I_{Nom}$ = 1 A<br>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<br>$0.8 \le V_{PS}/V_{PSNom} \le 1.15$ | <1 % |
| Temperature in Range<br>0 °C ≤ $\Theta_{amb}$ ≤ 40 °C | <0.5 %/ K |
| Frequency in range $0.98 \le f/f_N \le 1.02$ | <5% relating to the set time |

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## 4.17 Automatic Reclosing System 79

| | | |
|---|---|---|
| Number of Reclosures | 0 to 9 (segregated into phase and ground settings)<br>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 $T_{Dead}$<br>(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)<br>Circuit breaker monitoring using breaker auxiliary contacts,<br>Synchronous closing (optionally with integrated or external synchrocheck, 7SJ64 only) | |

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## 4.18 Fault Location

| | | | |
|---|---|---|---|
| Units of Distance Measurement | | secondary in Ω<br>in km or miles line [1)] | |
| Trigger | | trip command,<br>Dropout of an Element, or<br>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)<br>$30° \leq \varphi_K \leq 90°$ 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 !

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# 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<br>– On Internal Start<br>– Using Controls<br>– For external Start | <br>included in time delay<br>included in time delay<br>included in time delay |
| Dropout Time | Approx. 25 ms [1] |

### Tolerances

| | |
|---|---|
| Pickup of Element 50, „BkrClosed I MIN“ | 2 % of setting value;<br>or 10 mA for $I_{Nom}$ = 1 A<br>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<br>23 °F (–5 °C) ≤ $\Theta_{amb}$ ≤ 131 °F (55 °C) | 0.5 %/10 K |
| Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$ | 1 % |
| Harmonics<br>- Up to 10 % 3rd harmonic<br>- Up to 10 % 5th harmonic | <br>1 %<br>1 % |

[1] A further delay for the current may be caused by compensation in the CT secondary circuit.

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## 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,<br>r.m.s. value (true rms),<br>positive sequence system,<br>negative sequence system |
| Pickup on | exceeding threshold or<br>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<br>for $f_{Nom}$ = 60 Hz | 45.5 to 54.5 Hz<br>55.5 to 64.5 Hz | Increments 0.1 Hz<br>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)<br>= 2 times pickup value<br>= 10 times pickup value | <br>approx. 30 ms<br>approx. 20 ms |

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| | |
|---|---|
| Current, voltage (symmetrical components)<br>= 2 times pickup value<br>= 10 times pickup value | <br>approx. 40 ms<br>approx. 30 ms |
| Power<br>typical<br>maximum (small signals and thresholds) | <br>approx. 120 ms<br>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<br>typical<br>maximum | <br><50 ms<br><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<br>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<br>– Up to 10 % 3rd harmonic<br>– Up to 10 % 5th harmonic | <br>1 %<br>1 % |

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## 4.21 Synchronism and Voltage Check 25 (7SJ64 only)

### Operating Modes

| |
|---|
| - Synchrocheck<br>- Asynchronous / Synchronous |

### Additional Release Conditions

| |
|---|
| - Live bus / dead line,<br>- Dead bus / live line,<br>- Dead bus and dead line<br>- 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<<br>V> for live line V> | 1 V to 60 V (phase-to-phase)<br>20 V to 140 V (phase-to-phase) | Increments 1 V<br>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<br>Tolerance | 0.5 V to 50.0 V (phase-to-phase)<br>1 V | Increments 0.1 V |
| Frequency Difference f2>f1; f2<f1<br>Tolerance | 0.01 Hz to 2.00 Hz<br>15 mHz | Increments 0.01 Hz |
| Angle Difference $\alpha 2 > \alpha 1$; $\alpha 2 < \alpha 1$ | 2° to 80° | Increments 1° |
| Tolerance | 2° | |
| Max. angle error | 5° for $\Delta f \leq 1$ Hz<br>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 |

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### 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<br>- Range<br>- Tolerance [1)] | in kV primary, in V secondary or in % of $V_{Nom}$<br>10 % to 120 % of $V_{Nom}$<br>≤ 1 % of measured value, or 0.5 % of $V_{Nom}$ |
| Voltage to be synchronized V2<br>- Range<br>- Tolerance [1)] | in kV primary, in V secondary or in % of $V_{Nom}$<br>10 % to 120 % of $V_{Nom}$<br>≤ 1 % of measured value, or 0.5 % of $V_{Nom}$ |
| Frequency of voltage V1<br>- Range<br>- Tolerance [1)] | f1 in Hz<br>$f_{Nom}$ ± 5 Hz<br>20 mHz |
| Frequency of voltage V2<br>- Range<br>- Tolerance [1)] | f2 in Hz<br>$f_{Nom}$ ± 5 Hz<br>20 mHz |
| Voltage differences V2-V1<br>- Range<br>- Tolerance [1)] | in kV primary, in V secondary or in % of $V_{Nom}$<br>10 % to 120 % of $V_{Nom}$<br>≤ 1 % of measured value, or 0.5 % of $V_{Nom}$ |
| Frequency difference f2-f1<br>- Range<br>- Tolerance [1)] | in mHz<br>$f_{Nom}$ ± 5 Hz<br>20 mHz |
| Angle difference λ2-λ1<br>- Range<br>- Tolerance [1)] | in °<br>0 to 180°<br>0.5° |

[1)] at nominal frequency

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## 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<br>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<br>– for Pt 100<br>– for Ni 100<br>– for Ni 120 | <br>–199 °C to 800 °C (–326 °F to 1472 °F)<br>–54 °C to 278 °C (–65 °F to 532 °F)<br>–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<br>–58 °F to 482 °F<br>or ∞ (no indication) | (in increments of 1° F)<br>(in increments of 1°C) |
| Stage 2 | –58°F to 482°F or – 50 °C to 250 °C<br>–58°F to 482 °F or –50 °C to 250 °C<br>or ∞ (no indication) | (in increments of 1°F)<br>(in increments of 1°C) |

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## 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 |

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| 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 | |

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### 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 |

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| 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 |

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| 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.

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## 4.24 Additional Functions

### Operational Measured Values

| | |
|---|---|
| Currents<br>$I_A$; $I_B$; $I_C$<br>Positive sequence component $I_1$<br>Negative sequence component $I_2$<br>$I_N$ or 3I0 | in A (kA) primary and in A secondary or in % $I_{Nom}$ |
| Range<br>Tolerance [1] | 10 % to 200 % $I_{Nom}$<br>1 % of measured value, or 0.5 % $I_{Nom}$ |
| Phase-to-ground voltages<br>$V_{A-N}$, $V_{B-N}$, $V_{C-N}$<br>Phase-to-phase voltages<br>$V_{A-B}$, $V_{B-C}$, $V_{C-A}$, $V_{SYN}$<br>$V_N$ or $V_0$<br>Positive Sequence Component $V_1$<br>Negative Sequence Component $V_2$ | in kV primary, in V secondary or in % of $V_{Nom}$ |
| Range<br>Tolerance [1] | 10 % to 120 % of $V_{Nom}$<br>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<br>Tolerance [1] | 0 % to 120 % $S_{Nom}$<br>1 % of $S_{Nom}$<br>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<br>Tolerance [1]<br>for 7SJ62/63<br><br><br><br>for 7SJ64 | 0 % to 120 % $S_{Nom}$<br><br>2 % of $S_{Nom}$<br>for $V/V_{Nom}$ and $I/I_{Nom}$ = 50 to 120 % and \| cos φ \| = 0.707 to 1<br>with $S_{Nom} = \sqrt{3} \cdot V_{Nom} \cdot I_{Nom}$<br>1% of $S_{Nom}$<br>For $V/V_N$ and $I/I_N$ = 50 to 120 %<br>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<br>Tolerance [1]<br>for 7SJ62/63<br><br><br><br>for 7SJ64 | 0 % to 120 % $S_{Nom}$<br><br>2 % of $S_{Nom}$<br>for $V/V_{Nom}$ and $I/I_{Nom}$ = 50 to 120 % and \| sin φ \| = 0.707 to 1<br>with $S_{Nom} = \sqrt{3} \cdot V_{Nom} \cdot I_{Nom}$<br>1 % of $S_{Nom}$<br>For $V/V_N$ and $I/I_N$ = 50 to 120 %<br>With $S_{Nom} = \sqrt{3} \cdot V_{Nom} \cdot I_{Nom}$ |
| cos φ, power factor[2] | total and phase-segregated |
| Range<br>Tolerance [1]<br>for 7SJ62/63<br>for 7SJ64 | –1 to +1<br><br>3 % for \| cos φ \| ≥ 0.707<br>2 % for \| cos φ \| ≥ 0.707 |
| Frequency f | in Hz |
| Range<br>Tolerance [1] | $f_{Nom} \pm 5$ Hz<br>20 mHz |

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| | | |
|---|---|---|
| Temperature Overload Protection $\Theta/\Theta_{Trip}$ | | in %. |
| | Range<br>Tolerance [1] | 0 % to 400 %<br>5% class accuracy per IEC 60255-8 |
| Temperature Restart Inhibit $\Theta_L/\Theta_{L\ Trip}$ | | in %. |
| | Range<br>Tolerance [1] | 0 % to 400 %<br>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<br>Tolerance [1] | 0 mA to 1600 mA<br>2 % of measured value or 1 mA |
| Measuring transducer (7SJ63 only) | | |
| | Operating Range<br>Accuracy Range<br>Tolerance [1] | 0 mA to 24 mA<br>1 mA to 20 mA<br>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<br>of Real Power<br>of Reactive Power<br>of Apparent Power | $I_{Admd}$; $I_{Bdmd}$; $I_{Cdmd}$; $I_{1dmd}$ in A (kA)<br>$P_{dmd}$ in W (kW, MW)<br>$Q_{dmd}$ in VAr (kVAr, MVAr)<br>$S_{dmd}$ in VAr (kVAr, MVAr) |

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### Min / Max Report

| | |
|---|---|
| Storage of Measured Values | with date and time |
| Reset automatic | Time of day adjustable (in minutes, 0 to 1439 min)<br>Time frame and starting time adjustable (in days, 1 to 365 days, and ∞) |
| Manual Reset | Using binary input<br>Using keypad<br>Via communication |
| Min/Max Values for Current | $I_A$; $I_B$; $I_C$;<br>$I_1$ (positive sequence component) |
| Min/Max Values for Voltages | $V_{A-N}$; $V_{B-N}$; $V_{C-N}$;<br>$V_1$ (Positive Sequence Component);<br>$V_{A-B}$; $V_{B-C}$; $V_{C-A}$ |
| Min/Max Values for Power | S, P; Q, cos φ; frequency |
| Min/Max Values for Overload Protection | $\Theta/\Theta_{Trip}$ |
| Min/Max Values for Mean Values | $I_{Admd}$; $I_{Bdmd}$; $I_{Cdmd}$;<br>$I_1$ (positive sequence component);<br>$S_{dmd}$; $P_{dmd}$; $Q_{dmd}$ |

### 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 | $\lvert i_A + i_B + i_C + k_I \cdot i_N \rvert$ > limit value, with 1 %<br>$k_I = \frac{\text{Ignd-CT PRIM / Ignd-CT SEC}}{\text{CT PRIMARY / CT SECONDARY}}$ |
| Current Phase Sequence | Clockwise (ABC) / counter-clockwise (ACB) |
| Voltage Phase Sequence | Clockwise (ABC) / counter-clockwise (ACB) |
| Limit Value Monitoring | $I_A$ > limit value $I_{Admd}$><br>$I_B$ > limit value $I_{Bdmd}$><br>$I_C$ > limit value $I_{Cdmd}$><br>$I_1$ > limit value $I_{1dmd}$><br>$I_L$< limit value $I_L$<<br>cos φ < lower limit value \|cos φ\|<<br>P > limit value of real power $\lvert P_{dmd} \rvert$ ><br>Q > limit value of reactive power $\lvert Q_{dmd} \rvert$ ><br>S > limit value of apparent power $S_{dmd}$ ><br>Pressure < lower limit value Press<<br>Temperature > limit value Temp> |

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### 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<br>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<br>- 7SJ62/63<br>- 7SJ64 | <br>Total 5 s<br>Total 20 s<br>Pre-event and post-event recording and memory time adjustable |
| Sampling Rate for 50 Hz<br>Sampling Rate for 60 Hz | 1 sample/1.25 ms (16 sam/cyc)<br>1 sample/1.04 ms (16 sam/cyc) |

### Energy

| | |
|---|---|
| Meter Values for Energy<br>Wp, Wq (real and reactive energy) | in kWh (MWh or GWh) and in kVARh (MVARh or GVARh) |
| Range<br><br><br><br>Tolerance [1)] | 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)<br>$\leq$ 5% for $I > 0.5\ I_{Nom}$, $V > 0.5\ V_{Nom}$ and<br>$\lvert \cos \varphi \rvert \geq 0.707$ |

[1)] At nominal frequency

### Statistics

| | |
|---|---|
| Saved Number of Trips | Up to 9 digits |
| Number of Automatic Reclosing Commands<br>(segregated according to 1st and $\geq$ 2nd cycle) | Up to 9 digits |
| Accumulated Interrupted Current (segregated according to pole) | Up to 4 digits |

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### 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: $\Sigma I$, $\Sigma I^x$, 2P;<br>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<br>Operational Measured Values<br>Circuit Breaker / Switching Device Test<br>Creation of a Test Measurement Report |

### Clock

| | | |
|---|---|---|
| Time Synchronization | | DCF 77/IRIG B-Signal (telegram format IRIG-B000)<br>Binary Input<br>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) |

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### 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<br>DIGSI using the front PC port<br>with protocol via system (SCADA) interface<br>Binary Input |

### IEC 61850 GOOSE (inter-relay communication)

| |
|---|
| 7SJ62/63:<br>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:<br>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. |

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## 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<br>assignment of function keys |
| Remote Control | Using Communication Interfaces<br>Using a substation automation and control system (e.g. SICAM)<br>Using DIGSI (e.g. via Modem) |

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# 4.26 Dimensions

## 4.26.1 Panel Flush and Cubicle Mounting (Housing Size $^1/_3$)

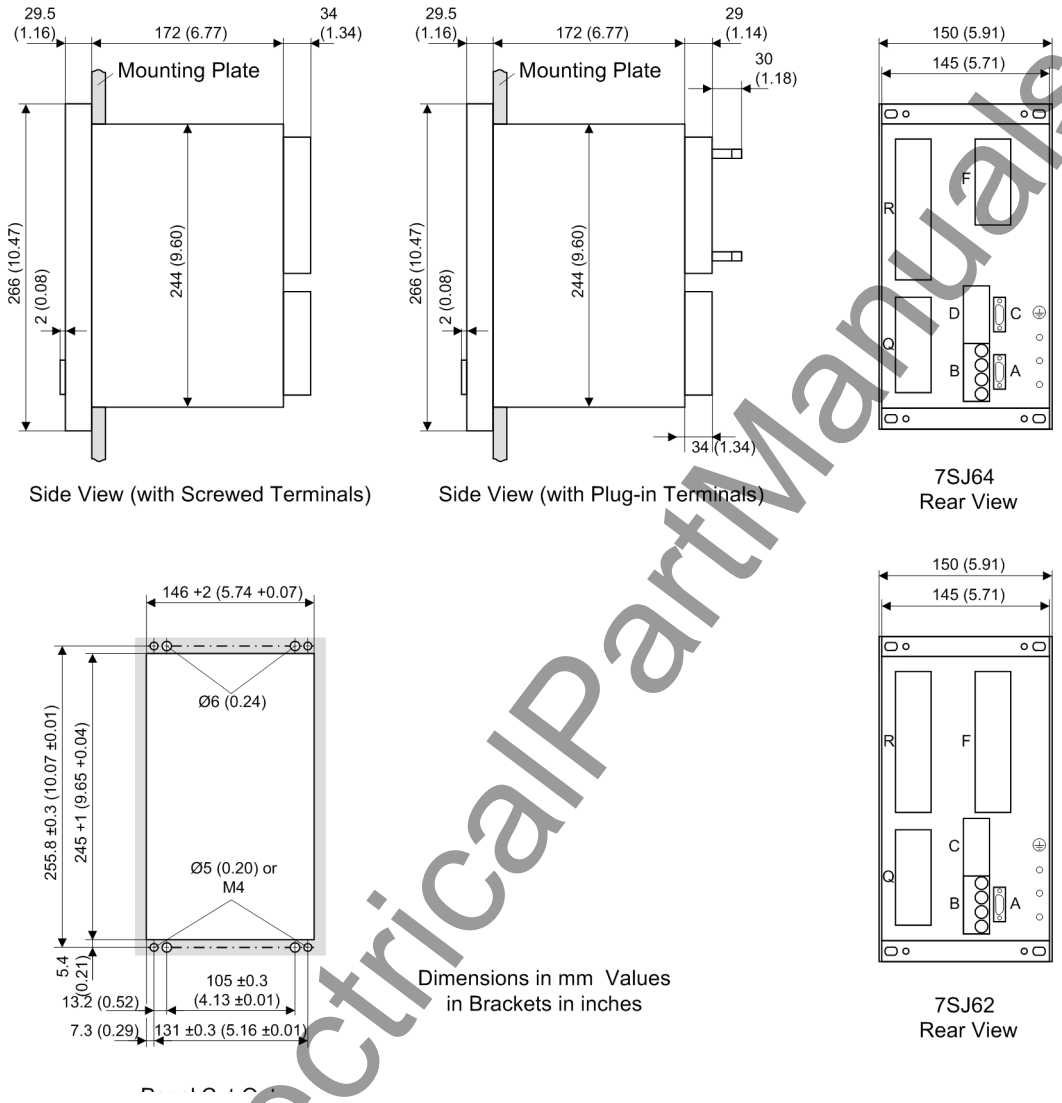


Figure 4-13 Dimensional drawing of a 7SJ62 or 7SJ64 for panel flush and cubicle mounting (housing size $^1/_3$)

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## 4.26.2 Panel Flush and Cubicle Mounting (Housing Size $^1/_2$)

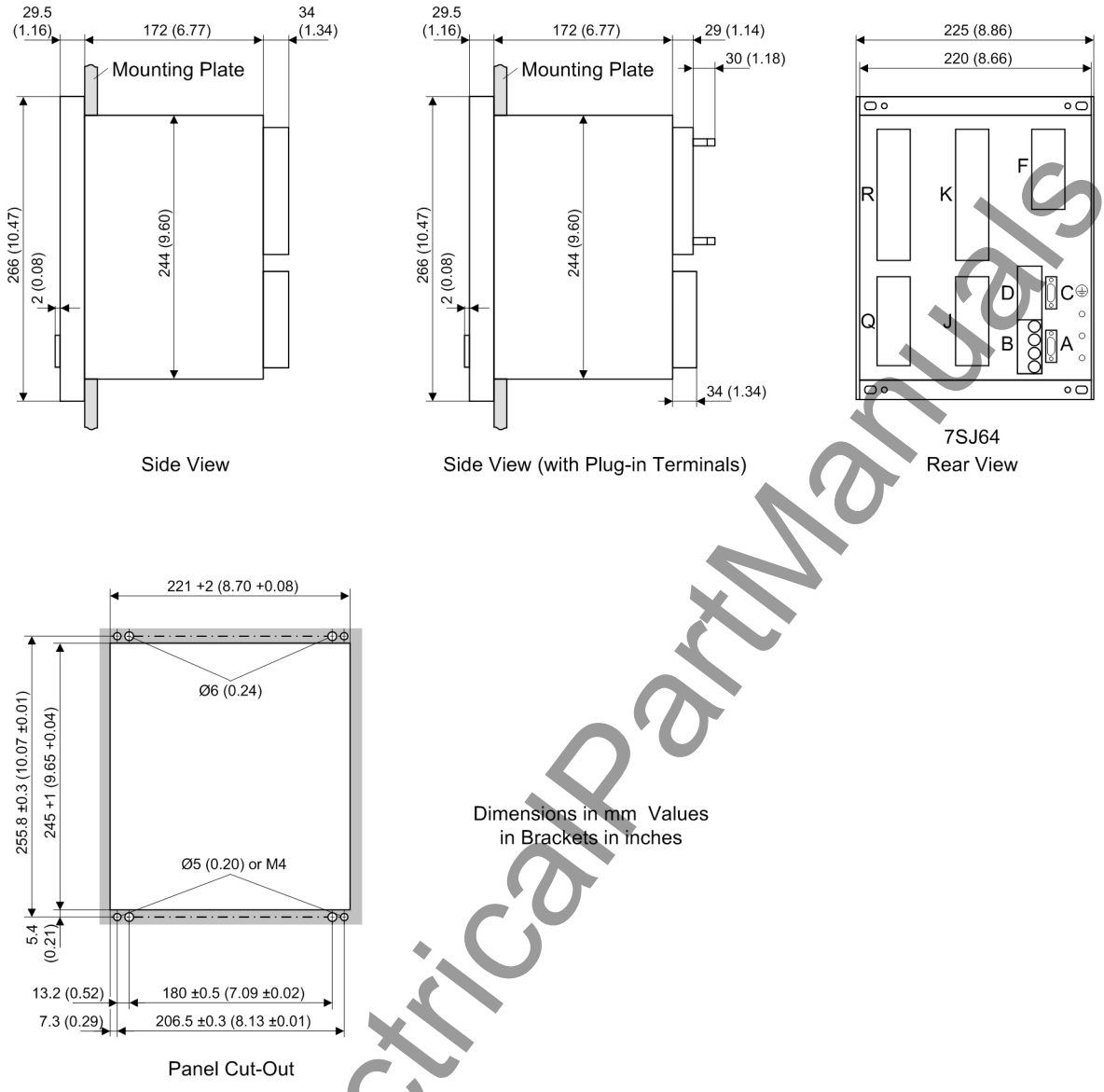


Figure 4-14 Dimensional drawing of a 7SJ63 or 7SJ64 for panel flush and cubicle mounting (housing size $^1/_2$)

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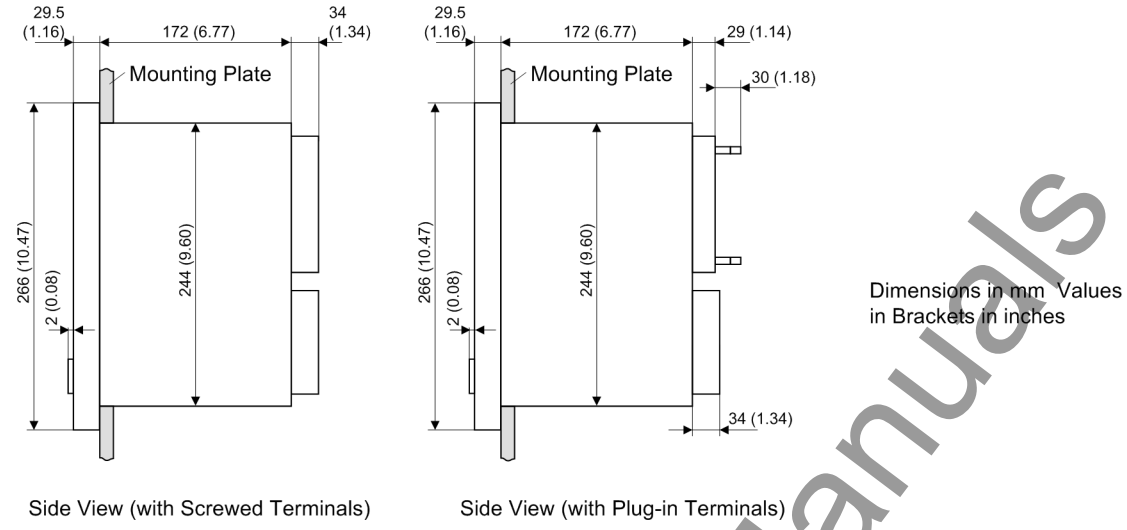
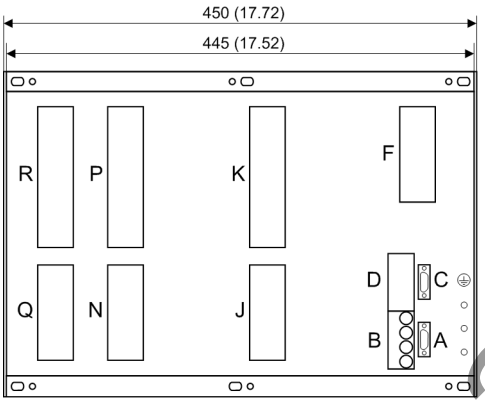
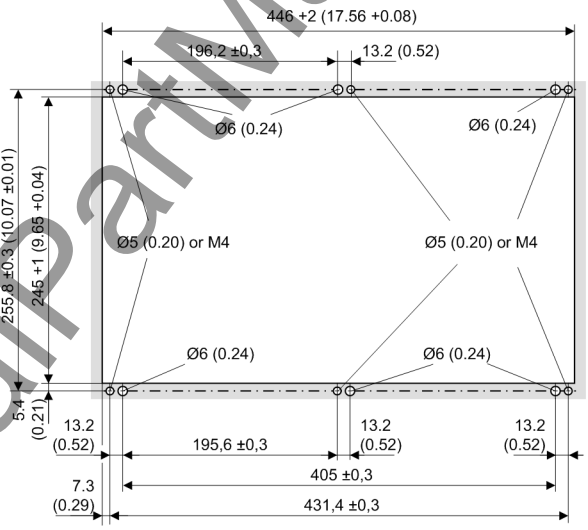
## 4.26.3 Panel Flush and Cubicle Mounting (Housing Size $^1/_1$)



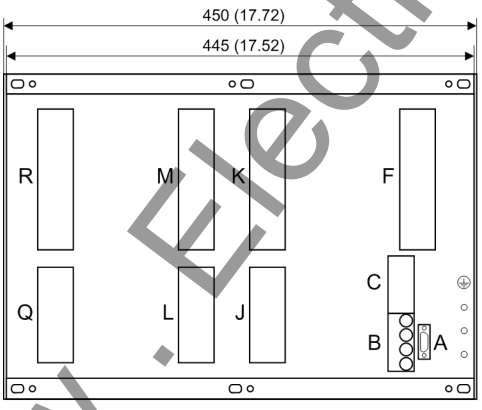




Figure 4-15 Dimensional drawing of a 7SJ63 or 7SJ64 for panel flush and cubicle mounting (housing size $^1/_1$)

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## 4.26.4 Panel Surface Mounting (Housing Size $^1/_3$)

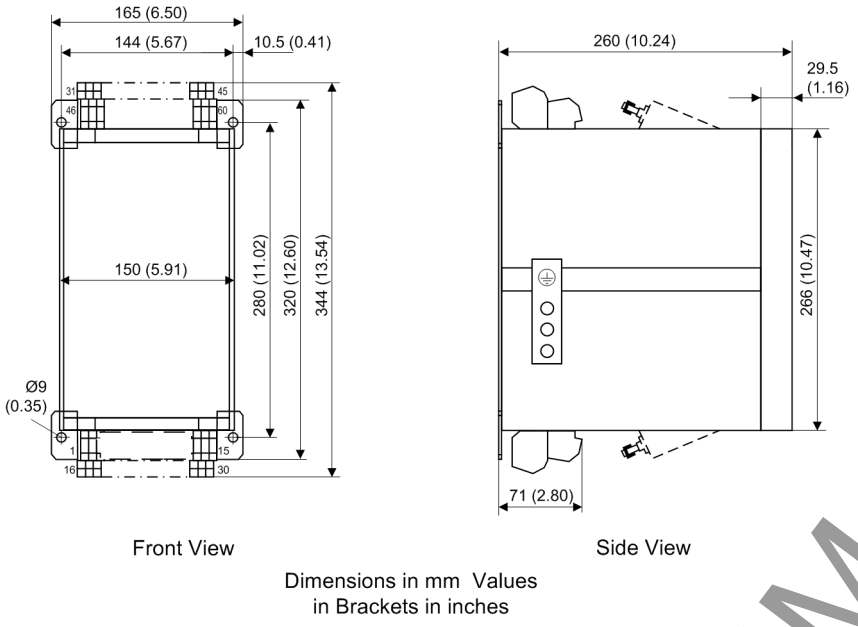


Figure 4-16 Dimensional drawing of a 7SJ62 or 7SJ64 for panel flush mounting (housing size $^1/_3$)

## 4.26.5 Panel Surface Mounting (Housing Size $^1/_2$)

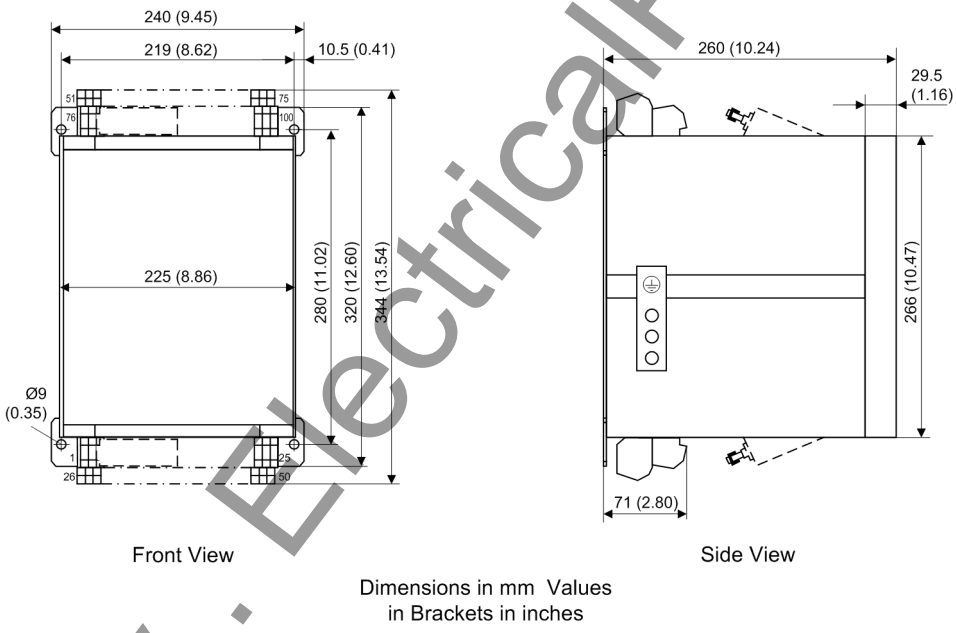


Figure 4-17 Dimensional drawing of a 7SJ63 or 7SJ64 for panel flush mounting (housing size $^1/_2$)

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## 4.26.6 Panel Surface Mounting (Housing Size $^1/_1$)

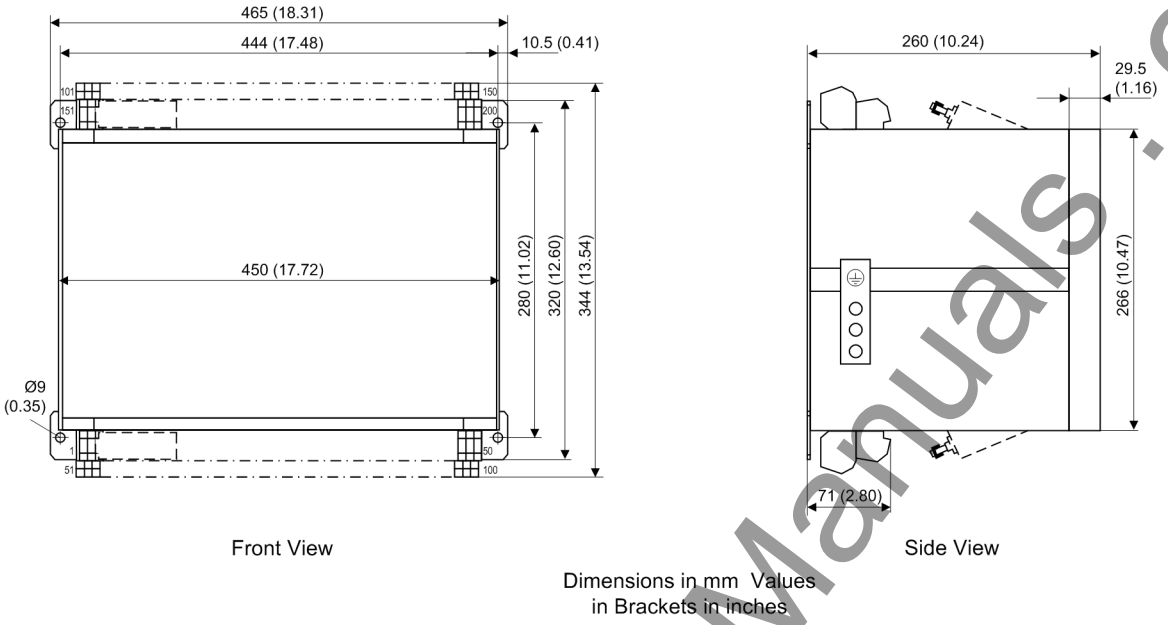


Figure 4-18 Dimensional drawing of a 7SJ63 or 7SJ64 for panel flush mounting (housing size $^1/_1$)

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## 4.26.7 Surface-mounted Housing with Detached Operator Panel or without Operator Panel (Housing Size $^1/_2$)

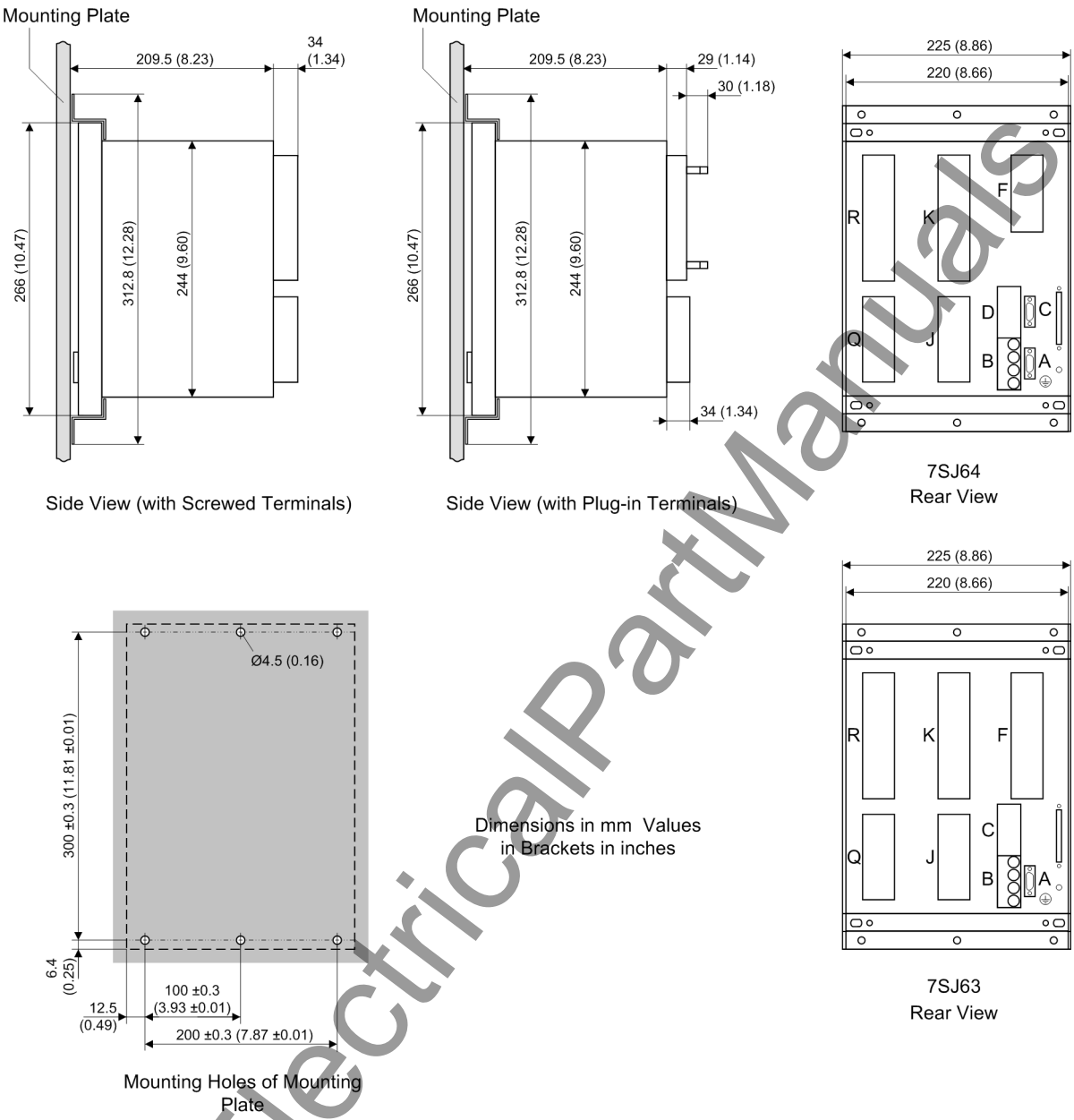


Figure 4-19 Dimensional drawing of a 7SJ63 or 7SJ64 (housing size $^1/_2$)) for mounting with detached operator panel or without operator panel

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## 4.26.8 Housing for Mounting with Detached Operator Panel or without Operator Panel (Housing Size $^1/_1$)

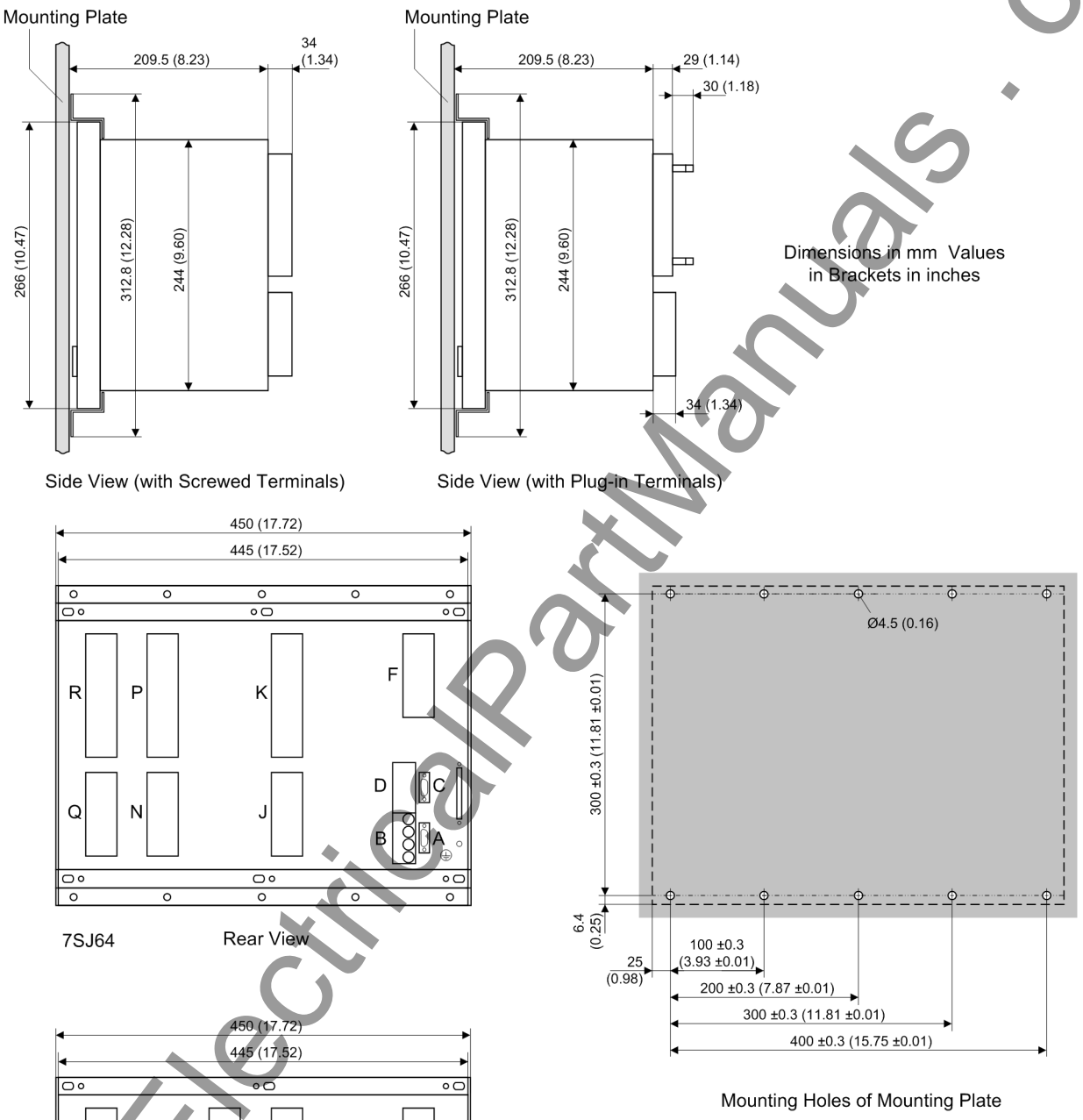


Figure 4-20 Dimensions 7SJ63 or 7SJ64 for mounting with detached operator panel or without operator panel (housing size $^1/_1$)

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## 4.26.9 Detached Operator Panel

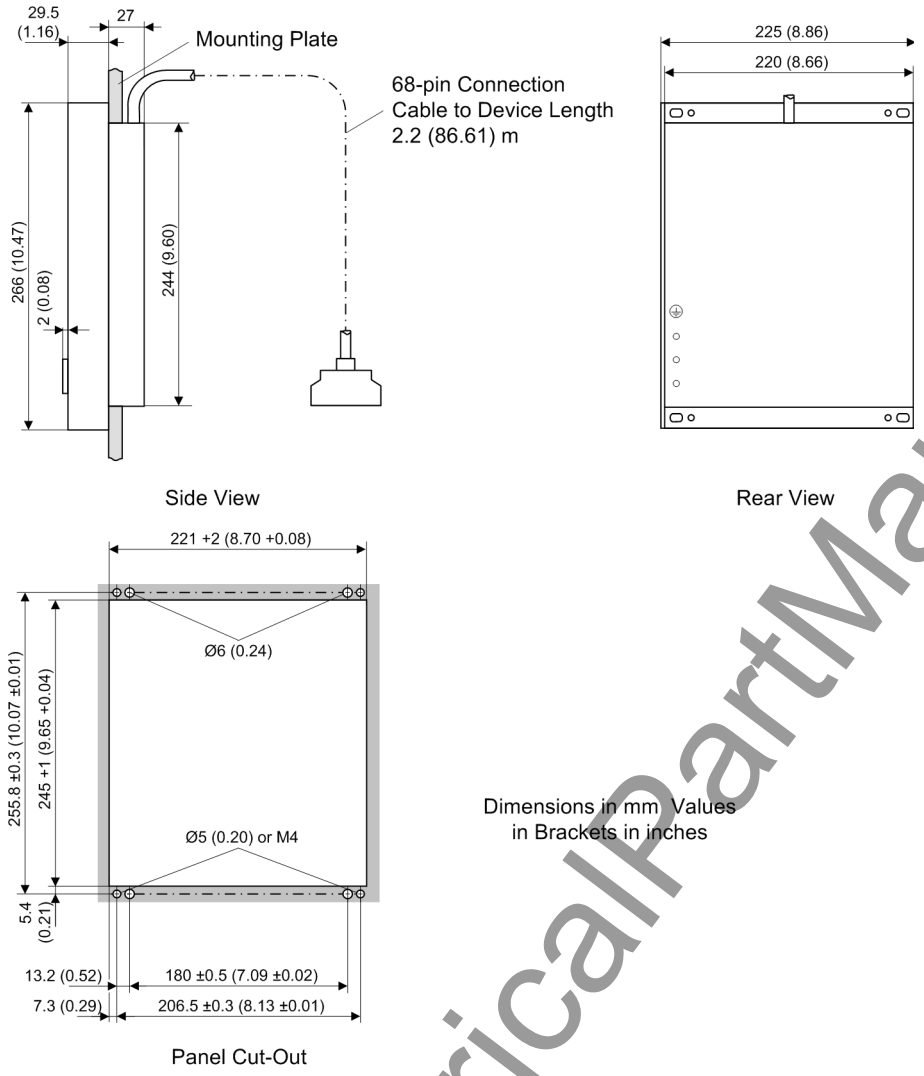


Figure 4-21 Dimensions of a detached operator panel for a 7SJ63 or a 7SJ64 device

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### 4.26.10 D-Subminiature Connector of Dongle Cable (Panel Flush or Cubicle Door Cutout)

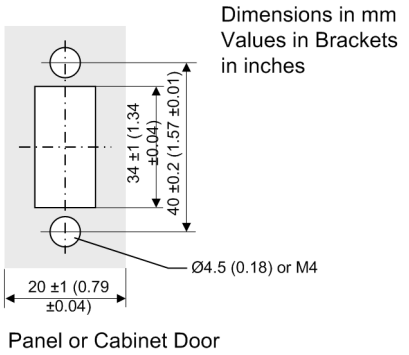


Figure 4-22 Dimensions of panel flush or cubicle door cutout of D-subminiature connector of dongle cable for a 7SJ63 or a 7SJ64 device without integrated operator panel

■

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# Appendix

A

This appendix is primarily a reference for the experienced user. This section provides ordering information for the models of this device. Connection diagrams indicating the terminal connections of the models of this device are included. Following the general diagrams are diagrams that show the proper connections of the devices to primary equipment in many typical power system configurations. Tables with all settings and all information available in this device equipped with all options are provided. Default settings are also given.


| | | |
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# A.1 Ordering Information and Accessories

## A.1.1 Ordering Information

### A.1.1.1 7SJ62 V4.6

| Multi-Functional Protective Relay with Local Control | 7 | S | J | 6 | 2 | 6 | 7 | – | 8 | 9 | 10 | 11 | 12 | – | 13 | 14 | 15 | 16 | + | Supplementary |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| 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 |

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| 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) | 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 | 1 |
| With fault recording, average values, min/max values | 3 |

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| 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<br>81O/U | Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency | F E |
| | IEF | V, f | 27/59<br>81O/U<br>— | Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency<br>Intermittent ground fault | P E |
| Dir | | | 67/67N | Directional overcurrent protection | F C |
| Dir | | V, f | 67/67N<br>27/59<br>81O/U | Directional overcurrent protection<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency | F G |
| Dir | IEF | | 67/67N<br>— | Directional overcurrent protection<br>Intermittent ground fault | P C |
| DGFD Dir | | | 67/67N<br>67Ns<br>87N | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection | F D [1)] |
| DGFD Dir | IEF | | 67/67N<br>67Ns<br>87N<br>— | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Intermittent ground fault | P D [1)] |
| DGFD | | | 67Ns<br>87N | Directional sensitive ground fault detection<br>High-impedance ground fault differential protection | F B [1)] |
| DGFD Motor | | V, f | 67Ns<br>87N<br>48/14<br>66/86<br>27/59<br>81O/U | Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit for Motors<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency | H F [1)] |

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| Functions | | | | | | | Pos. 14 and 15 |
|---|---|---|---|---|---|---|---|
| DGFD | Motor | Dir | | V, f | 67/67N<br>67Ns<br>87N<br>48/14<br>66/86<br>27/59<br>81O/U | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit for Motors<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency | H H [1] |
| DGFD | Motor | Dir | IEF | V, f | 67/67N<br>67Ns<br>87N<br>48/14<br>66/86<br>27/59<br>81O/U<br>— | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit for Motors<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency<br>Intermittent ground fault | R H [1] |
| | Motor | Dir | | V, f | 67/67N<br>48/14<br>66/86<br>27/59<br>81O/U | Directional overcurrent protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit for Motors<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency | H G |
| DGFD = Directional ground fault detection<br>IEF = Intermittent ground (earth) fault protection<br>Dir = Directional Time Overcurrent Protection (67 and 67N Elements)<br>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 |

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### A.1.1.2 7SJ63 V4.6

| Multi-Functional Protective Relay with Local Control | 7 S J 6 3 | 6 7 | – | 8 9 10 11 12 | – | 13 14 15 16 | + | Supplementary |
|---|---|---|---|---|---|---|---|---|

| 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 |

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| 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 |

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| 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<br>81O/U | Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency | F E |
| | IEF | V, f | 27/59<br>81O/U<br>— | Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency<br>Intermittent ground fault | P E |
| | Dir | | 67/67N | Directional overcurrent protection | F C |
| | Dir | V, f | 67/67N<br>27/59<br>81O/U | Directional overcurrent protection<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency | F G |
| | Dir IEF | | 67/67N<br>— | Directional overcurrent protection<br>Intermittent ground fault | P C |
| DGFD | Dir | | 67/67N<br>67Ns<br>87N | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection | F D [1)] |
| DGFD | Dir IEF | | 67/67N<br>67Ns<br>87N<br>— | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Intermittent ground fault | P D [1)] |
| DGFD | | | 67Ns<br>87N | Directional sensitive ground fault detection<br>High-impedance ground fault differential protection | F B [1)] |
| DGFD | Motor | V, f | 67Ns<br>87N<br>48/14<br>66/86<br>27/59<br>81O/U | Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit for Motors<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency | H F [1)] |
| DGFD | Motor Dir | V, f | 67/67N<br>67Ns<br>87N<br>48/14<br>66/86<br>27/59<br>81O/U | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit for Motors<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency | H H [1)] |

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| Functions | | | | | | | Pos. 14 and 15 |
|---|---|---|---|---|---|---|---|
| DGFD | Motor | Dir | IEF | V, f | 67/67N<br>67Ns<br>87N<br>48/14<br>66/86<br>27/59<br>81O/U<br>— | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit for Motors<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency<br>Intermittent ground fault | R H [1] |
| | motor | Dir | | V, f | 67/67N<br>48/14<br>66/86<br>27/59<br>81O/U | Directional overcurrent protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit<br>Under/Overvoltage<br>Under/Overfrequency | H G |
| | motor | | | | 48/14<br>66/86 | Motor starting supervision, locked rotor<br>Restart Inhibit for Motors | H A |
| DGFD = Directional ground fault detection<br>IEF = Intermittent ground (earth) fault protection<br>Dir = Directional Time Overcurrent Protection (67 and 67N Elements)<br>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 | Supple-mentary |
|---|---|
| with ATEX 100 approval (for the protection of explosion-protected motors of protection type increased safety "e" | +Z X 9 9 |

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### A.1.1.3 7SJ64 V4.6

| Multi-Functional Protective Relay with Local Control | 7 S J 6 4 | 6 7 | – | 8 9 10 11 12 | – | 13 14 15 16 | + | Supplementary |
|---|---|---|---|---|---|---|---|---|

| 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 |

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| 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.

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| 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<br>81O/U<br>27/47/59(N)/<br>32/55/81R | Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency<br>Flexible Protection Functions (current and voltage parameters): Protective function for voltage, power, power factor, frequency change | F E |
| | IEF V, f, P | 27/59<br>81O/U<br>27/47/59(N)/<br>32/55/81R<br>— | Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency<br>Flexible Protection Functions (current and voltage parameters): Protective function for voltage, power, power factor, frequency change<br>Intermittent ground fault | P E |
| | Dir | 67/67N | Directional overcurrent protection | F C |
| | Dir V, f, P | 67/67N<br>27/59<br>81O/U<br>27/47/59(N)/<br>32/55/81R | Directional overcurrent protection<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency<br>Flexible Protection Functions (current and voltage parameters): Protective function for voltage, power, power factor, frequency change | F G |
| | Dir IEF | 67/67N<br>— | Directional overcurrent protection<br>Intermittent ground fault | P C |
| DGFD | Dir | 67/67N<br>67Ns<br>87N | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection | F D [1)] |
| DGFD | Dir IEF | 67/67N<br>67Ns<br>87N<br>— | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Intermittent ground fault | P D [1)] |

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| Functions | | | | | | Pos. 14 and 15 |
|---|---|---|---|---|---|---|
| DGFD | | | | 67Ns<br>87N | Directional sensitive ground fault detection<br>High-impedance ground fault differential protection | F B [1] |
| DGFD | Motor | | V, f, P | 67Ns<br>87N<br>48/14<br>66/86<br>27/59<br>81O/U<br>27/47/59(N)/<br>32/55/81R | Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit for Motors<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency<br>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<br>67Ns<br>87N<br>48/14<br>66/86<br>27/59<br>81O/U<br>27/47/59(N)/<br>32/55/81R | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit for Motors<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency<br>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<br>67Ns<br>87N<br>48/14<br>66/86<br>27/59<br>81O/U<br>27/47/59(N)/<br>32/55/81R<br><br>— | Directional overcurrent protection<br>Directional sensitive ground fault detection<br>High-impedance ground fault differential protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit for Motors<br>Under/Overvoltage 59-1, 59-2, 27-1, 27-2<br>Under/Overfrequency<br>Flexible Protection Functions (current and voltage parameters): Protective function for voltage, power, power factor, frequency change<br>Intermittent ground fault | R H [1] |
| | Motor | Dir | V, f, P | 67/67N<br>48/14<br>66/86<br>27/59<br>81O/U<br>27/47/59(N)/<br>32/55/81R | Directional overcurrent protection<br>Motor starting supervision, locked rotor<br>Restart Inhibit<br>Under/Overvoltage<br>Under/Overfrequency<br>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 |

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| Automatic Reclosing (79) / Fault Locator / Synchronization | | | Pos. 16 |
|---|---|---|---|
| | 25 | With Synchronization | 4 |
| | 25, 79, 21FL | With synchronization, 79 and fault locator | 7 |

| Special model | Supplement |
|---|---|
| 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 |

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| | | |
|---|---|---|
| **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- |

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| | | |
|---|---|---|
| | 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 |

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# A.2 Terminal Assignments

## A.2.1 7SJ62 — Housing for panel flush mounting or cubicle installation

**7SJ621*-*D/E**

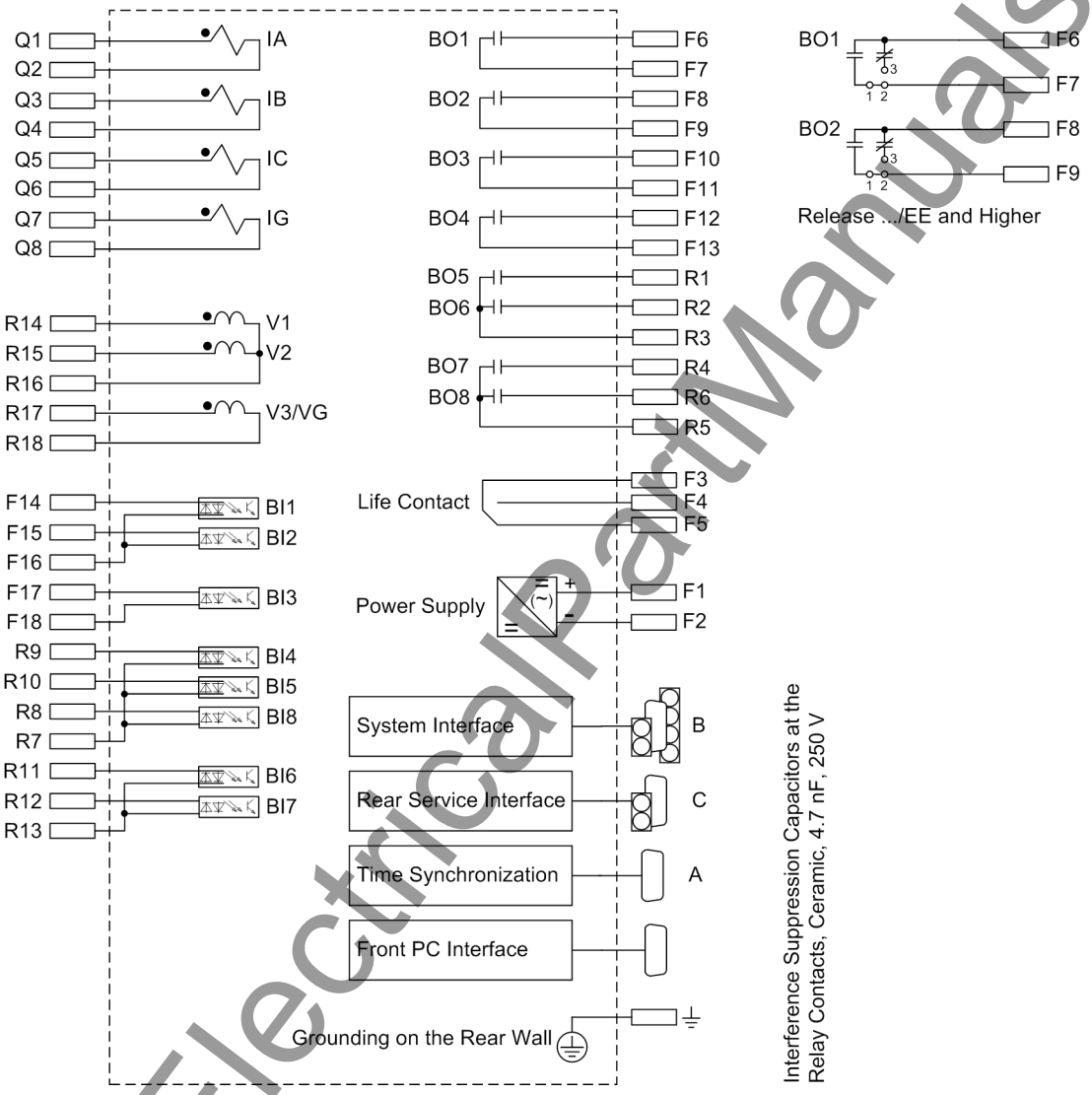


Figure A-1 General diagram for 7SJ621*–*D/E (panel flush mounting or cubicle mounting)

www . ElectricalPartManuals . com

**7SJ622*-*D/E**

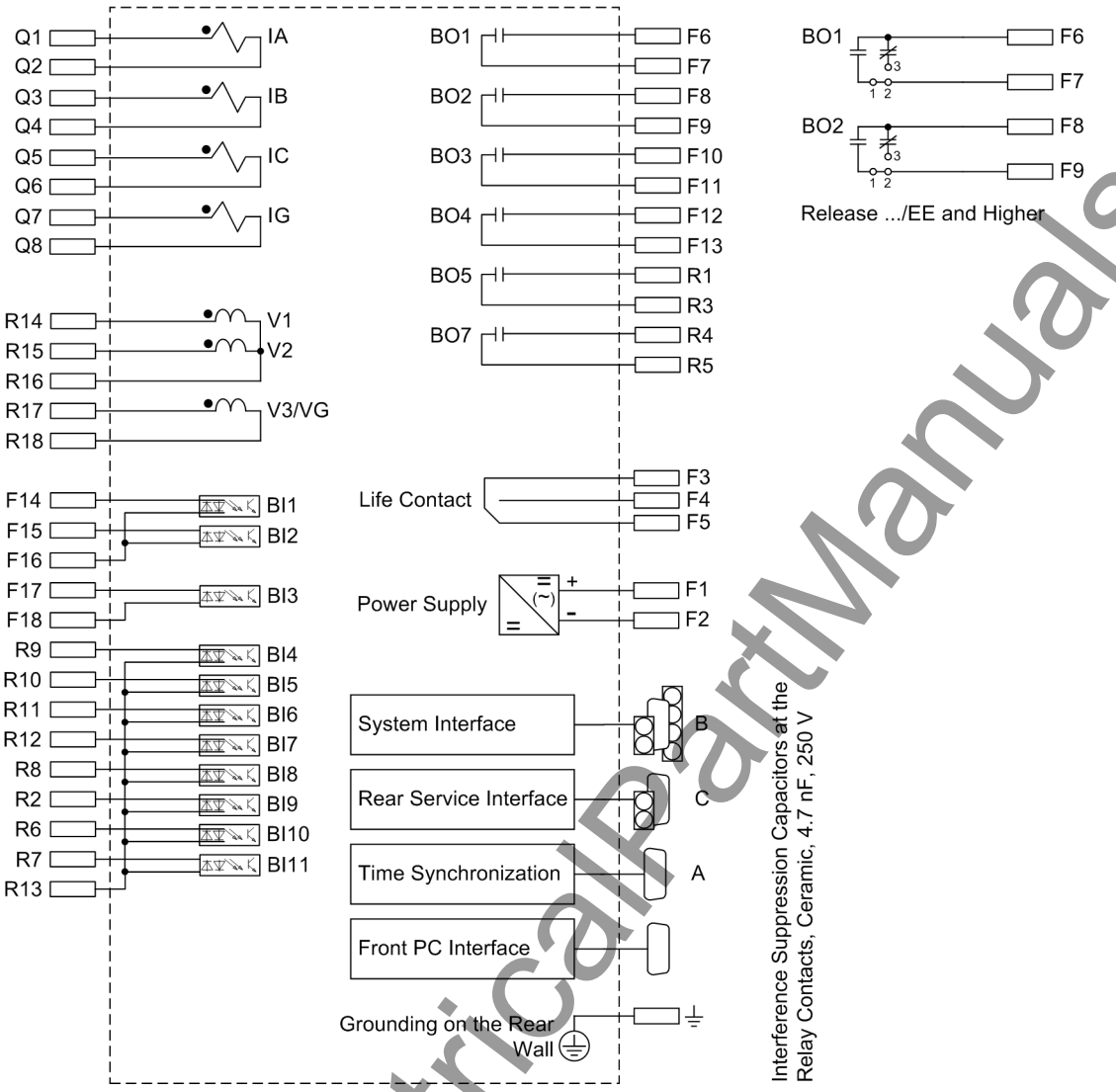


Figure A-2 General diagram for 7SJ622*–*D/E (panel flush mounted or cubicle mounted)

www . ElectricalPartManuals . com

## A.2.2 7SJ62 — Housing for Panel Surface Mounting

**7SJ621*-*B**

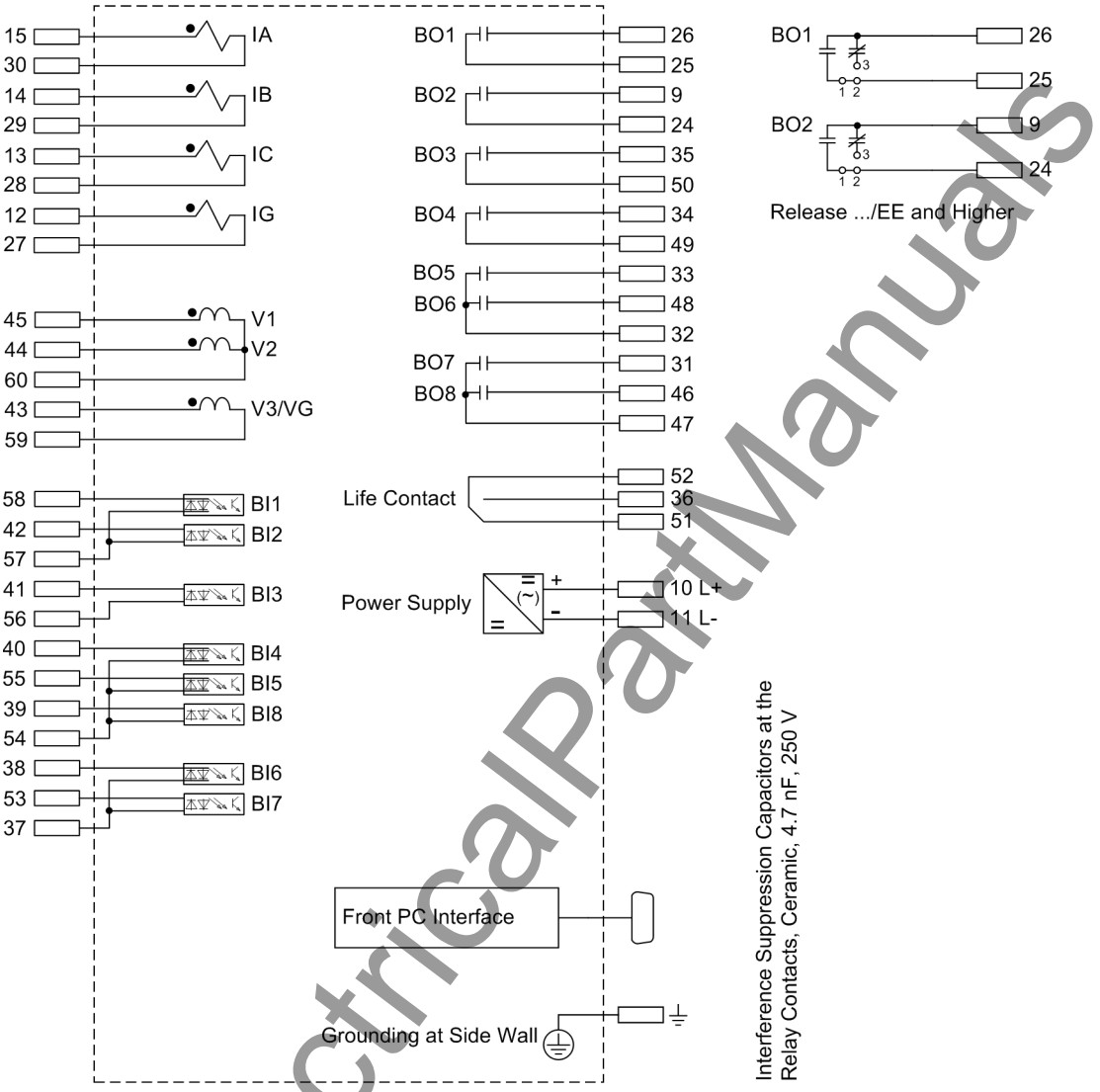


Figure A-3 General diagram for 7SJ621*–*B (panel surface mounted)

www . ElectricalPartManuals . com

**7SJ622*-*B**

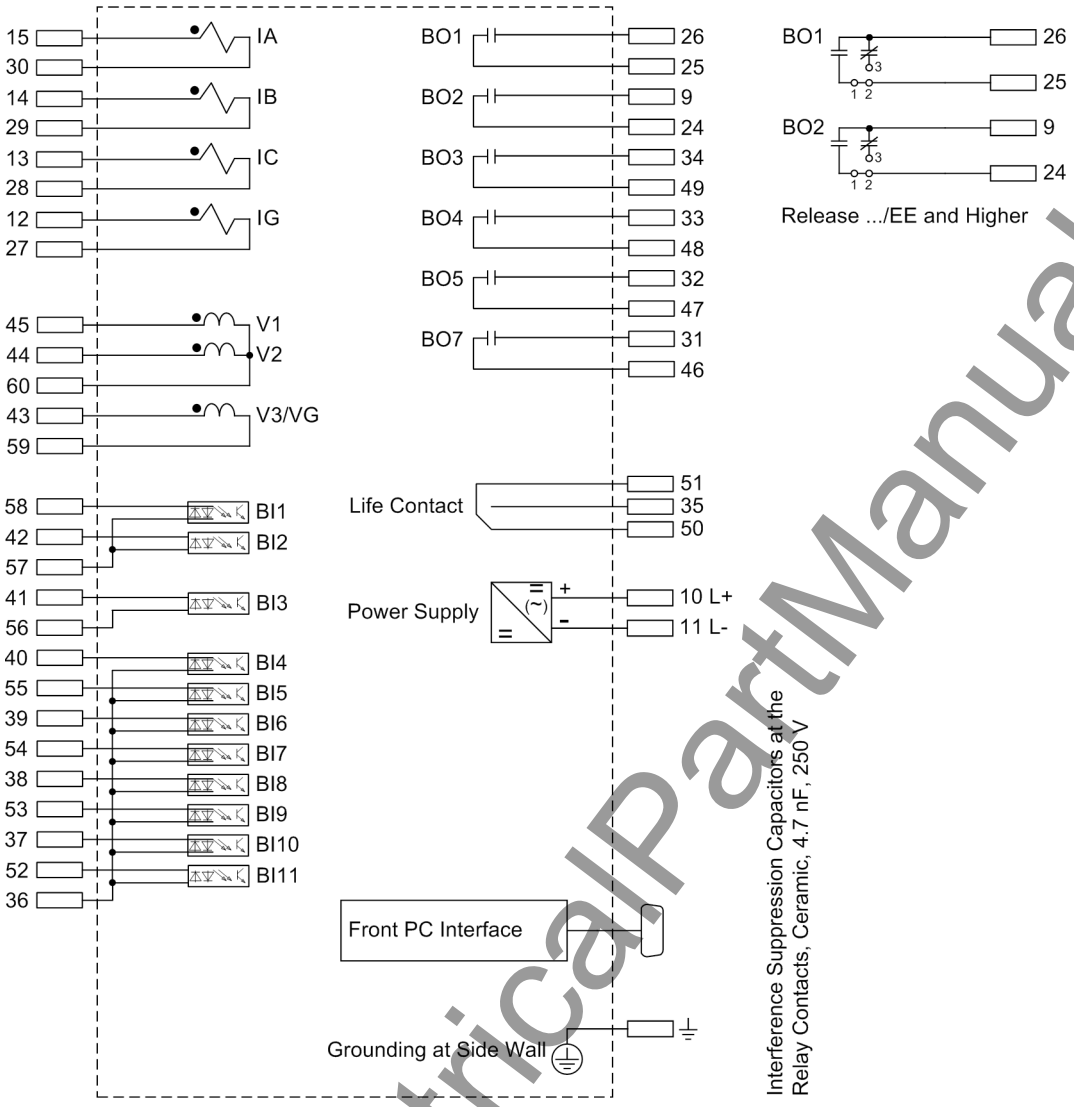


Figure A-4 General diagram for 7SJ622*-*B (panel surface mounted)

www . ElectricalPartManuals . com

### A.2.3 7SJ62 — Interface assignment on housing for panel surface mounting

**7SJ621/2*-*B (up to release ... /CC)**

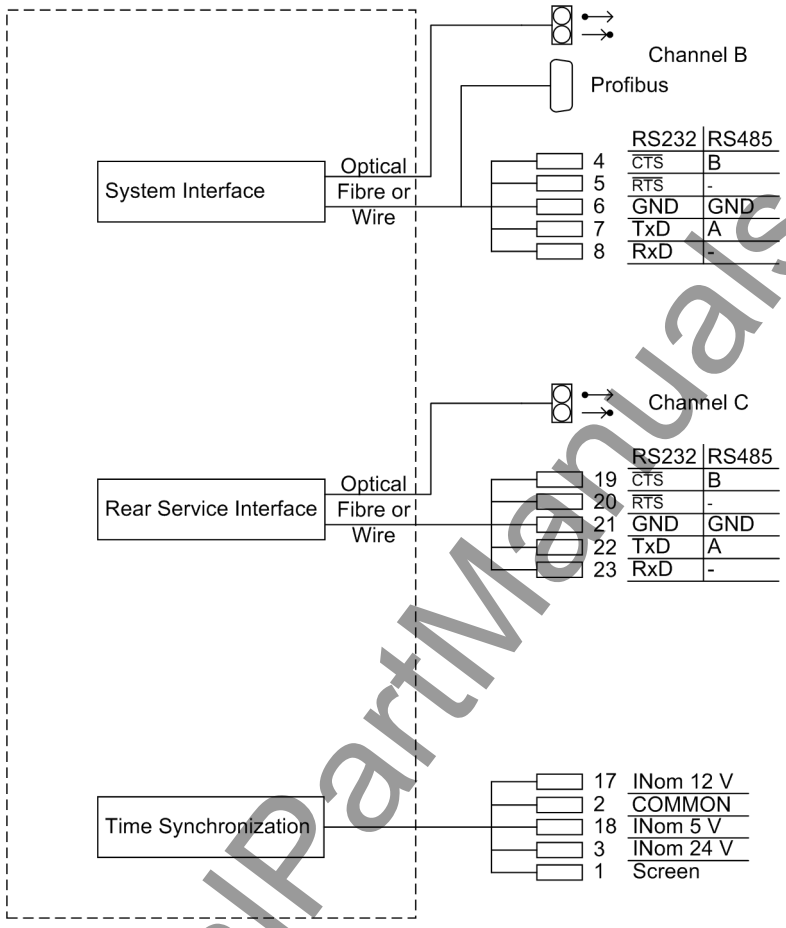


Figure A-5 General diagram for 7SJ621/2*–*B up to release ... /CC (panel surface mounted)

www . ElectricalPartManuals . com

**7SJ621/2*-*B (release ... /DD and higher)**

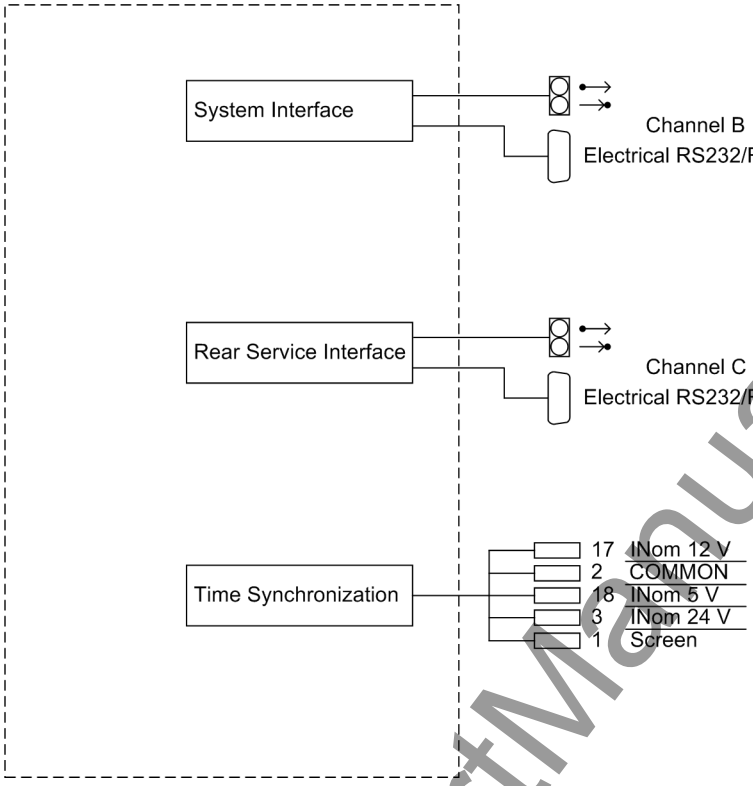


Figure A-6 General diagram for 7SJ621/2*–*B, release ... /DD and higher (panel surface mounted)

www . ElectricalPartManuals . com

## A.2.4 7SJ63 — Housing for panel flush mounting or cubicle installation

**7SJ631*-*D/E**

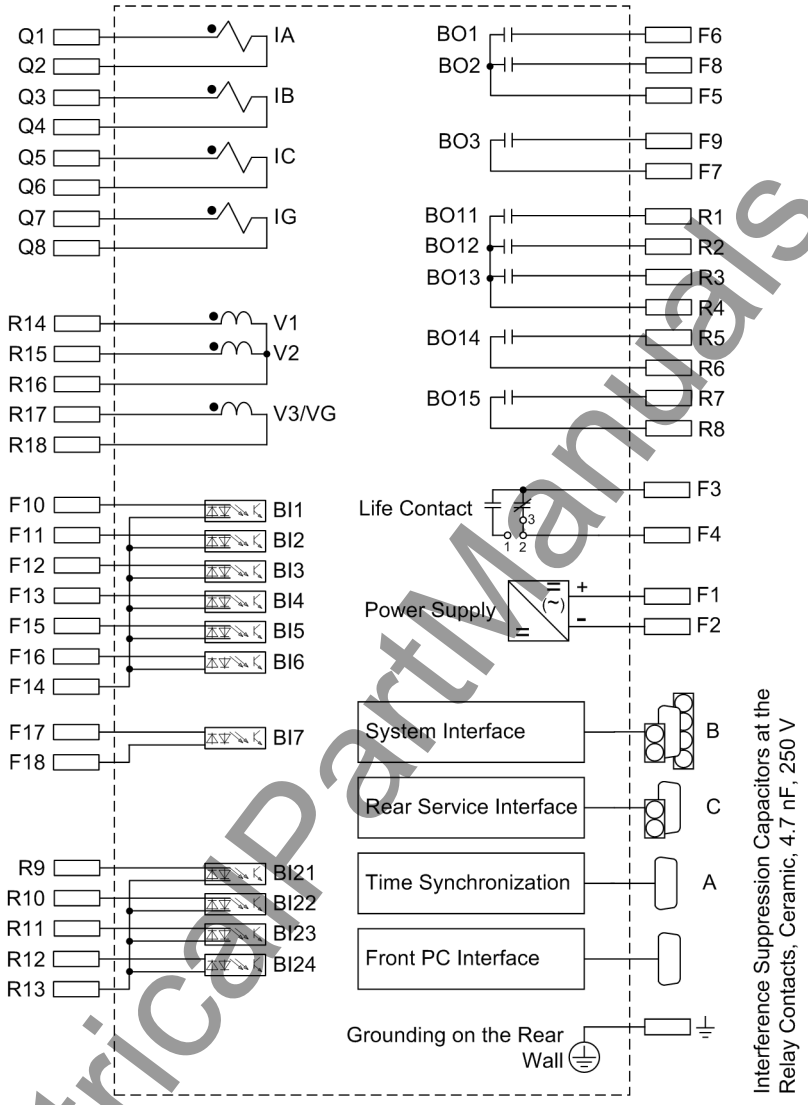


Figure A-7 General diagram for 7SJ631*–*D/E (panel flush mounted or cubicle mounted)

www . ElectricalPartManuals . com

**7SJ632*-*D/E**

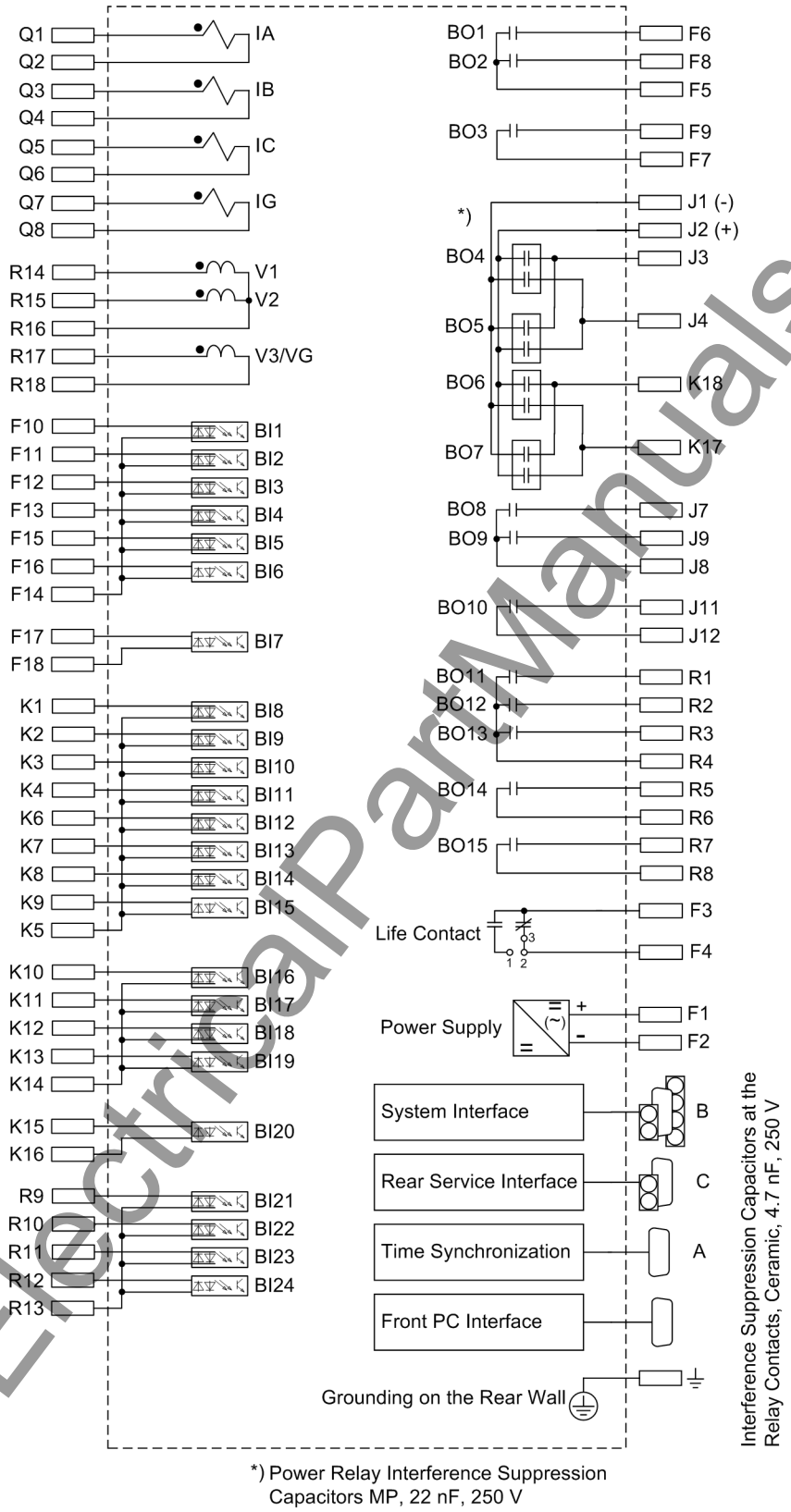


Figure A-8 General diagram for 7SJ632*–*D/E (panel flush mounting or cubicle mounting)

www . ElectricalPartManuals . com

**7SJ633*-*D/E**

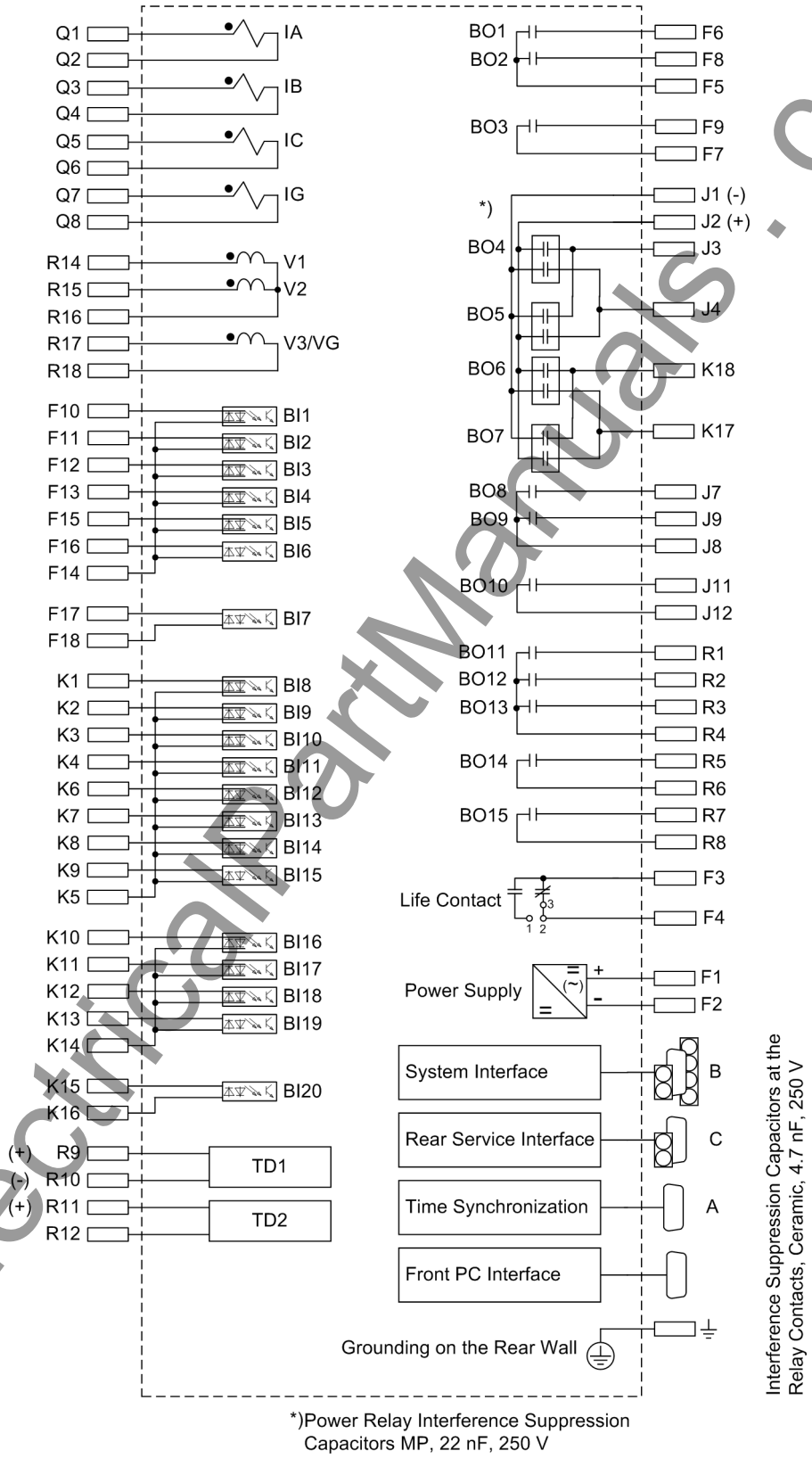


Figure A-9 General diagram for 7SJ633*–*D/E (panel flush mounting or cubicle mounting)

www . ElectricalPartManuals . com

**7SJ635*-*D/E**

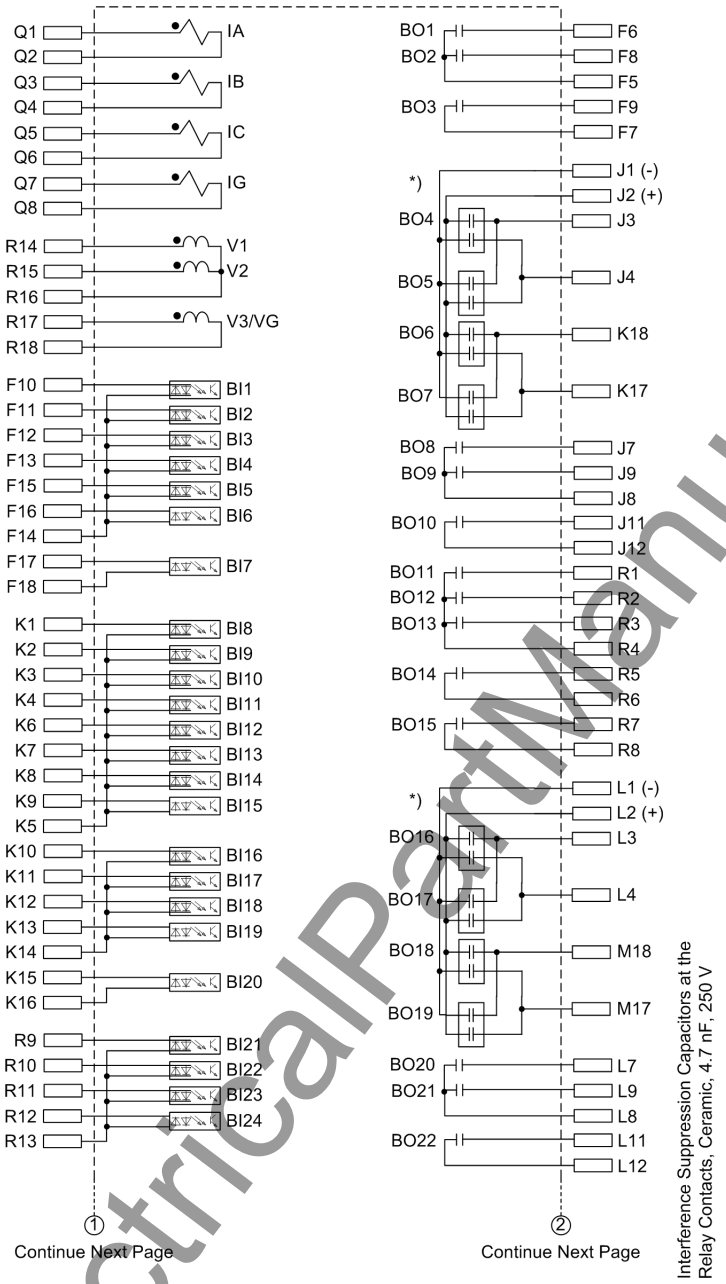


Figure A-10 General diagram for 7SJ635*–*D/E (panel flush mounting or cubicle mounting), part 1

www . ElectricalPartManuals . com

**7SJ635*-*D/E**

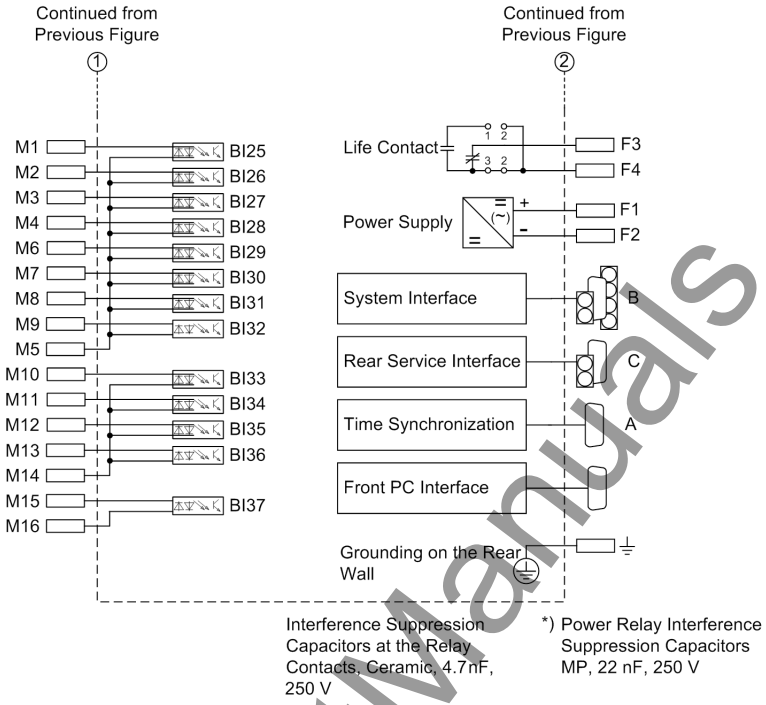


Figure A-11 General diagram for 7SJ635*–*D/E (panel flush mounting or cubicle mounting), part 2

www . ElectricalPartManuals . com

**7SJ636*-*D/E**

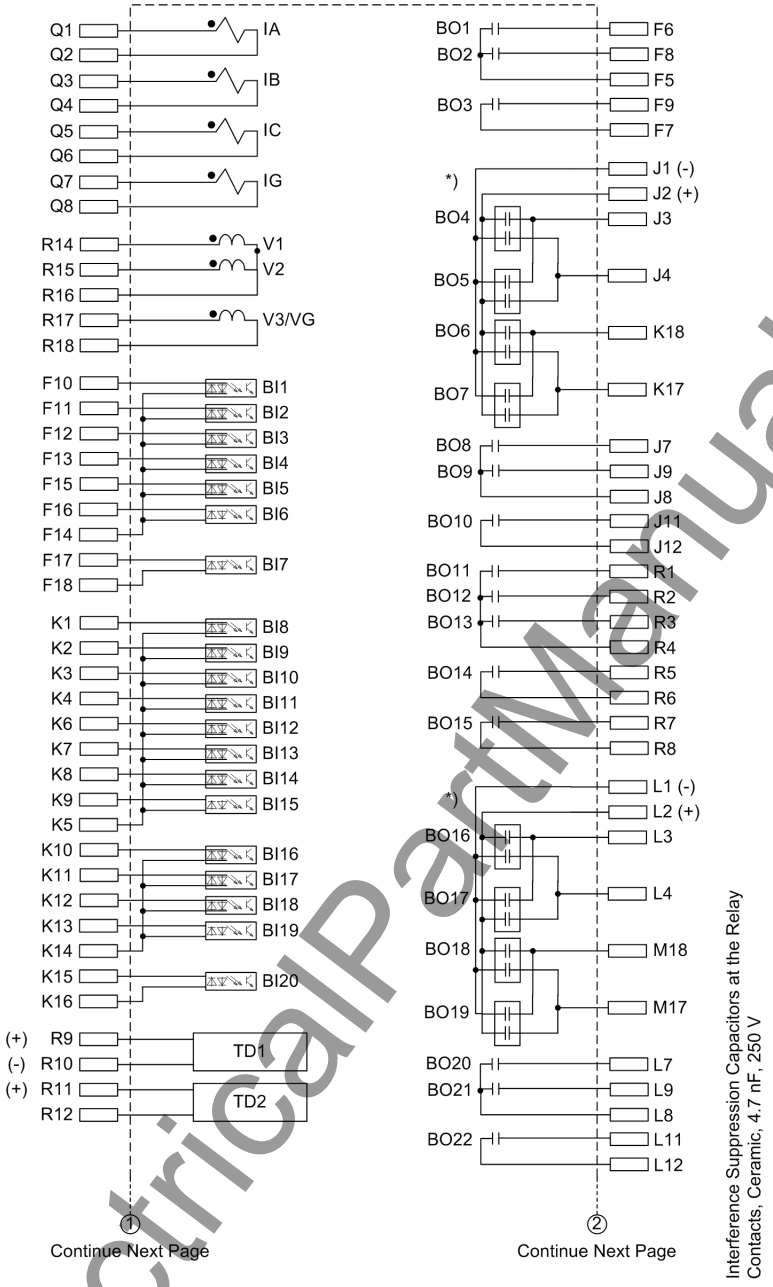


Figure A-12 General diagram for 7SJ636*–*D/E (panel flush mounting or cubicle mounting), part 1

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**7SJ636*-*D/E**

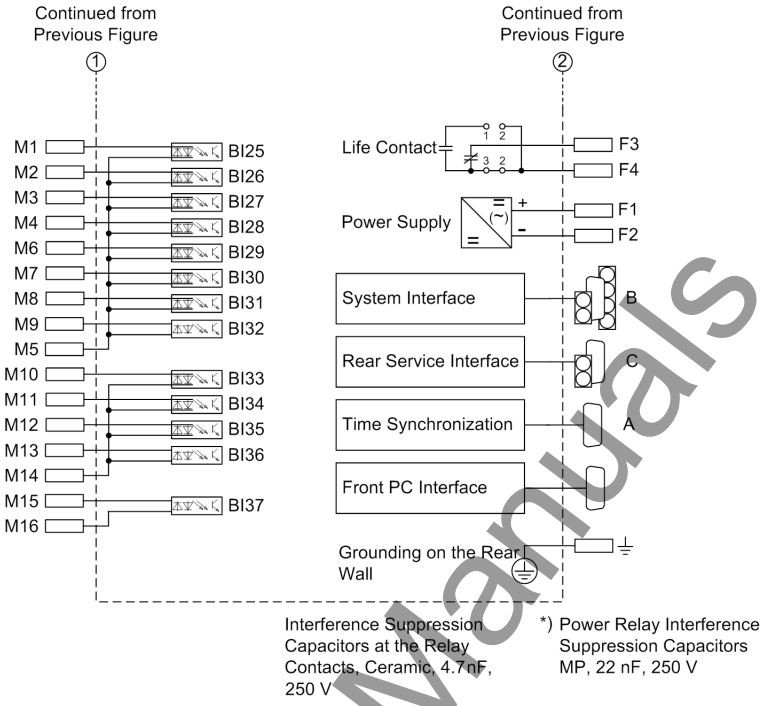


Figure A-13 General diagram for 7SJ636*–*D/E (panel flush mounting or cubicle mounting), part 2

www . ElectricalPartManuals . com

## A.2.5 7SJ631/2/3 — Housing for panel surface mounting

**7SJ631*-*B**

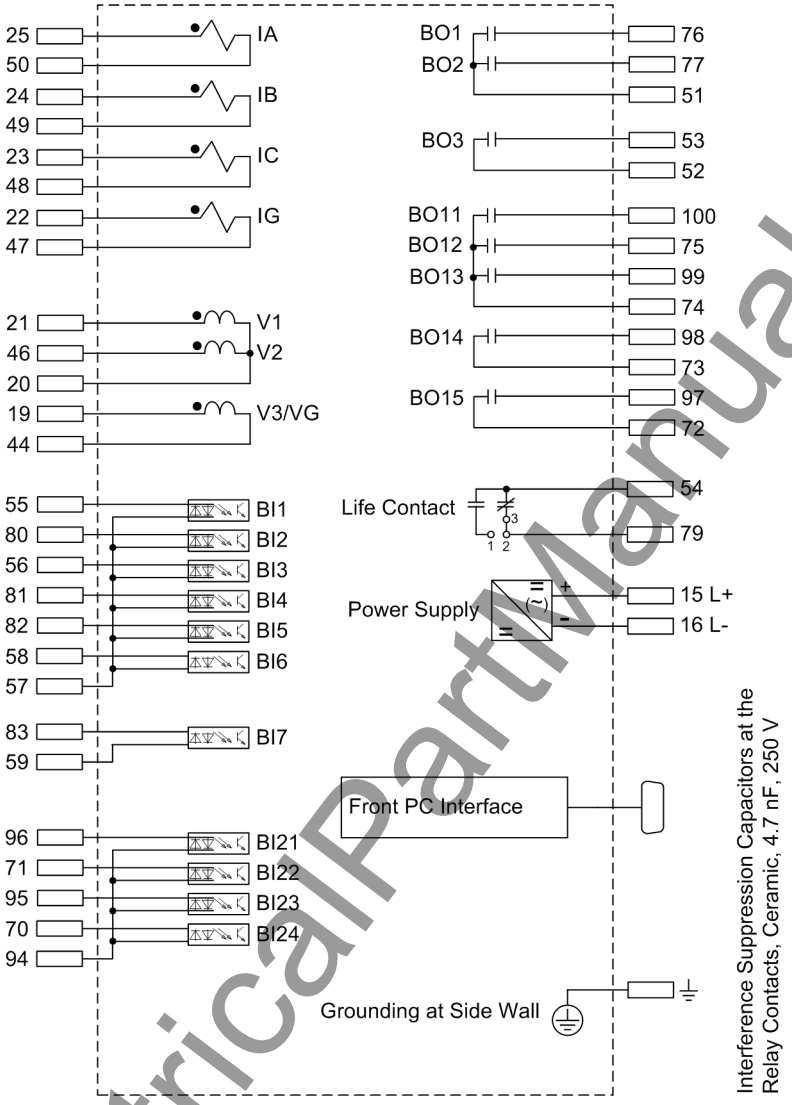


Figure A-14 General diagram for 7SJ631*-*B (panel surface mounting)

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**7SJ632*-*B**

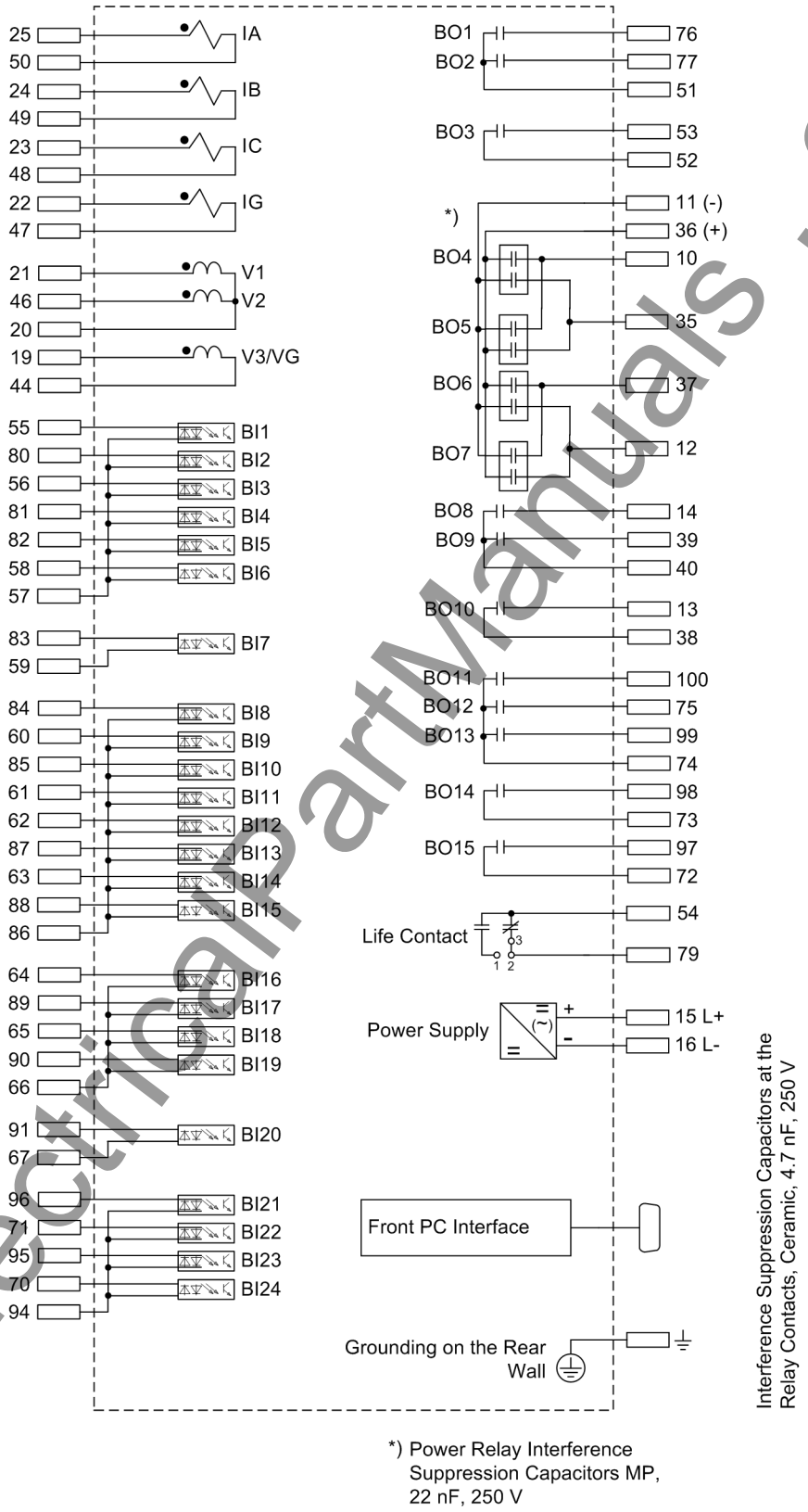


Figure A-15 General diagram for 7SJ632*-*B (panel surface mounted)

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**7SJ633*-*B**

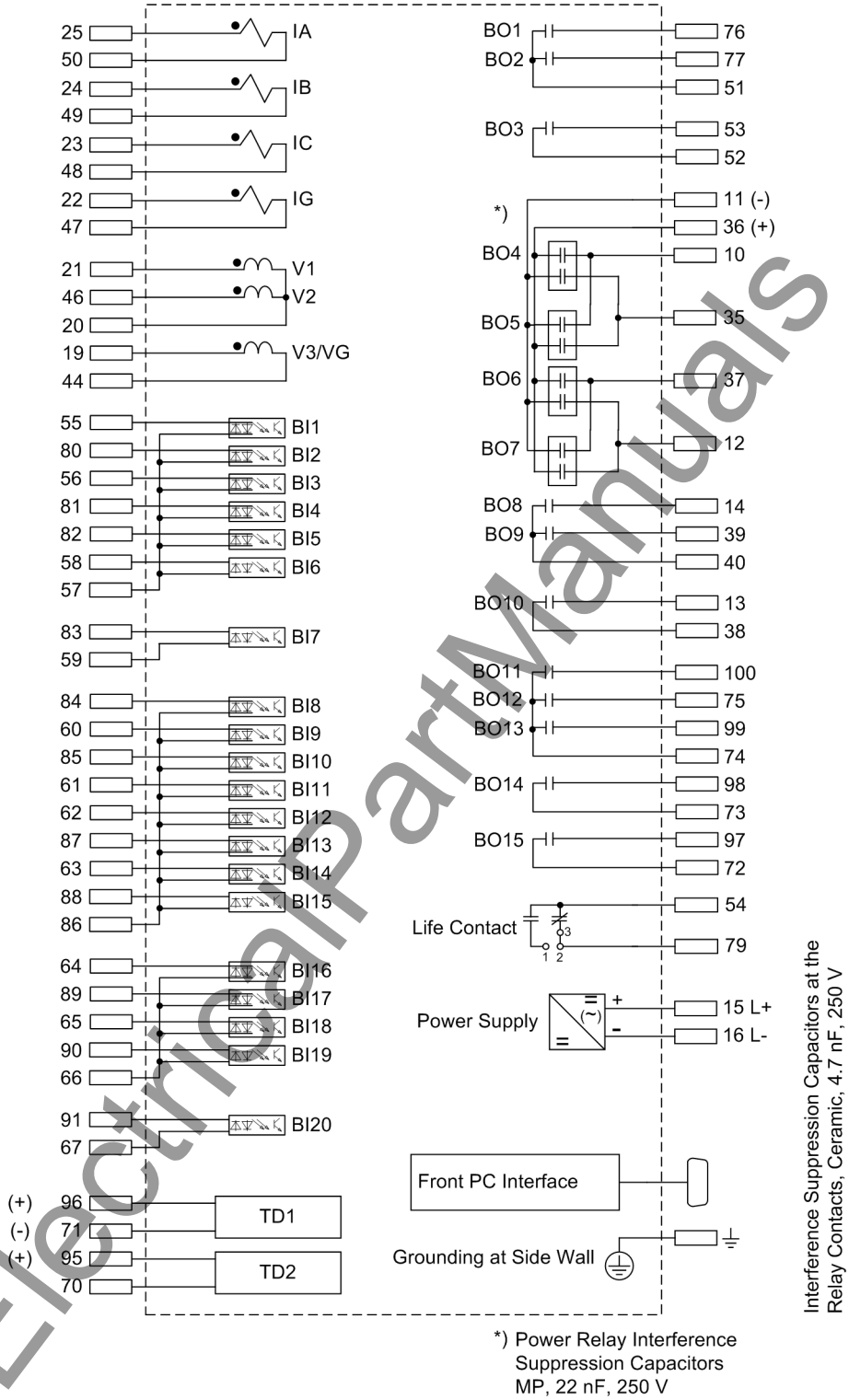


Figure A-16 General diagram for 7SJ633*-*B (panel surface mounting)

www . ElectricalPartManuals . com

### A.2.6 7SJ631/2/3 — Interface assignment on housing for panel surface mounting

**7SJ631/2/3*-*B (up to release ... /CC)**

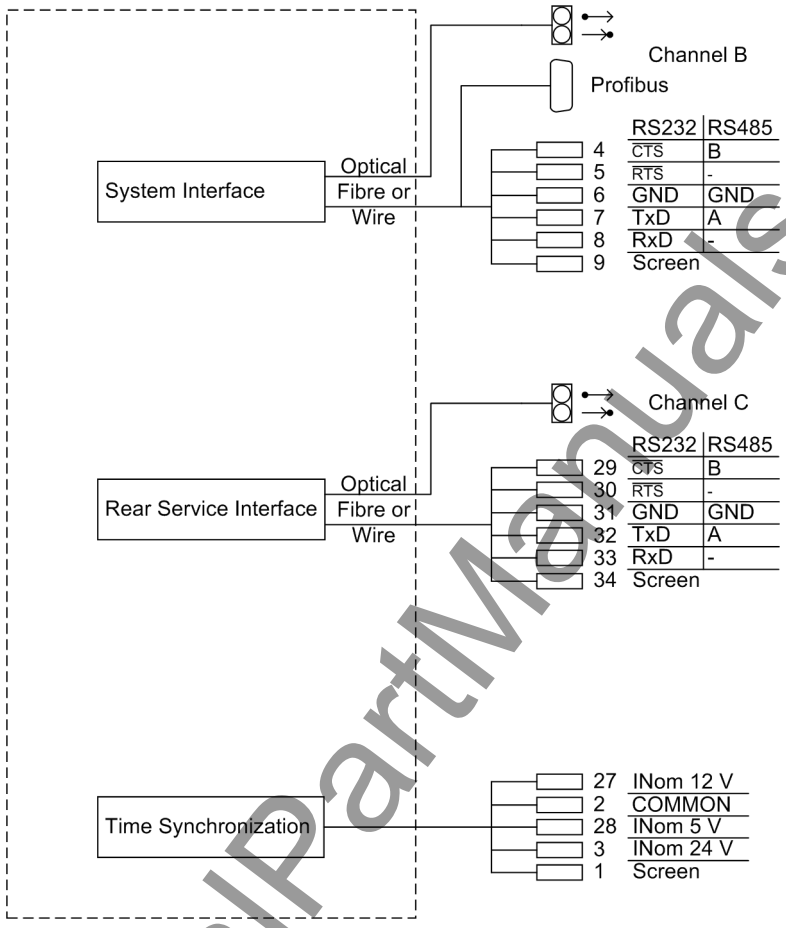


Figure A-17 General diagram 7SJ631/2/3*-*B up to release ... /CC (panel surface mounting)

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**7SJ631/2/3*-*B (release ... /DD and higher)**

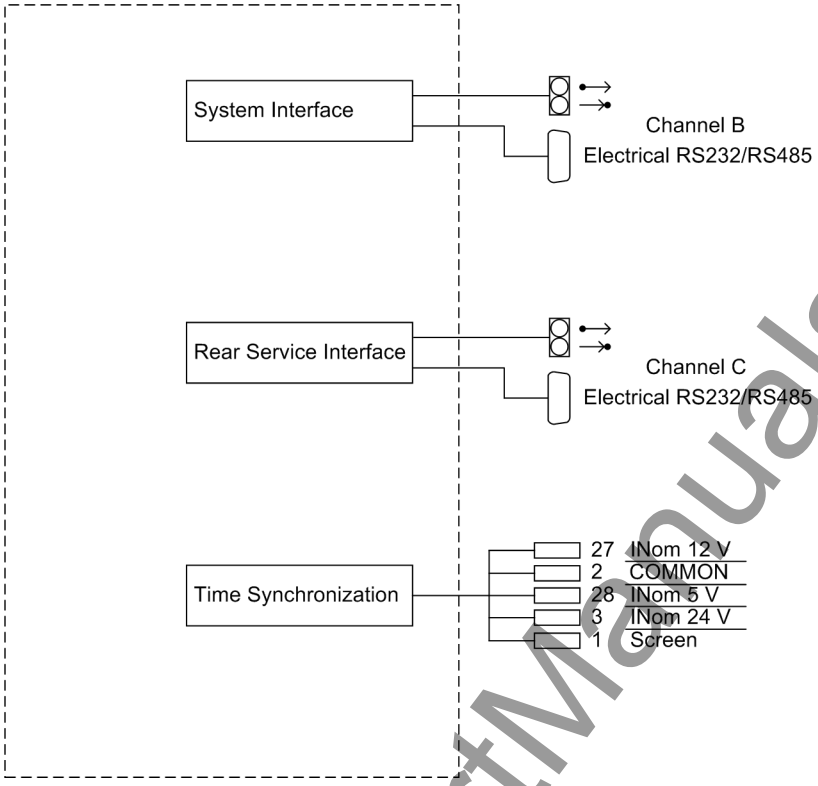


Figure A-18 General diagram for 7SJ631/2/3*–*B, release ... /DD and higher (panel surface mounting)

www . ElectricalPartManuals . com

## A.2.7 7SJ635/6 — Housing for panel surface mounting

**7SJ635*-*B**

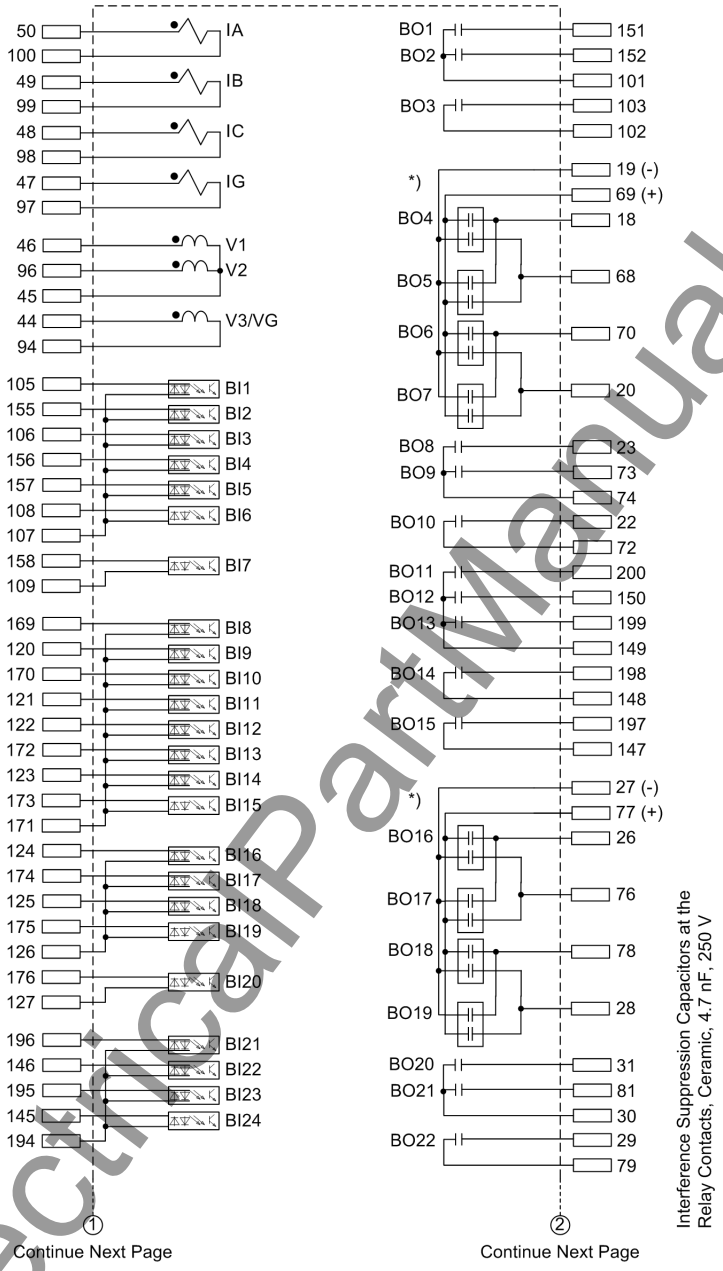


Figure A-19 General diagram for 7SJ635*-*B (panel surface mounting), part 1

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**7SJ635*-*B**

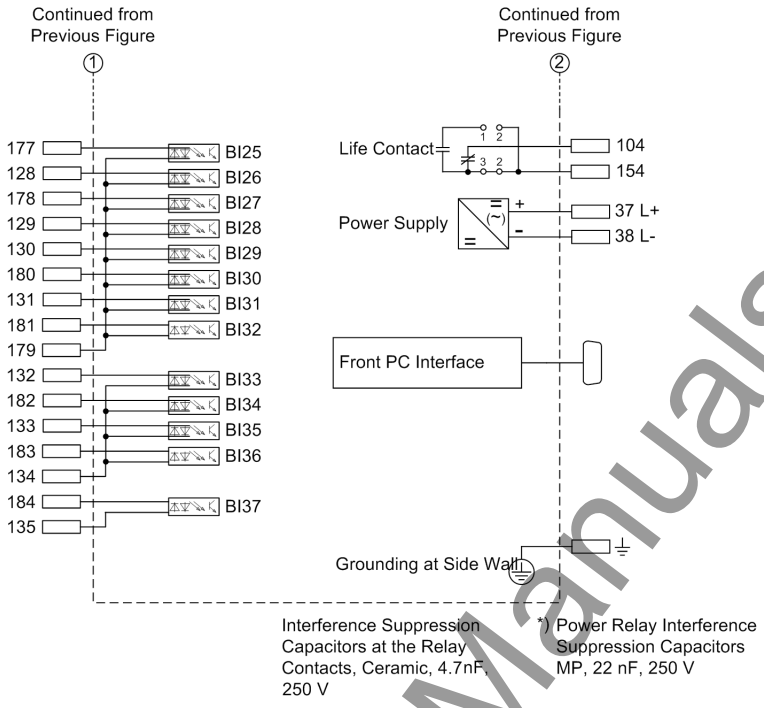


Figure A-20 General diagram for 7SJ635*-*B (panel surface mounting), part 2

www . ElectricalPartManuals . com

**7SJ636*-*B**

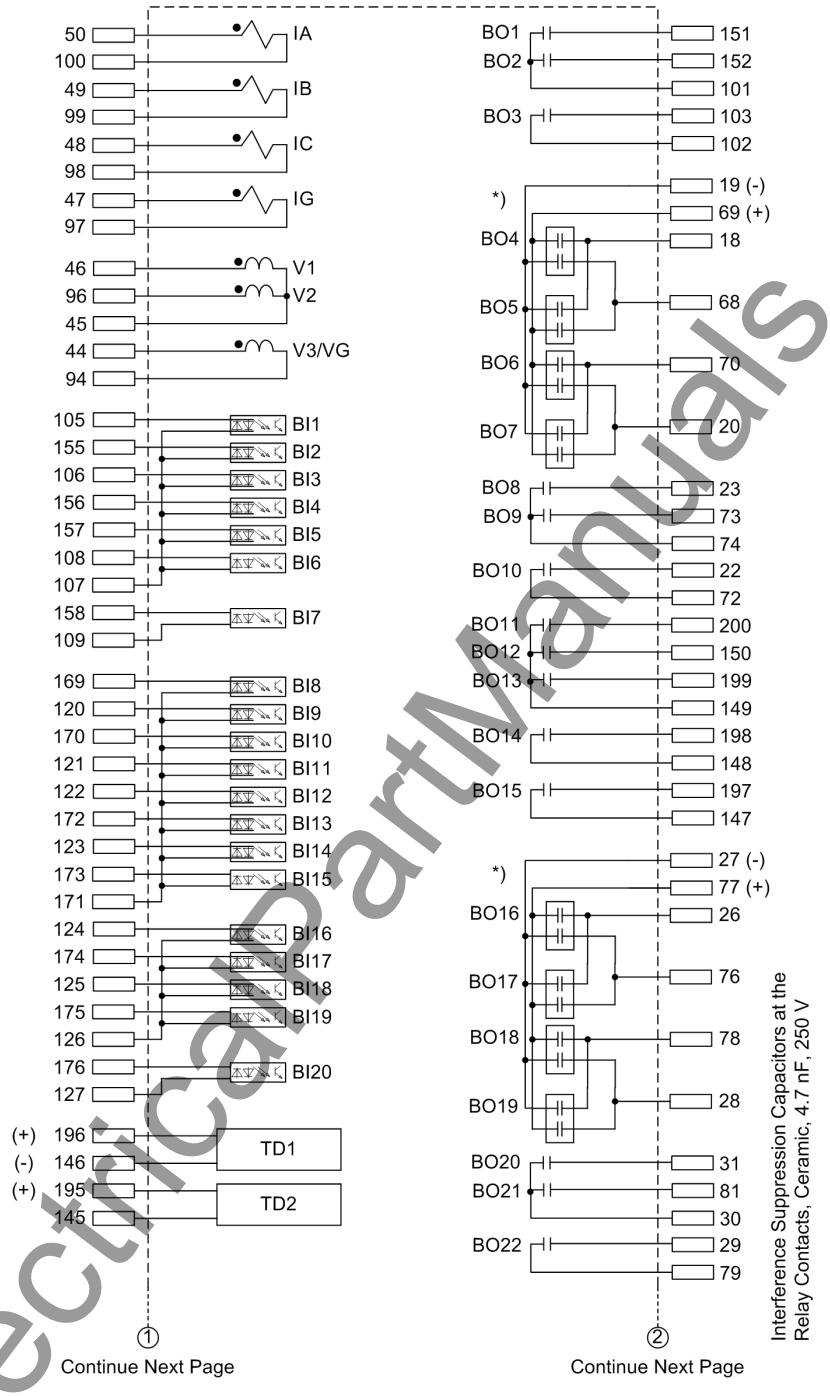


Figure A-21 General diagram for 7SJ636*-*B (panel surface mounting), part 1

www . ElectricalPartManuals . com

**7SJ636*-*B**

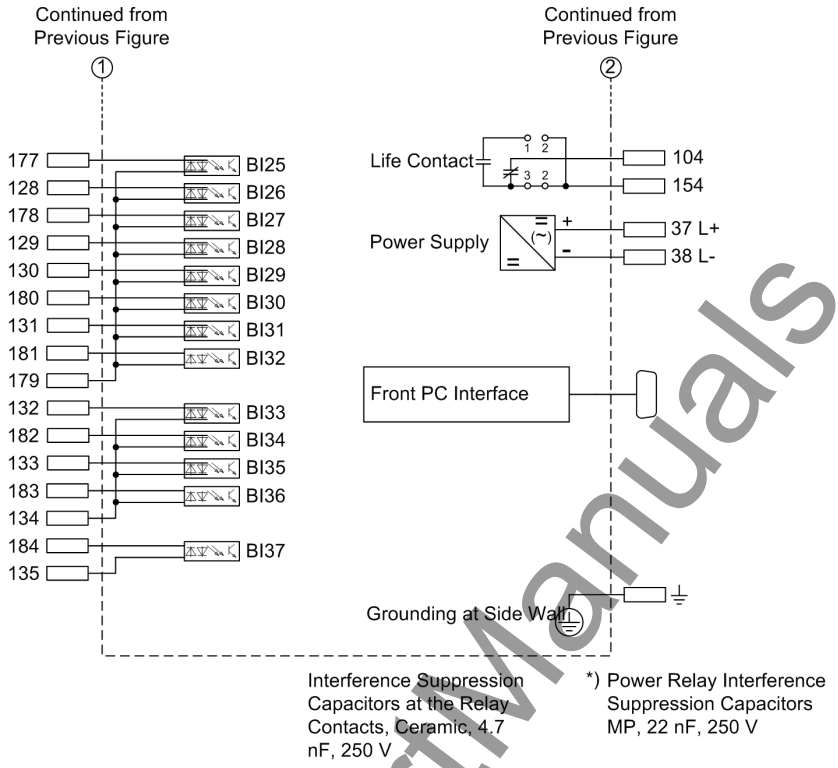


Figure A-22 General diagram for 7SJ636*-*B (panel surface mounting), part 2

www . ElectricalPartManuals . com

## A.2.8 7SJ635/6 — Interface assignment on housing for panel surface mounting

**7SJ635/6*-*B (up to release ... /CC)**

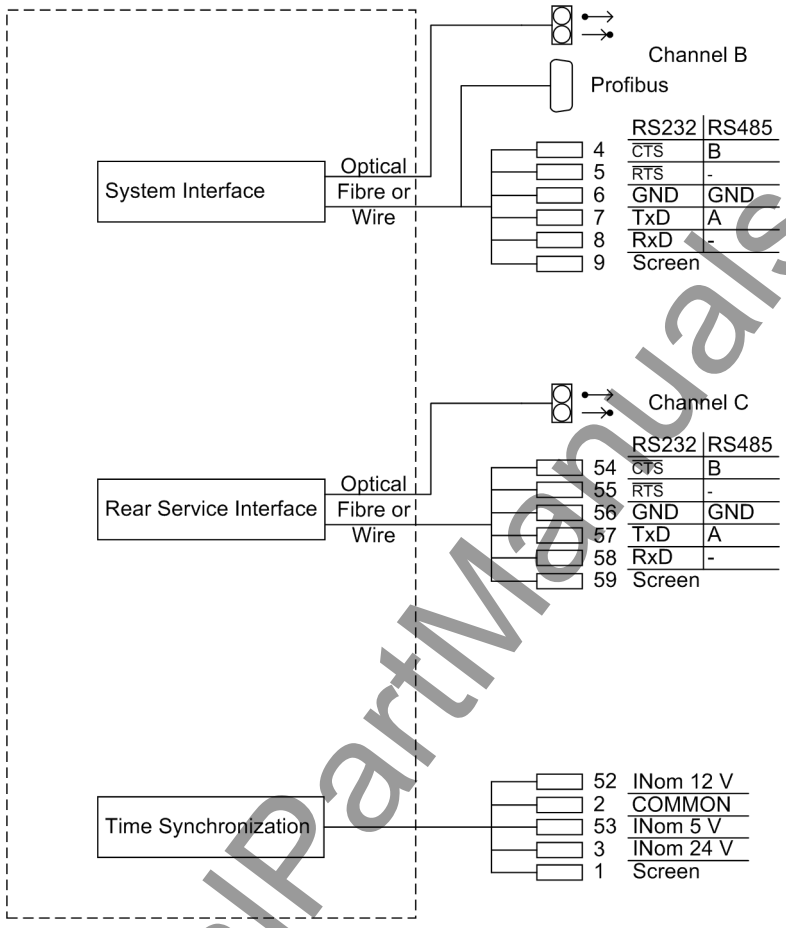


Figure A-23 General diagram for 7SJ635/6*-*B up to release ... /CC (panel surface mounting)

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**7SJ635/6*-*B (release ... /DD and higher)**

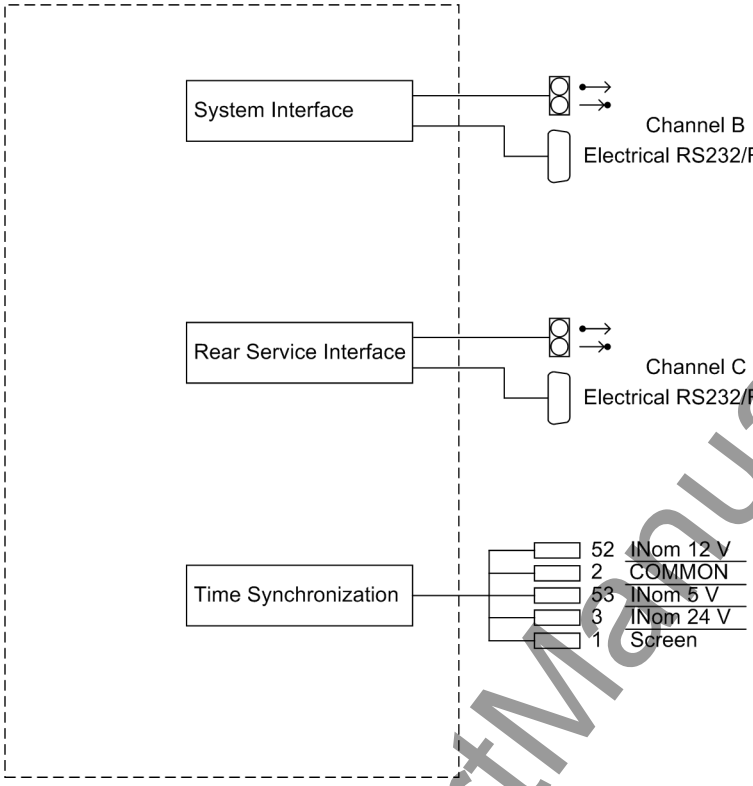


Figure A-24 General diagram for 7SJ635/6*-*, release ... /DD and higher (panel surface mounted)

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## A.2.9 7SJ63 — Housing with detached operator panel

**7SJ631*-*A/C**

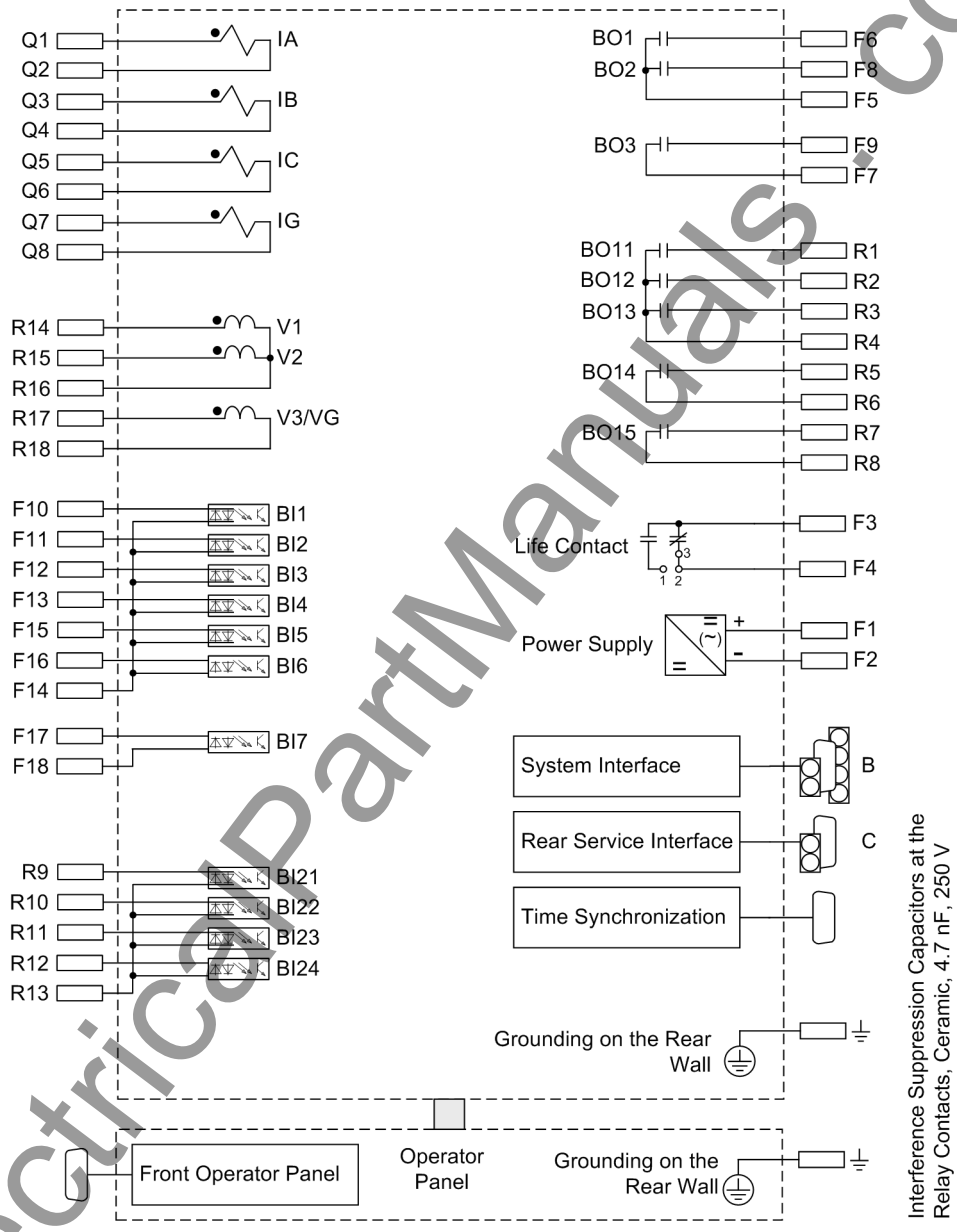


Figure A-25 General diagram 7SJ631*-*A/C (panel surface mounting with detached operator panel)

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**7SJ632*-*A/C**

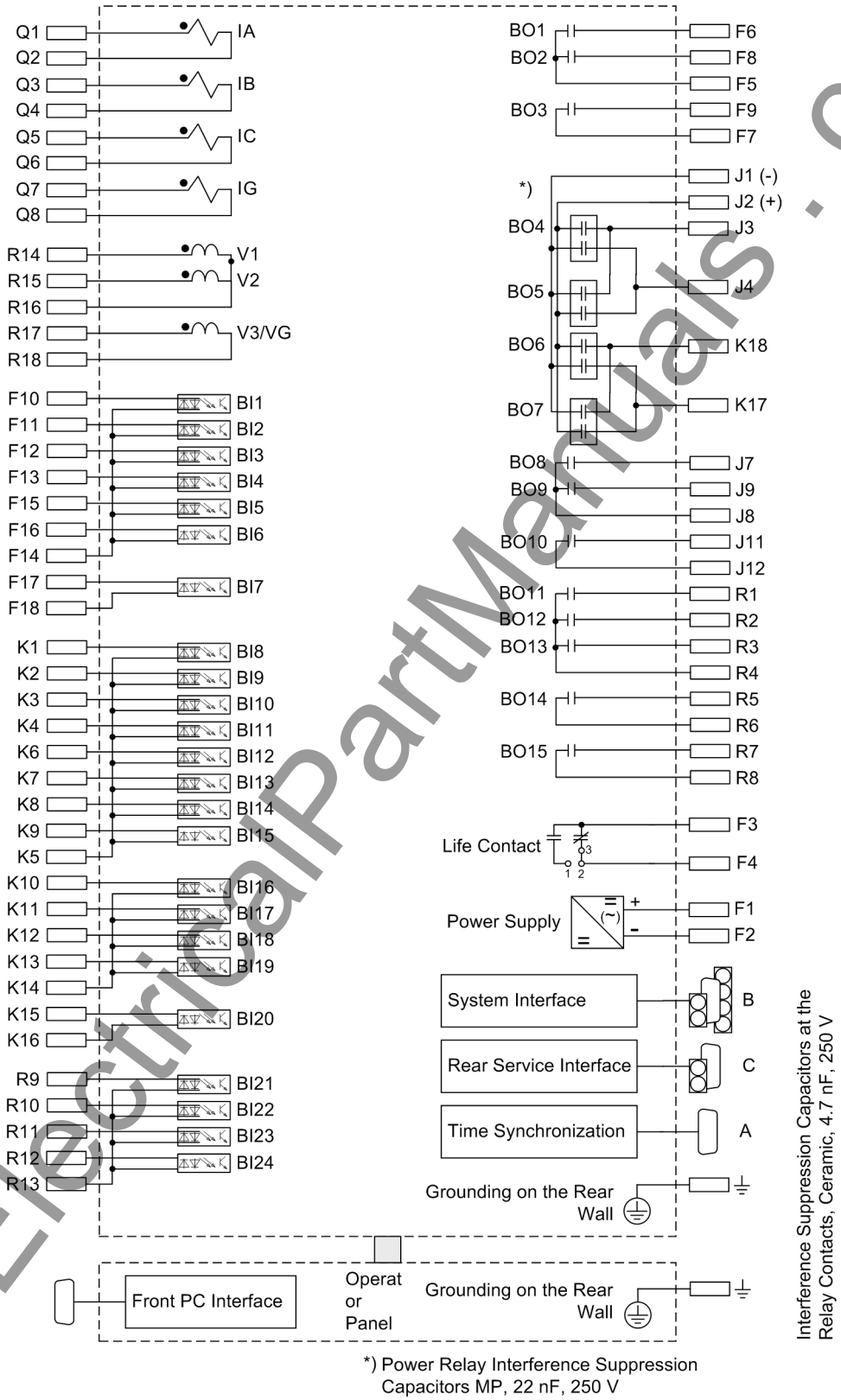


Figure A-26 General diagram 7SJ632*-*A/C (panel surface mounting with detached operator panel)

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**7SJ633*-*A/C**

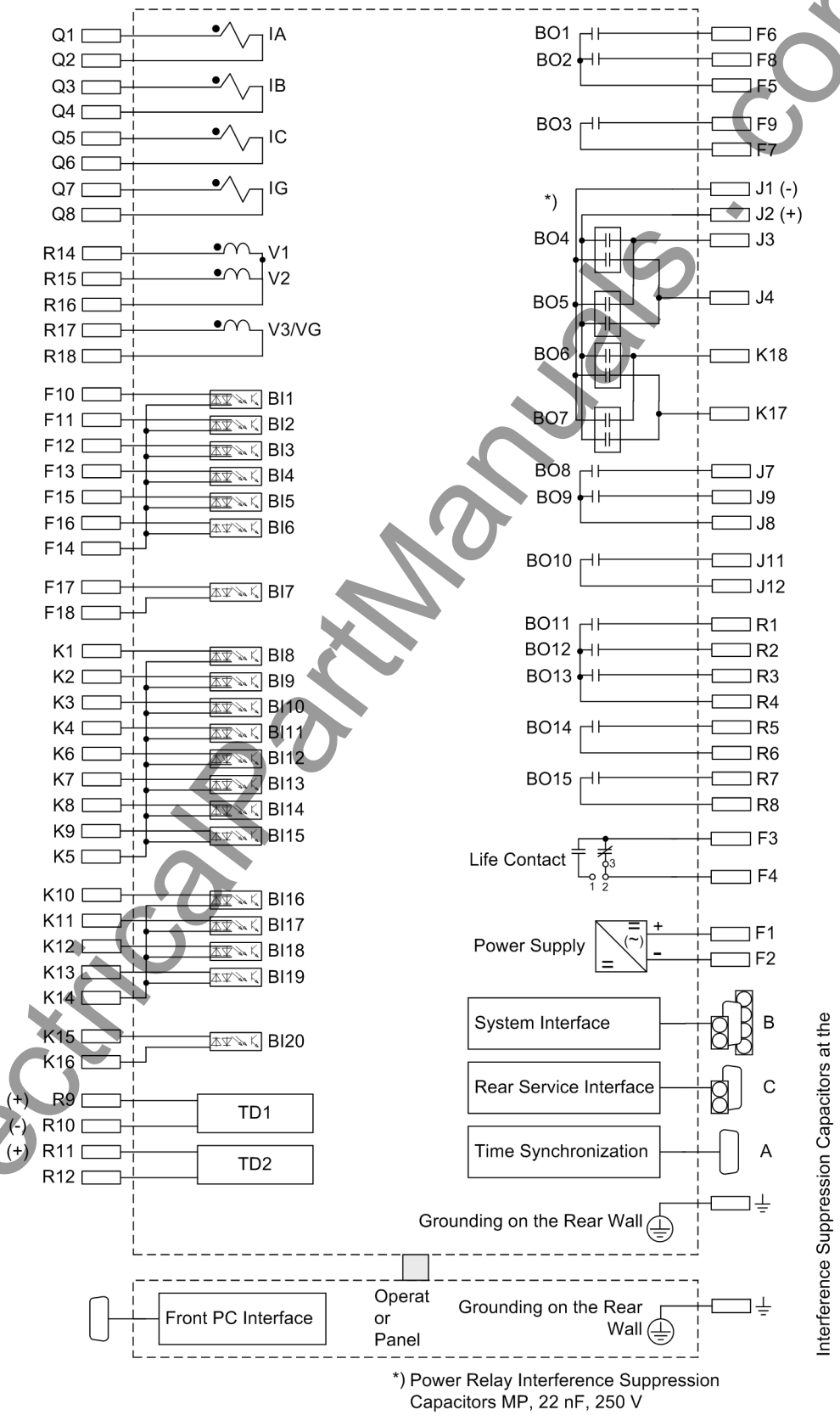


Figure A-27 General diagram 7SJ633*-*A/C (panel surface mounting with detached operator panel)

www . ElectricalPartManuals . com

**7SJ635*-*A/C**

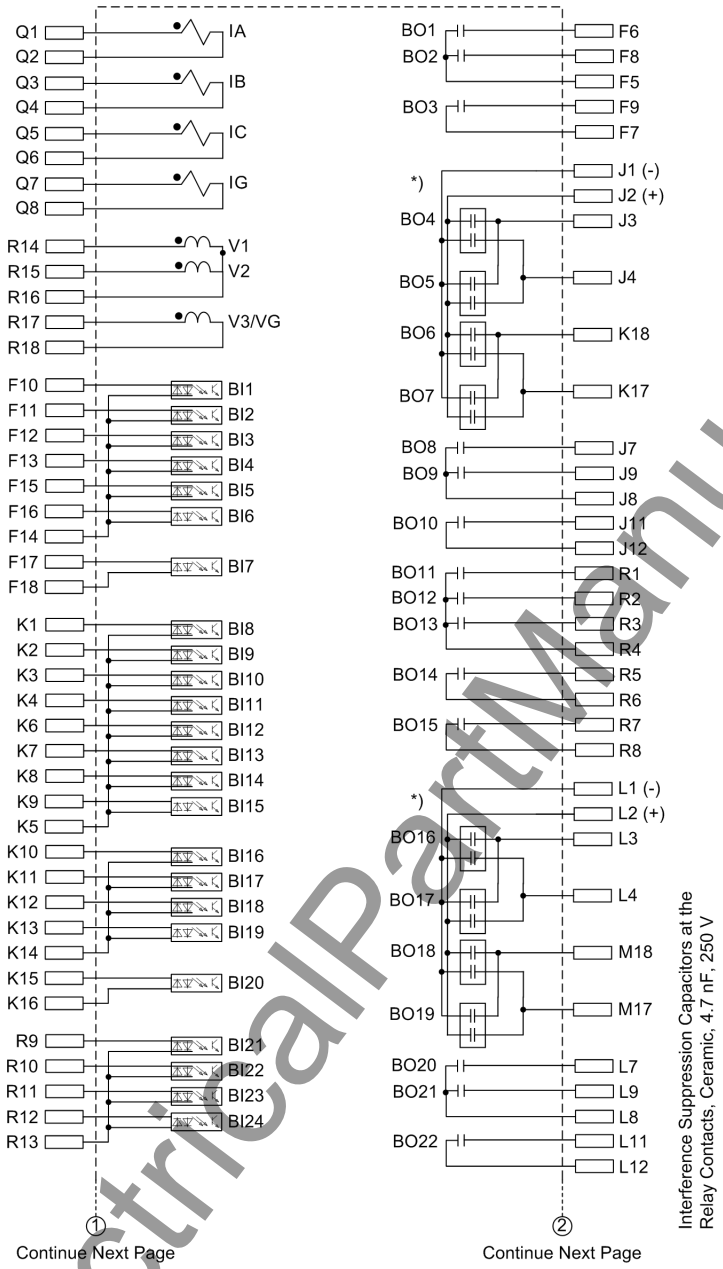


Figure A-28 General diagram 7SJ635*-*A/C (panel surface mounting with detached operator panel), part 1

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**7SJ635*-*A/C**

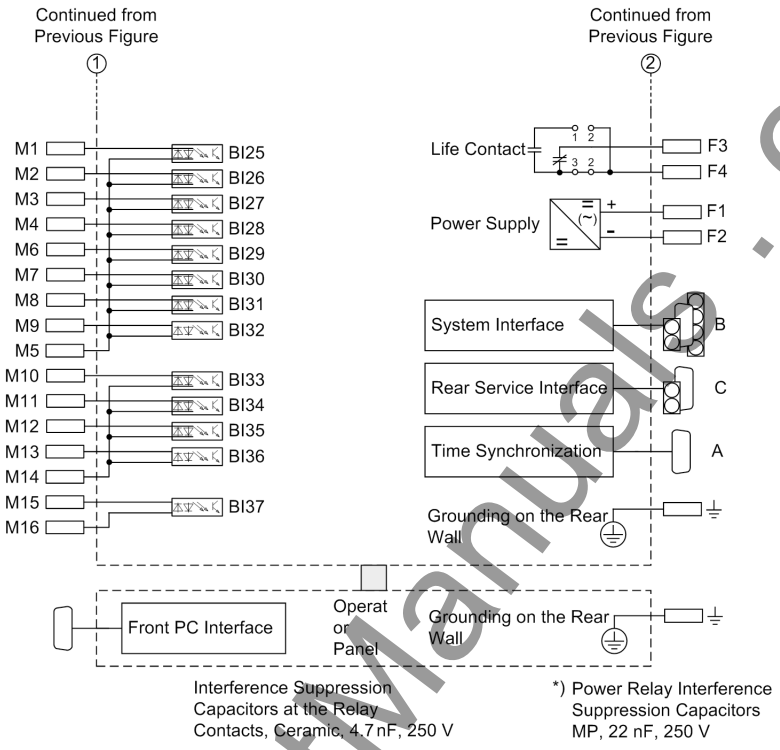


Figure A-29 General diagram 7SJ635*-*A/C (panel surface mounting with detached operator panel), part 2

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**7SJ636*-*A/C**

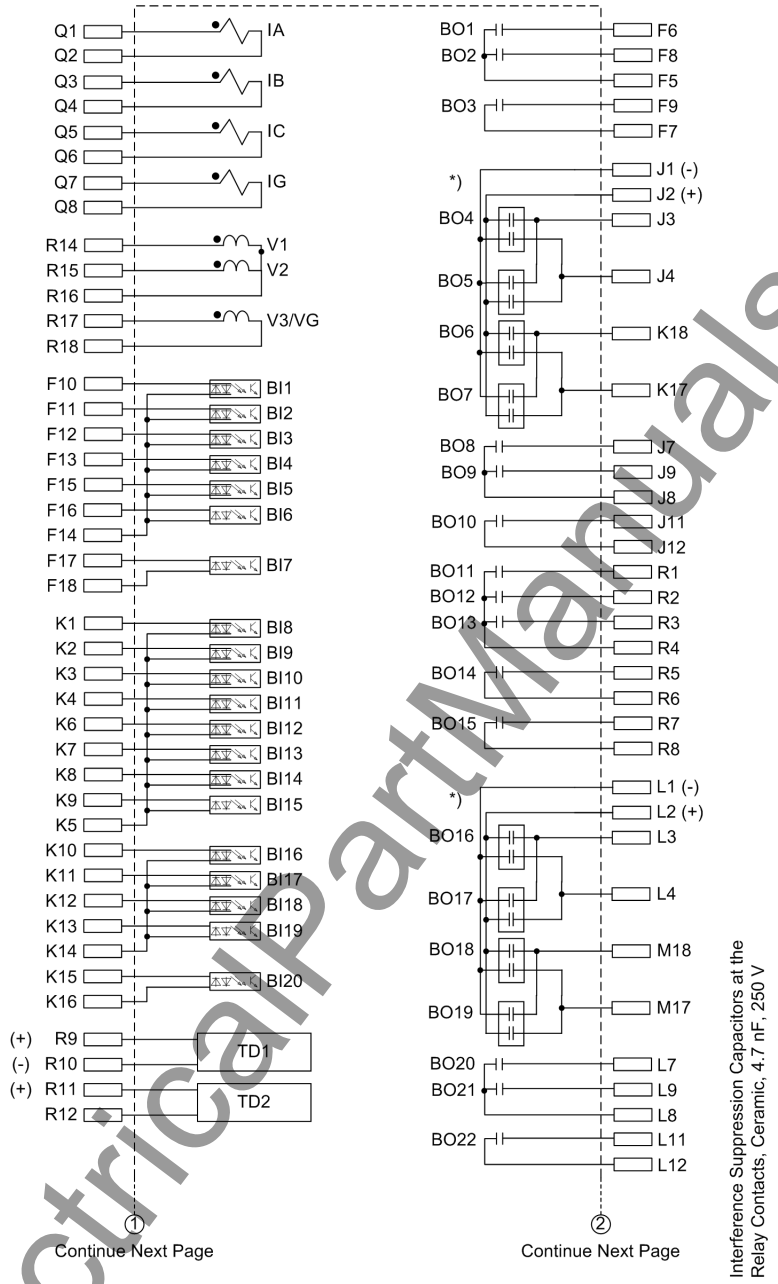


Figure A-30 General diagram 7SJ636*-*A/C (panel surface mounting with detached operator panel), part 1

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**7SJ636*-*A/C**

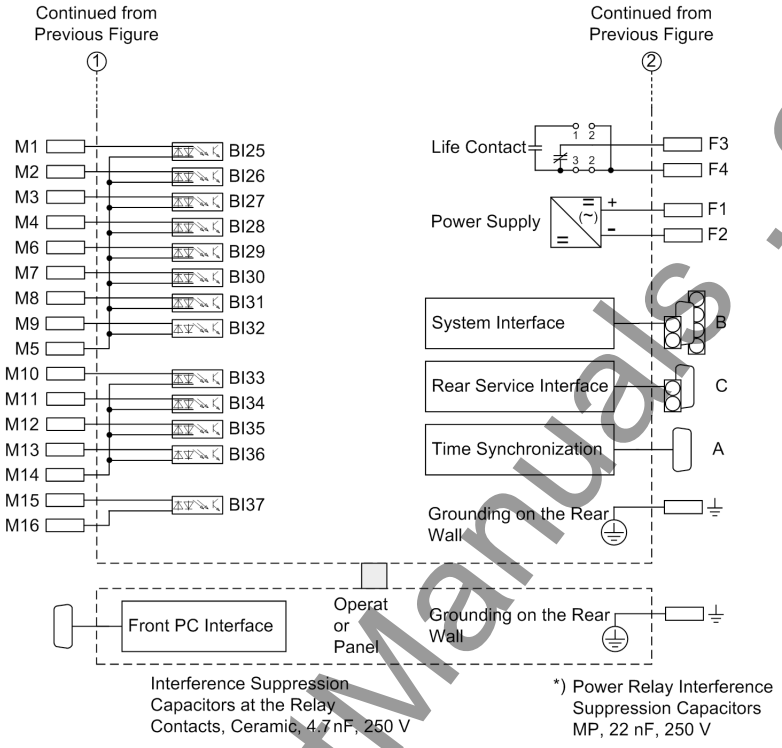


Figure A-31 General diagram 7SJ636*-*A/C (panel surface mounting with detached operator panel), part 2

www . ElectricalPartManuals . com

## A.2.10 7SJ63 — Housing for Panel Surface Mounting without Operator Panel

**7SJ631*-*F/G**

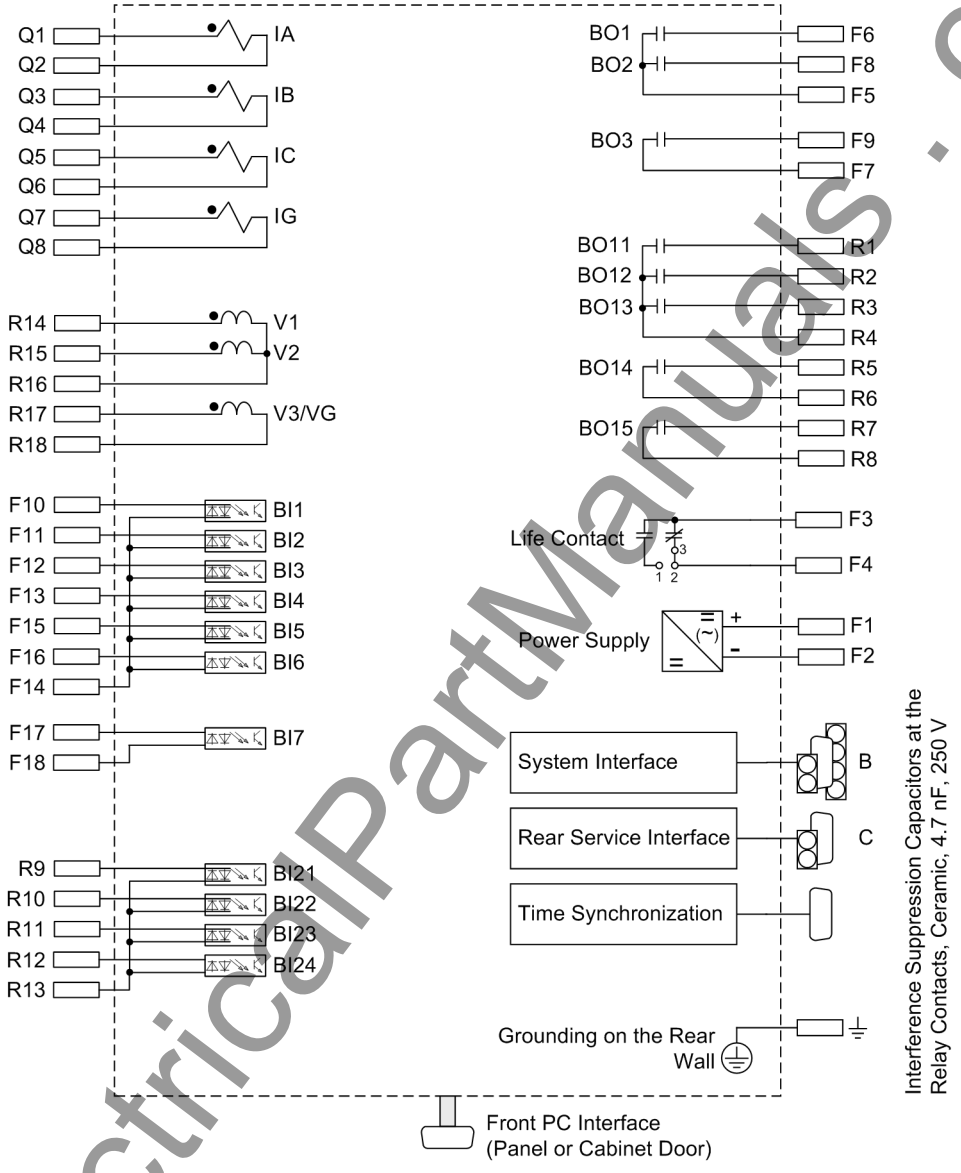


Figure A-32 General diagram 7SJ631*-*F/G (devices for panel surface mounting without operator panel)

www . ElectricalPartManuals . com

**7SJ632*-*F/G**

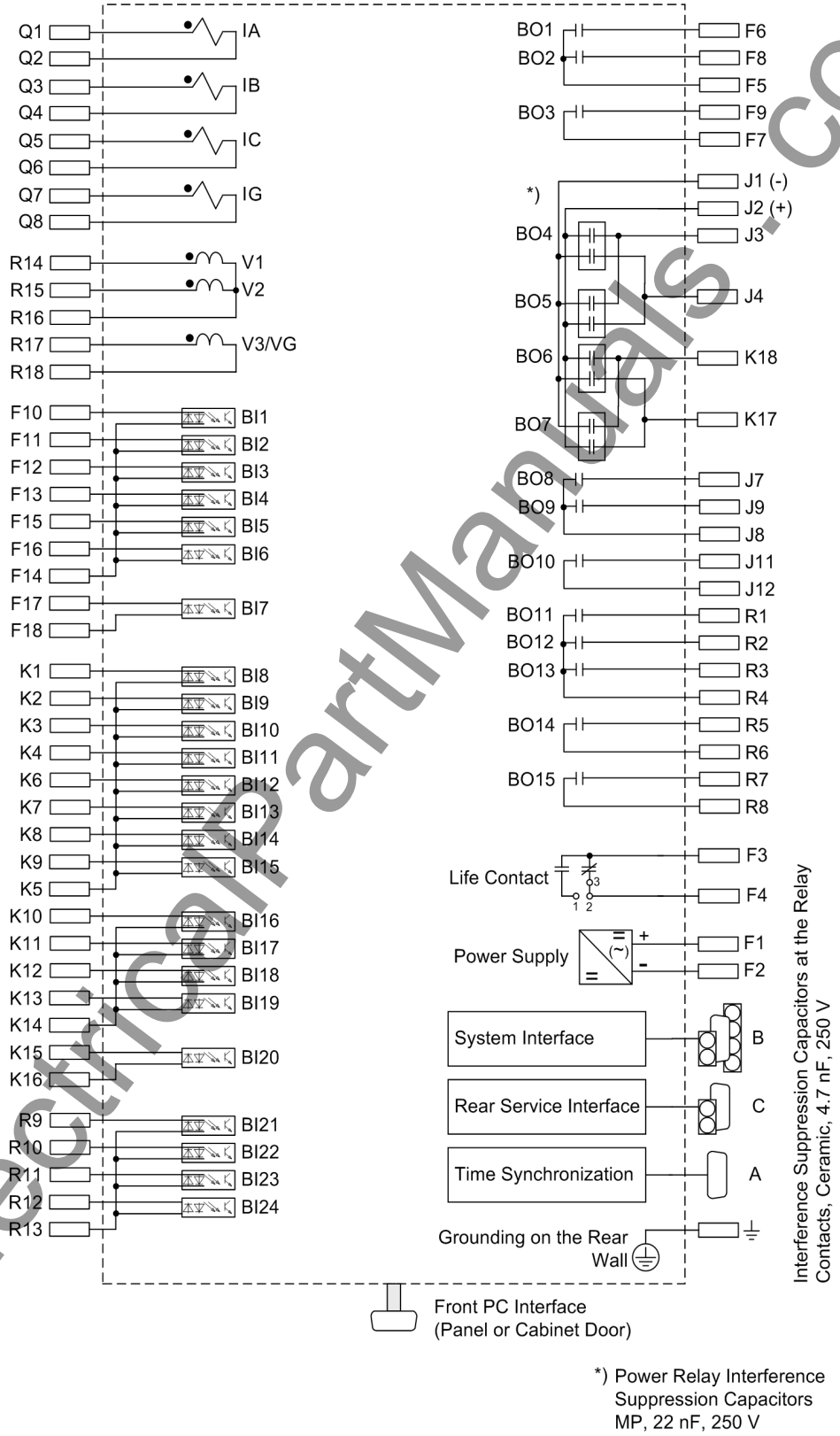


Figure A-33 General diagram 7SJ632*-*F/G (devices for panel surface mounting without operation unit)

www . ElectricalPartManuals . com

**7SJ633*-*F/G**

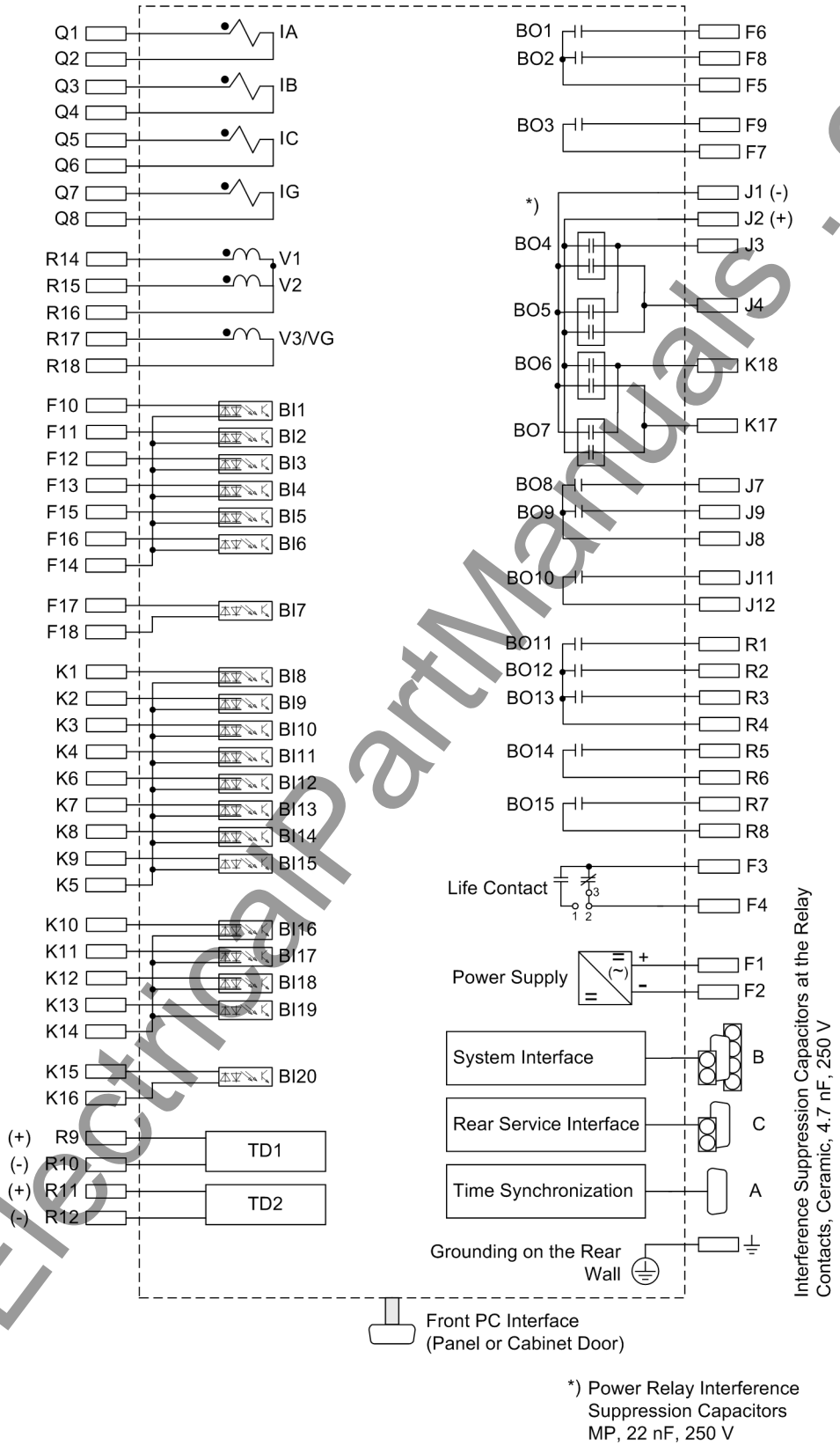


Figure A-34 General diagram 7SJ633*-*F/G (devices for panel surface mounting without operation unit)

www . ElectricalPartManuals . com

**7SJ635*-*F/G**

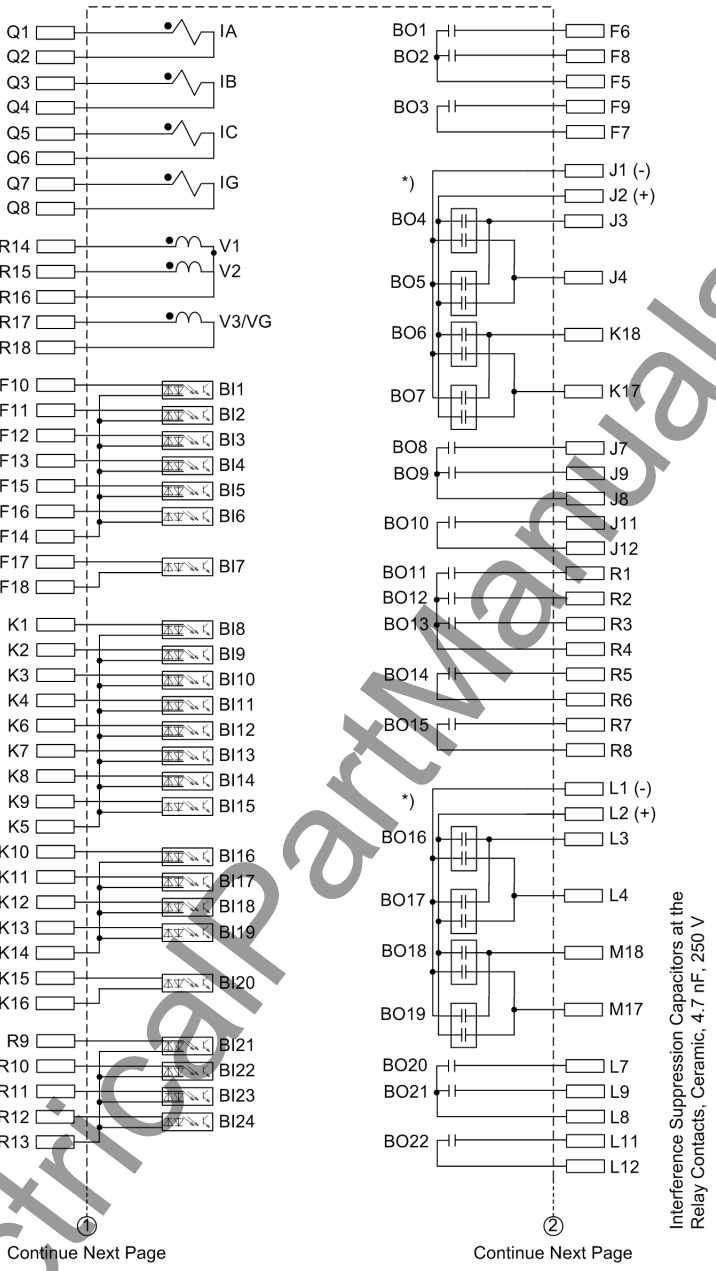


Figure A-35 General diagram 7SJ635*-*F/G (devices for panel surface mounting without operation unit), part 1

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**7SJ635*-*F/G**

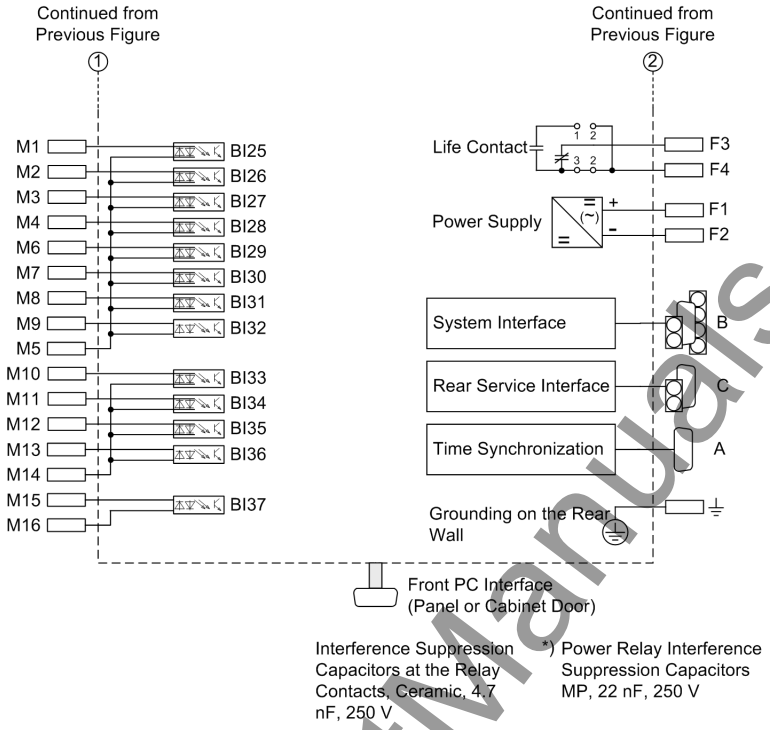


Figure A-36 General diagram 7SJ635*-*F/G (devices for panel surface mounting without operation unit), part 2

www . ElectricalPartManuals . com

**7SJ636*-*F/G**

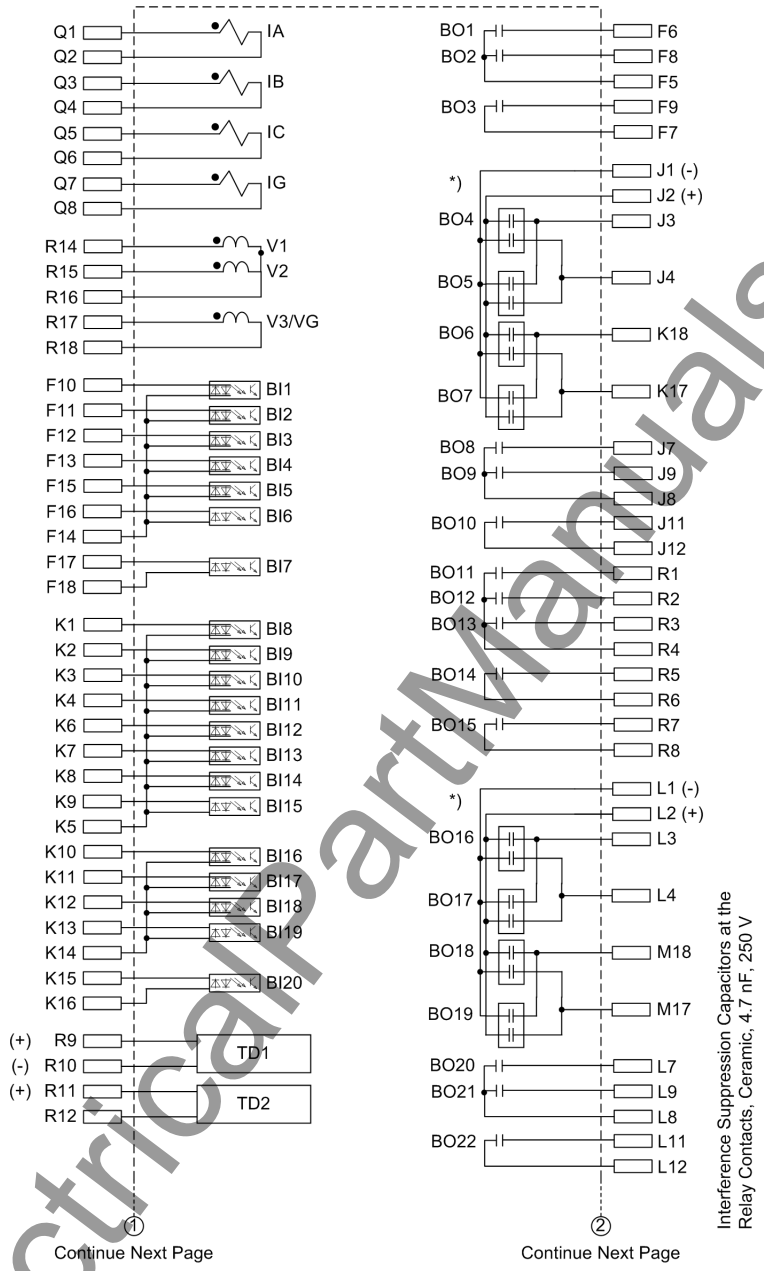


Figure A-37 General diagram 7SJ636*-*F/G (devices for panel surface mounting without operator panel), part 1

www . ElectricalPartManuals . com

**7SJ636*-*F/G**

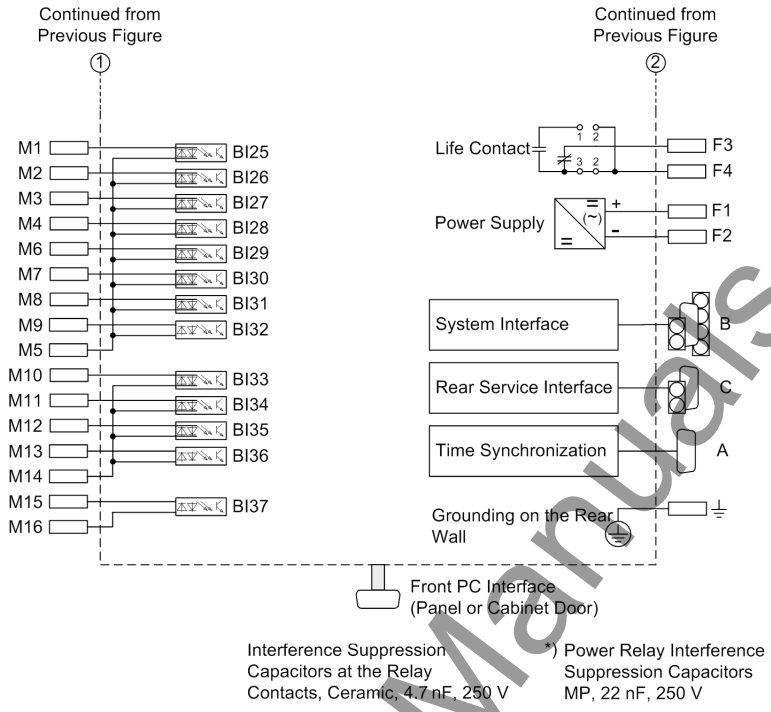


Figure A-38 General diagram 7SJ636*-*F/G (devices for panel surface mounting without operator panel), part 2

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## A.2.11 7SJ64 — Housing for Panel Flush Mounting or Cubicle Installation

**7SJ640*-*D/E**

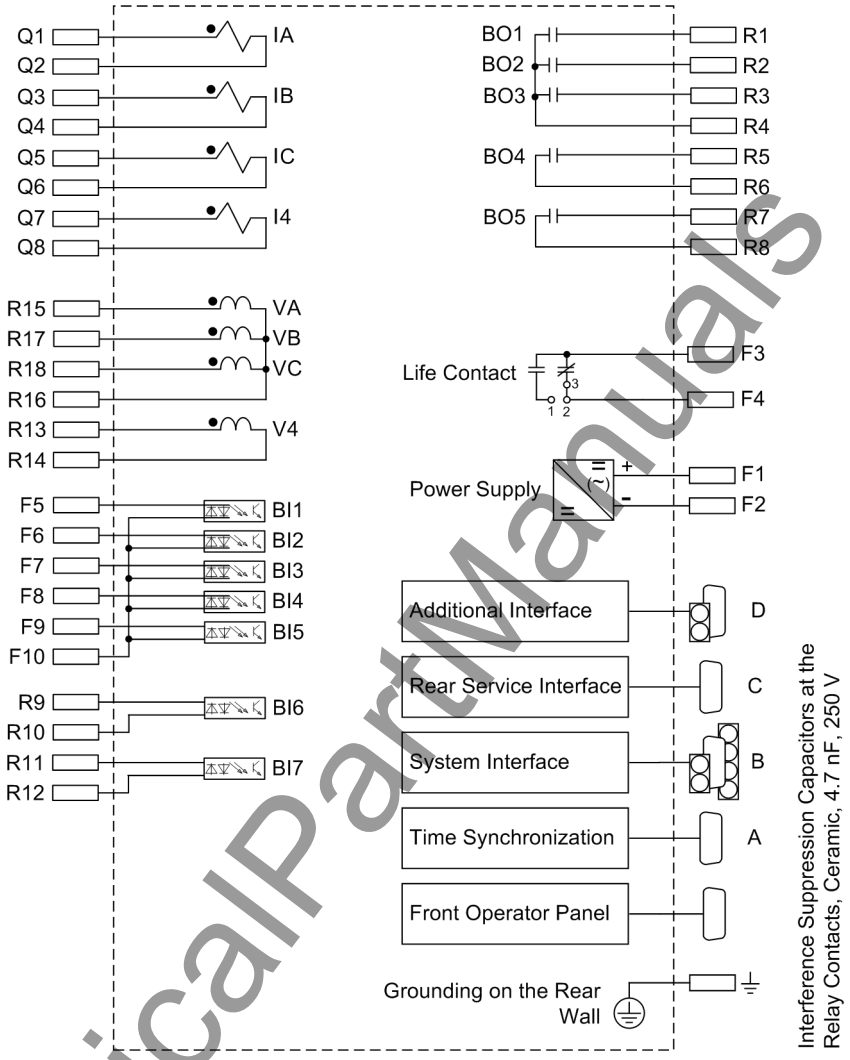


Figure A-39 General diagram for 7SJ640*–*D/E (panel flush mounting or cubicle mounting)

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**7SJ641*-*D/E**

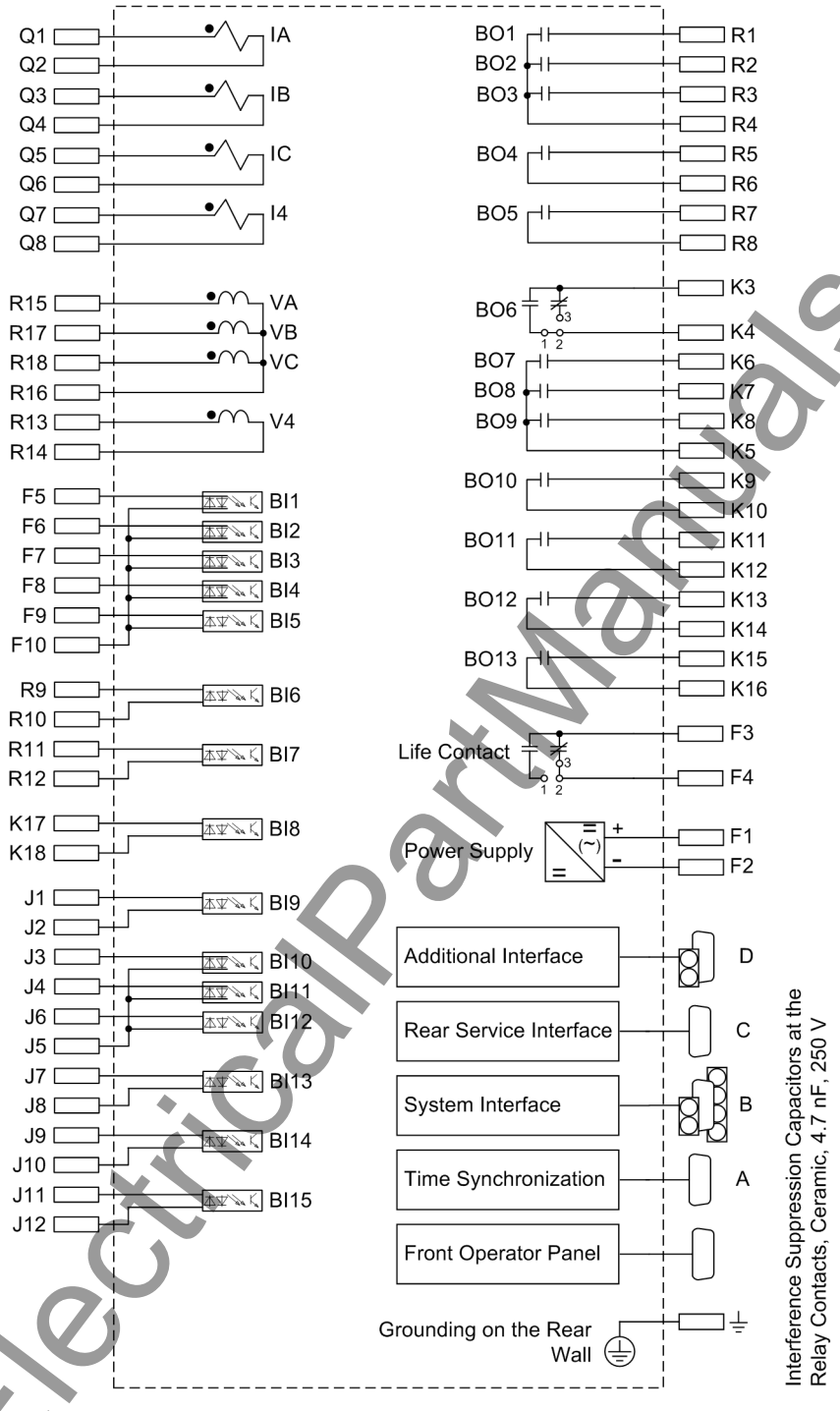


Figure A-40 General diagram for 7SJ641*–*D/E (panel flush mounting or cubicle mounting)

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**7SJ642*-*D/E**

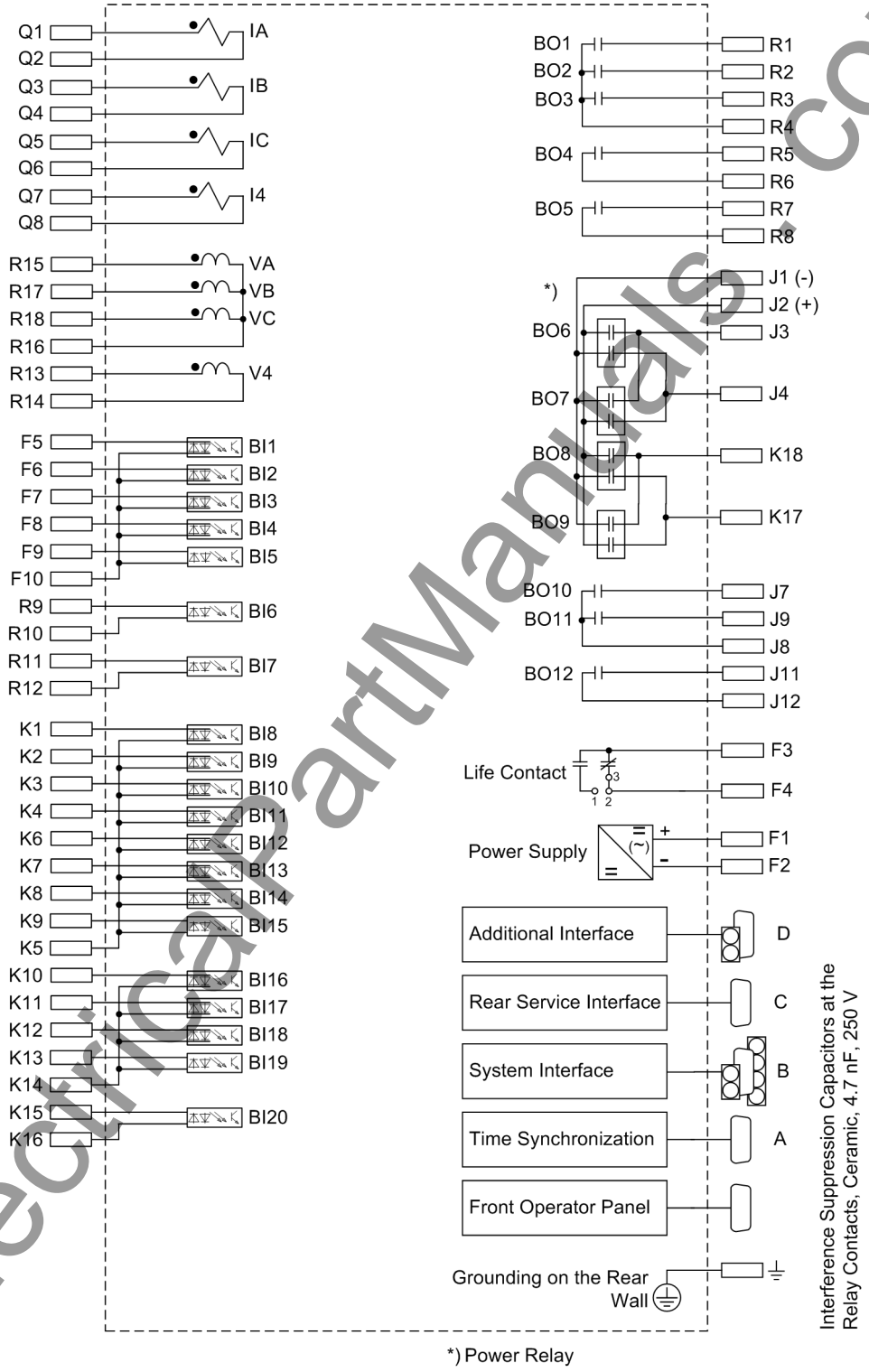


Figure A-41 General diagram for 7SJ642*–*D/E (panel flush mounting or cubicle mounting)

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**7SJ645*-*D/E**

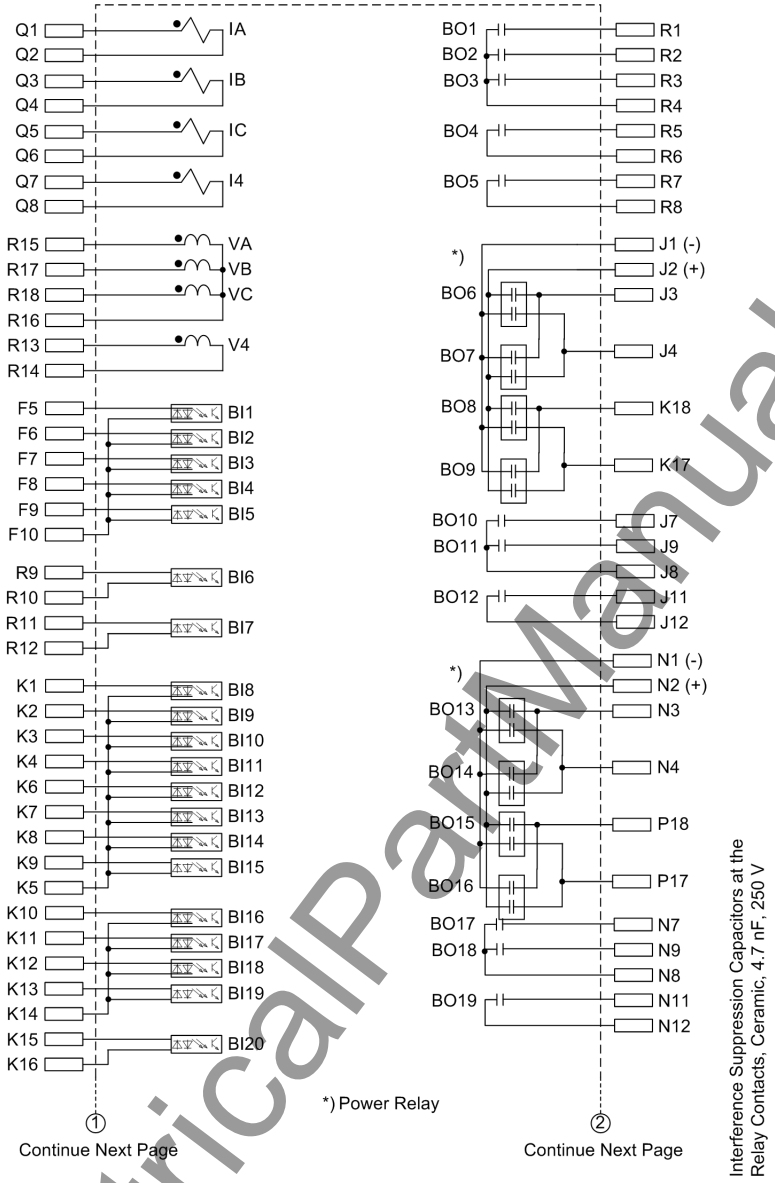


Figure A-42 General diagram for 7SJ645*–*D/E (panel flush mounting or cubicle mounting), part 1

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**7SJ645*-*D/E**

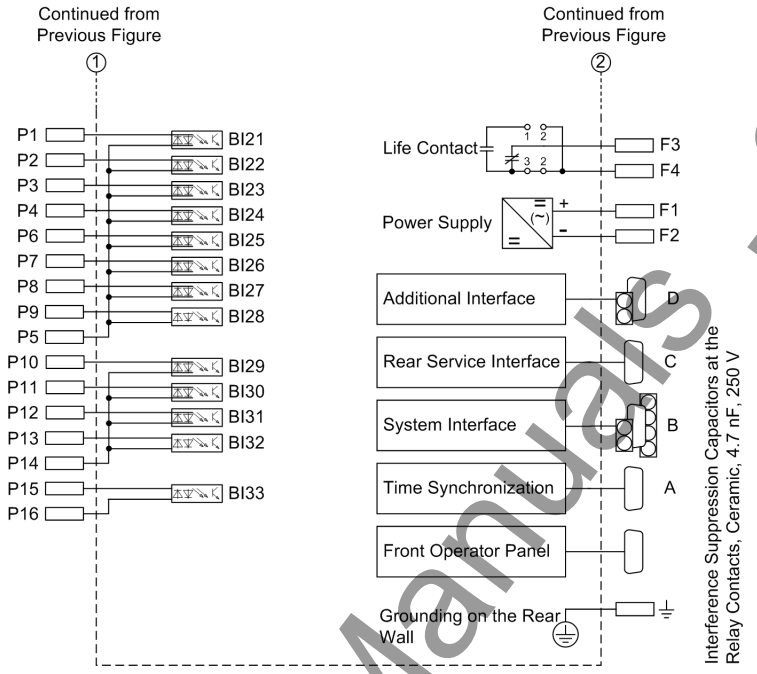


Figure A-43 General diagram for 7SJ645*–*D/E (panel flush mounting or cubicle mounting), part 2

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## A.2.12 7SJ64 — Housing for Panel Surface Mounting

**7SJ640*-*B**

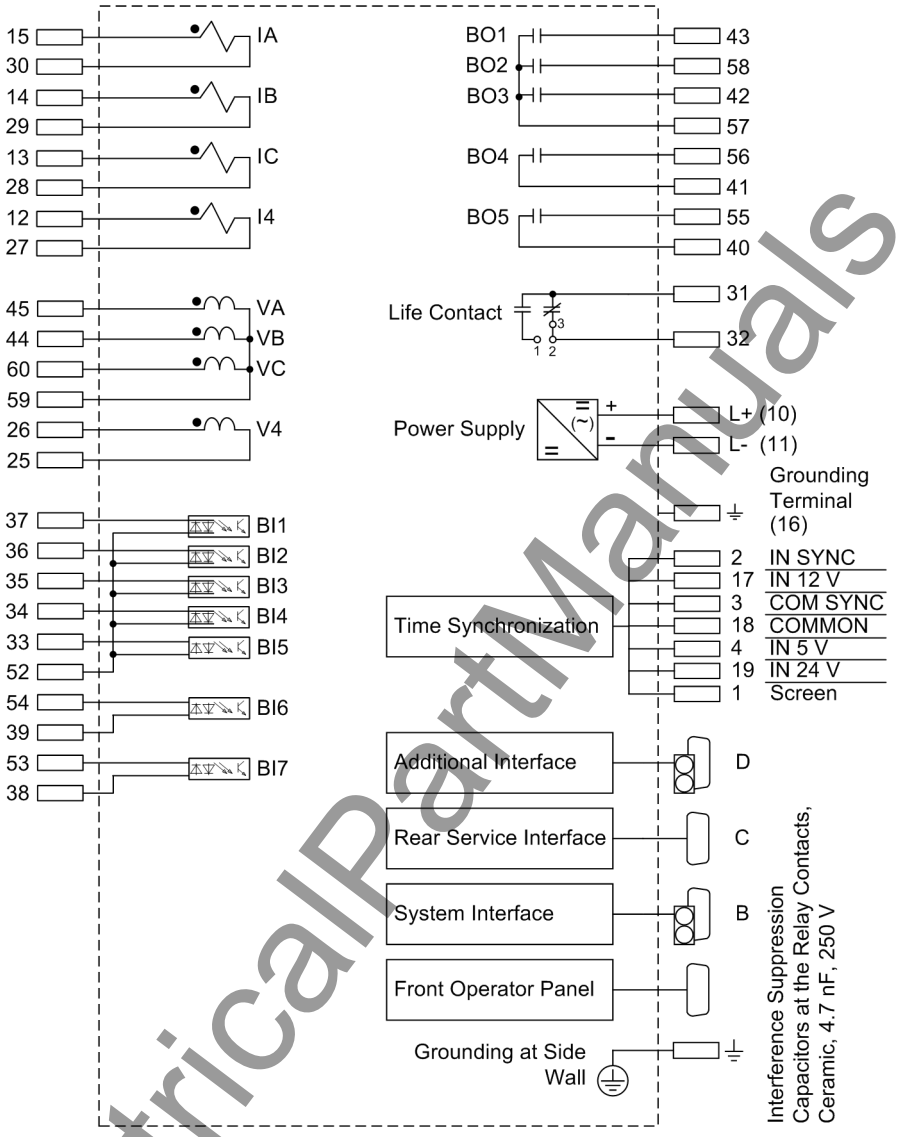


Figure A-44 General diagram for 7SJ640*–*B (panel surface mounted)

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**7SJ641*-*B**

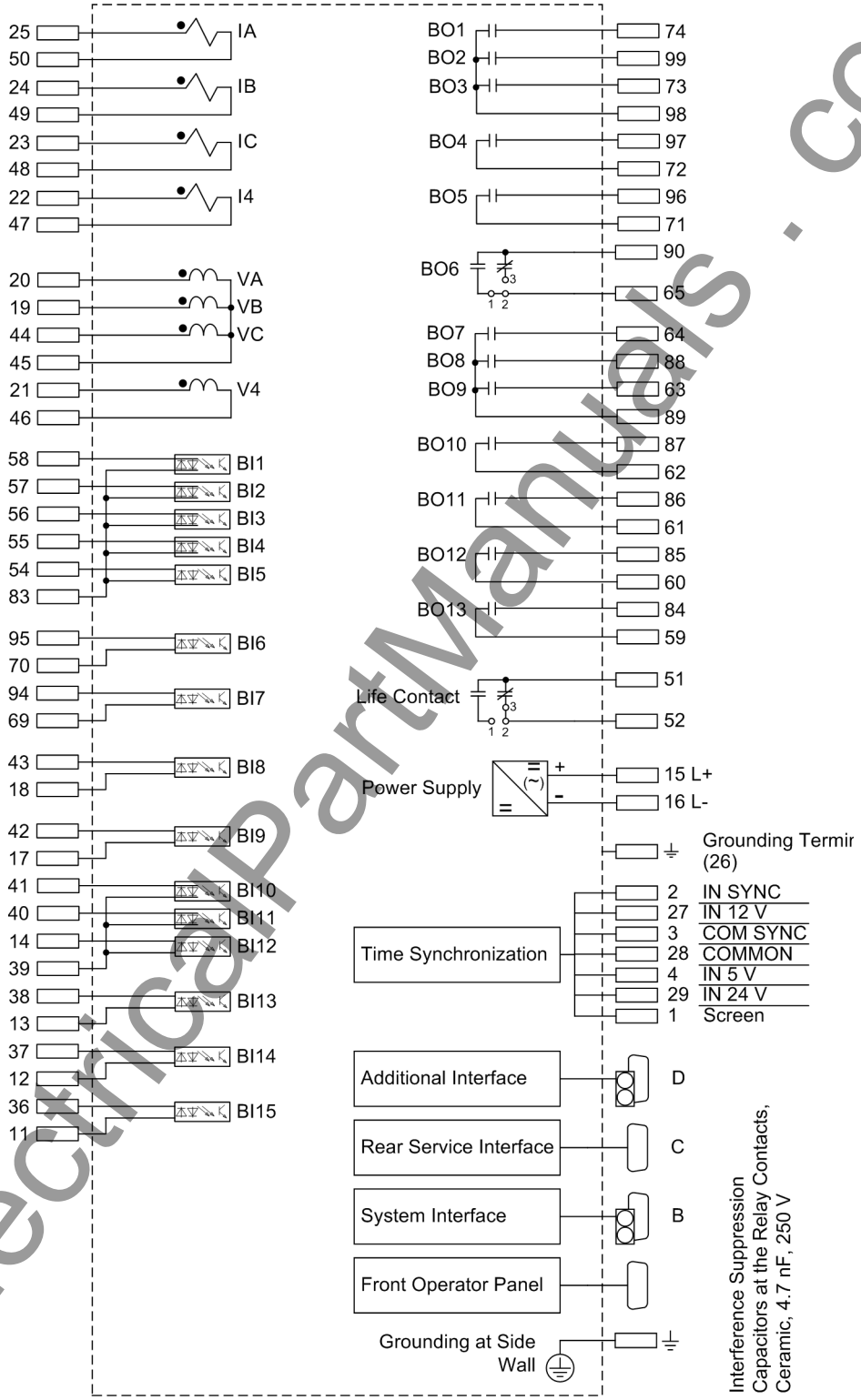


Figure A-45 General diagram for 7SJ641*–*B (panel surface mounting)

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**7SJ642*-*B**

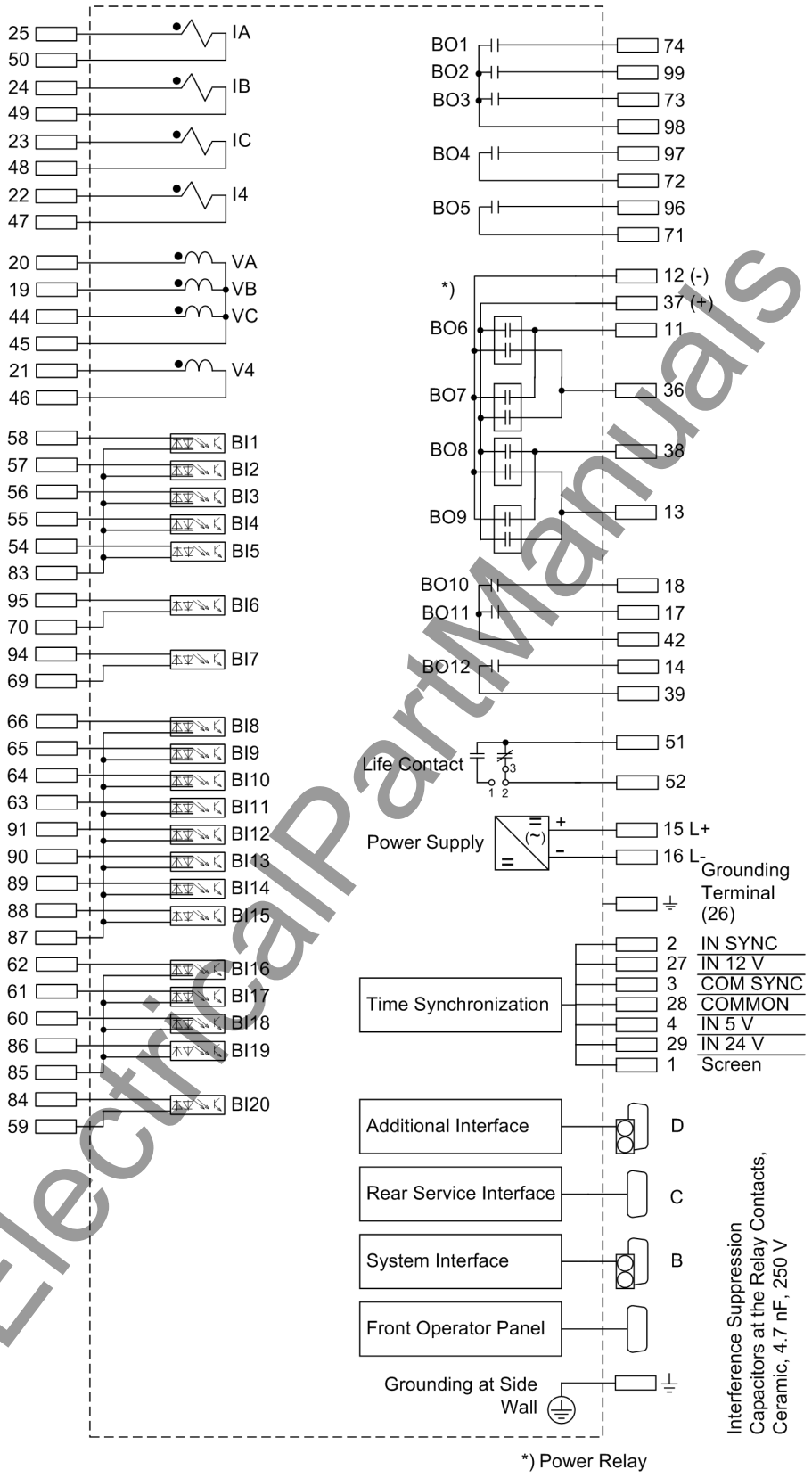


Figure A-46 General diagram for 7SJ642*–*B (panel surface mounting)

www . ElectricalPartManuals . com

**7SJ645*-*B**

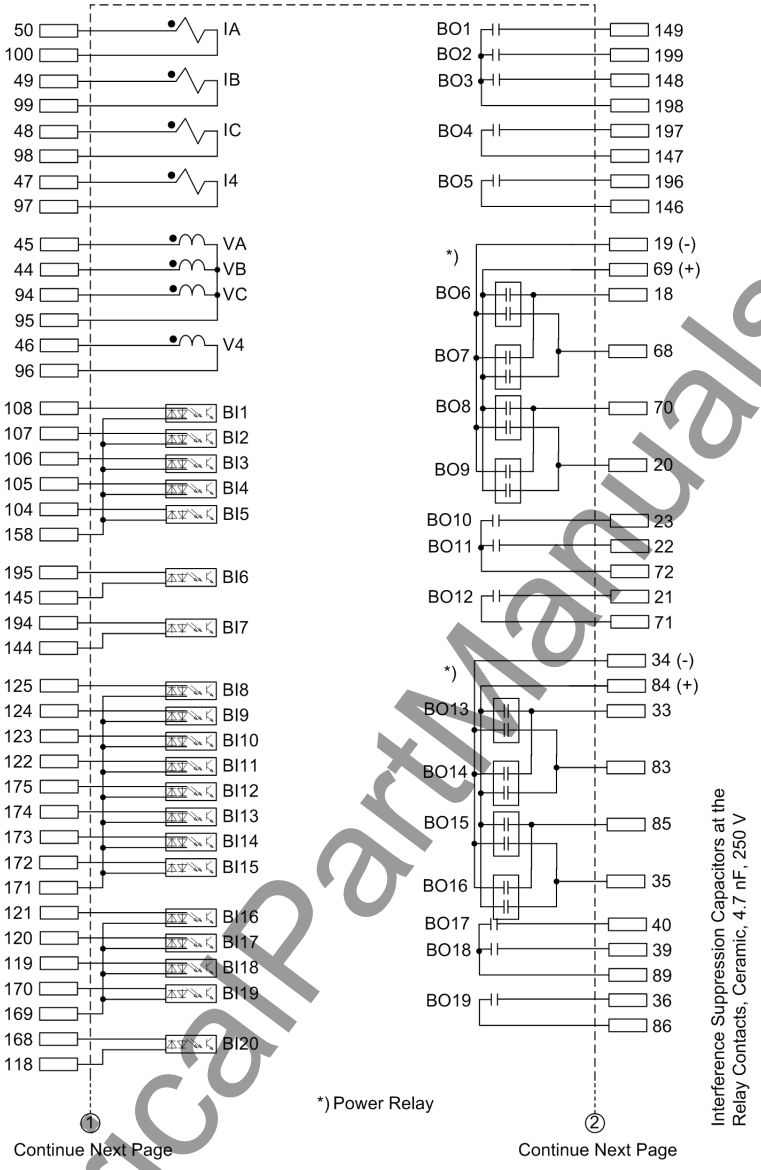


Figure A-47 General diagram for 7SJ645*–*B (panel surface mounting), part 1

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**7SJ645*-*B**

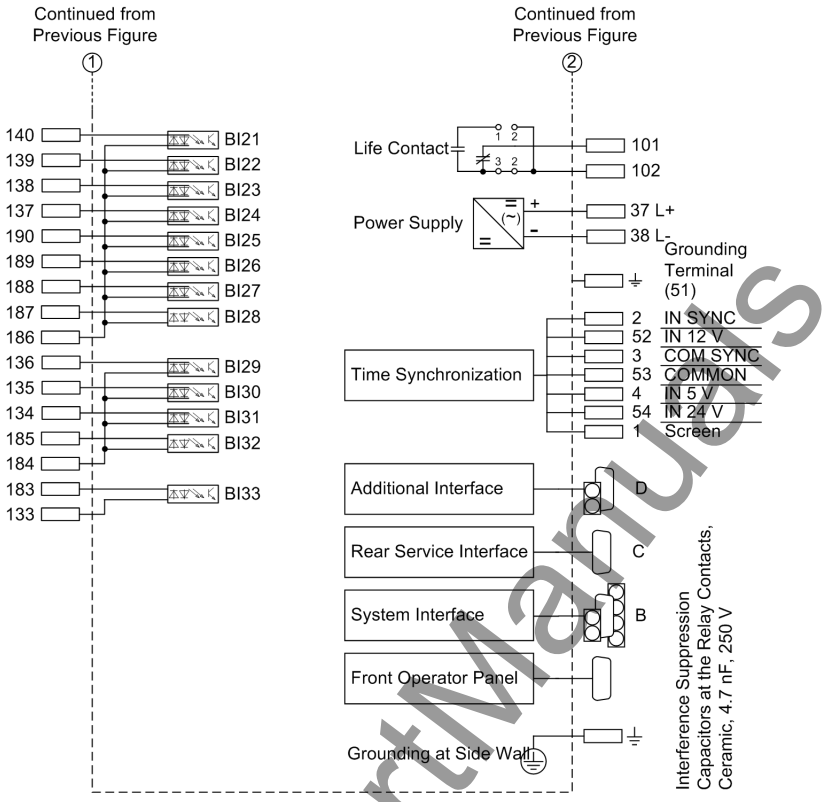


Figure A-48 General diagram for 7SJ645*–*B (panel surface mounting), part 2

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## A.2.13 7SJ64 — Housing with Detached Operator Panel

**7SJ641*-*A/C**

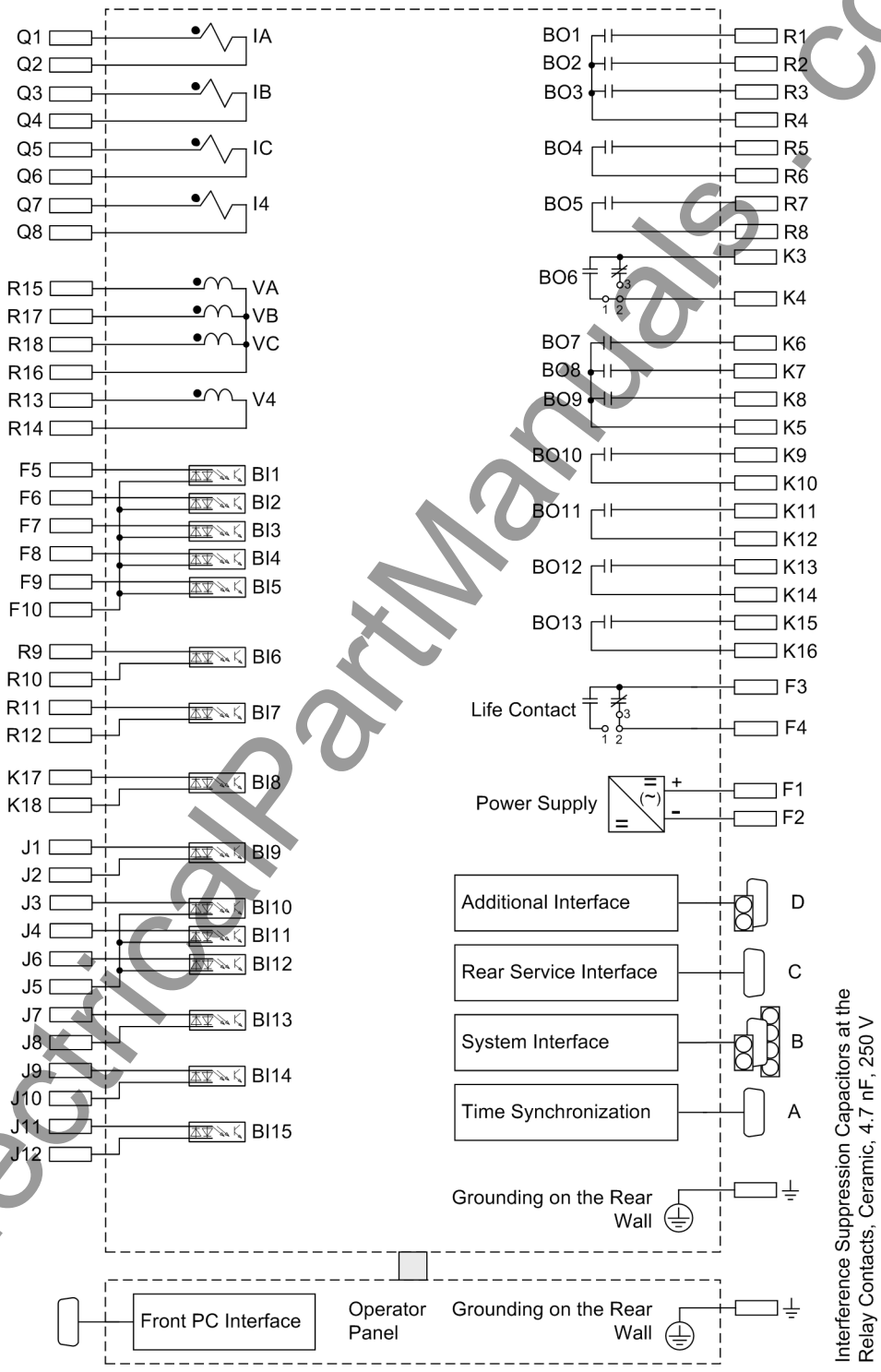


Figure A-49 General diagram 7SJ641*–*A/C (panel surface mounting with detached operator panel)

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**7SJ642*-*A/C**

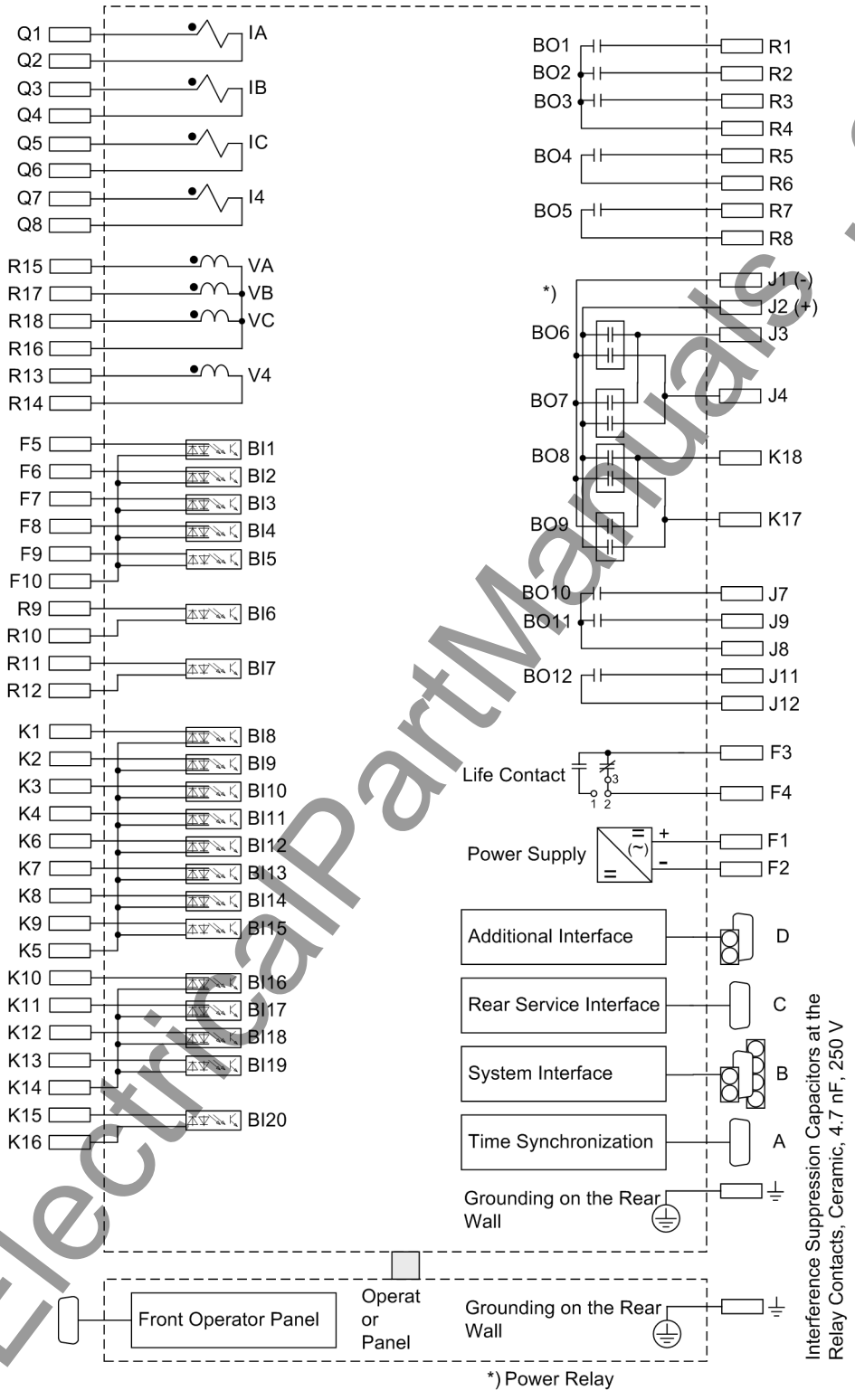


Figure A-50 General diagram 7SJ642*–*A/C (panel surface mounting with detached operator panel)

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**7SJ645*-*A/C**

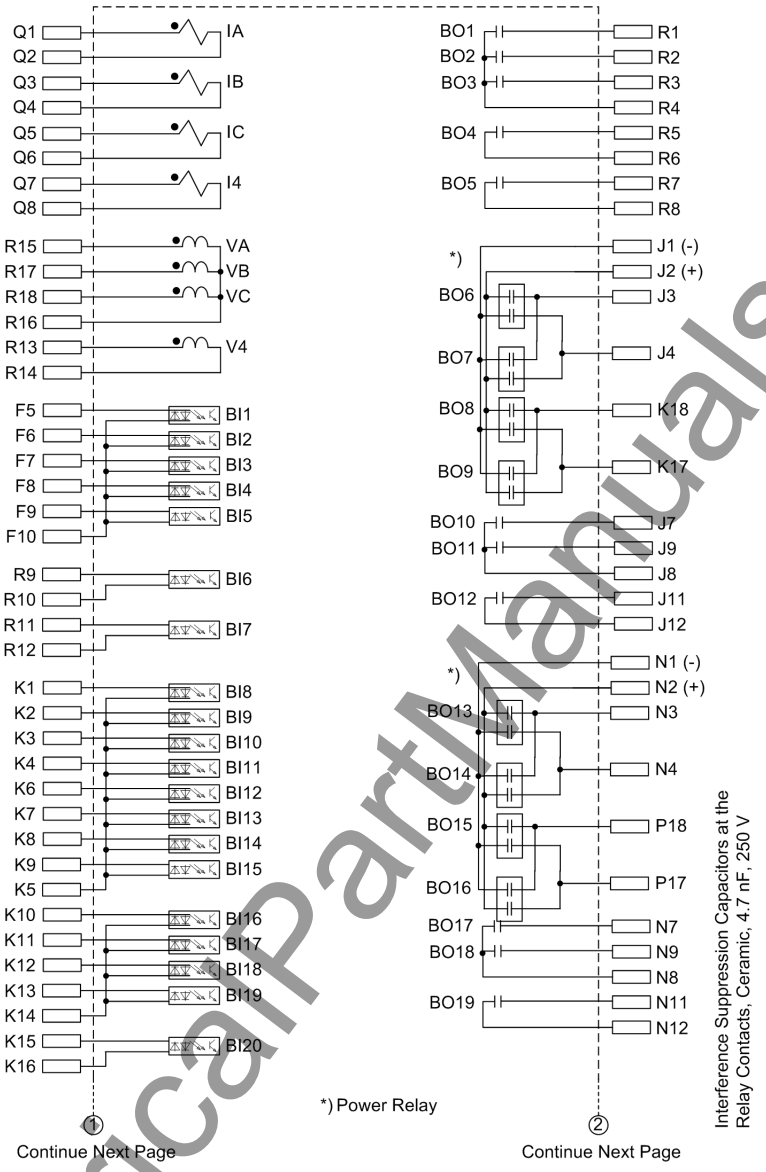


Figure A-51 General diagram 7SJ645*–*A/C (panel surface mounting with detached operator panel), part 1

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**7SJ645*-*A/C**

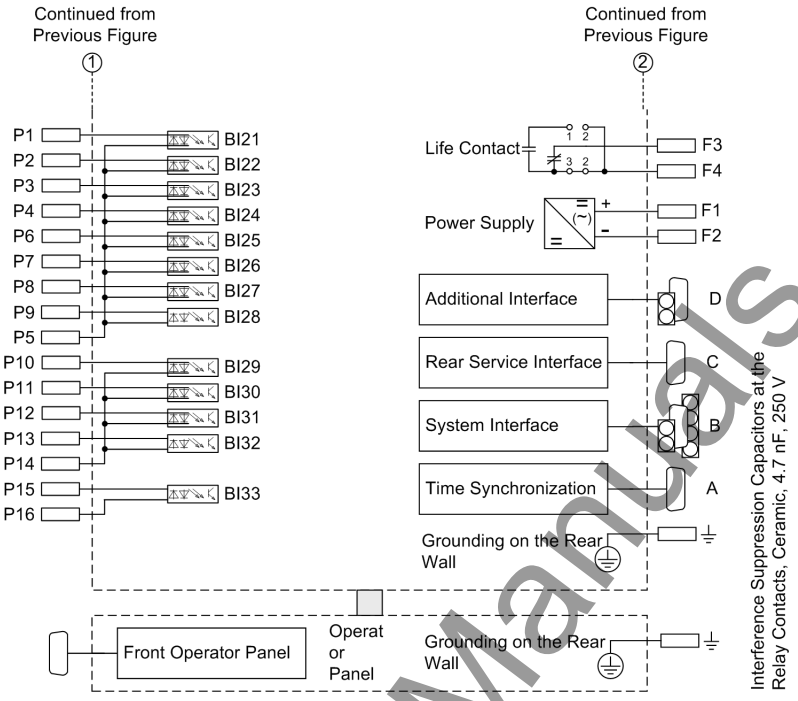


Figure A-52 General diagram 7SJ645*–*A/C (panel surface mounting with detached operator panel), part 2

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## A.2.14 7SJ64 — Housing for Panel Surface Mounting without Operator Panel

**7SJ641*-*F/G**

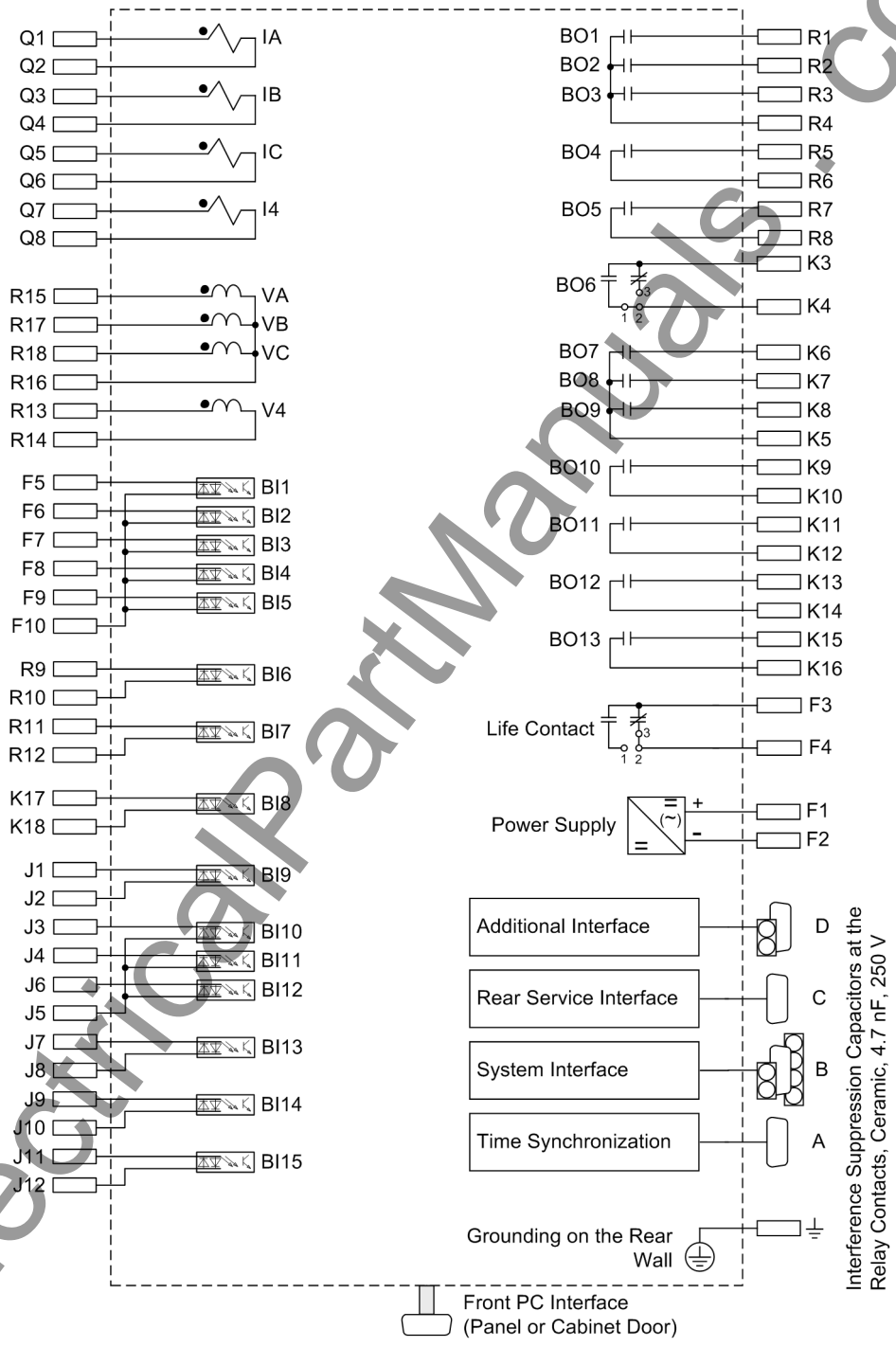


Figure A-53 General diagram 7SJ641*–*F/G (devices for panel surface mounting without operation unit)

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**7SJ642*-*F/G**

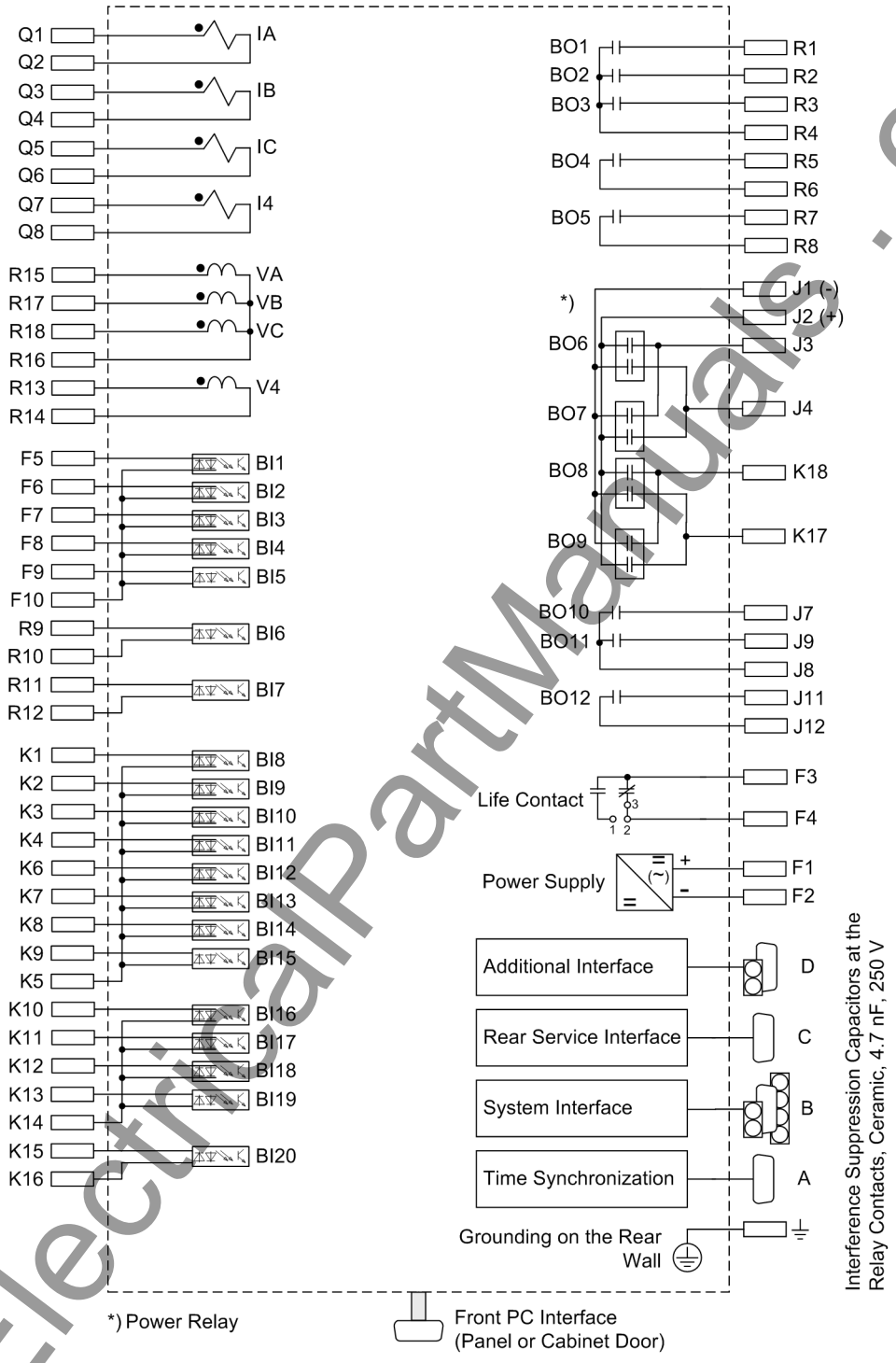


Figure A-54 General diagram 7SJ642*–*F/G (panel surface mounting without operator panel)

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**7SJ645*-*F/G**

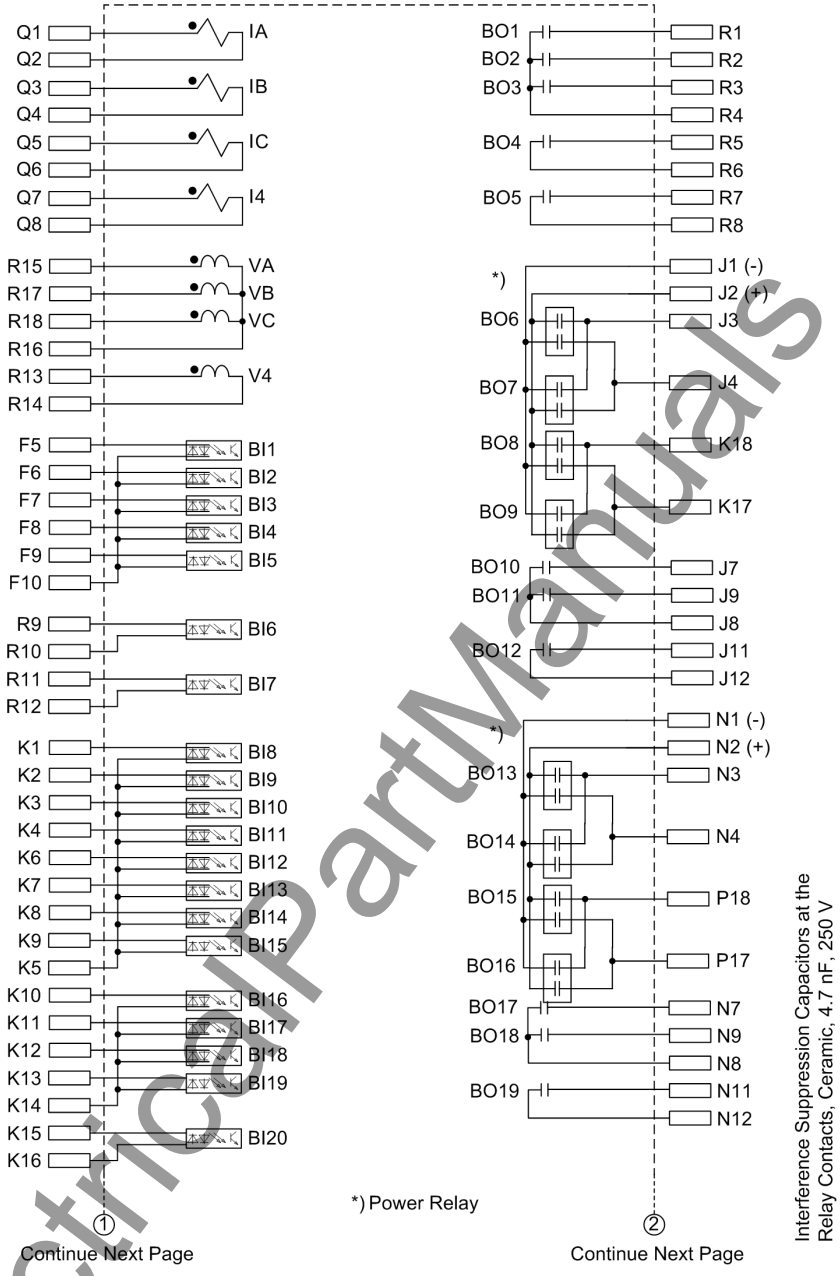


Figure A-55 General diagram 7SJ645*–*F/G (devices for panel surface mounting without operator panel), part 1

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**7SJ645*-*F/G**

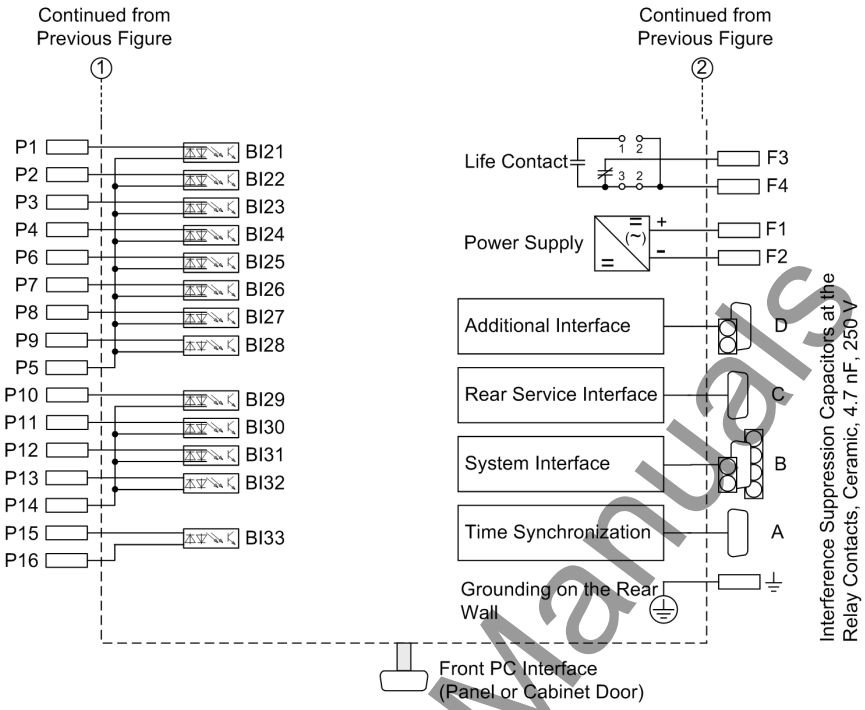


Figure A-56 General diagram 7SJ645*–*F/G (devices for panel surface mounting without operator panel), part 2

## A.2.15 Connector Assignment

**On the Ports**

| | RS232 | RS485 | Profibus FMS Slave, RS485<br>Profibus DP Slave, RS485 | Modbus, RS485<br>DNP3.0, RS485 | Ethernet<br>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

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# A.3 Connection Examples

## A.3.1 Connection Examples for 7SJ62

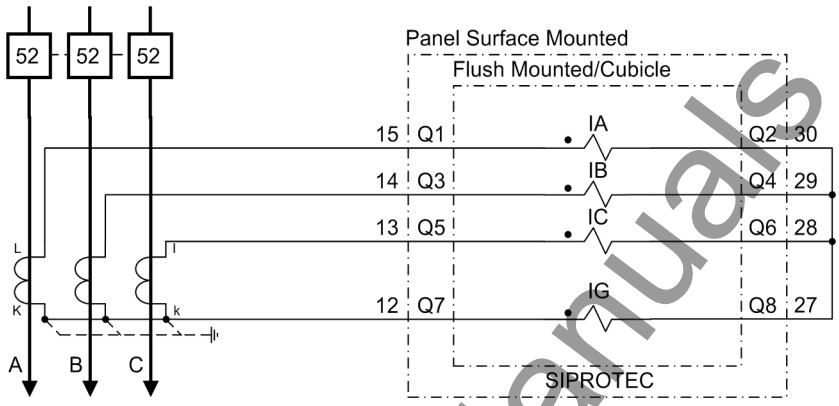


Figure A-57 7SJ62: Current connections to three current transformers with a starpoint connection for ground current (grounded-Wye connection with residual 3I0 neutral current), normal circuit layout appropriate for all networks

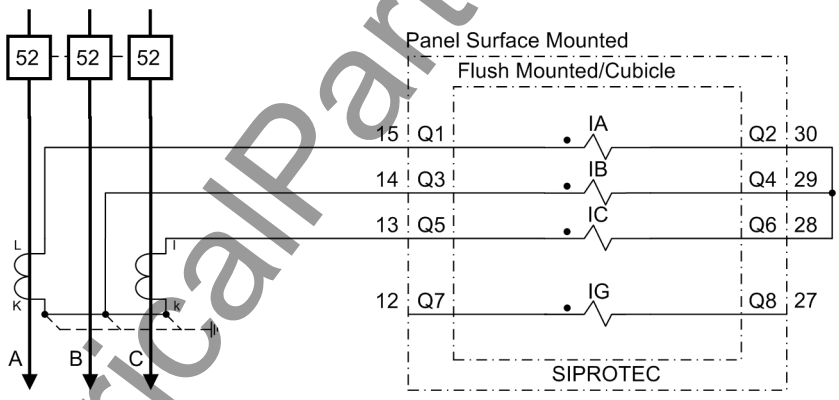


Figure A-58 7SJ62: Current connections to two current transformers - only for ungrounded or compensated networks

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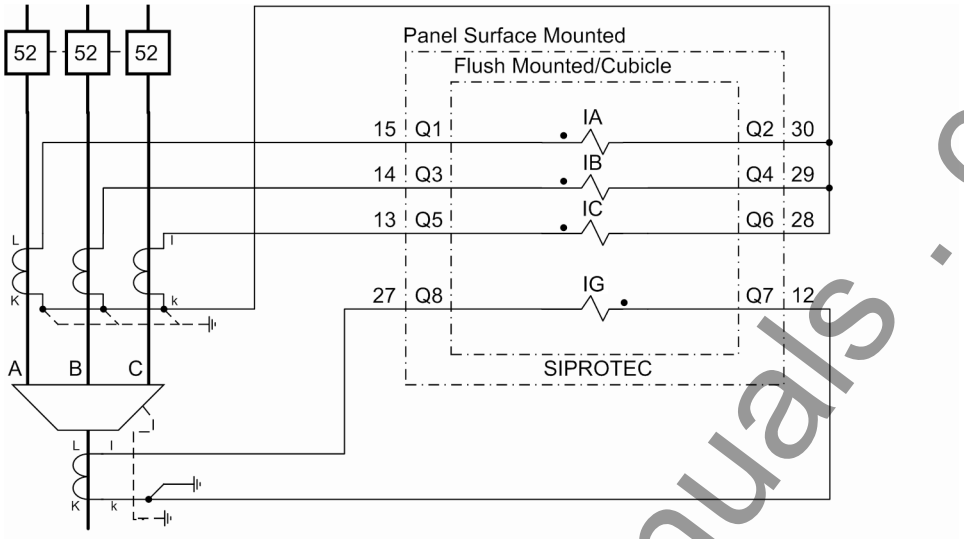
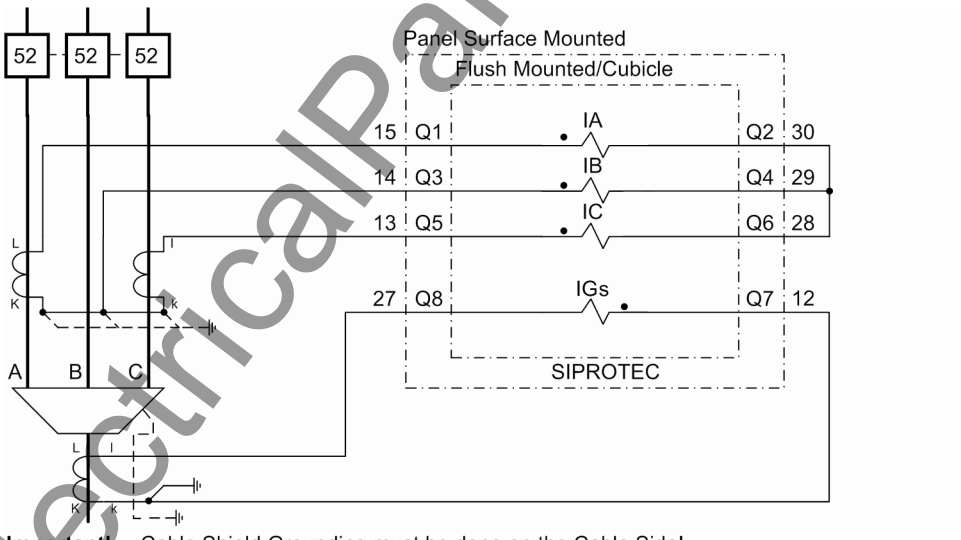



**Important!** Cable Shield Grounding must be done on the Cable Side!

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-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 I 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

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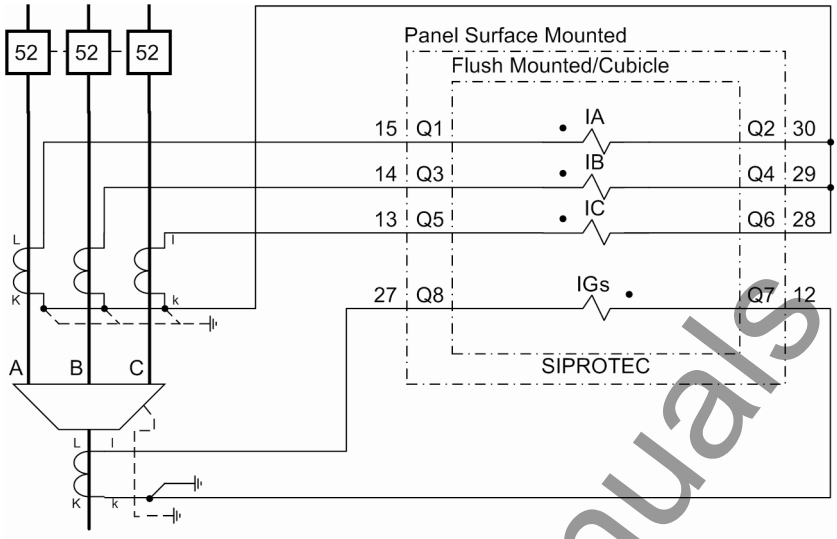


**Important!** Cable Shield Grounding must be done on the Cable Side!

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-61 7SJ62: Current connections to three current transformers – core balance neutral current transformers for sensitive ground fault detection.

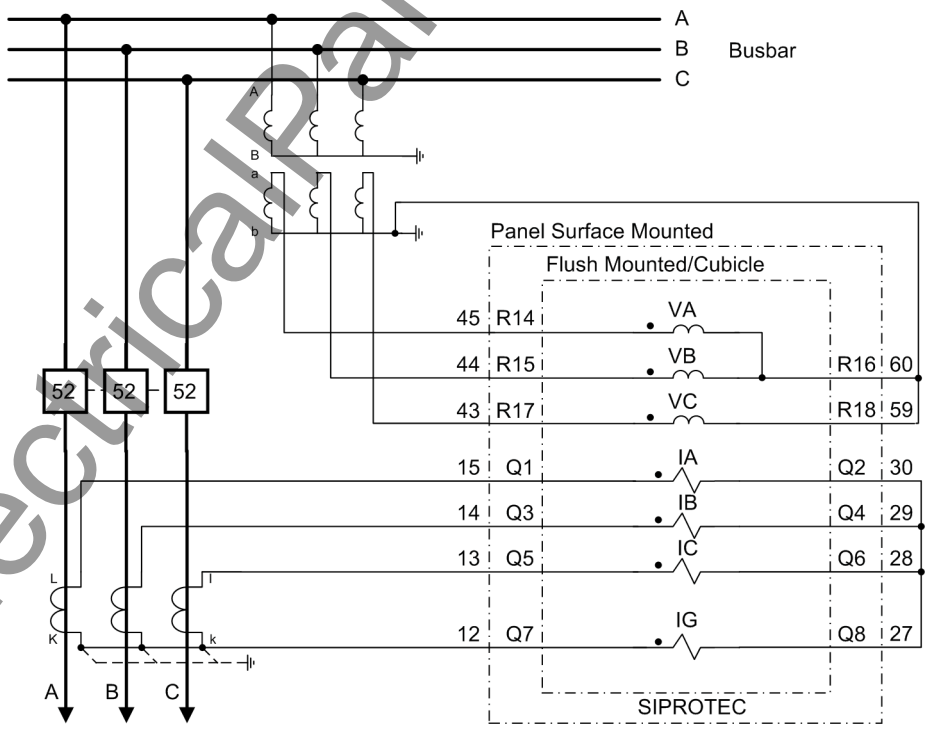


Figure A-62 7SJ62: Current and voltage connections to three current transformers and three voltage transformers (phase-ground), normal circuit layout – appropriate for all networks

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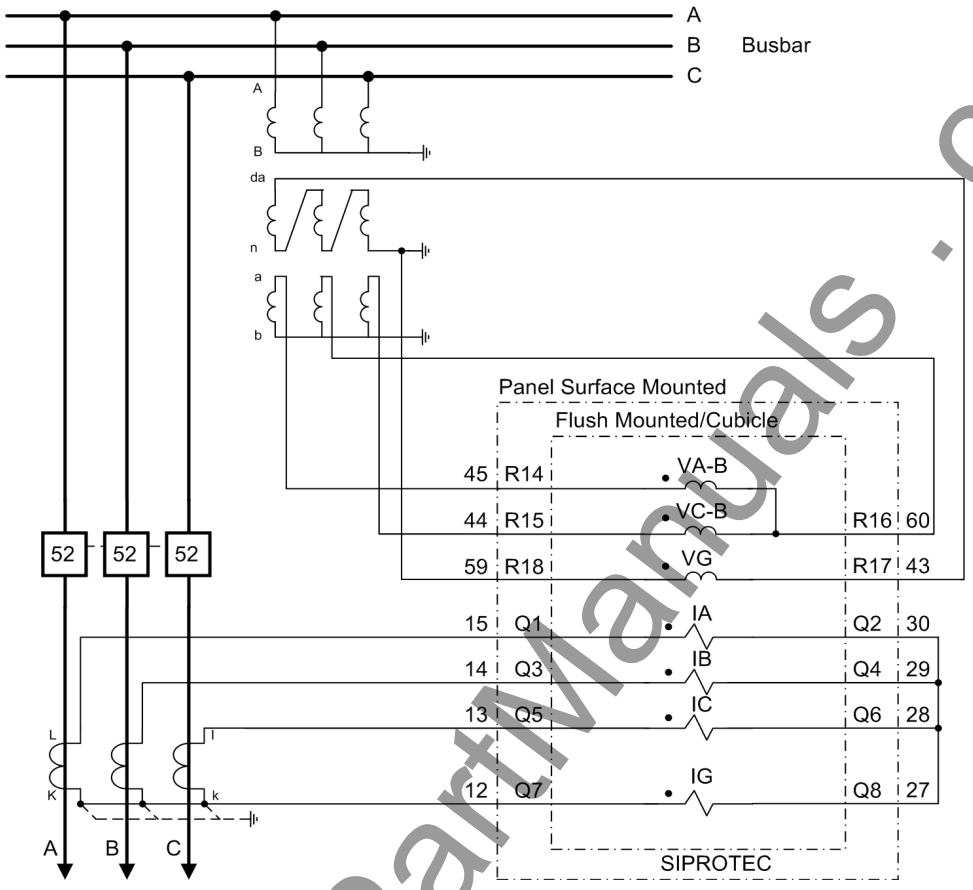


Figure A-63 7SJ62: Current and voltage connections to three current transformers, two voltage transformers (phase-phase) and open delta VT for VG, appropriate for all networks

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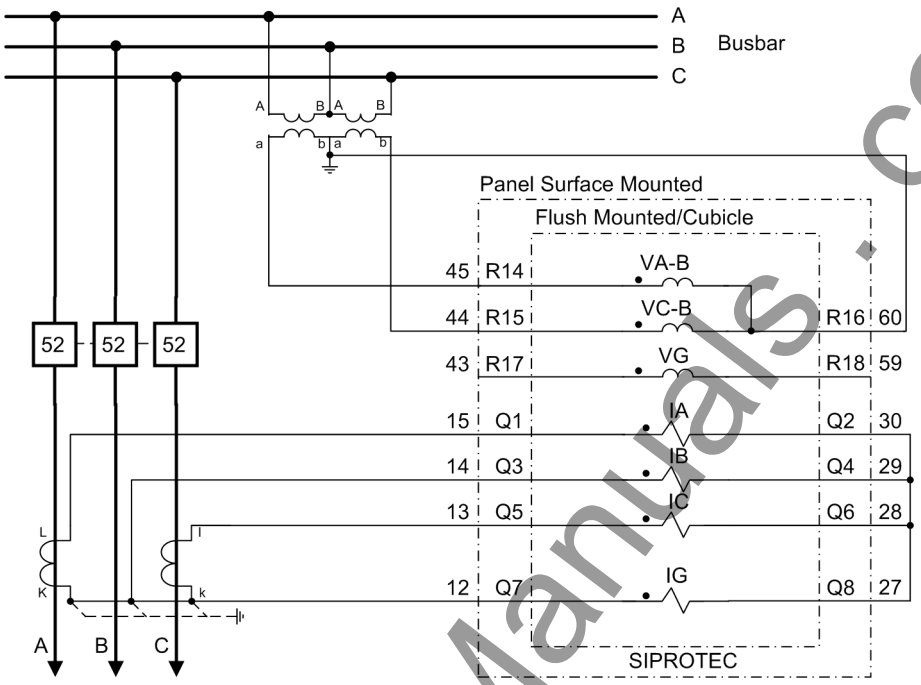


Figure A-64 7SJ62: Current and voltage connections to two current transformers and two voltage transformers, for ungrounded or compensated networks, if no ground protections is needed

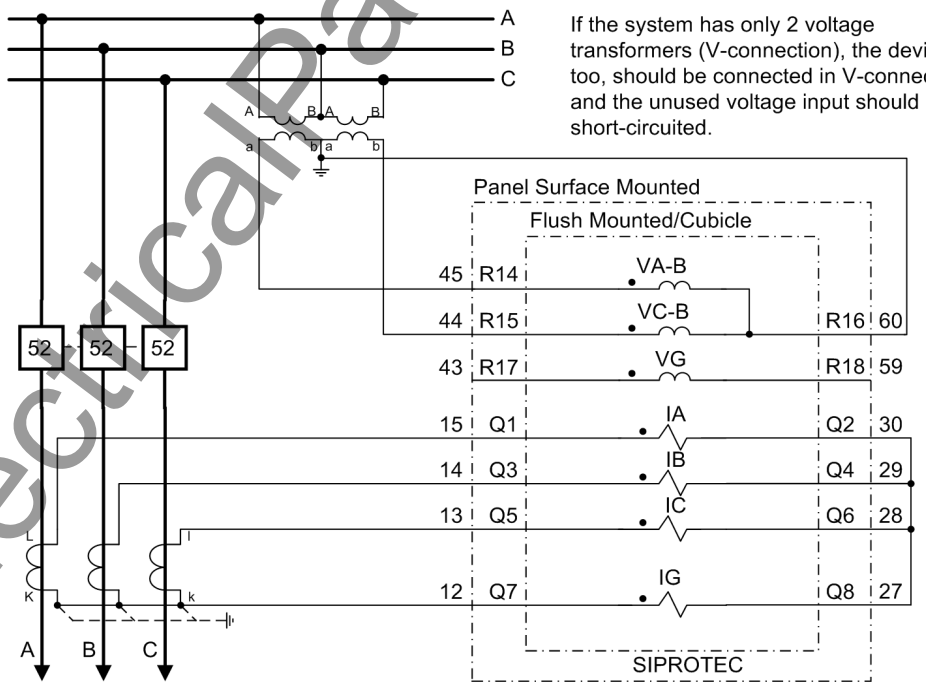


Figure A-65 7SJ62: Connection (grounded-Wye connection), two voltage transformers, for ungrounded or compensated networks; no directional ground protection, since displacement voltage cannot be calculated

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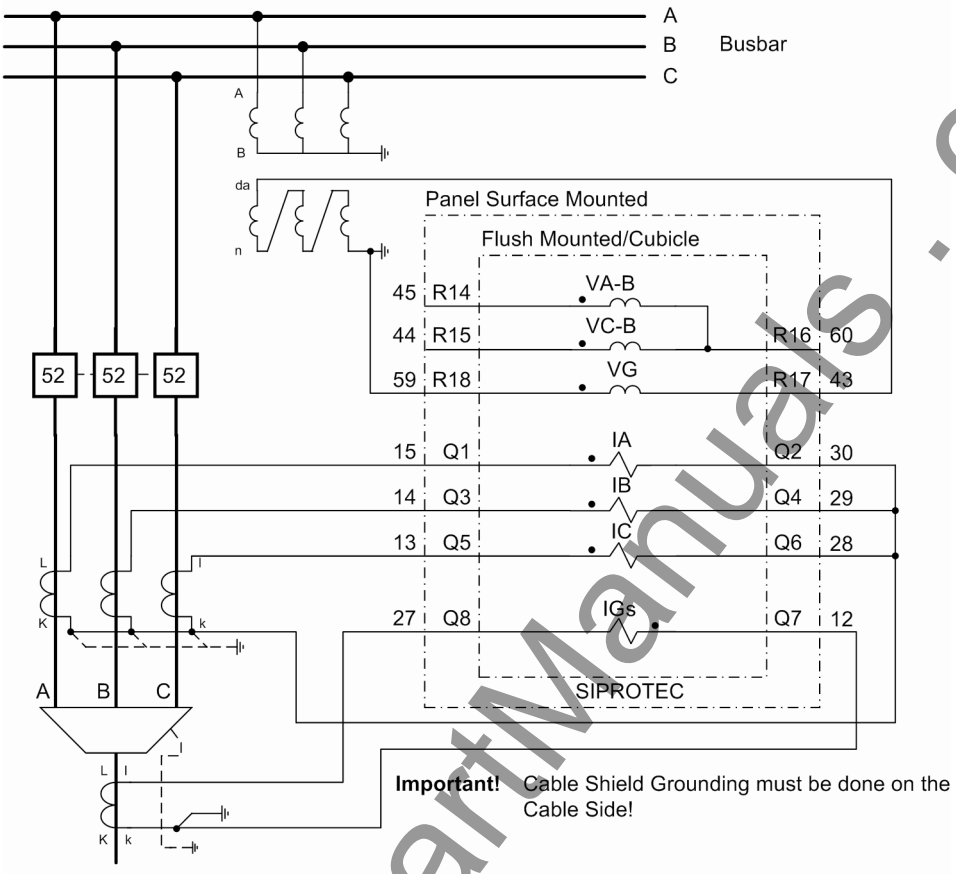


Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and I at Q7 and Q8 must be changed!

Figure A-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

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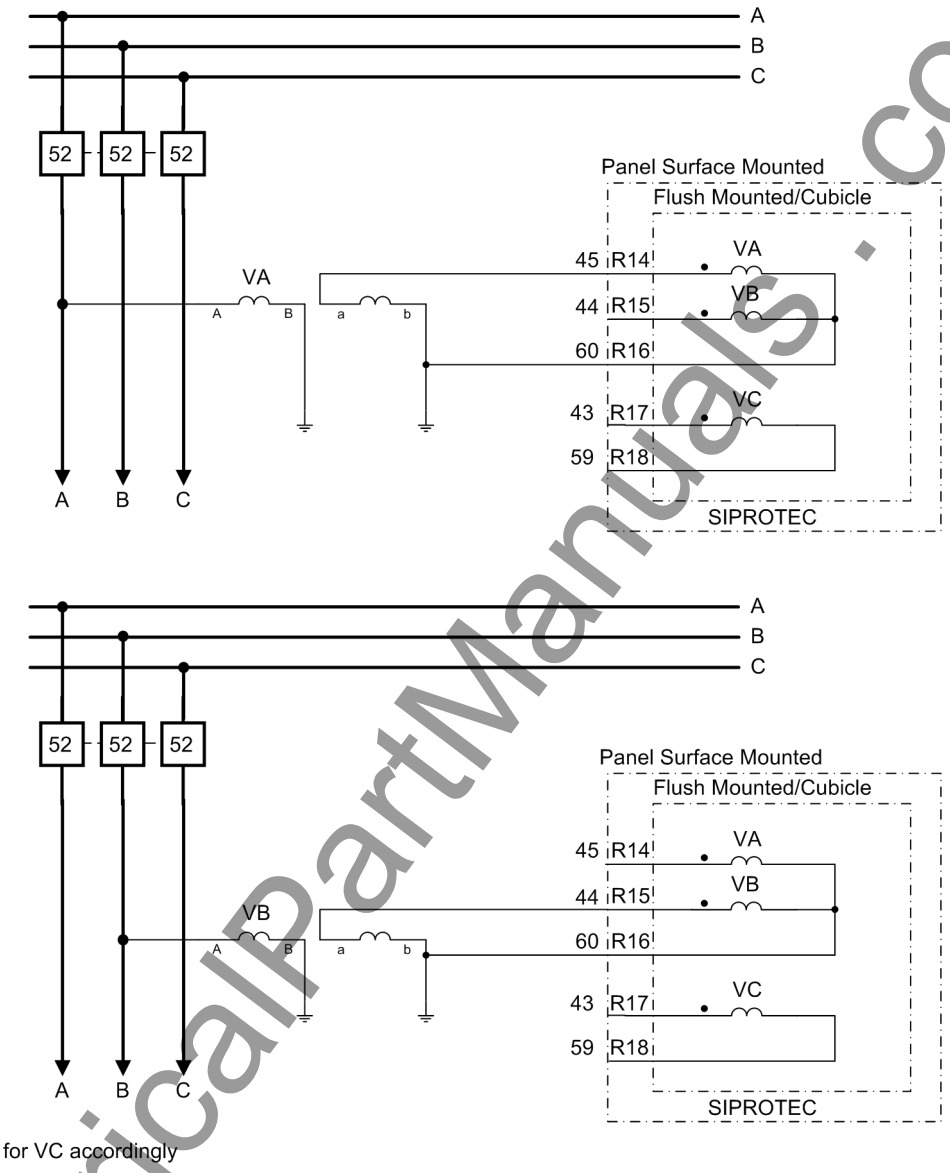


for VC accordingly

Figure A-67 7SJ62: Connection circuit for single-phase voltage transformers with phase-to-ground voltages

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## A.3.2 Connection Examples for 7SJ63

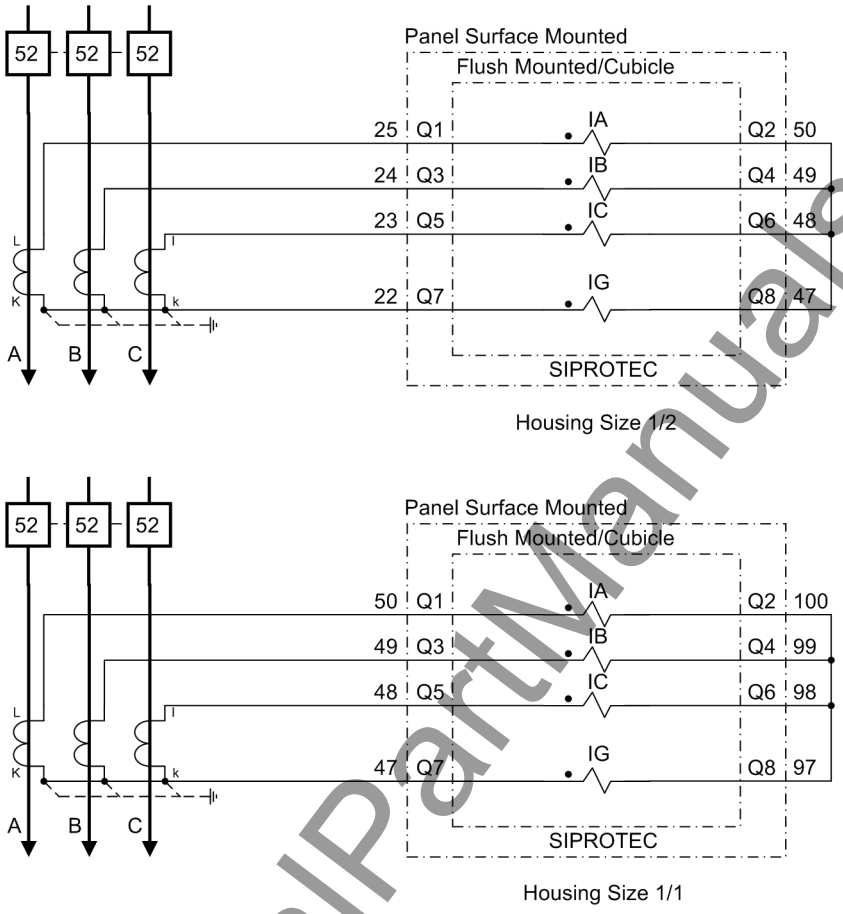


Figure A-68 7SJ63: Current connections to three current transformers with a starpoint connection for ground current (Grounded-Wye Connection with residual 3I0 Neutral Current), normal circuit layout \endash appropriate for all networks

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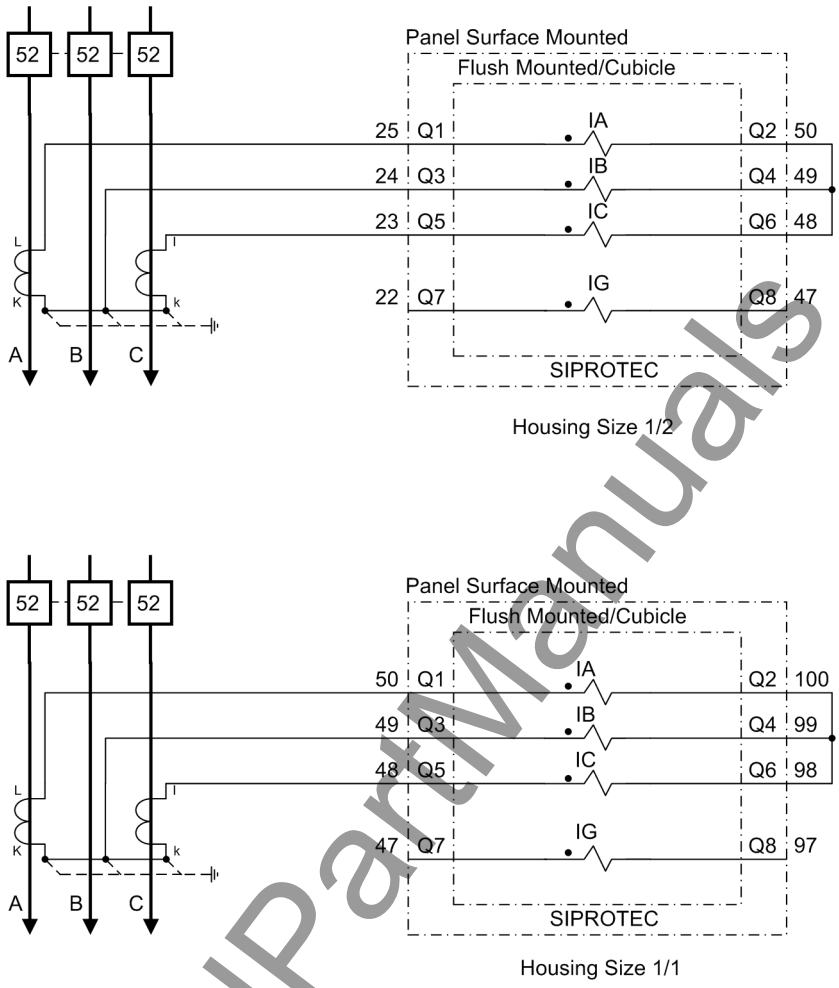


Figure A-69 7SJ63: Current connections to two current transformers - only for ungrounded or compensated networks

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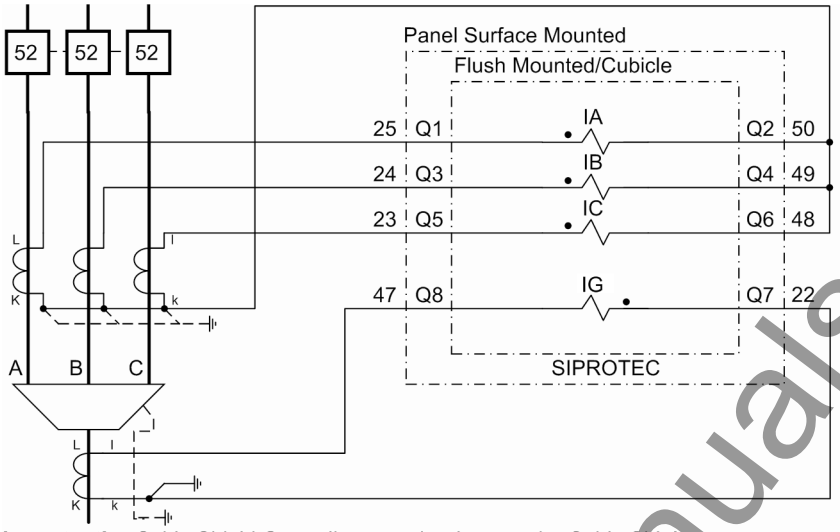
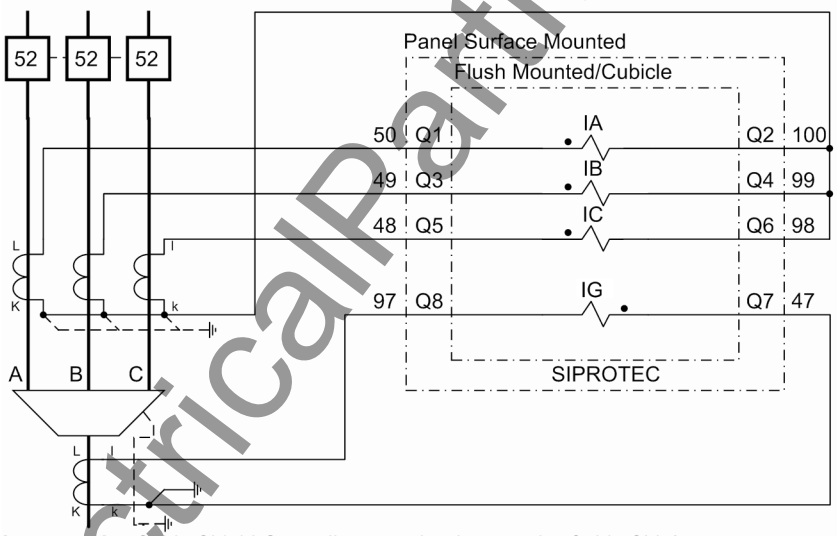



**Important!** Cable Shield Grounding must be done on the Cable Side!

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 1/2




**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 I 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

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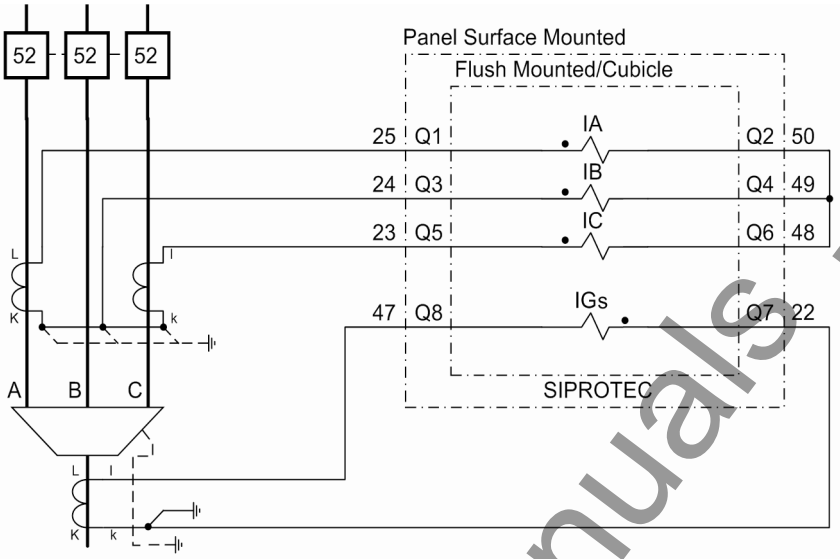
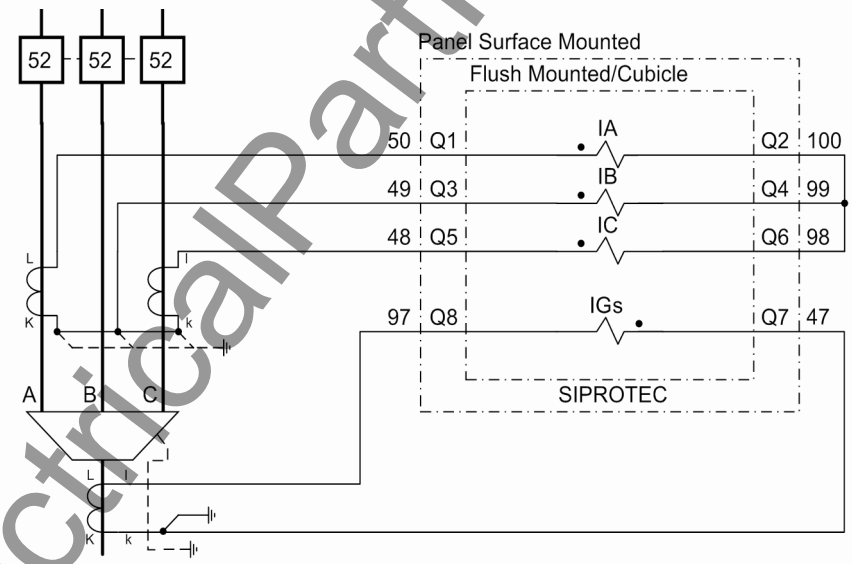



**Important!** Cable Shield Grounding must be done on the Cable Side!

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

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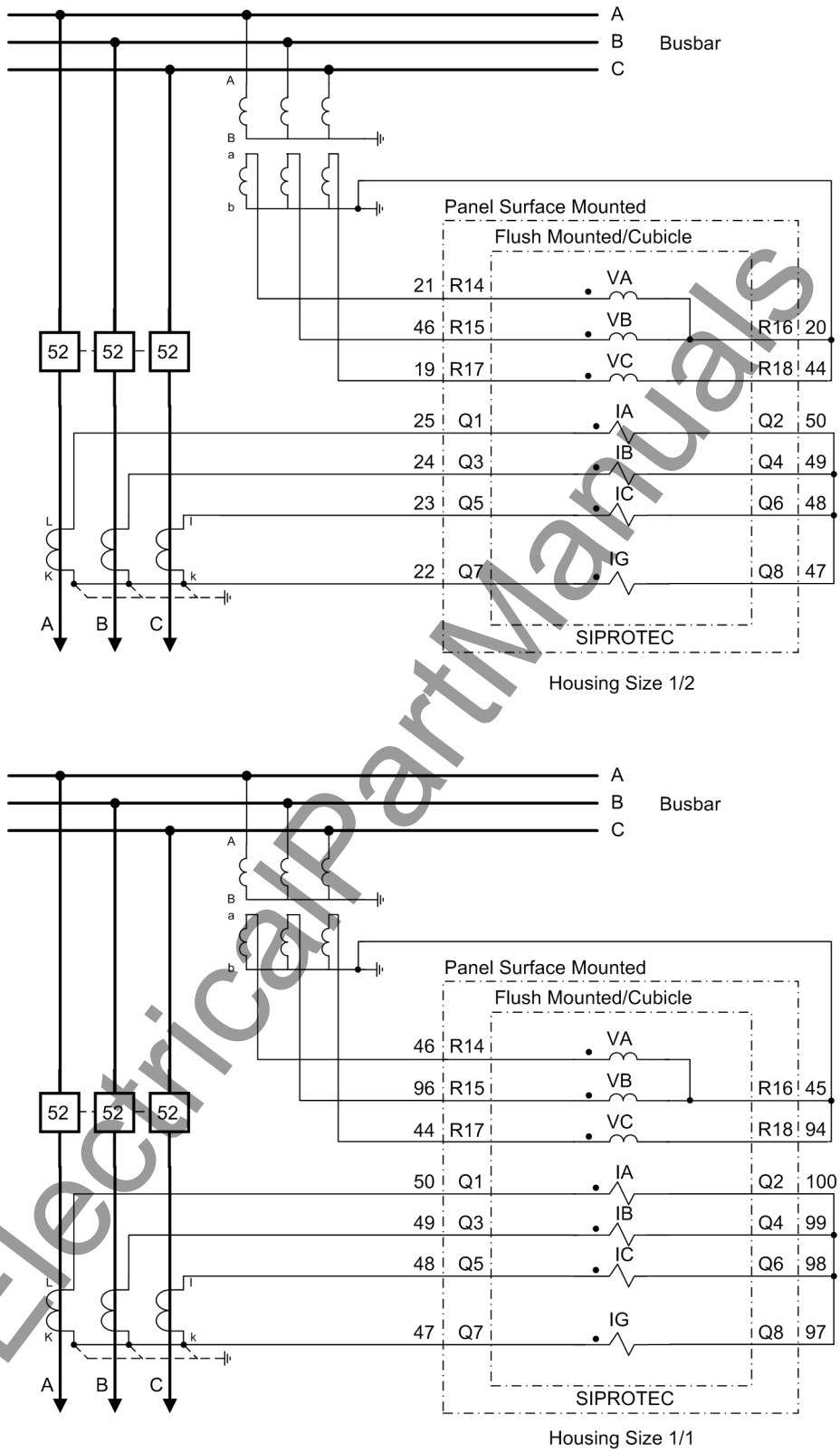


Figure A-72 7SJ63: Current and voltage connections to three current transformers and three voltage transformers (phase-ground), normal circuit layout – appropriate for all networks

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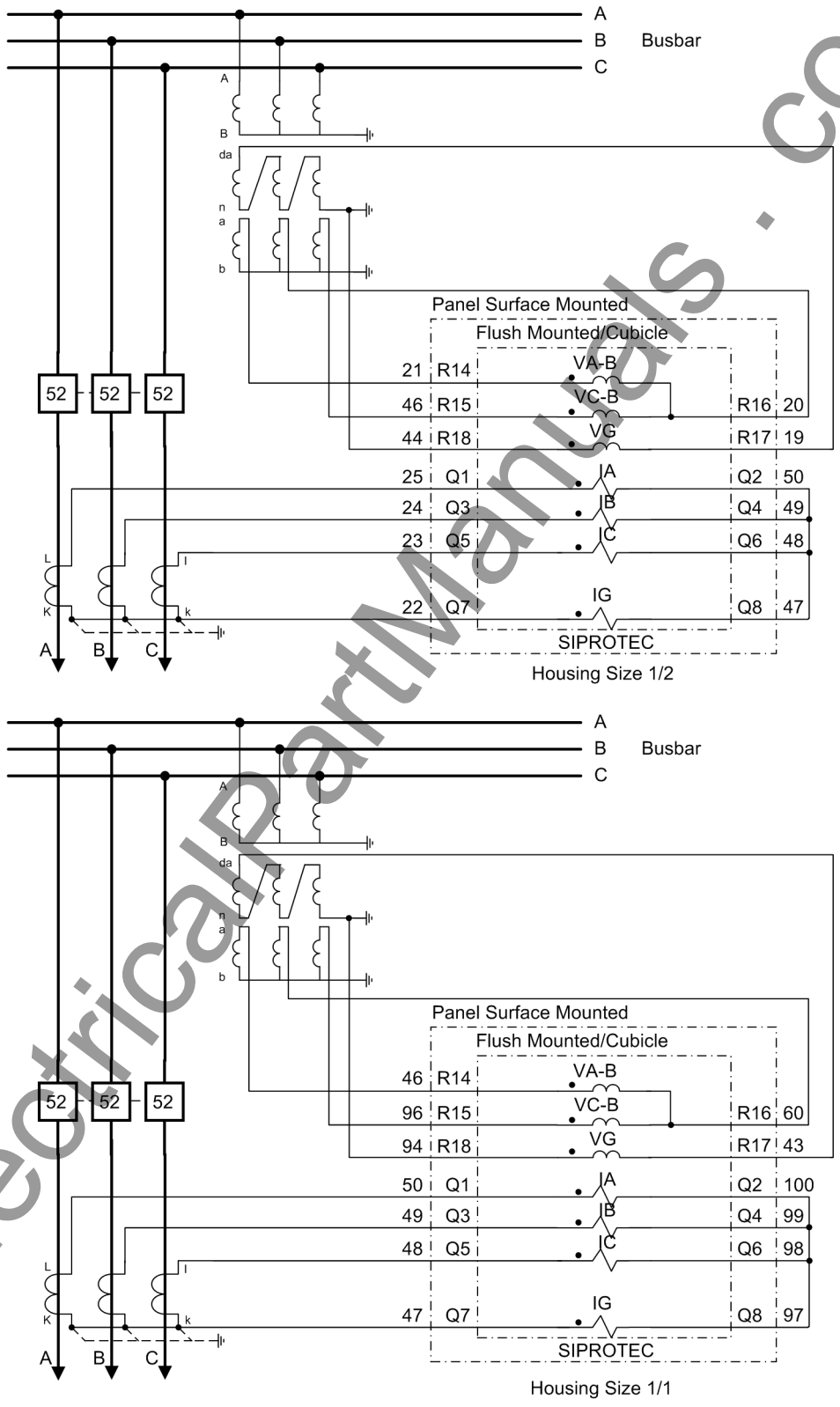


Figure A-73 7SJ63: Current and voltage connections to three current transformers, two voltage transformers (phase-phase) and open delta VT for VG, appropriate for all networks

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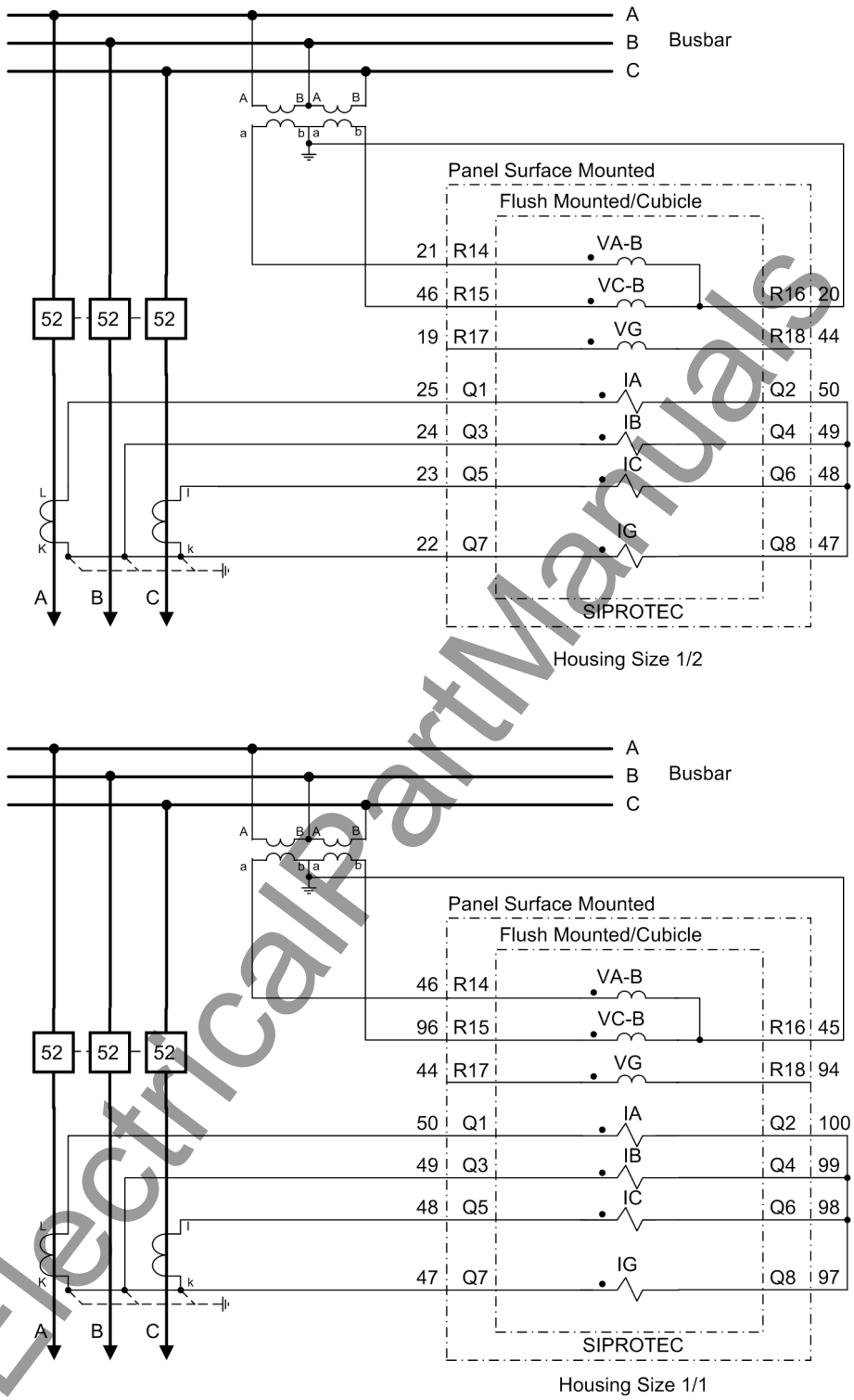


Figure A-74 7SJ63: Current and voltage connections to two current transformers and two voltage transformers, for ungrounded or compensated networks, if no directional ground protections is needed

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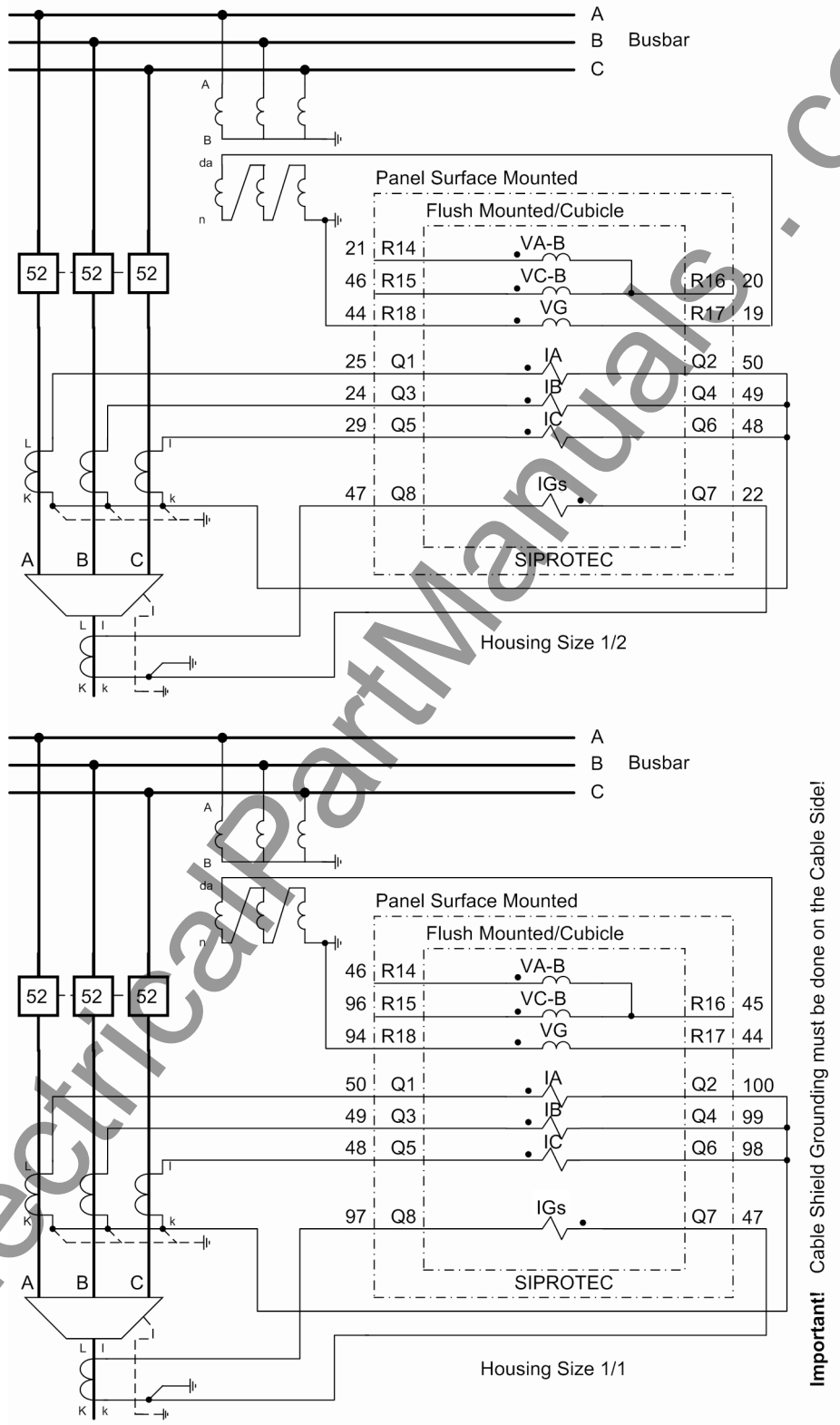


Note: For busbar-side grounding of the current transformers, the current polarity of the device is changed via address 0201. This also reverses the polarity of current input IG/IGs. When using a cable-type current transformer, the connection of k and l at Q7 and Q8 must be

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

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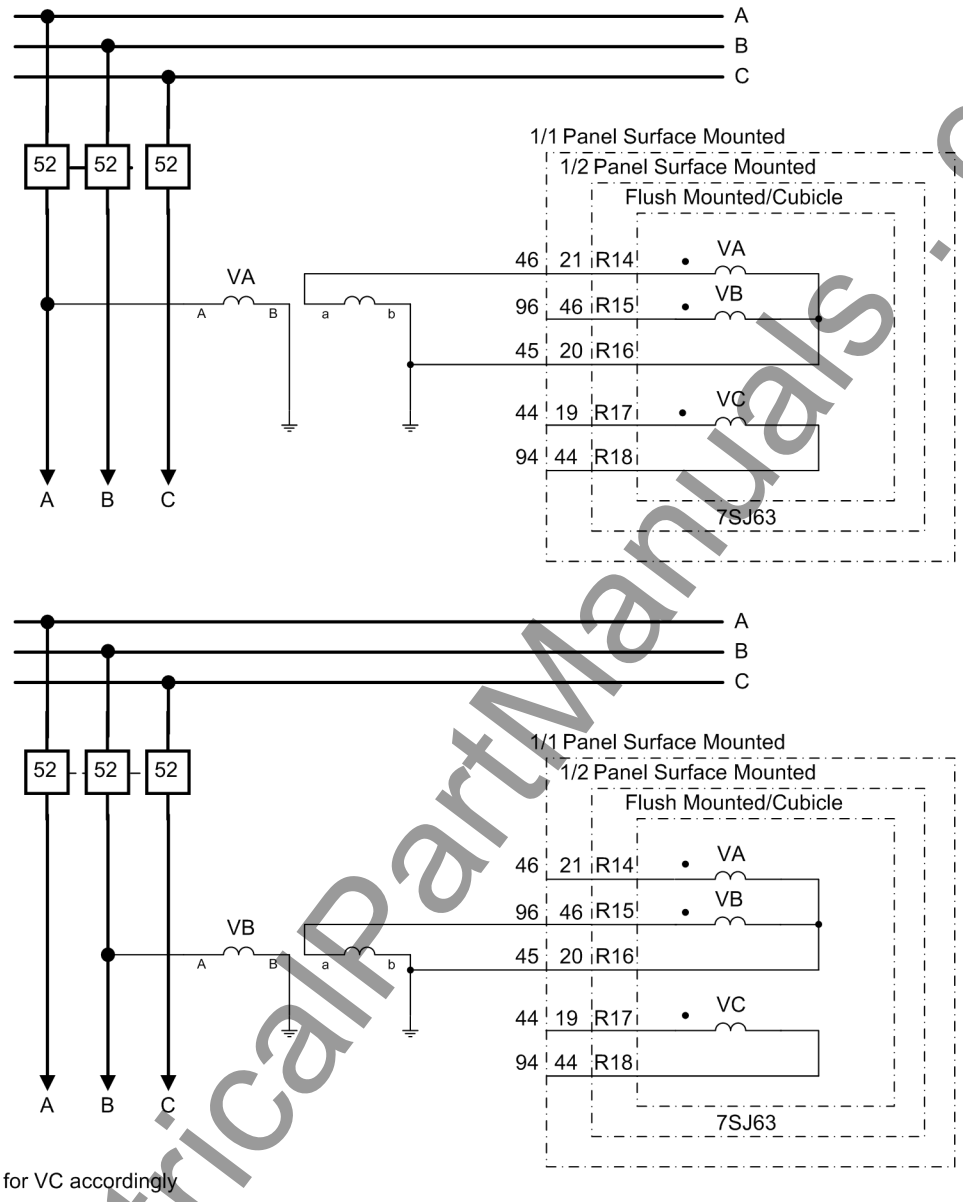


for VC accordingly

Figure A-76 7SJ63: Connection circuit for single-phase voltage transformers with phase-to-ground voltages

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### A.3.3 Connection Examples for 7SJ64

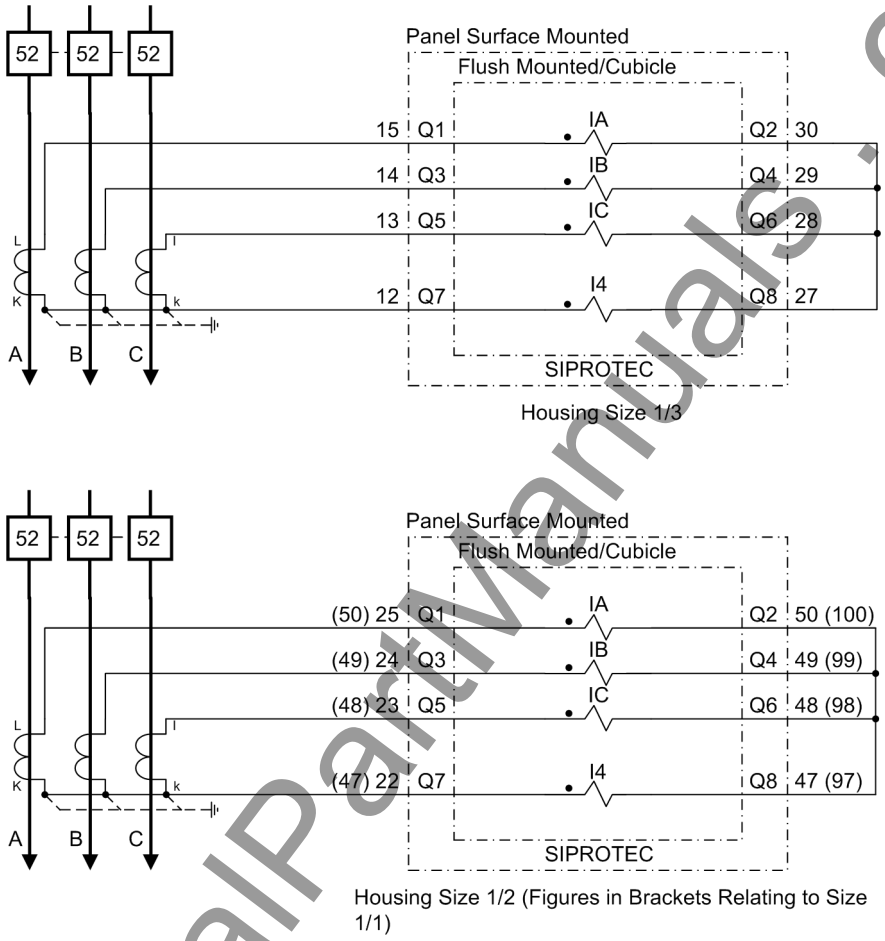


Figure A-77 7SJ64: Current connections to three current transformers with a starpoint connection for ground current (residual 3I0 neutral current), normal circuit layout

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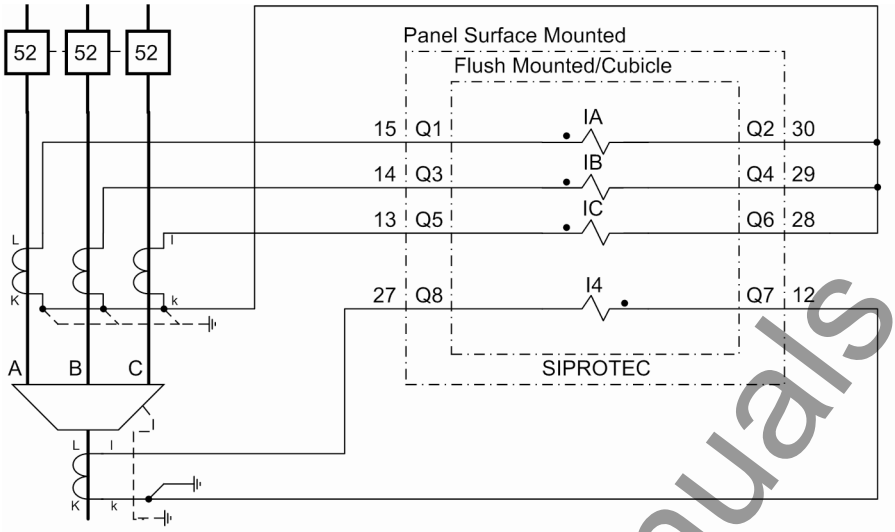
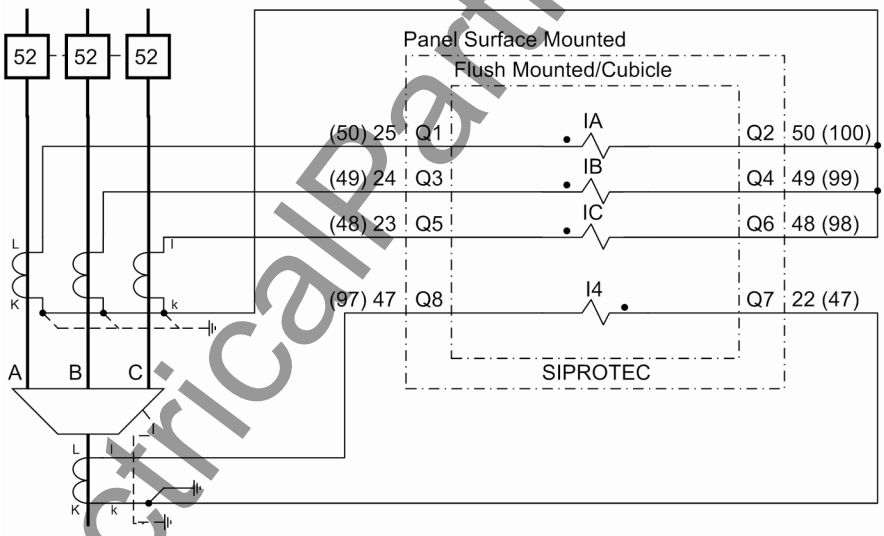



**Important!** Cable Shield Grounding must be done on the Cable Side!

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)

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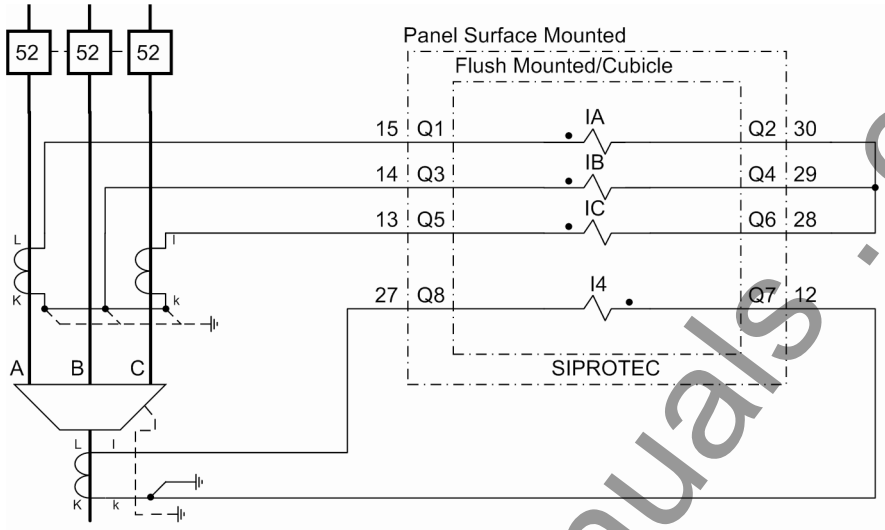
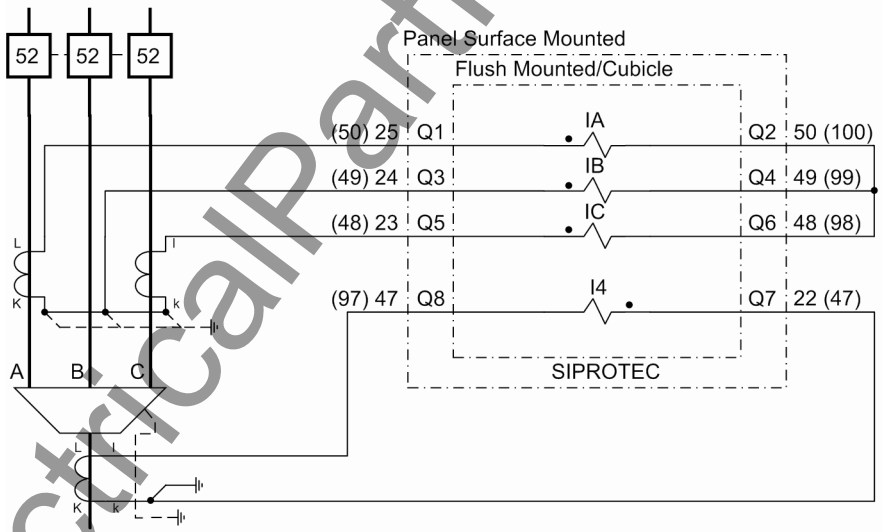



**Important!** Cable Shield Grounding must be done on the Cable Side!

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-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

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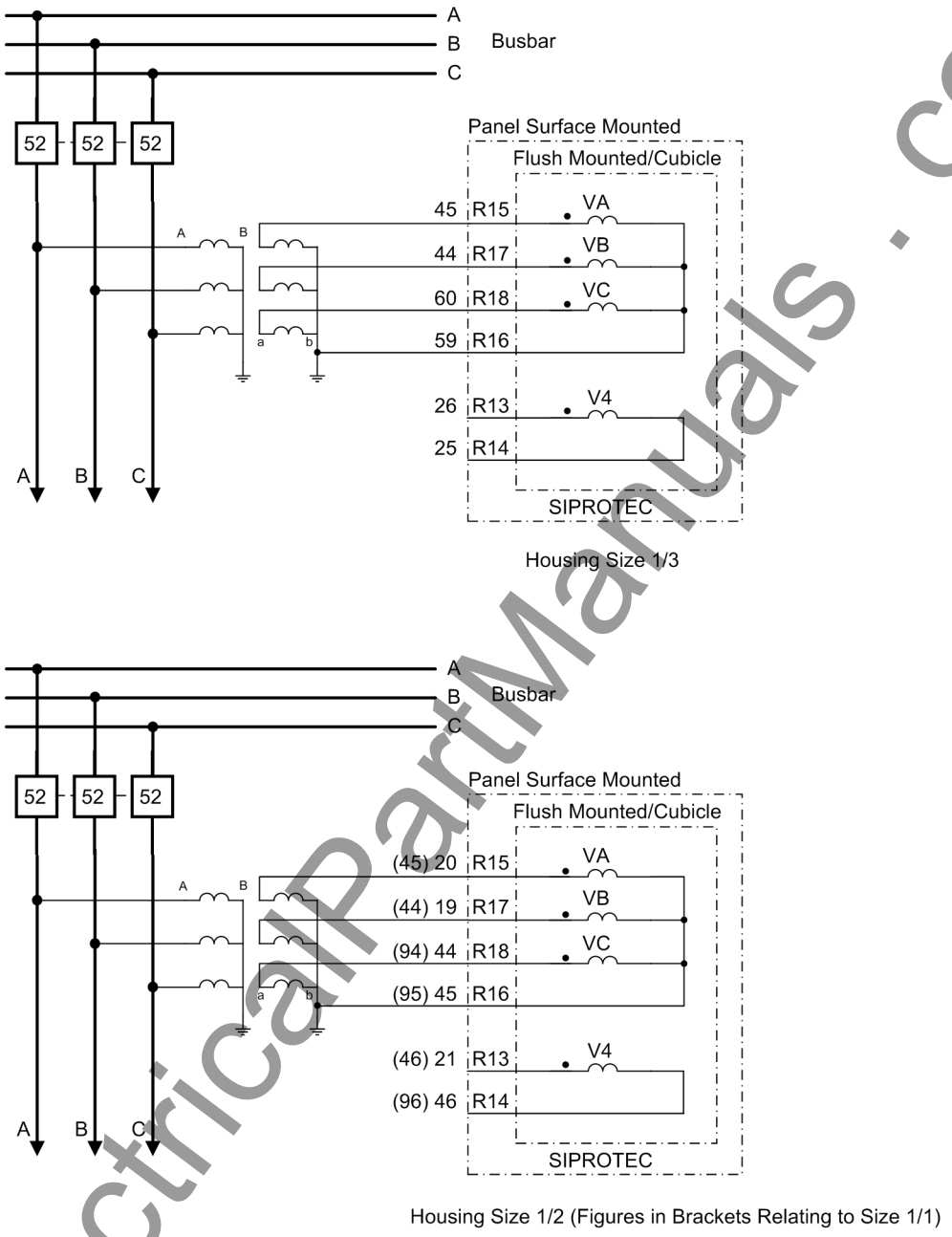


Figure A-80 7SJ64: Voltage connections to three Wye-connected voltage transformers (normal circuit layout)

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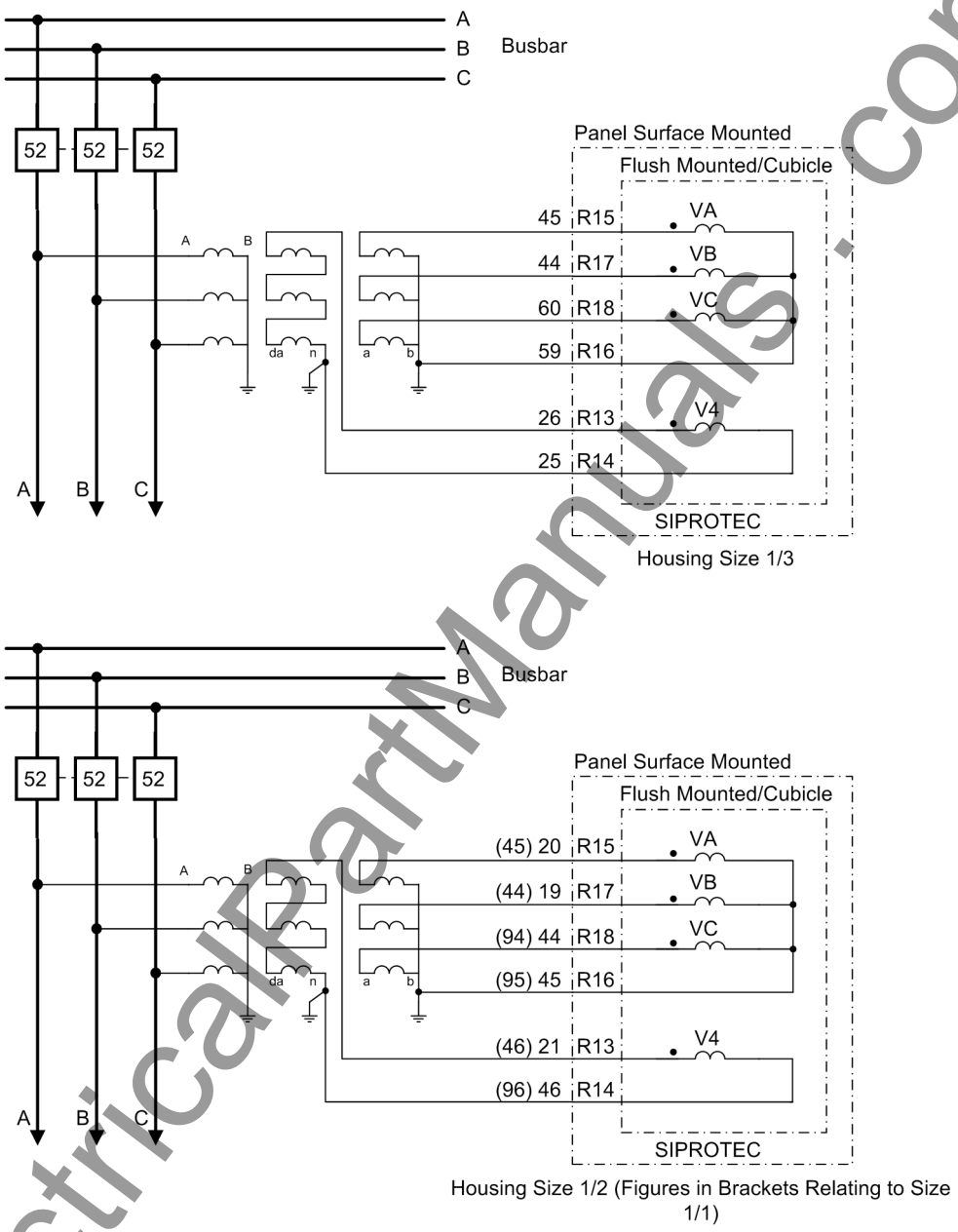


Figure A-81 7SJ64: Voltage connections to three Wye-connected voltage transformers with additional open-delta windings (da–dn–winding)

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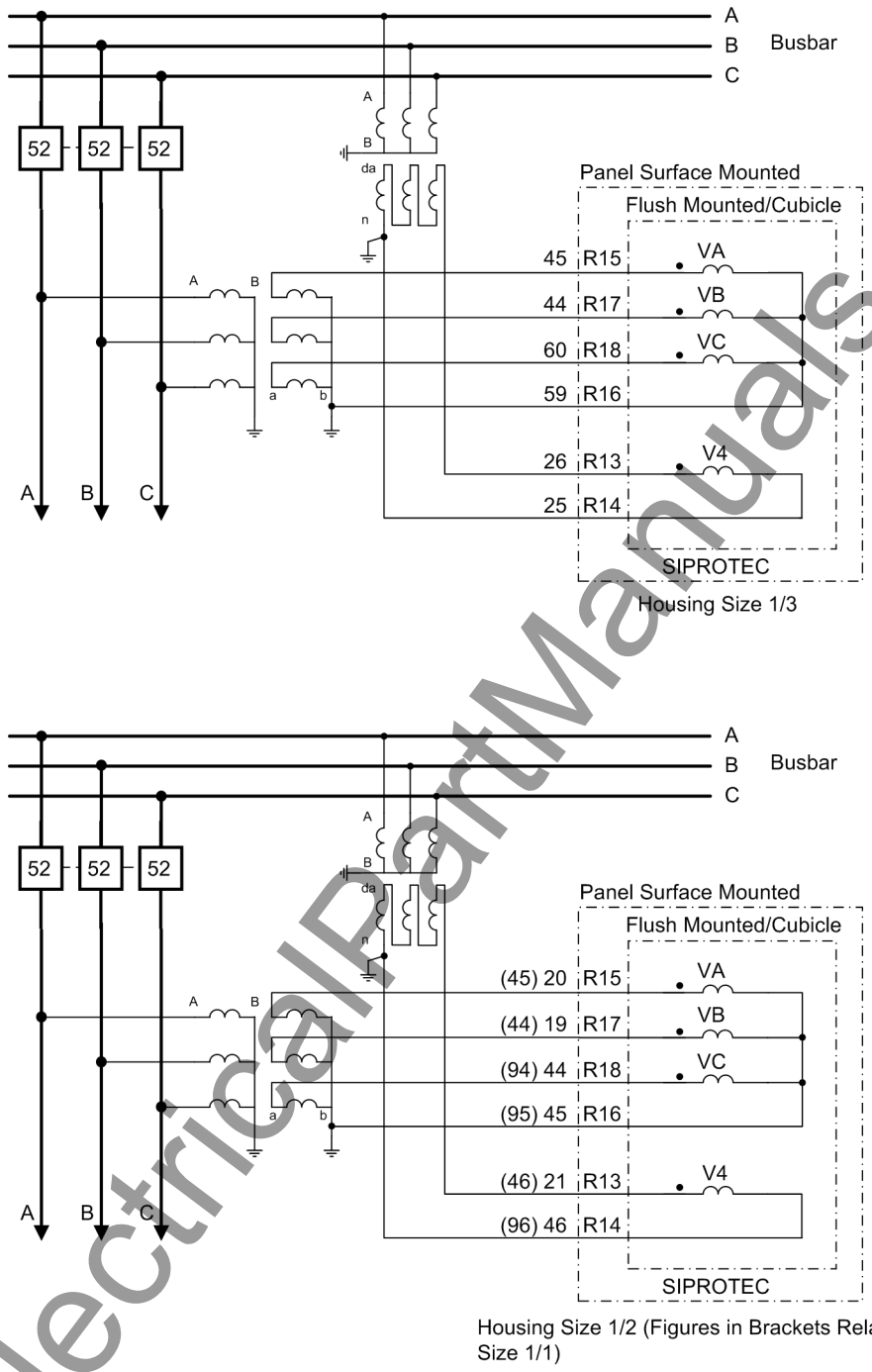


Figure A-82 7SJ64: Voltage connections to three Wye-connected voltage transformers with additional open-delta windings (da–dn–winding) from the busbar

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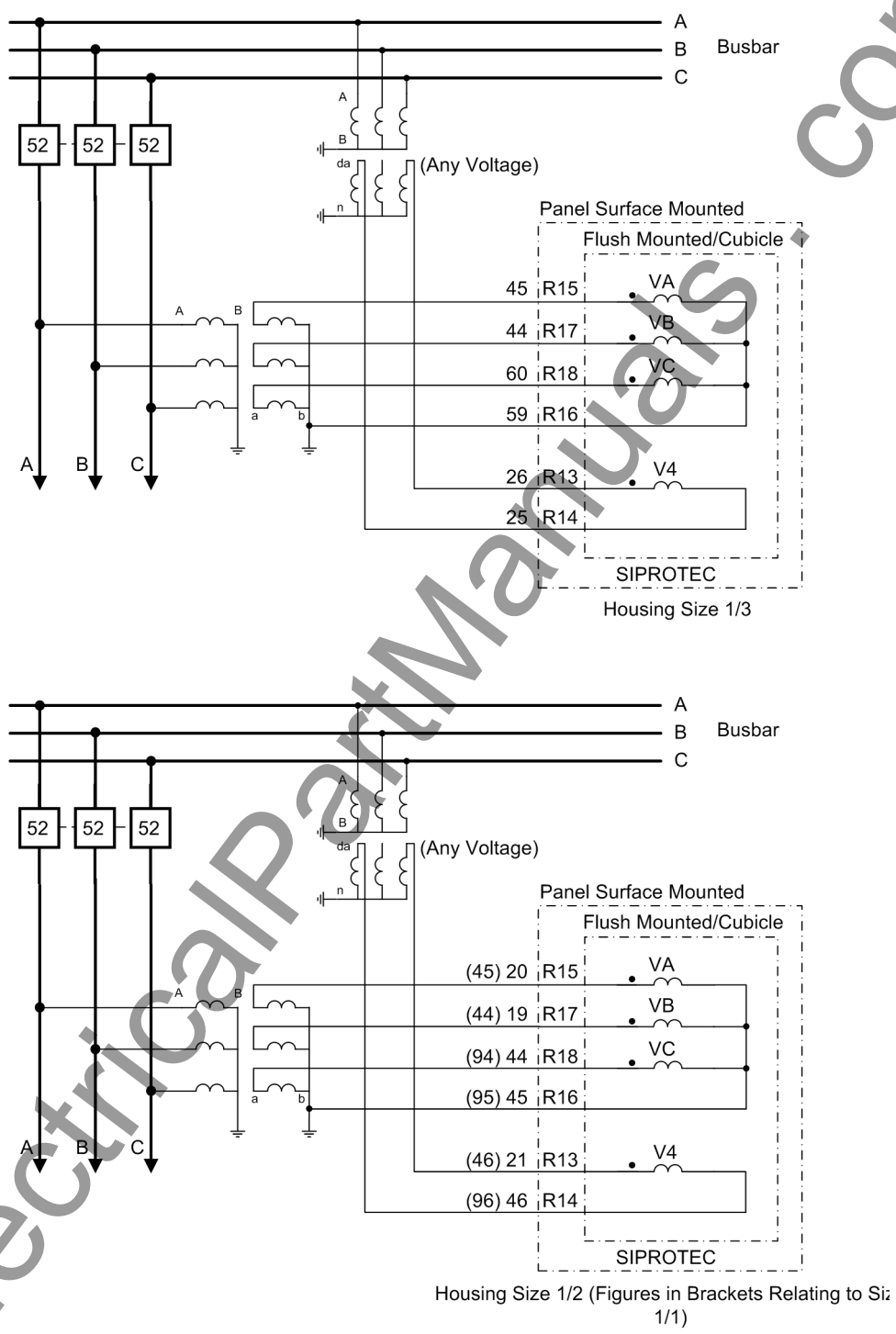


Figure A-83 7SJ64: Voltage connections to three Wye-connected voltage transformers and additionally to any phase-to-phase voltage (for synchronism check for example)

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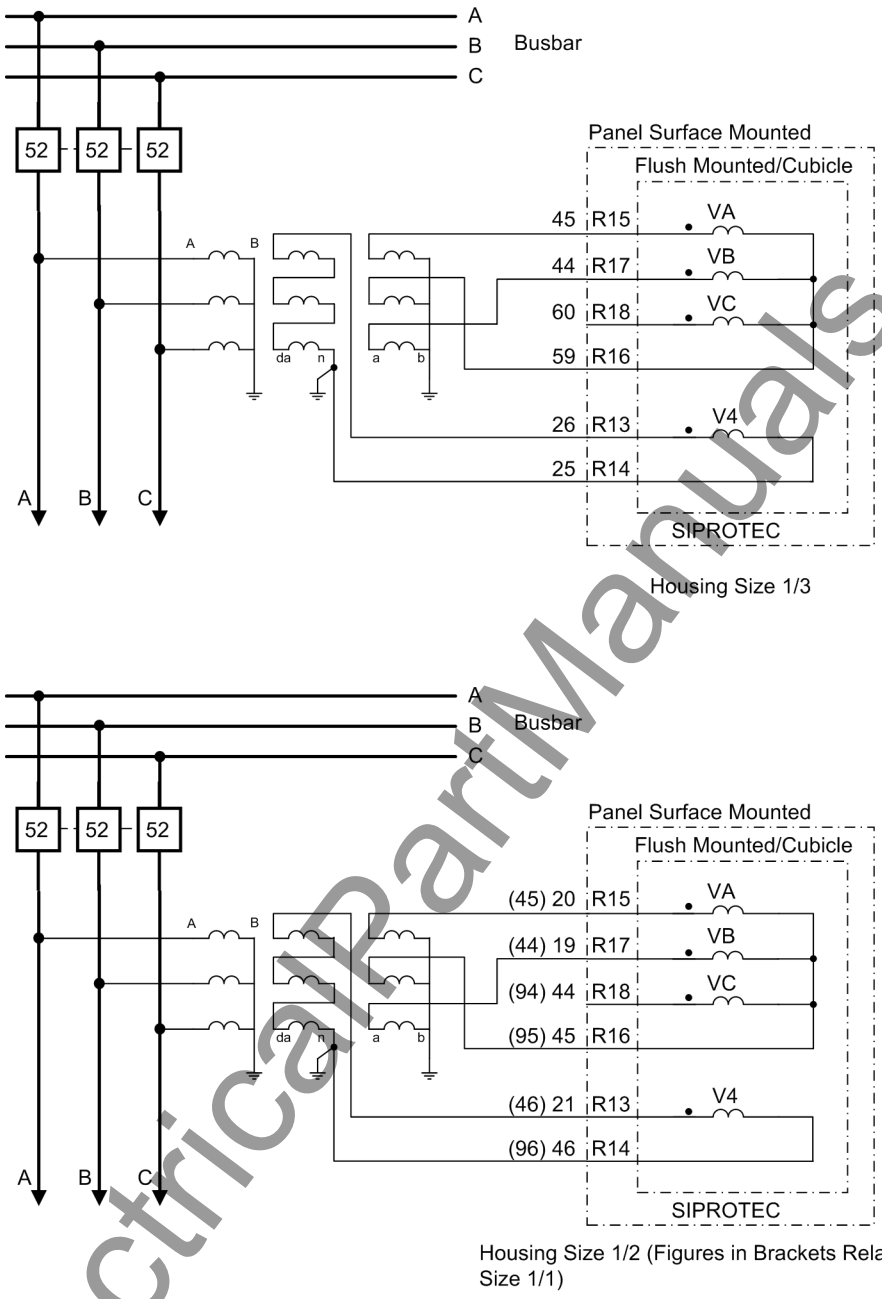


Figure A-84 7SJ64: Two phase-to-phase voltages to three Wye-connected voltage transformers with additional open-delta windings (da–dn–winding)

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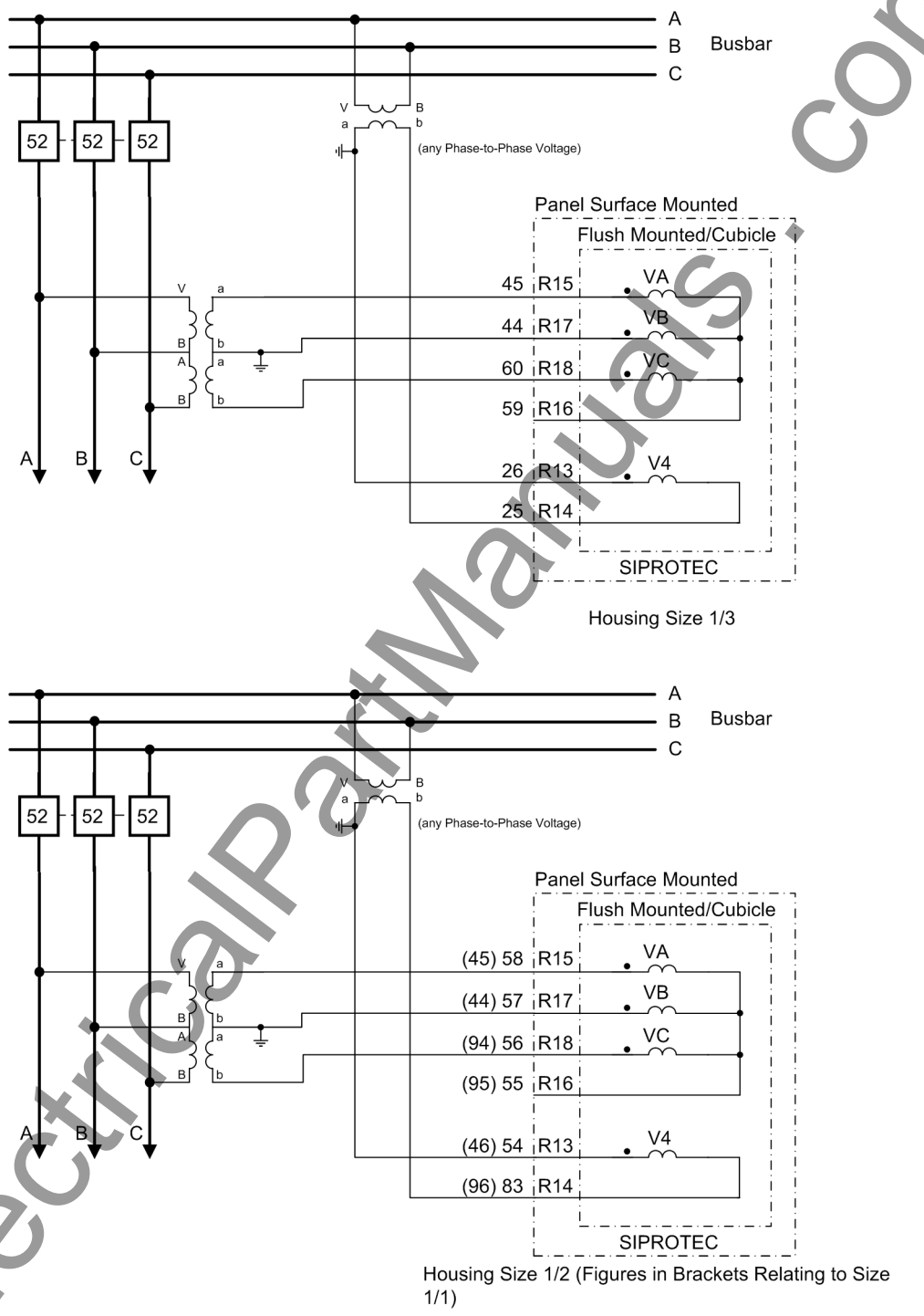


Figure A-85 7SJ64: Voltage connections to two voltage transformers and additionally to any phase-to-phase voltage (for synchronism check for example) With this type of connection it is not possible to determine the zero sequence voltage V0. Functions that use the zero sequence voltage must be hidden or disabled.

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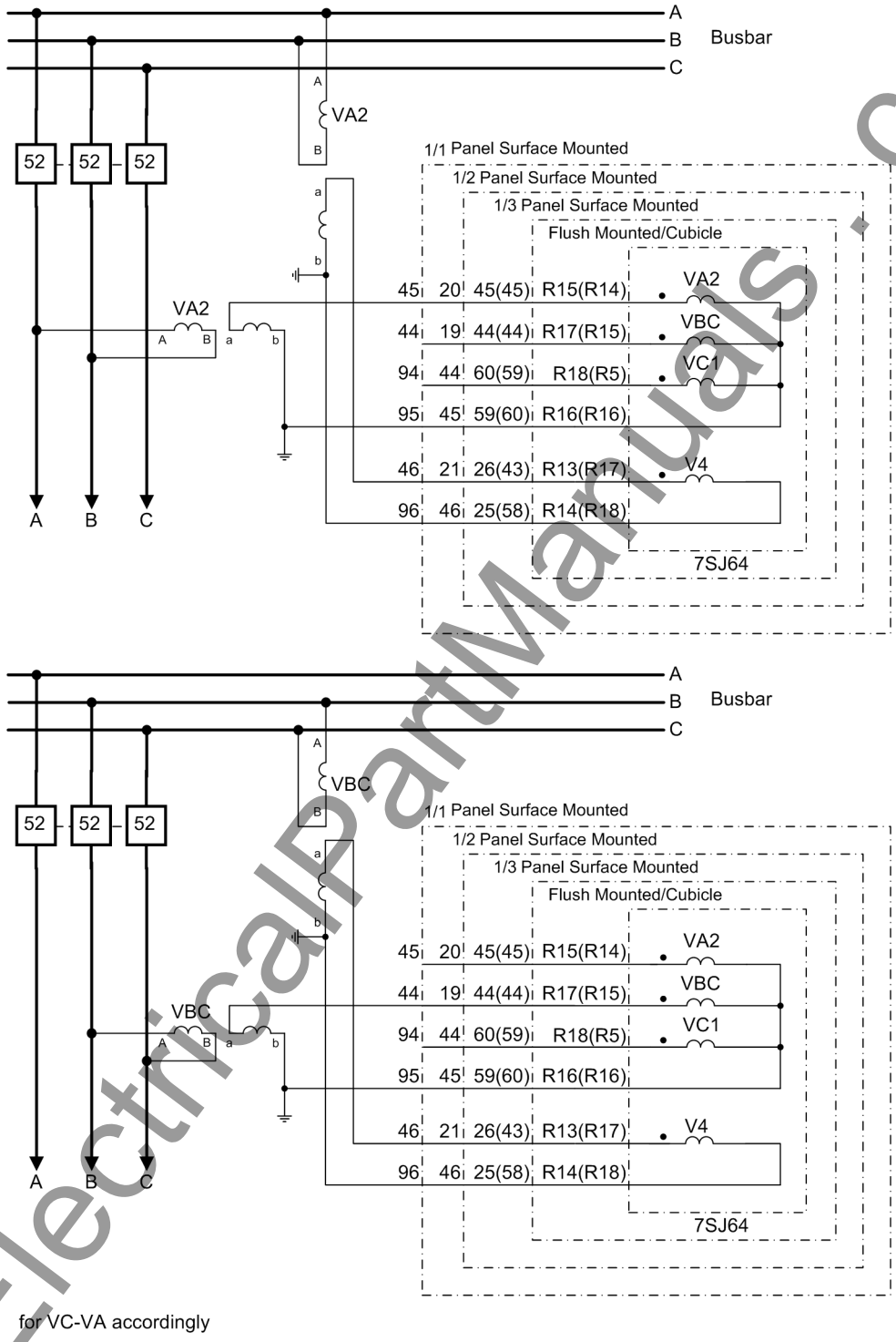


Figure A-86 7SJ64: Connection circuit for single-phase voltage transformers with phase-to-phase voltages

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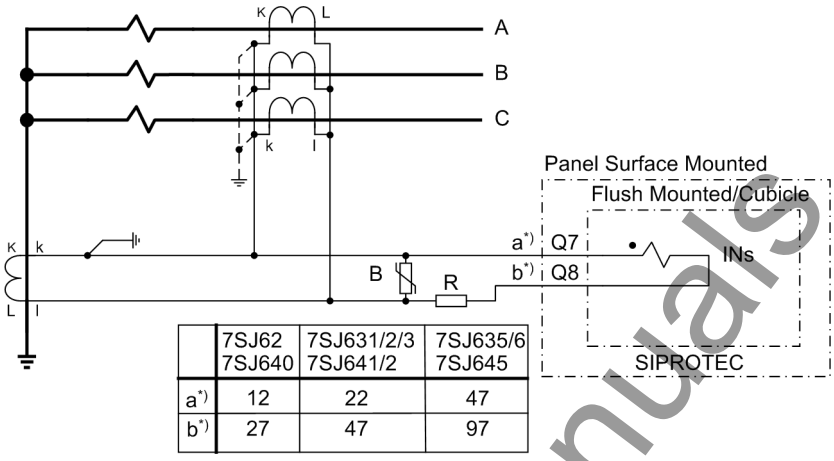
## A.3.4 Connection example for high-impedance ground fault differential protection




| | 7SJ62<br>7SJ640 | 7SJ631/2/3<br>7SJ641/2 | 7SJ635/6<br>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

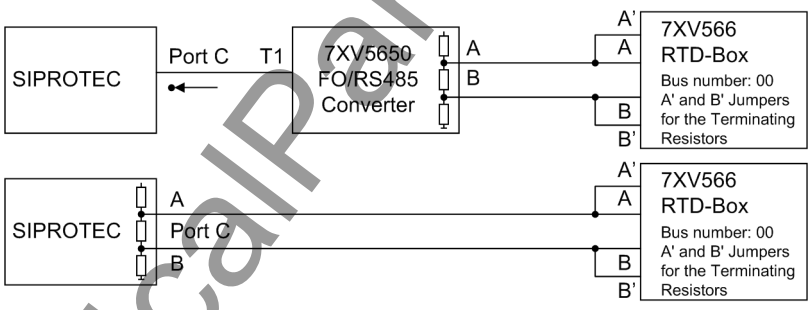



Figure A-88 Simplex operation with one RTD-Box, above: optical design (1 FO); below: design with RS 485

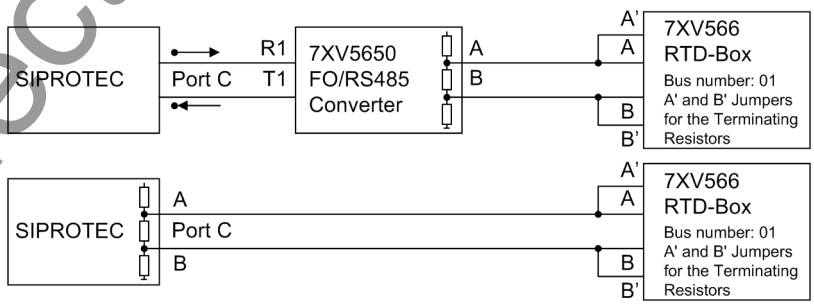



Figure A-89 Half-duplex operation with one RTD-Box, above: optical design (2 FOs); below: design with RS 485

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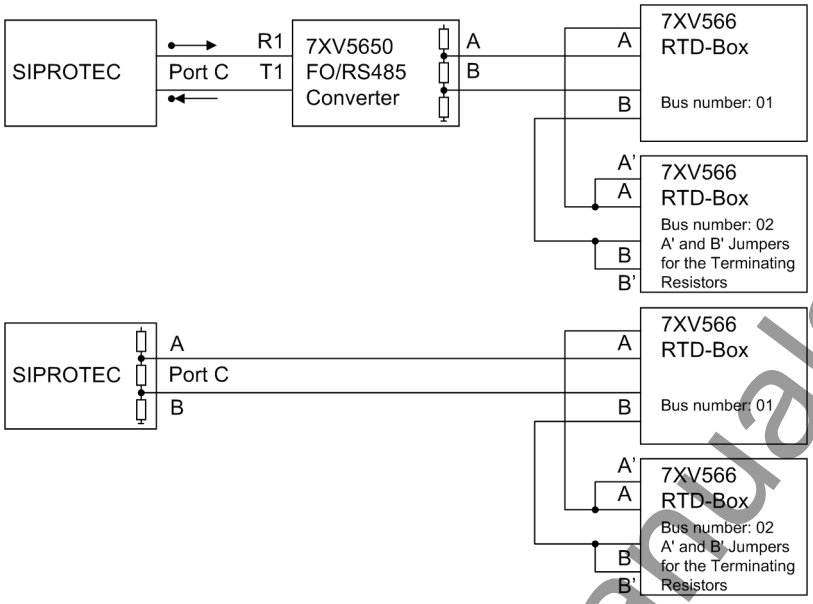


Figure A-90 Half-duplex operation with two RTD-Boxes, above: optical design (2 FOs); below: design with RS 485

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.

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# 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<br><br>$K_{ALF'}$ = 20<br>$R_{BC}$ = 0.6 Ω (device and cables)<br>$R_{Ct}$ = 3 Ω<br>$R_{BN}$ = 5 Ω (5 VA) | $K_{ALF} = \frac{0.6+3}{5+3} \cdot 20 = 9$<br><br>$K_{ALF}$ set to 10,<br>so that: 5P10, 5 VA |
| with<br>$I_{sNom}$ = secondary transformer nominal current | |

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## 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 | $V_{s.t.max} = 20 \cdot I_{sNom} \cdot R_{BN} \cdot \frac{K_{ALF}}{20}$<br>$I_{sNom}$ = 5 A (typical value) | |
| IEC 60044-6 (transient response), class TPS | $V_{al} = K \cdot K_{SSC} \cdot (R_{Ct} + R_{BN}) \cdot I_{sNom}$<br>K≈ 1<br>$K_{SSC} \approx K_{ALF}$ | |
| Classes TPX, TPY, TPZ | Calculated as in Chapter A.4.1 where:<br>$K_{SSC} \approx K_{ALF}$<br>$T_P$ 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 |

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### 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<br>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<br><br>- For secondary current threshold values ≥ 20 mA<br>- For secondary current threshold values < 20 mA | <br><br>≤ 1.2 VA (≤ 1.2 Ω)<br>≤ 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“).

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## 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<br>67 A picked up | 1762<br>2692 | 50/51 Phase A picked up<br>67/67-TOC Phase A picked up |
| LED3 | 50/51 Ph B PU<br>67 B picked up | 1763<br>2693 | 50/51 Phase B picked up<br>67/67-TOC Phase B picked up |
| LED4 | 50/51 Ph C PU<br>67 C picked up | 1764<br>2694 | 50/51 Phase C picked up<br>67/67-TOC Phase C picked up |
| LED5 | 50N/51NPickedup<br>67N picked up | 1765<br>2695 | 50N/51N picked up<br>67N/67N-TOC picked up |
| LED6 | Failure Σ I<br>Fail I balance<br>Fail V balance<br>Fail Ph. Seq. I<br>Fail Ph. Seq. V | 162<br>163<br>167<br>175<br>176 | Failure: Current Summation<br>Failure: Current Balance<br>Failure: Voltage Balance<br>Failure: Phase Sequence Current<br>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<br>>BLOCK 50N-2 | 1721<br>1724 | >BLOCK 50-2<br>>BLOCK 50N-2 |
| BI2 | >Reset LED | 5 | >Reset LED |
| BI3 | >Light on | | >Back Light on |
| BI4 | >52-b<br><br>52Breaker | 4602 | >52-b contact (OPEN, if bkr is closed)<br>52 Breaker |
| BI5 | >52-a<br>52Breaker | 4601 | >52-a contact (OPEN, if bkr is open)<br>52 Breaker |

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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<br>52Breaker | 511 | Relay GENERAL TRIP command<br>52 Breaker |
| BO2 | 52Breaker<br>79 Close | <br>2851 | 52 Breaker<br>79 - Close command |
| BO3 | 52Breaker<br>79 Close | <br>2851 | 52 Breaker<br>79 - Close command |

Table A-8 Further Output Relay Presettings for 7SJ62**-

| Binary Output | Default function | Function No. | Description |
|---|---|---|---|
| BO4 | Failure Σ I | 162 | Failure: Current Summation |
| | Fail I balance | 163 | Failure: Current Balance |
| | Fail V balance | 167 | Failure: Voltage Balance |
| | Fail Ph. Seq. I | 175 | Failure: Phase Sequence Current |
| | Fail Ph. Seq. V | 176 | 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 | 162 | Failure: Current Summation |
| | Fail I balance | 163 | Failure: Current Balance |
| | Fail V balance | 167 | Failure: Voltage Balance |
| | Fail Ph. Seq. I | 175 | Failure: Phase Sequence Current |
| | Fail Ph. Seq. V | 176 | Failure: Phase Sequence Voltage |

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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<br>52Breaker | 511 | Relay GENERAL TRIP command<br>52 Breaker |
| BO4 | 52Breaker<br>79 Close | <br>2851 | 52 Breaker<br>79 - Close command |
| BO5 | 52Breaker<br>79 Close | <br>2851 | 52 Breaker<br>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.

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**4-Line Display of 7SJ62**

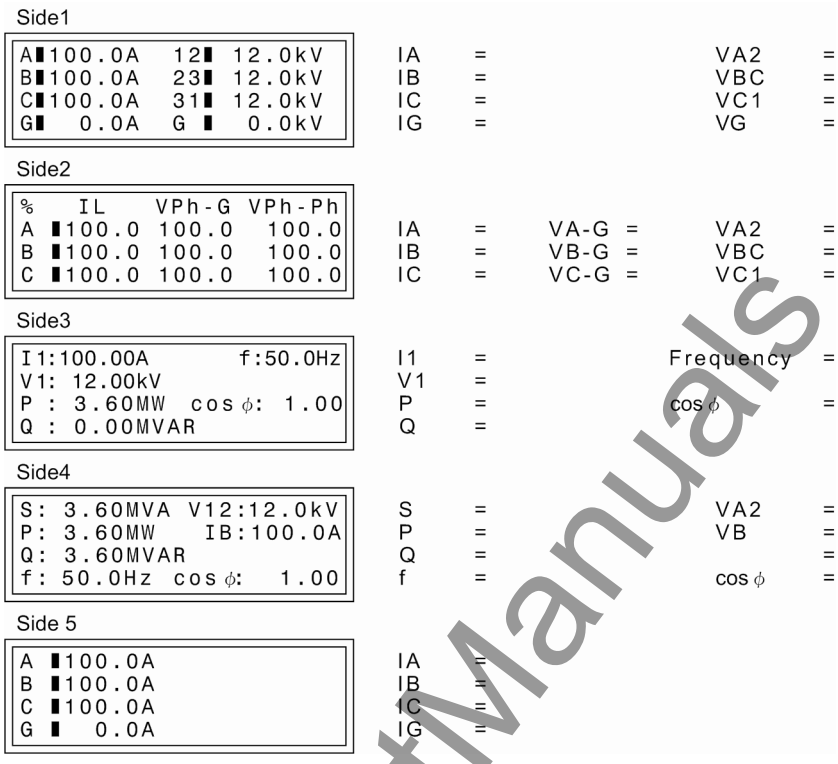


Figure A-91 Default display for configurations without extended measured values (13th position of MLFB = 0 or 1)

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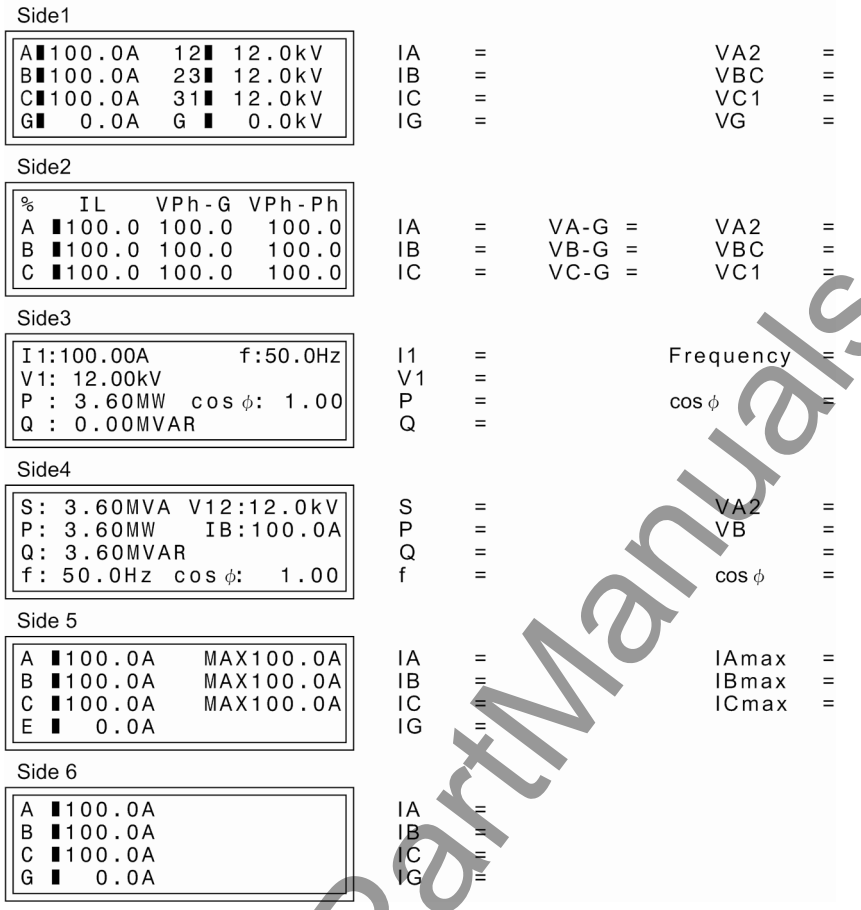


Figure A-92 Default display for configurations with extended measured values (13th position of MLFB = 2 or 3)

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**4-Line Display of 7SJ640**

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   MAX100.0A    IA   =              IAmax =
B ▮100.0A   MAX100.0A    IB   =              IBmax =
C ▮100.0A   MAX100.0A    IC   =              ICmax =
E ▮  0.0A                IG   =
```

Side 6

```
A ▮100.0A                IA   =
B ▮100.0A                IB   =
C ▮100.0A                IC   =
G ▮  0.0A                IG   =
```

Figure A-93 Default display of the 4-line display 7SJ640*-)

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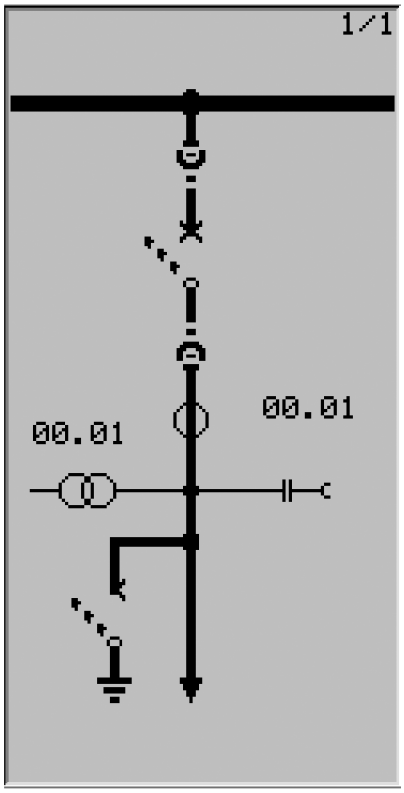
**Graphic Display of 7SJ63 and 7SJ641/2/5**



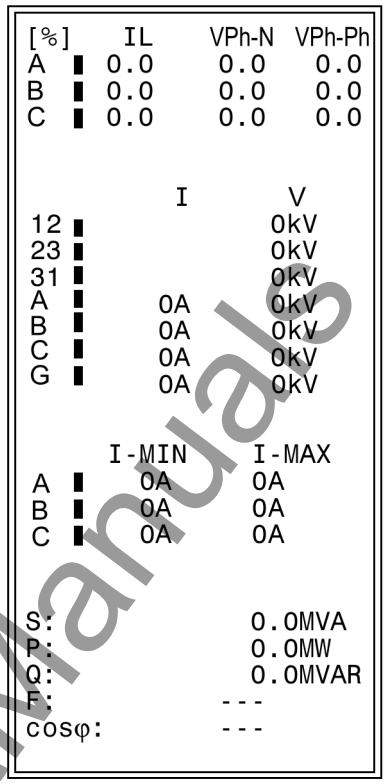
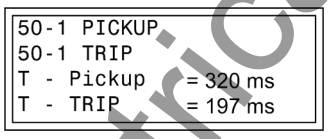




Figure A-94 Default displays for graphic display

**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.




Protective Function that Picked up First;
Protective Function that Tripped Last;
Operating Time from General Pickup to Dropout;
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.

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## 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.

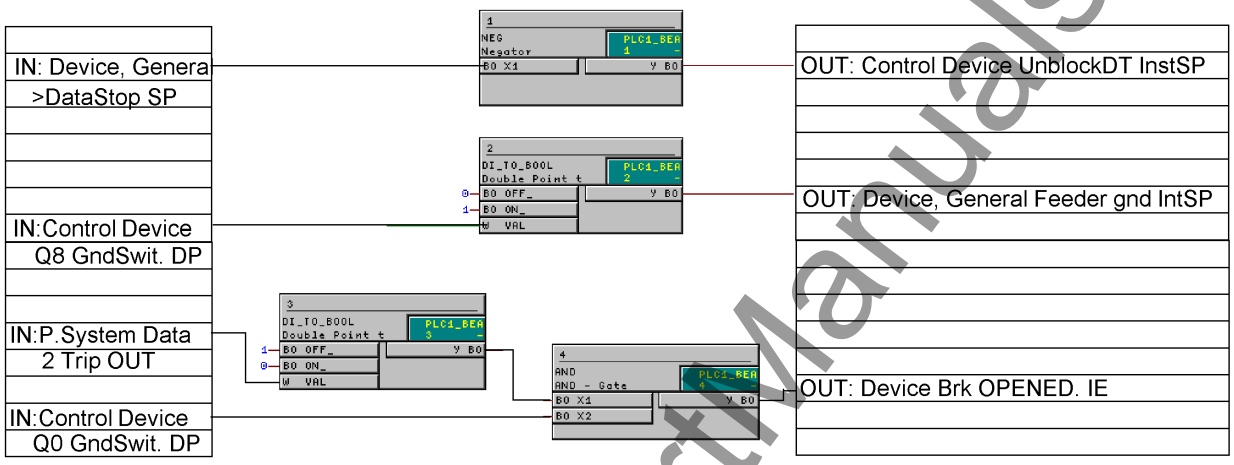


Figure A-96 Logical links between input and output

**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:

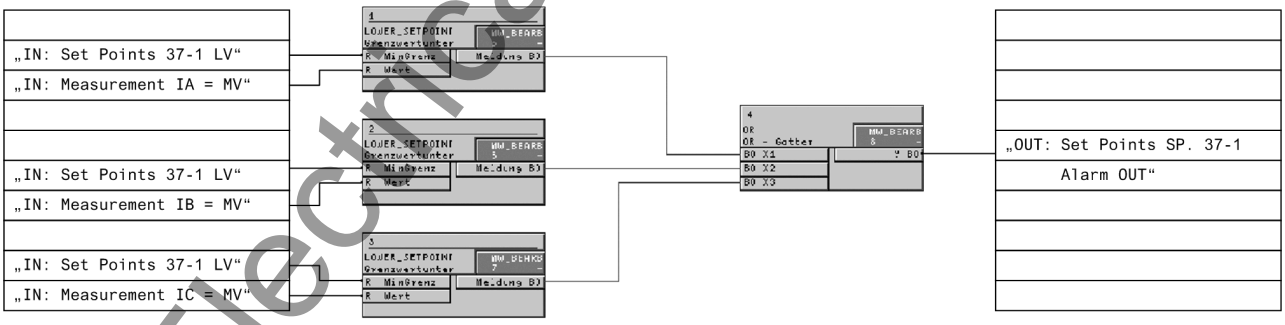


Figure A-97 Undercurrent monitoring

Blocks of the task level "MW_BEARB" (measured value processing) are used to implement the overcurrent monitoring and the power monitoring.

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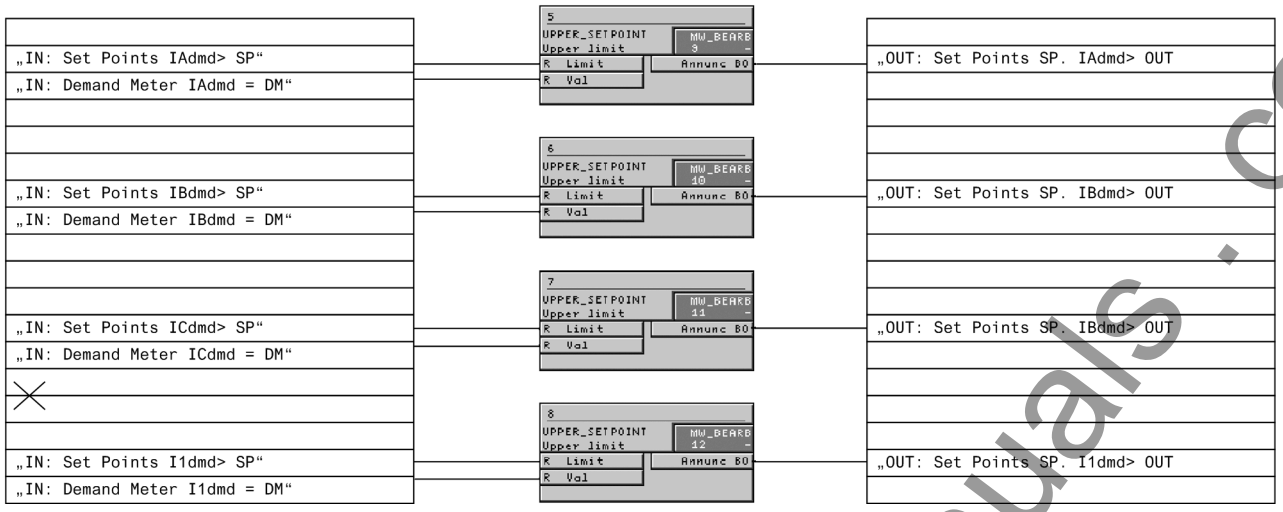


Figure A-98 Overcurrent monitoring

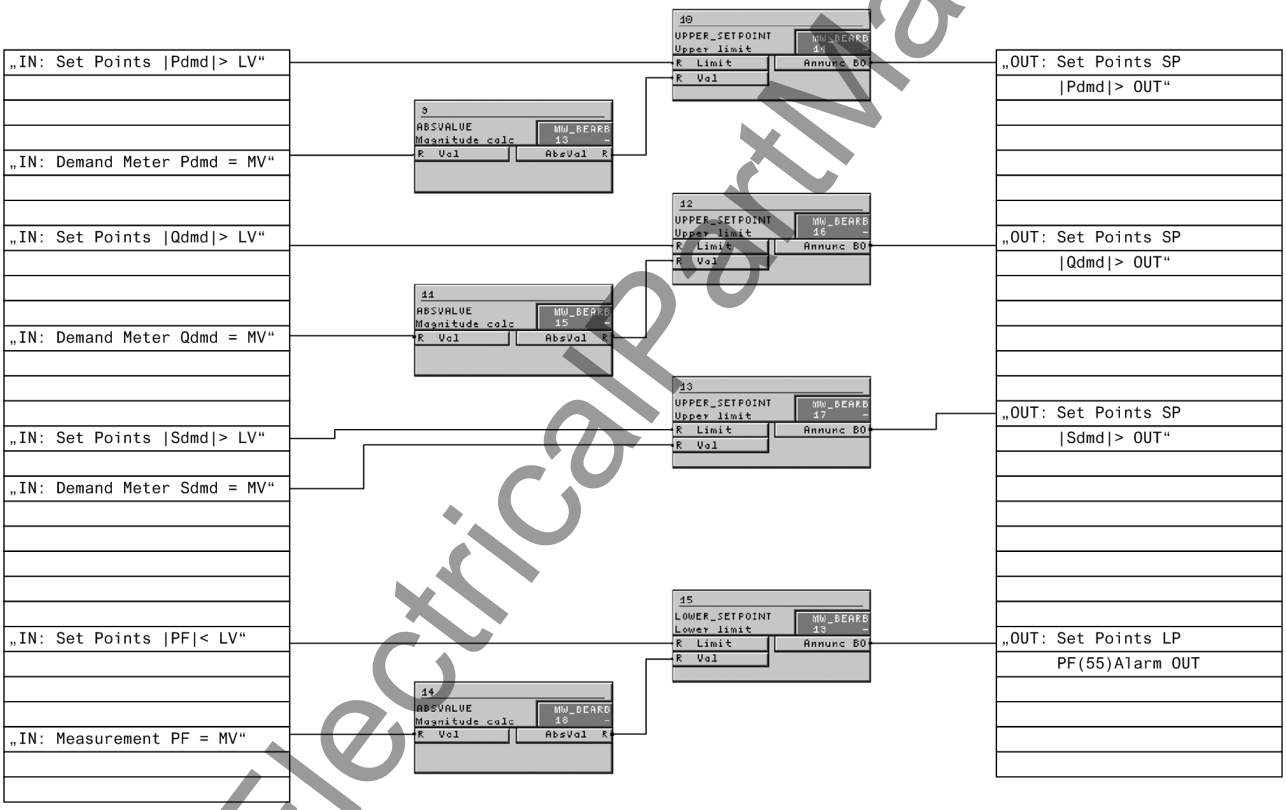


Figure A-99 Power monitoring

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**Interlocking with 7SJ63/64**

Standard interlocking for three switching devices (52, Disc. and GndSw):

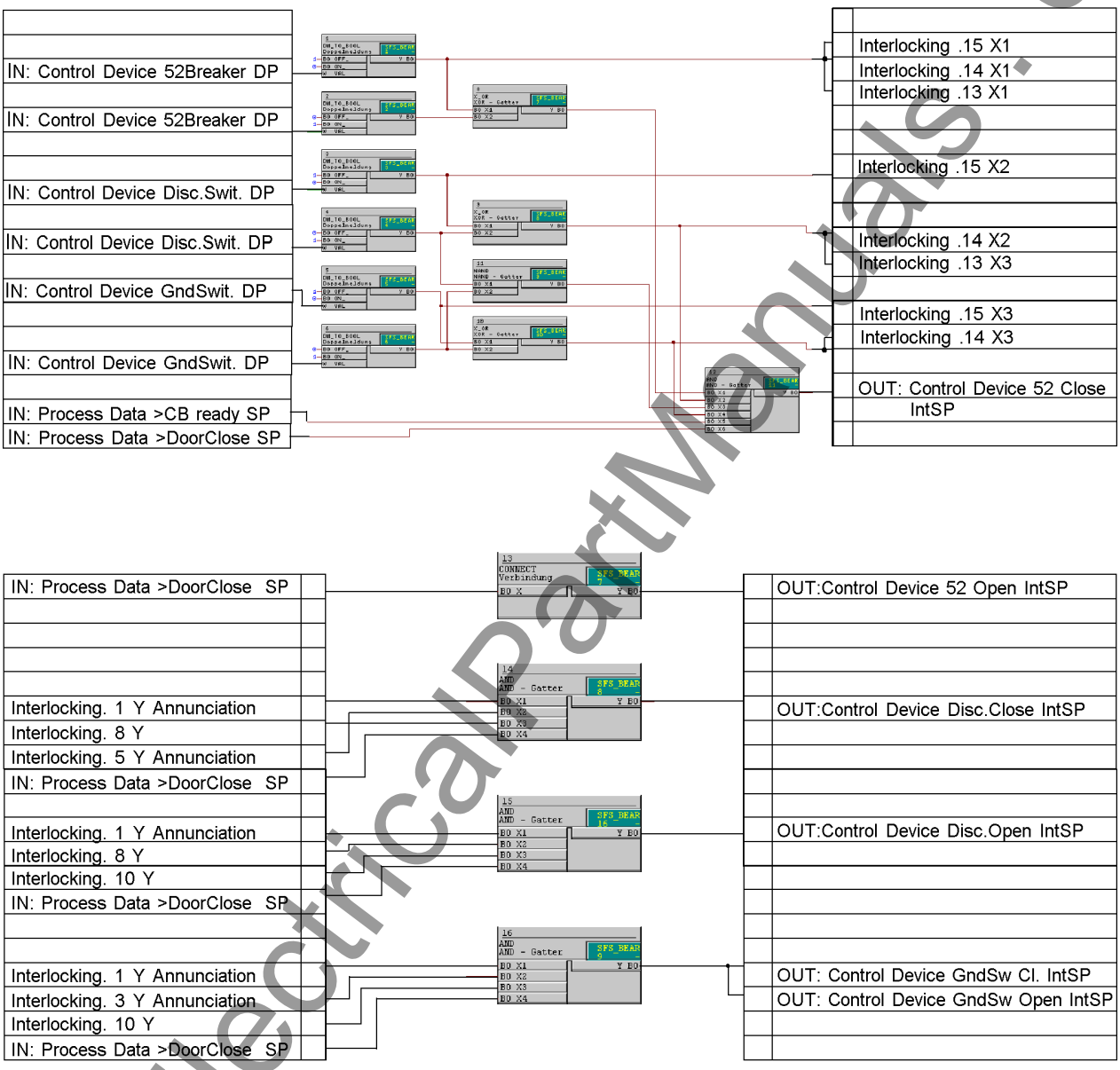


Figure A-100 Standard interlocking for circuit breaker, disconnector and ground switch

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## 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<br>- RS485<br>- Fiber-optic cables | Ethernet TP | - RS485<br>- Optical fiber (Double ring) | - RS485<br>- Optical fiber (Single ring, Double ring) | - RS 485<br>- Optical fiber | - RS232<br>- RS485<br>- Optical fiber |

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## A.7 Functional Scope

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 103 | Grp Chge OPTION | Disabled<br>Enabled | Disabled | Setting Group Change Option |
| 104 | OSC. FAULT REC. | Disabled<br>Enabled | Disabled | Oscillographic Fault Records |
| 112 | Charac. Phase | Disabled<br>Definite Time<br>TOC IEC<br>TOC ANSI<br>User Defined PU<br>User def. Reset | Definite Time | 50/51 |
| 113 | Charac. Ground | Disabled<br>Definite Time<br>TOC IEC<br>TOC ANSI<br>User Defined PU<br>User def. Reset | Definite Time | 50N/51N |
| 115 | 67/67-TOC | Disabled<br>Definite Time<br>TOC IEC<br>TOC ANSI<br>User Defined PU<br>User def. Reset | Definite Time | 67, 67-TOC |
| 116 | 67N/67N-TOC | Disabled<br>Definite Time<br>TOC IEC<br>TOC ANSI<br>User Defined PU<br>User def. Reset | Definite Time | 67N, 67N-TOC |
| 117 | Coldload Pickup | Disabled<br>Enabled | Disabled | Cold Load Pickup |
| 122 | InrushRestraint | Disabled<br>Enabled | Disabled | 2nd Harmonic Inrush Restraint |
| 127 | 50 1Ph | Disabled<br>Enabled | Disabled | 50 1Ph |
| 131 | Sens. Gnd Fault | Disabled<br>Definite Time<br>User Defined PU<br>Log. inverse A<br>Log. Inverse B | Disabled | (sensitive) Ground fault |
| 133 | INTERM.EF | Disabled<br>with Ignd<br>with 3I0<br>with Ignd,sens. | Disabled | Intermittent earth fault protection |
| 140 | 46 | Disabled<br>TOC ANSI<br>TOC IEC<br>Definite Time | Disabled | 46 Negative Sequence Protection |
| 141 | 48 | Disabled<br>Enabled | Disabled | 48 Startup Supervision of Motors |
| 142 | 49 | Disabled<br>No ambient temp<br>With amb. temp. | Disabled | 49 Thermal Overload Protection |

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| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 143 | 66 #of Starts | Disabled<br>Enabled | Disabled | 66 Startup Counter for Motors |
| 150 | 27/59 | Disabled<br>Enabled | Disabled | 27, 59 Under/Overvoltage Protection |
| 154 | 81 O/U | Disabled<br>Enabled | Disabled | 81 Over/Underfrequency Protection |
| 161 | 25 Function 1 | Disabled<br>ASYN/SYNCHRON<br>SYNCHROCHECK | Disabled | 25 Function group 1 |
| 162 | 25 Function 2 | Disabled<br>ASYN/SYNCHRON<br>SYNCHROCHECK | Disabled | 25 Function group 2 |
| 163 | 25 Function 3 | Disabled<br>ASYN/SYNCHRON<br>SYNCHROCHECK | Disabled | 25 Function group 3 |
| 164 | 25 Function 4 | Disabled<br>ASYN/SYNCHRON<br>SYNCHROCHECK | Disabled | 25 Function group 4 |
| 170 | 50BF | Disabled<br>Enabled | Disabled | 50BF Breaker Failure Protection |
| 171 | 79 Auto Recl. | Disabled<br>Enabled | Disabled | 79 Auto-Reclose Function |
| 172 | 52 B.WEAR MONIT | Disabled<br>Ix-Method<br>2P-Method<br>I2t-Method | Disabled | 52 Breaker Wear Monitoring |
| 180 | Fault Locator | Disabled<br>Enabled | Disabled | Fault Locator |
| 182 | 74 Trip Ct Supv | Disabled<br>2 Binary Inputs<br>1 Binary Input | Disabled | 74TC Trip Circuit Supervision |
| 190 | RTD-BOX INPUT | Disabled<br>Port C | Disabled | External Temperature Input |

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| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 191 | RTD CONNECTION | 6 RTD simplex<br>6 RTD HDX<br>12 RTD HDX | 6 RTD simplex | Ext. Temperature Input Connection Type |
| - | FLEXIBLE FUNC. 1..20 | Flexible Function 01<br>Flexible Function 02<br>Flexible Function 03<br>Flexible Function 04<br>Flexible Function 05<br>Flexible Function 06<br>Flexible Function 07<br>Flexible Function 08<br>Flexible Function 09<br>Flexible Function 10<br>Flexible Function 11<br>Flexible Function 12<br>Flexible Function 13<br>Flexible Function 14<br>Flexible Function 15<br>Flexible Function 16<br>Flexible Function 17<br>Flexible Function 18<br>Flexible Function 19<br>Flexible Function 20 | Please select | Flexible Functions |

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## 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<br>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<br>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<br>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<br>Vab, Vbc, VGnd<br>Van,Vbn,Vcn,VGn<br>Van,Vbn,Vcn,VSy | Van, Vbn, Vcn | VT Connection, three-phase |
| 214 | Rated Frequency | P.System Data 1 | | 50 Hz<br>60 Hz | 50 Hz | Rated Frequency |
| 215 | Distance Unit | P.System Data 1 | | km<br>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<br>5A | 1A | Ignd-CT rated secondary current |
| 235A | ATEX100 | P.System Data 1 | | NO<br>YES | NO | Storage of th. Replicas w/o Power Supply |
| 240 | VT Connect. 1ph | P.System Data 1 | | NO<br>Van<br>Vbn<br>Vcn<br>Vab<br>Vbc<br>Vca | NO | VT Connection, single-phase |
| 250A | 50/51 2-ph prot | P.System Data 1 | | ON<br>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<br>Fahrenheit | Celsius | Unit of temperature measurement |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 302 | CHANGE | Change Group | | Group A<br>Group B<br>Group C<br>Group D<br>Binary Input<br>Protocol | Group A | Change to Another Setting Group |
| 401 | WAVEFORMTRIGGER | Osc. Fault Rec. | | Save w. Pickup<br>Save w. TRIP<br>Start w. TRIP | Save w. Pickup | Waveform Capture |
| 402 | WAVEFORM DATA | Osc. Fault Rec. | | Fault event<br>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<br>Target on TRIP | Target on PU | Fault Display on LED / LCD |
| 611 | Spont. FltDisp. | Device, General | | YES<br>NO | NO | Spontaneous display of flt.annunciations |
| 613A | Gnd O/Cprot. w. | P.System Data 1 | | Ignd (measured)<br>3I0 (calcul.) | Ignd (measured) | Ground Overcurrent protection with |
| 614A | OP. QUANTITY 59 | P.System Data 1 | | Vphph<br>V2 | Vphph | Opera. Quantity for 59 Overvolt. Prot. |
| 615A | OP. QUANTITY 27 | P.System Data 1 | | V1<br>Vphph | V1 | Opera. Quantity for 27 Undervolt. Prot. |
| 640 | Start image DD | Device, General | | image 1<br>image 2<br>image 3<br>image 4<br>image 5<br>image 6 | image 1 | Start image Default Display |
| 1101 | FullScaleVolt. | P.System Data 2 | | 0.10 .. 800.00 kV | 12.00 kV | Measurem:FullScaleVoltage(Equipm.rating) |
| 1102 | FullScaleCurr. | P.System Data 2 | | 10 .. 50000 A | 100 A | Measurem:FullScaleCurrent(Equipm.rating) |
| 1103 | RG/RL Ratio | P.System Data 2 | | -0.33 .. 7.00 | 1.00 | RG/RL - Ratio of Gnd to Line Resistance |
| 1104 | XG/XL Ratio | P.System Data 2 | | -0.33 .. 7.00 | 1.00 | XG/XL - Ratio of Gnd to Line Reactance |
| 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<br>reversed | not reversed | P,Q operational measured values sign |
| 1201 | FCT 50/51 | 50/51 Overcur. | | ON<br>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<br>Disk Emulation | Disk Emulation | Drop-out characteristic |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 1211 | 51 IEC CURVE | 50/51 Overcur. | | Normal Inverse<br>Very Inverse<br>Extremely Inv.<br>Long Inverse | Normal Inverse | IEC Curve |
| 1212 | 51 ANSI CURVE | 50/51 Overcur. | | Very Inverse<br>Inverse<br>Short Inverse<br>Long Inverse<br>Moderately Inv.<br>Extremely Inv.<br>Definite Inv. | Very Inverse | ANSI Curve |
| 1213A | MANUAL CLOSE | 50/51 Overcur. | | 50-2 instant.<br>50 -1 instant.<br>51 instant.<br>Inactive | 50-2 instant. | Manual Close Mode |
| 1214A | 50-2 active | 50/51 Overcur. | | Always<br>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; ∞<br>0.01 .. 999.00 TD | | 51/51N |
| 1231 | MofPU Res T/Tp | 50/51 Overcur. | | 0.05 .. 0.95 I/Ip; ∞<br>0.01 .. 999.00 TD | | Multiple of Pickup <-> T/Tp |
| 1301 | FCT 50N/51N | 50/51 Overcur. | | ON<br>OFF | ON | 50N, 51N Ground Time Overcurrent |
| 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<br>Disk Emulation | Disk Emulation | Drop-Out Characteristic |
| 1311 | 51N IEC CURVE | 50/51 Overcur. | | Normal Inverse<br>Very Inverse<br>Extremely Inv.<br>Long Inverse | Normal Inverse | IEC Curve |
| 1312 | 51N ANSI CURVE | 50/51 Overcur. | | Very Inverse<br>Inverse<br>Short Inverse<br>Long Inverse<br>Moderately Inv.<br>Extremely Inv.<br>Definite Inv. | Very Inverse | ANSI Curve |
| 1313A | MANUAL CLOSE | 50/51 Overcur. | | 50N-2 instant.<br>50N-1 instant.<br>51N instant.<br>Inactive | 50N-2 instant. | Manual Close Mode |
| 1314A | 50N-2 active | 50/51 Overcur. | | Always<br>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; ∞<br>0.01 .. 999.00 TD | | 50N/51N |
| 1331 | MofPU Res T/TEp | 50/51 Overcur. | | 0.05 .. 0.95 I/Ip; ∞<br>0.01 .. 999.00 TD | | Multiple of Pickup <-> T/TEp |
| 1501 | FCT 67/67-TOC | 67 Direct. O/C | | OFF<br>ON | OFF | 67, 67-TOC Phase Time Overcurrent |
| 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 | |

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| 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<br>Disk Emulation | Disk Emulation | Drop-Out Characteristic |
| 1511 | 67- IEC CURVE | 67 Direct. O/C | | Normal Inverse<br>Very Inverse<br>Extremely Inv.<br>Long Inverse | Normal Inverse | IEC Curve |
| 1512 | 67- ANSI CURVE | 67 Direct. O/C | | Very Inverse<br>Inverse<br>Short Inverse<br>Long Inverse<br>Moderately Inv.<br>Extremely Inv.<br>Definite Inv. | Very Inverse | ANSI Curve |
| 1513A | MANUAL CLOSE | 67 Direct. O/C | | 67-2 instant.<br>67-1 instant.<br>67-TOC instant.<br>Inactive | 67-2 instant. | Manual Close Mode |
| 1514A | 67 active | 67 Direct. O/C | | with 79 active<br>always | always | 67 active |
| 1516 | 67 Direction | 67 Direct. O/C | | Forward<br>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; ∞<br>0.01 .. 999.00 TD | | 67 |
| 1531 | MofPU Res T/Tp | 67 Direct. O/C | | 0.05 .. 0.95 I/Ip; ∞<br>0.01 .. 999.00 TD | | Multiple of Pickup <-> T/Tp |
| 1601 | FCT 67N/67N-TOC | 67 Direct. O/C | | OFF<br>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<br>Disk Emulation | Disk Emulation | Drop-Out Characteristic |
| 1611 | 67N-TOC IEC | 67 Direct. O/C | | Normal Inverse<br>Very Inverse<br>Extremely Inv.<br>Long Inverse | Normal Inverse | IEC Curve |
| 1612 | 67N-TOC ANSI | 67 Direct. O/C | | Very Inverse<br>Inverse<br>Short Inverse<br>Long Inverse<br>Moderately Inv.<br>Extremely Inv.<br>Definite Inv. | Very Inverse | ANSI Curve |
| 1613A | MANUAL CLOSE | 67 Direct. O/C | | 67N-2 instant.<br>67N-1 instant.<br>67N-TOC instant<br>Inactive | 67N-2 instant. | Manual Close Mode |
| 1614A | 67N active | 67 Direct. O/C | | always<br>with 79 active | always | 67N active |
| 1616 | 67N Direction | 67 Direct. O/C | | Forward<br>Reverse | Forward | Ground Direction |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 1617 | 67N POLARIZAT. | 67 Direct. O/C | | with VN and IN<br>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; ∞<br>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; ∞<br>0.01 .. 999.00 TD | | 67N TOC |
| 1701 | COLDLOAD PICKUP | ColdLoadPickup | | OFF<br>ON | OFF | Cold-Load-Pickup Function |
| 1702 | Start Condition | ColdLoadPickup | | No Current<br>Breaker Contact<br>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 |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 2201 | INRUSH REST. | 50/51 Overcur. | | OFF<br>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<br>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<br>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<br>ON<br>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<br>Reverse<br>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 |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 3122 | 67Ns-1 DIRECT. | Sens. Gnd Fault | | Forward<br>Reverse<br>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<br>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<br>Vgnd AND INs | Vgnd OR INs | Sensitive Ground Fault PICKUP criteria |
| 3131 | M.of PU TD | Sens. Gnd Fault | | 1.00 .. 20.00 MofPU; ∞<br>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<br>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<br>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<br>Very Inverse<br>Extremely Inv. | Extremely Inv. | IEC Curve |
| 4007 | 46 ANSI CURVE | 46 Negative Seq | | Extremely Inv.<br>Inverse<br>Moderately Inv.<br>Very Inverse | Extremely Inv. | ANSI Curve |

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| 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<br>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<br>ON | OFF | 48 / 66 Motor (Startup Monitor/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<br>ON<br>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<br>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<br>ON<br>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<br>ON<br>Alarm Only | OFF | 27 Undervoltage Protection |

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| 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<br>ON | ON | Current Supervision |
| 5301 | FUSE FAIL MON. | Measurem.Superv | | ON<br>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<br>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<br>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<br>NO | NO | ON-Command at V1< and V2> |
| 6108 | SYNC V1>V2< | SYNC function 1 | | YES<br>NO | NO | ON-Command at V1> and V2< |
| 6109 | SYNC V1<V2< | SYNC function 1 | | YES<br>NO | NO | ON-Command at V1< and V2< |
| 6110A | Direct CO | SYNC function 1 | | YES<br>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<br>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) |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 6123 | CONNECTIONof V2 | SYNC function 1 | | A-G<br>B-G<br>C-G<br>A-B<br>B-C<br>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<br>NO | YES | Switching at synchronous conditions |
| 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<br>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<br>NO | NO | ON-Command at V1< and V2> |
| 6208 | SYNC V1>V2< | SYNC function 2 | | YES<br>NO | NO | ON-Command at V1> and V2< |
| 6209 | SYNC V1<V2< | SYNC function 2 | | YES<br>NO | NO | ON-Command at V1< and V2< |
| 6210A | Direct CO | SYNC function 2 | | YES<br>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 Synchronization |
| 6213A | 25 Synchron | SYNC function 2 | | YES<br>NO | YES | Switching at synchronous condition |
| 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 |

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| 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<br>B-G<br>C-G<br>A-B<br>B-C<br>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<br>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<br>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<br>NO | NO | ON-Command at V1< and V2> |
| 6308 | SYNC V1>V2< | SYNC function 3 | | YES<br>NO | NO | ON-Command at V1> and V2< |
| 6309 | SYNC V1<V2< | SYNC function 3 | | YES<br>NO | NO | ON-Command at V1< and V2< |
| 6310A | Direct CO | SYNC function 3 | | YES<br>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<br>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 |

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| 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<br>B-G<br>C-G<br>A-B<br>B-C<br>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<br>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<br>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<br>NO | NO | ON-Command at V1< and V2> |
| 6408 | SYNC V1>V2< | SYNC function 4 | | YES<br>NO | NO | ON-Command at V1> and V2< |
| 6409 | SYNC V1<V2< | SYNC function 4 | | YES<br>NO | NO | ON-Command at V1< and V2< |
| 6410A | Direct CO | SYNC function 4 | | YES<br>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<br>NO | YES | Switching at synchronous condition |

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| 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<br>B-G<br>C-G<br>A-B<br>B-C<br>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<br>NO | YES | Switching at synchronous conditions |
| 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<br>ON | OFF | 50BF Breaker Failure Protection |
| 7004 | Chk BRK CONTACT | 50BF BkrFailure | | OFF<br>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<br>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<br>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 |

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| 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<br>NO | NO | External 25 synchronisation |
| 7140 | ZONE SEQ.COORD. | 79M Auto Recl. | | OFF<br>ON | OFF | ZSC - Zone sequence coordination |
| 7150 | 50-1 | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 50-1 |
| 7151 | 50N-1 | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 50N-1 |
| 7152 | 50-2 | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 50-2 |
| 7153 | 50N-2 | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 50N-2 |
| 7154 | 51 | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 51 |
| 7155 | 51N | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 51N |
| 7156 | 67-1 | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 67-1 |
| 7157 | 67N-1 | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 67N-1 |
| 7158 | 67-2 | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 67-2 |
| 7159 | 67N-2 | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 67N-2 |
| 7160 | 67 TOC | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 67 TOC |
| 7161 | 67N TOC | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 67N TOC |
| 7162 | sens Ground Flt | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | (Sensitive) Ground Fault |
| 7163 | 46 | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | 46 |
| 7164 | BINARY INPUT | 79M Auto Recl. | | No influence<br>Starts 79<br>Stops 79 | No influence | Binary Input |
| 7165 | 3Pol.PICKUP BLK | 79M Auto Recl. | | YES<br>NO | NO | 3 Pole Pickup blocks 79 |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 7200 | bef.1.Cy:50-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 50-1 |
| 7201 | bef.1.Cy:50N-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 50N-1 |
| 7202 | bef.1.Cy:50-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 50-2 |
| 7203 | bef.1.Cy:50N-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 50N-2 |
| 7204 | bef.1.Cy:51 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 51 |
| 7205 | bef.1.Cy:51N | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 51N |
| 7206 | bef.1.Cy:67-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67-1 |
| 7207 | bef.1.Cy:67N-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67N-1 |
| 7208 | bef.1.Cy:67-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67-2 |
| 7209 | bef.1.Cy:67N-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67N-2 |
| 7210 | bef.1.Cy:67 TOC | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67 TOC |
| 7211 | bef.1.Cy:67NTOC | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 1. Cycle: 67N TOC |
| 7212 | bef.2.Cy:50-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 50-1 |
| 7213 | bef.2.Cy:50N-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 50N-1 |
| 7214 | bef.2.Cy:50-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 50-2 |
| 7215 | bef.2.Cy:50N-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 50N-2 |
| 7216 | bef.2.Cy:51 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 51 |
| 7217 | bef.2.Cy:51N | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 51N |
| 7218 | bef.2.Cy:67-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67-1 |
| 7219 | bef.2.Cy:67N-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67N-1 |
| 7220 | bef.2.Cy:67-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67-2 |
| 7221 | bef.2.Cy:67N-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67N-2 |
| 7222 | bef.2.Cy:67 TOC | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67 TOC |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 7223 | bef.2.Cy:67NTOC | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 67N TOC |
| 7224 | bef.3.Cy:50-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 50-1 |
| 7225 | bef.3.Cy:50N-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 50N-1 |
| 7226 | bef.3.Cy:50-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 50-2 |
| 7227 | bef.3.Cy:50N-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 50N-2 |
| 7228 | bef.3.Cy:51 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 51 |
| 7229 | bef.3.Cy:51N | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 51N |
| 7230 | bef.3.Cy:67-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67-1 |
| 7231 | bef.3.Cy:67N-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67N-1 |
| 7232 | bef.3.Cy:67-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67-2 |
| 7233 | bef.3.Cy:67N-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67N-2 |
| 7234 | bef.3.Cy:67 TOC | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67 TOC |
| 7235 | bef.3.Cy:67NTOC | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 3. Cycle: 67N TOC |
| 7236 | bef.4.Cy:50-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 50-1 |
| 7237 | bef.4.Cy:50N-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 50N-1 |
| 7238 | bef.4.Cy:50-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 50-2 |
| 7239 | bef.4.Cy:50N-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 50N-2 |
| 7240 | bef.4.Cy:51 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 51 |
| 7241 | bef.4.Cy:51N | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 51N |
| 7242 | bef.4.Cy:67-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67-1 |
| 7243 | bef.4.Cy:67N-1 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67N-1 |
| 7244 | bef.4.Cy:67-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67-2 |
| 7245 | bef.4.Cy:67N-2 | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67N-2 |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 7246 | bef.4.Cy:67 TOC | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67 TOC |
| 7247 | bef.4.Cy:67NTOC | 79M Auto Recl. | | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 4. Cycle: 67N TOC |
| 8001 | START | Fault Locator | | Pickup<br>TRIP | Pickup | Start fault locator with |
| 8101 | MEASURE. SUPERV | Measurem.Superv | | OFF<br>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<br>OFF | ON | 74TC TRIP Circuit Supervision |
| 8301 | DMD Interval | Demand meter | | 15 Min., 1 Sub<br>15 Min., 3 Subs<br>15 Min.,15 Subs<br>30 Min., 1 Sub<br>60 Min., 1 Sub<br>60 Min.,10 Subs<br>5 Min., 5 Subs | 60 Min., 1 Sub | Demand Calculation Intervals |
| 8302 | DMD Sync.Time | Demand meter | | On The Hour<br>15 After Hour<br>30 After Hour<br>45 After Hour | On The Hour | Demand Synchronization Time |
| 8311 | MinMax cycRESET | Min/Max meter | | NO<br>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<br>Factor 10<br>Factor 100 | Standard | Meter resolution |
| 9011A | RTD 1 TYPE | RTD-Box | | Not connected<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Pt 100 Ω | RTD 1: Type |
| 9012A | RTD 1 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 2: Type |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 9022A | RTD 2 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 3: Type |
| 9032A | RTD 3 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 4: Type |
| 9042A | RTD 4 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 5: Type |
| 9052A | RTD 5 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 6: Type |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 9062A | RTD 6 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 7: Type |
| 9072A | RTD 7 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 8: Type |
| 9082A | RTD 8 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD 9: Type |
| 9092A | RTD 9 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD10: Type |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 9102A | RTD10 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD11: Type |
| 9112A | RTD11 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>Pt 100 Ω<br>Ni 120 Ω<br>Ni 100 Ω | Not connected | RTD12: Type |
| 9122A | RTD12 LOCATION | RTD-Box | | Oil<br>Ambient<br>Winding<br>Bearing<br>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<br>ON<br>Alarm Only | OFF | Flexible Function |
| 0 | OPERRAT. MODE | Flx | | 3-phase<br>1-phase<br>no reference | 3-phase | Mode of Operation |
| 0 | MEAS. QUANTITY | Flx | | Please select<br>Current<br>Voltage<br>P forward<br>P reverse<br>Q forward<br>Q reverse<br>Power factor<br>Frequency<br>df/dt rising<br>df/dt falling<br>Binray Input | Please select | Selection of Measured Quantity |
| 0 | MEAS. METHOD | Flx | | Fundamental<br>True RMS<br>Positive seq.<br>Negative seq.<br>Zero sequence | Fundamental | Selection of Measurement Method |

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| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 0 | PICKUP WITH | Flx | | Exceeding<br>Dropping below | Exceeding | Pickup with |
| 0 | CURRENT | Flx | | Ia<br>Ib<br>Ic<br>In<br>In sensitive | Ia | Current |
| 0 | VOLTAGE | Flx | | Please select<br>Va-n<br>Vb-n<br>Vc-n<br>Va-b<br>Vb-c<br>Vc-a<br>Vn | Please select | Voltage |
| 0 | POWER | Flx | | Ia Va-n<br>Ib Vb-n<br>Ic Vc-n | Ia Va-n | Power |
| 0 | VOLTAGE SYSTEM | Flx | | Phase-Phase<br>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<br>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 |

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# 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 |

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| 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 |
| - | 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 (ModeLO-CAL) | Cntrl Authority | DP | On Off | * | | | LED | | | BO | | 101 | 86 | 1 | Yes |
| - | Controlmode REMOTE (ModeR-EMOTE) | Cntrl Authority | IntSP | On Off | * | | | LED | | | BO | | | | | |
| - | Control Authority (Cntrl Auth) | Cntrl Authority | IntSP | On Off | * | | | LED | | | BO | | | | | |
| - | Controlmode LOCAL (ModeLO-CAL) | Cntrl Authority | IntSP | On Off | * | | | LED | | | BO | | | | | |
| - | 52 Breaker (52Breaker) | Control Device | CF_D 12 | 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_D 2 | 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_D 2 | 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_D 2 | 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_D 2 | 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_D 2 | 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 | | | | |

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| 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 |
| - | >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 (>ErrCntr-lV) | 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 (SysIn-tErr.) | 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 con-figured) | Device, General | SP | * | * | | | | | | | | | | | |
| 2 | Function Not Available (Non Exis-tent) | 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 Pro-tecting (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 | | | | | |

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| 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 | | | | | | | |

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| 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 |
| 170.0043 | >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 | | | | | | | |

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| 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 |
| 170.2011 | >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 | | | | | |

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| 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 | | | | | |

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| 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 |
| 170.2032 | 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 | | | | | |

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| 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 |
| 170.2039 | 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 $\alpha$2>$\alpha$1) | SYNC function 1 | OUT | On Off | | | * | LED | | | BO | | | | | |
| 170.2094 | 25 alphadiff too large (a2>a1) (25 $\alpha$2>$\alpha$1) | SYNC function 2 | OUT | On Off | | | * | LED | | | BO | | | | | |
| 170.2094 | 25 alphadiff too large (a2>a1) (25 $\alpha$2>$\alpha$1) | SYNC function 3 | OUT | On Off | | | * | LED | | | BO | | | | | |
| 170.2094 | 25 alphadiff too large (a2>a1) (25 $\alpha$2>$\alpha$1) | SYNC function 4 | OUT | On Off | | | * | LED | | | BO | | | | | |
| 170.2095 | 25 alphadiff too large (a2<a1) (25 $\alpha$2<$\alpha$1) | SYNC function 1 | OUT | On Off | | | * | LED | | | BO | | | | | |
| 170.2095 | 25 alphadiff too large (a2<a1) (25 $\alpha$2<$\alpha$1) | SYNC function 2 | OUT | On Off | | | * | LED | | | BO | | | | | |
| 170.2095 | 25 alphadiff too large (a2<a1) (25 $\alpha$2<$\alpha$1) | SYNC function 3 | OUT | On Off | | | * | LED | | | BO | | | | | |

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| 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 |
| 170.2095 | 25 alphadiff too large (a2<a1) (25 $\alpha$2<$\alpha$1) | 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 | | | | | |

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| 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 | | | | | |

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| No. | Description | Function | Type of Information | Log Buffers | | | | Configurable in Matrix | | | | | IEC 60870-5-103 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Event Log ON/OFF | Trip (Fault) Log ON/OFF | Ground Fault Log ON/OFF | Marked in Oscill. Record | LED | Binary Input | Function Key | Relay | Chatter Suppression | Type | Information Number | Data Unit | General Interrogation |
| 235.2125 | 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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| 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 |
| 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 | | | | | | | | | | | | | |

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| 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 |
| 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 | | | | | | | | | | |

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| 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 |

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| 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 |
| 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 |

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| 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 |
| 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 |

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| 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 |
| 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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| 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 |
| 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 coordination ON (>ZSC ON) | 79M Auto Recl. | SP | On Off | * | | * | LED | BI | | BO | | | | | |
| 2723 | >Switch zone sequence coordination OFF (>ZSC OFF) | 79M Auto Recl. | SP | On Off | * | | * | LED | BI | | BO | | | | | |
| 2730 | >Circuit breaker READY for reclosing (>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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| 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 |
| 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 Suc-cessful) | 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 se-quence (79 L-N Sequence) | 79M Auto Recl. | OUT | * | on | | * | LED | | | BO | | 40 | 180 | 2 | Yes |
| 2879 | 79-A/R multi-phase reclosing se-quence (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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| 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 |
| 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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| 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 |
| 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 | | | | | | | | | | | |

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| 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 |

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| 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 enabled) | 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 (Intermitt.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 InRushPU) | 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 InRushPU) | 50/51 Overcur. | OUT | * | On Off | | * | LED | | | BO | | 60 | 82 | 2 | Yes |
| 7554 | 51N InRush picked up (51N InRushPU) | 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 |

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| 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 |
| 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 InRushPU) | 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 | | | | | |

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| 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 | | | | | |

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| 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 | * | | | | | | | | | | | | |

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## A.10 Group Alarms

| No. | Description | Function No.[1)] | Description[1)] |
|---|---|---|---|
| 140 | Error Sum Alarm | 144 | Error 5V |
| | | 145 | Error 0V |
| | | 146 | Error -5V |
| | | 147 | Error PwrSupply |
| | | 177 | Fail Battery |
| | | 178 | I/O-Board error |
| | | 183 | Error Board 1 |
| | | 184 | Error Board 2 |
| | | 185 | Error Board 3 |
| | | 186 | Error Board 4 |
| | | 187 | Error Board 5 |
| | | 188 | Error Board 6 |
| | | 189 | Error Board 7 |
| | | 191 | Error Offset |
| | | 193 | Alarm NO calibr |
| 160 | Alarm Sum Event | 162 | Failure Σ I |
| | | 163 | Fail I balance |
| | | 167 | Fail V balance |
| | | 175 | Fail Ph. Seq. I |
| | | 176 | Fail Ph. Seq. V |
| | | 264 | Fail: RTD-Box 1 |
| | | 267 | Fail: RTD-Box 2 |
| 161 | Fail I Superv. | 162 | Failure Σ I |
| | | 163 | Fail I balance |
| 171 | Fail Ph. Seq. | 175 | Fail Ph. Seq. I |
| | | 176 | Fail Ph. Seq. V |

1) The allocation of the individual alarms to the group alarms indicated here applies starting from firmware version V4.62.

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# 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 | | | |

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| 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 |

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| 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 |

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| 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 |
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■

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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


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# 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.

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**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

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**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.

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**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.

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**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.

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**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.

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**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.

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**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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