# SIPROTEC

# Multi-functional Protective Relay with Bay Controller 7SJ61

V4.6

Manual



C53000-G1140-C118-8

**Disclaimer of liability**

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

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

We reserve the right to make technical improvements without notice.

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Release 4.60.03

# Preface

**Purpose of this Manual**

This manual describes the functions, operation, installation, and commissioning of the device 7SJ61. 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 Bay Controller 7SJ61; firmware version V4.6.

**Indication of Conformity**

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 89/336/EEC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 73/23 EEC).
This conformity is proved by tests conducted by Siemens AG in accordance with 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 the low-voltage directive.
This device is designed and produced for industrial use.
The product conforms with the international standards of the series IEC 60255 and the German standard VDE 0435.

**Further Standards**

IEEE Std C37.90-*

This product is UL-certified according to the Technical Data:

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 center in Nuremberg.

**Instructions and Warnings**

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

**DANGER**

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

**Warning**

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

**Caution**

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

**Note**

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

## WARNING!

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

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

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

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

**Definition**

QUALIFIED PERSONNEL

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

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

**Typographic and Symbol Conventions**

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

**`Parameter names`**

Designators of configuration or function parameters which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI®), are marked in bold letters 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 Options***

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

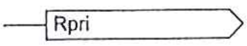
`"Annunciations"`

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

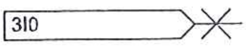
Deviations may be permitted in drawings and tables when the type of designator can be obviously derived from the illustration.

The following symbols are used in drawings:

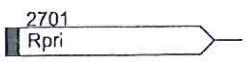
Device-internal logical input signal



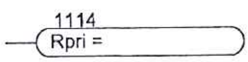
Device-internal logical output signal



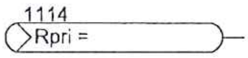
Internal input signal of an analog quantity



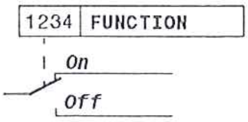
External binary input signal with number (binary input, input indication)



External binary output signal with number (device indication)

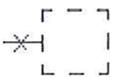



External binary output signal with number (device indication) used as input signal

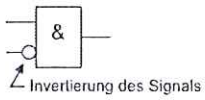



Example of a parameter switch designated **FUNCTION** with address 1234 and the possible settings **ON** and **OFF**

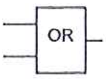
Besides these, graphical symbols are used according to IEC 60617-12 and IEC 60617-13 or symbols derived from these standards. Some of the most frequently used are listed below:



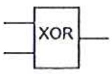
Input signal of an analogue quantity



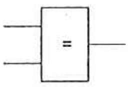

AND gate



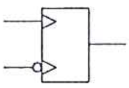

OR gate



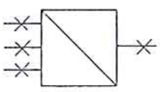

Exclusive OR gate (antivalence): output is active, if only **one** of the inputs is active



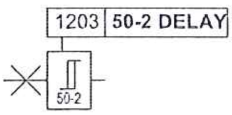

Coincidence gate (equivalence): output is active, if **both** inputs are active or inactive at the same time



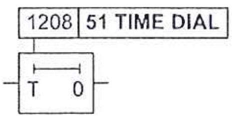
Dynamic inputs (edge-triggered) above with positive, below with negative edge



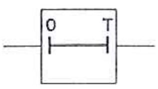
Formation of one analogue output signal from a number of analogue input signals



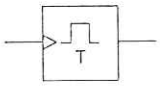

Threshold setting with setting address and parameter names



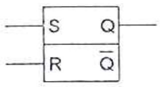

Timer (pickup delay T, example adjustable) with setting address and parameter designator (name)




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 ($\overline{Q}$)

# Contents

# Introduction

# 1

The device SIPROTEC® 7SJ61 is introduced in this section. An overview of the 7SJ61 is presented with its applications areas, characteristics, and scope of functions.

## 1.1 Overall Operation

The digital SIPROTEC® 7SJ61 is 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 shows the basic structure of the device.

**Analog Inputs**

The measuring inputs MI transform the currents derived from the instrument transformers and match them to the internal signal levels for processing in the device. Four current inputs are available in the MI section, three of these are for the 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 ground fault detection $I_{Ns}$). The analog input quantities are passed on to the input amplifiers (IA).

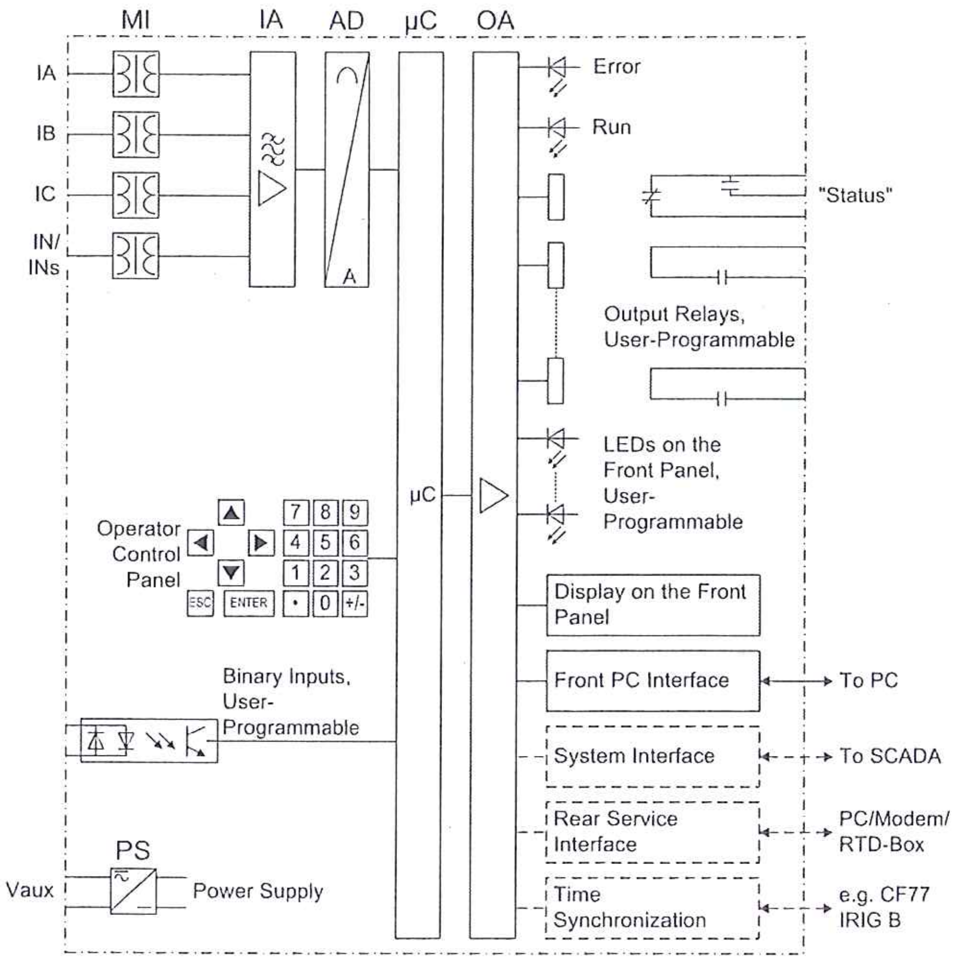



Figure 1-1 Hardware structure of the numerical multi-functional device 7SJ61

The input amplification IA stage provides high-resistance terminations for the analog input quantities. It consists of filters that are optimized 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.

**Microcomputer System**

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

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

**Binary Inputs and Outputs**

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

**Front Elements**

Optical indicators (LEDs) and a front display panel (LC display) provide information on the function of the device, and indicate events, states and measured values.

Integrated control and numeric keys in conjunction with the LCD facilitate local interaction with the 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 device** 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).

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.

**Power Supply**

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

## 1.2 Application Scope

The numerical, multi-functional SIPROTEC® 7SJ61 is a versatile device designed for protection, control, and monitoring of busbar feeders. For line protection, the device can be used in networks with grounded, low resistance grounded, isolated or compensated neutral point. It is suitable for radial systems with single-end infeed or open ring systems. The device is equipped with motor protection applicable to asynchronous machines of all sizes.

The device includes the functions that are necessary for protection, for 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 also 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 currents and ground current. For inverse time overcurrent protective elements, several curves of different standards are provided. Alternatively, user-defined characteristics can be programmed.

Depending on the variant ordered, the overcurrent time protection can feature breaker failure protection and ground fault protection for high-resistence ground short-circuits and faults.

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 negative sequence protection (46), thermal 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. An automatic reclosing system may also be connected externally.

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).

**Control Functions**

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

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

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

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

**Messages and Measured Values; Recording of Event and Fault Data**

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

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

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

**Communication**

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

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

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

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

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

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

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

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

## 1.3 Characteristics

**General Characteristics**

- Powerful 32-bit microprocessor system.
- Complete digital processing and control of measured values, from the sampling of the analog input quantities to the initiation of outputs for, as an example, tripping or closing circuit breakers or other switchgear devices.
- Total galvanical and failure proof isolation 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 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 8 system faults (fault in a network) with real-time information as well as instantaneous values for fault recording for a maximum time range of 5 s.
- Continuous monitoring of measured quantities, as well as continuous self-diagnostics covering the hardware and software.
- Communication with SCADA or substation controller equipment via serial interfaces through the choice of data cable, modem, or optical fibers.
- Battery-buffered clock 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 under load being protected.
- Commissioning aids such as connection check, status indication of all binary inputs and outputs, easy check of system interface and influencing of information of the system interface during test operation.

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

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

**Ground Fault Protection 50N, 51N**

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

**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.

**Negative Sequence Protection 46**

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

**Motor Starting Protection 48**

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

**Motor Start Inhibit 66, 86**

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

**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;
- Supervision of the current transformer secondary circuits by means of sum and symmetry checks.
- Trip circuit monitoring;
- Phase rotation check.

**Ground Fault Detection 50N(s), 51N(s)**

- Ground fault protection optionally with high sensitivity or for large current range;
- Two-element Ground Fault Detection: 50N(s)-1 and 50N(s)-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;
- Optionally applicable as additional ground fault protection.

**Intermittent Ground Fault Protection**

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

**Automatic Reclosing System 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 or instantaneously released depending on the reclosing cycle.

**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.

**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 coordinate the maintenance intervals for CB contacts according to their actual wear;
- Several autonomous subfunctions are implemented ($\Sigma I$ procedure, $\Sigma I^x$ procedure and 2P 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;

**Breaker Control**

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

■

# Functions

# 2

This chapter describes the various functions of the SIPROTEC 4 device 7SJ61. It shows the setting options to each function in maximum configuration and provides information on how to determine the setting values and, if required, formulas.

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

# 2.1 General

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

## 2.1.1 Functions Overview

The 7SJ61 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 activated or deactivated 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 is possible, as described below.

Functions configured as ***Disabled*** are not processed by the 7SJ61. There are no indications, 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 Section 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 /1/.

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

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

**Special Characteristics**

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

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

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

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

For (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***.

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. For 7SJ61 Port C (service port) is used for this purpose. 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 of the RTD-box (see Subsection 2.13.2, "RTD-box").

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 ($\Sigma I$ 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.

Section 2.16.2 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 |
| 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 |
| 170 | 50BF | Disabled<br>Enabled | Disabled | 50BF Breaker Failure Protection |

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 171 | 79 Auto Recl. | Disabled<br>Enabled | Disabled | 79 Auto-Reclose Function |
| 172 | 52 B.WEAR MONIT | Disabled<br>Ix-Method<br>2P-Method | Disabled | 52 Breaker Wear Monitoring |
| 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 |

## 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 7SJ61 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.

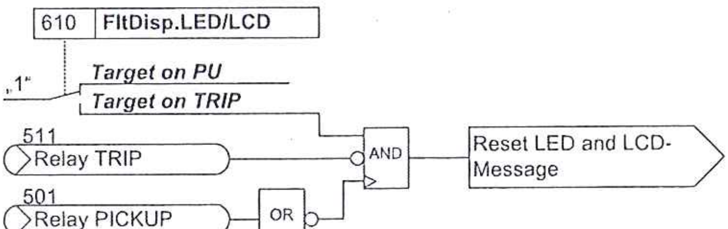



Figure 2-1 Creation of the reset command for the latched LED and LCD messages

### 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*.

**Selection of Default Display**

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

### 2.1.2.3 Settings

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 610 | FltDisp.LED/LCD | Target on PU<br>Target on TRIP | Target on PU | Fault Display on LED / LCD |
| 640 | Start image DD | image 1<br>image 2 | image 1 | Start image Default Display |

### 2.1.2.4 Information List

| No. | Information | Type of In-formation | Comments |
|---|---|---|---|
| - | >Light on | SP | >Back Light on |
| - | Reset LED | IntSP | Reset LED |
| - | DataStop | IntSP | Stop data transmission |
| - | Test mode | IntSP | Test mode |
| - | Feeder gnd | IntSP | Feeder GROUNDED |
| - | Brk OPENED | IntSP | Breaker OPENED |
| - | HWTestMod | IntSP | Hardware Test Mode |
| - | SynchClock | IntSP_Ev | Clock Synchronization |
| - | Error FMS1 | OUT | Error FMS FO 1 |
| - | Error FMS2 | OUT | Error FMS FO 2 |
| - | Distur.CFC | OUT | Disturbance CFC |
| 1 | Not configured | SP | No Function configured |
| 2 | Non Existent | SP | Function Not Available |
| 3 | >Time Synch | SP_Ev | >Synchronize Internal Real Time Clock |
| 5 | >Reset LED | SP | >Reset LED |
| 15 | >Test mode | SP | >Test mode |
| 16 | >DataStop | SP | >Stop data transmission |
| 51 | Device OK | OUT | Device is Operational and Protecting |
| 52 | ProtActive | IntSP | At Least 1 Protection Funct. is Active |
| 55 | Reset Device | OUT | Reset Device |

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 56 | Initial Start | OUT | Initial Start of Device |
| 67 | Resume | OUT | Resume |
| 68 | Clock SyncError | OUT | Clock Synchronization Error |
| 69 | DayLightSavTime | OUT | Daylight Saving Time |
| 70 | Settings Calc. | OUT | Setting calculation is running |
| 71 | Settings Check | OUT | Settings Check |
| 72 | Level-2 change | OUT | Level-2 change |
| 73 | Local change | OUT | Local setting change |
| 110 | Event Lost | OUT_Ev | Event lost |
| 113 | Flag Lost | OUT | Flag Lost |
| 125 | Chatter ON | OUT | Chatter ON |
| 140 | Error Sum Alarm | OUT | Error with a summary alarm |
| 144 | Error 5V | OUT | Error 5V |
| 145 | Error 0V | OUT | Error 0V |
| 146 | Error -5V | OUT | Error -5V |
| 147 | Error PwrSupply | OUT | Error Power Supply |
| 160 | Alarm Sum Event | OUT | Alarm Summary Event |
| 177 | Fail Battery | OUT | Failure: Battery empty |
| 178 | I/O-Board error | OUT | I/O-Board Error |
| 183 | Error Board 1 | OUT | Error Board 1 |
| 184 | Error Board 2 | OUT | Error Board 2 |
| 185 | Error Board 3 | OUT | Error Board 3 |
| 186 | Error Board 4 | OUT | Error Board 4 |
| 187 | Error Board 5 | OUT | Error Board 5 |
| 188 | Error Board 6 | OUT | Error Board 6 |
| 189 | Error Board 7 | OUT | Error Board 7 |
| 191 | Error Offset | OUT | Error: Offset |
| 192 | Error1A/5Awrong | OUT | Error:1A/5Ajumper different from setting |
| 193 | Alarm NO calibr | OUT | Alarm: NO calibration data available |
| 194 | Error neutralCT | OUT | Error: Neutral CT different from MLFB |
| 220 | CT Ph wrong | OUT | Error: Range CT Ph wrong |
| 301 | Pow.Sys.Flt. | OUT | Power System fault |
| 302 | Fault Event | OUT | Fault Event |
| 303 | sens Gnd flt | OUT | sensitive Ground fault |
| 320 | Warn Mem. Data | OUT | Warn: Limit of Memory Data exceeded |
| 321 | Warn Mem. Para. | OUT | Warn: Limit of Memory Parameter exceeded |
| 322 | Warn Mem. Oper. | OUT | Warn: Limit of Memory Operation exceeded |
| 323 | Warn Mem. New | OUT | Warn: Limit of Memory New exceeded |
| 502 | Relay Drop Out | SP | Relay Drop Out |
| 510 | Relay CLOSE | SP | General CLOSE of relay |

## 2.1.3 Power System Data 1

### 2.1.3.1 Description

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

### 2.1.3.2 Setting Notes

**General**

This data can be entered directly at the device: Select the MAIN MENU by pressing the MENU key. The user should use the ▼ key to select **SETTINGS**, and then use the ▶ key to navigate to the SETTINGS display. To obtain the Power System Data display, select the **P.System Data 1** in **SETTINGS** display.

In DIGSI® double-click **Settings** to display the available data. A dialog box will open the option **P.System Data 1** with the tabs Power system, CT's 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 2.14 „Phase Rotation").

**Temperature Unit**

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

**Polarity of Current Transformers**

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

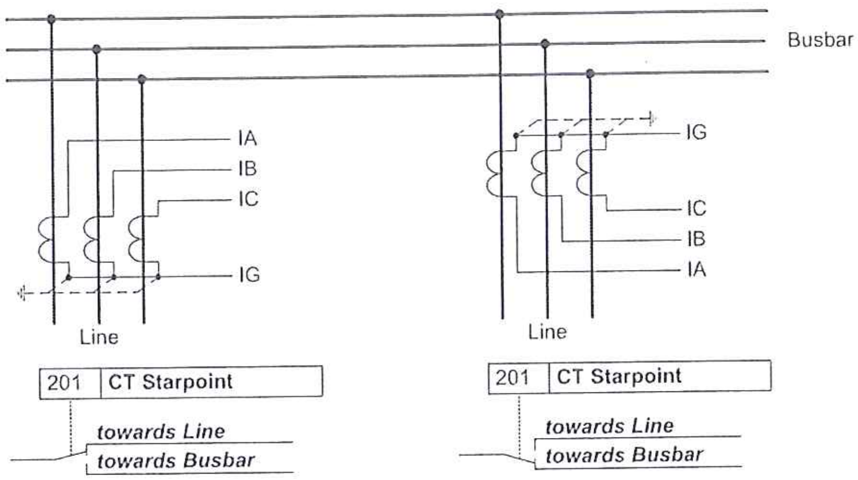



Figure 2-2 Polarity of current transformers

**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 7SJ61 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 0 A 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.

**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 $I_G$–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.

**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 setting value is used by several protective functions (e.g. breaker failure protection, overload protection, and restart inhibit for motors). 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 behavior. 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 2.16.2).

### 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 |
| 204 | CT PRIMARY | | 10 .. 50000 A | 100 A | CT Rated Primary Current |
| 205 | CT SECONDARY | | 1A<br>5A | 1A | CT Rated Secondary Current |
| 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 | |
| 214 | Rated Frequency | | 50 Hz<br>60 Hz | 50 Hz | Rated Frequency |
| 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 |
| 250A | 50/51 2-ph prot | | ON<br>OFF | OFF | 50, 51 Time Overcurrent with 2ph. prot. |
| 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) |

| Addr. | Parameter | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|
| 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 |

### 2.1.3.4 Information List

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

## 2.1.4 Oscillographic Fault Records

The Multi-Functional Protection with Control 7SJ61 is equipped with a fault record memory. The instantaneous values of the measured quantities

$i_A$, $i_B$, $i_C$, $i_N$ or $i_{Ns}$

are scanned at intervals of 1.25 ms (for 50 Hz) or 1.04 ms (for 60 Hz), and stored in a ring buffer (16 samples per cycle). For a fault, the data is recorded for a set period of time, but not for more than 5 seconds. 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 previous acknowledgments is required. The fault record buffer can also be started with protection pickup, via binary input, operator interface or serial interface.

### 2.1.4.1 Description

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

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

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

### 2.1.4.2 Setting Notes

**Configuration**

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

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

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

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

### 2.1.4.3 Settings

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 401 | WAVEFORMTRIGGER | Save w. Pickup<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 |

### 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 different applications 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 7SJ61 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 3.1.1 of this manual tells you how to change between several setting groups externally via binary inputs.

#### 2.1.5.3 Settings

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 302 | CHANGE | Group A<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 |

### 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 address 1102 `FullScaleCurr.`, the primary reference current (phase) of the protected equipment is entered (e.g. motors). If this reference variable matches the primary value of the current transformer, it is equivalent to the setting at Address 204 (Section 2.1.3.2). They are generally used to show values as a percentage of full scale.

**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 value 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. Therefore the setting value should not be set unnecessarily low since it limits the operating range of the overload protection for high currents during operation.

### 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 |
|---|---|---|---|---|---|
| 1102 | FullScaleCurr. | | 10 .. 50000 A | 100 A | Measurem:FullScaleCurrent(Equipm.rating) |
| 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 | |

### 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 |

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 16027 | 52WL.blk I PErr | OUT | 52 Breaker Wear Logic blk Ir-CB>=Isc-CB |
| 16028 | 52WL.blk n PErr | OUT | 52 Breaker W.Log.blk SwCyc.Isc>=SwCyc.Ir |

## 2.1.7 EN100-Module

### 2.1.7.1 Functional Description

The `EN100-Module` enables integration of the 7SJ61 in 100-MBit communication networks in control and automation systems with the protocols according to IEC 61850 standard. This standard permits continuous communication of the devices without gateways and protocol converters. Even when installed in heterogeneous environments, SIPROTEC 4 relays therefore provide for open and interoperable operation. Besides control system integration, this interface enables DIGSI-communication and inter-relay communication via GOOSE.

### 2.1.7.2 Setting Notes

**Interface Selection**

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

### 2.1.7.3 Information List

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

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

General time overcurrent protection is the main protective function of the 7SJ61 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 $I_G$ 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 elements enabled in the device may be blocked individually 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 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.

Pickup and delay settings may be quickly adapted to system requirements via dynamic setting swapping (see Section 2.3).

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

The following table gives an overview of the interconnection to other functions of 7SJ61.

Table 2-1 Interconnection to other functions

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

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

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

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

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

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

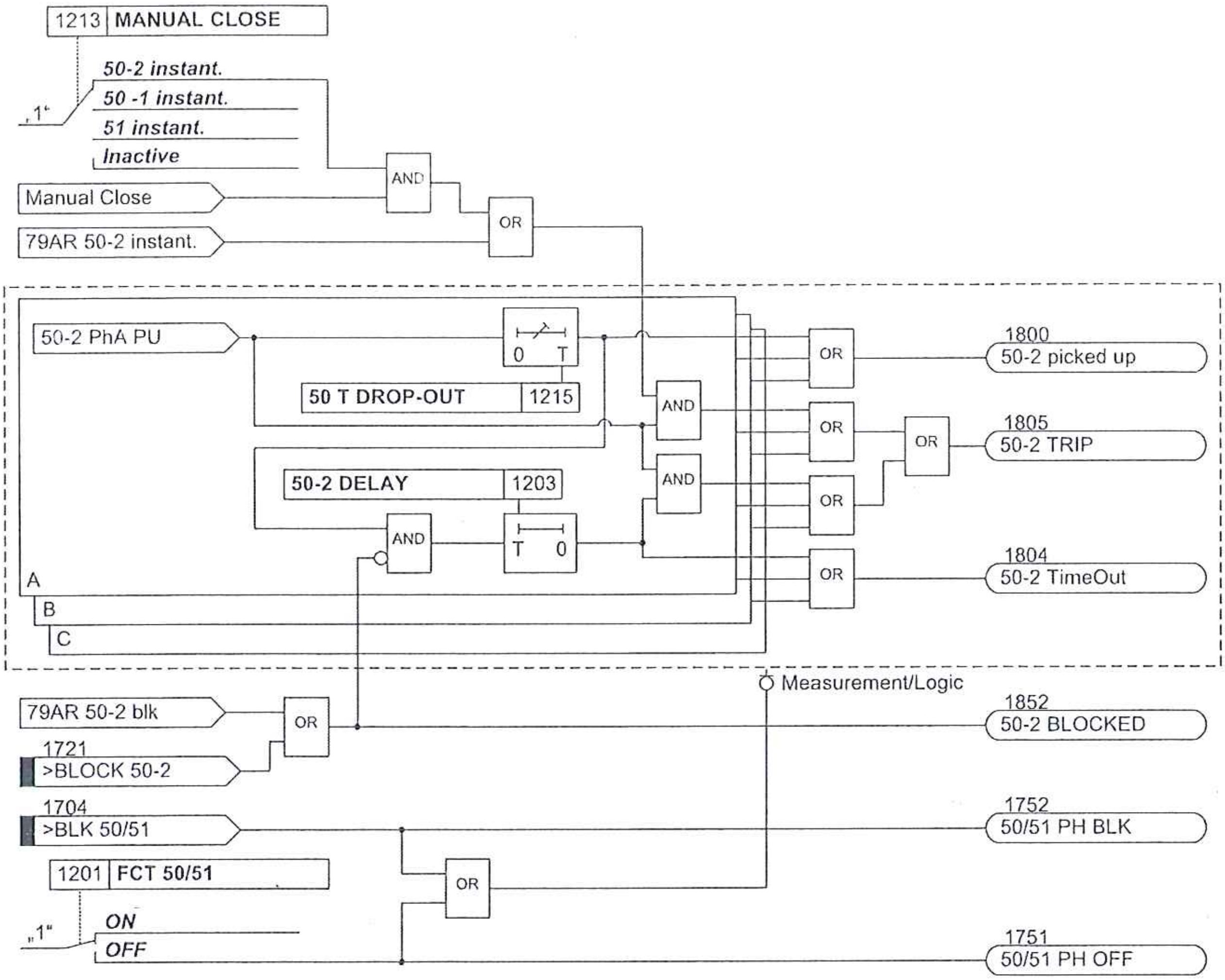



Figure 2-3 Logic diagram of the 50-2 high-current element for phases

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

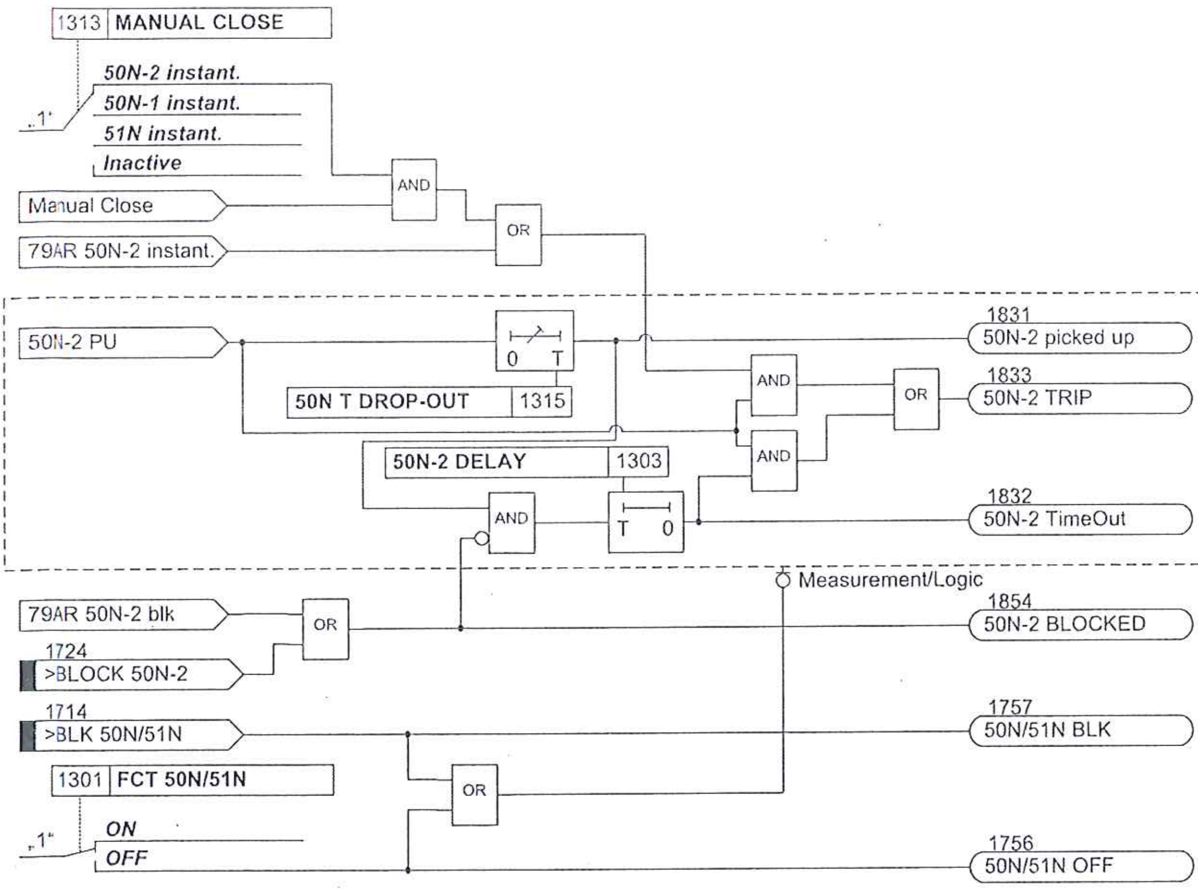



Figure 2-4 Logic diagram of the 50N-2 high-current element for ground

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

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

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

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

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

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

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

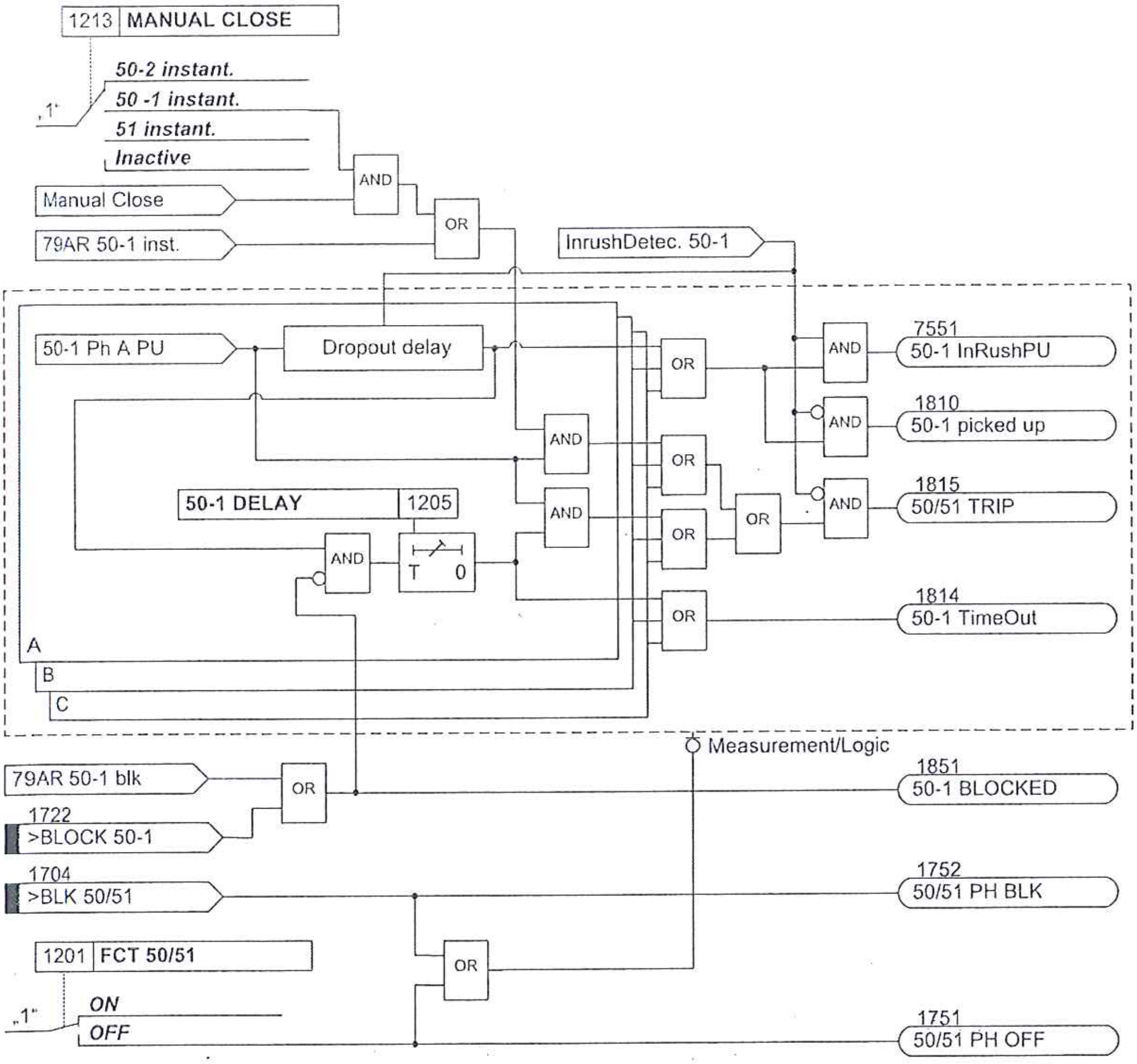



Figure 2-5 Logic diagram of the 50-1 current element for phases

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

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

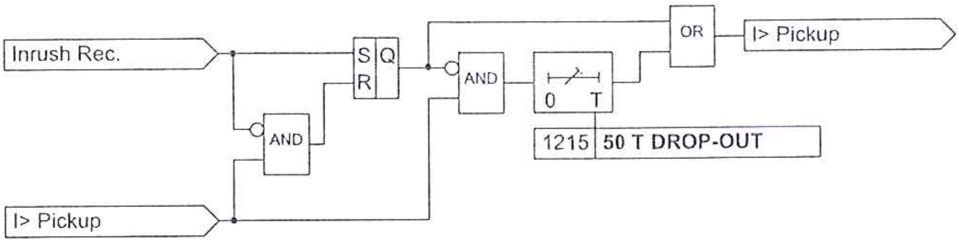



Figure 2-6 Logic of the dropout delay for 50-1 phase current element

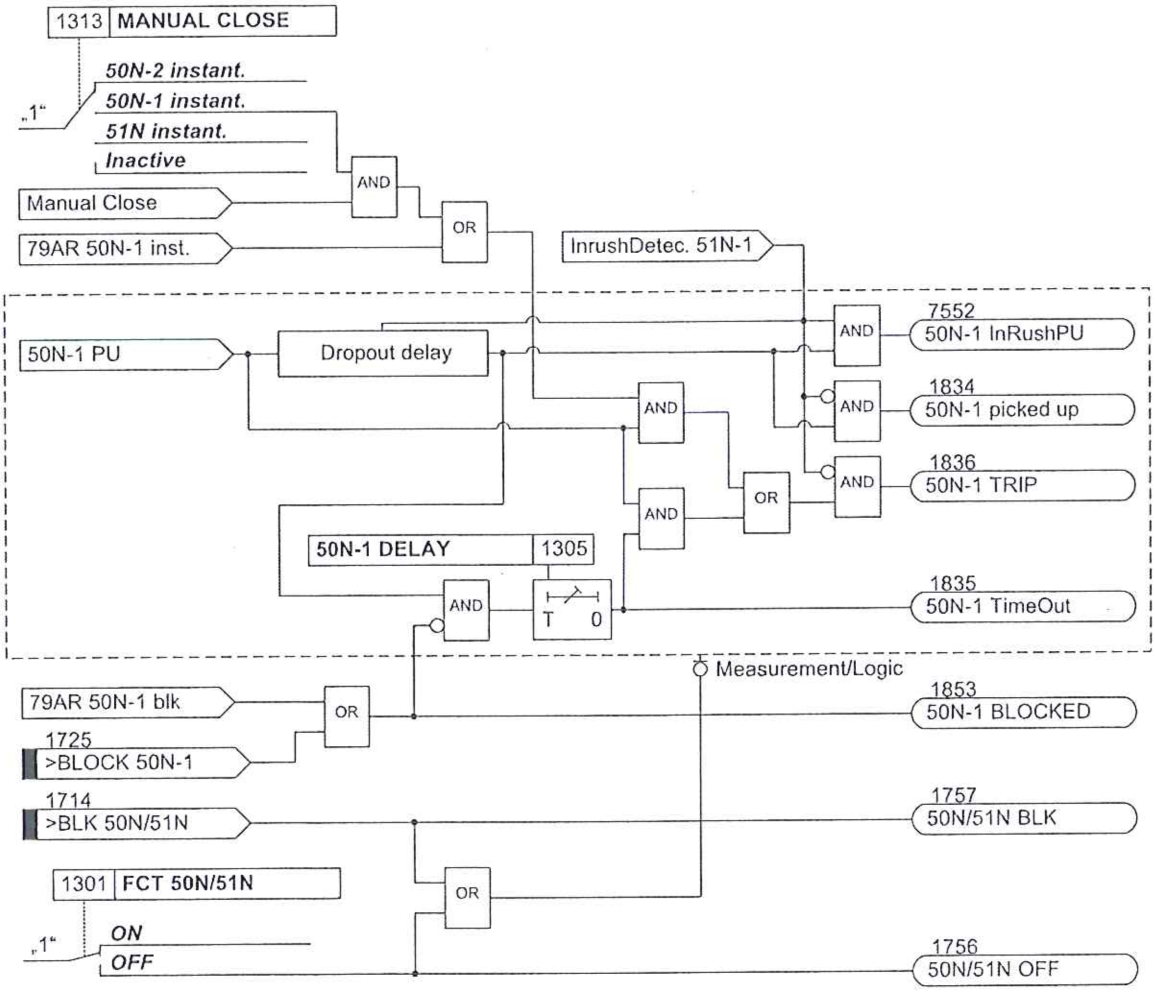



Figure 2-7 Logic diagram of the 50N-1 current element for ground

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

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

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

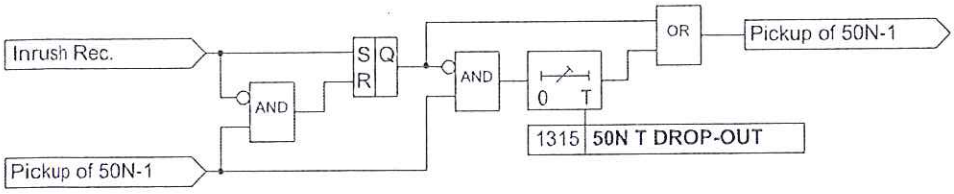



Figure 2-8 Logic of the dropout delay for 50N-1 ground current element

## 2.2.4 Inverse Time Overcurrent Elements 51, 51N

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

**Pickup Behavior**

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

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

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

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

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

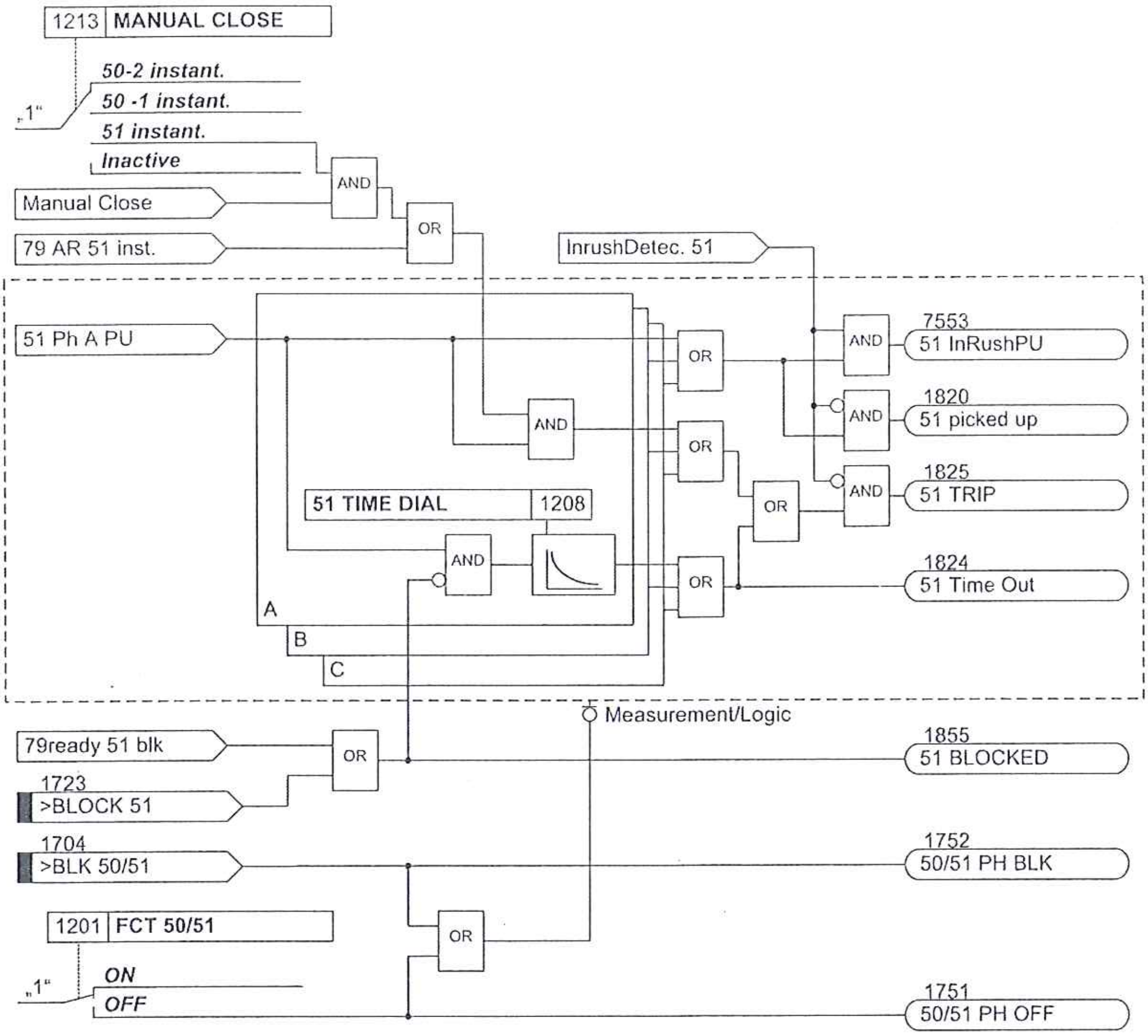



Figure 2-9 Logic diagram of the 51 current element for phases

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

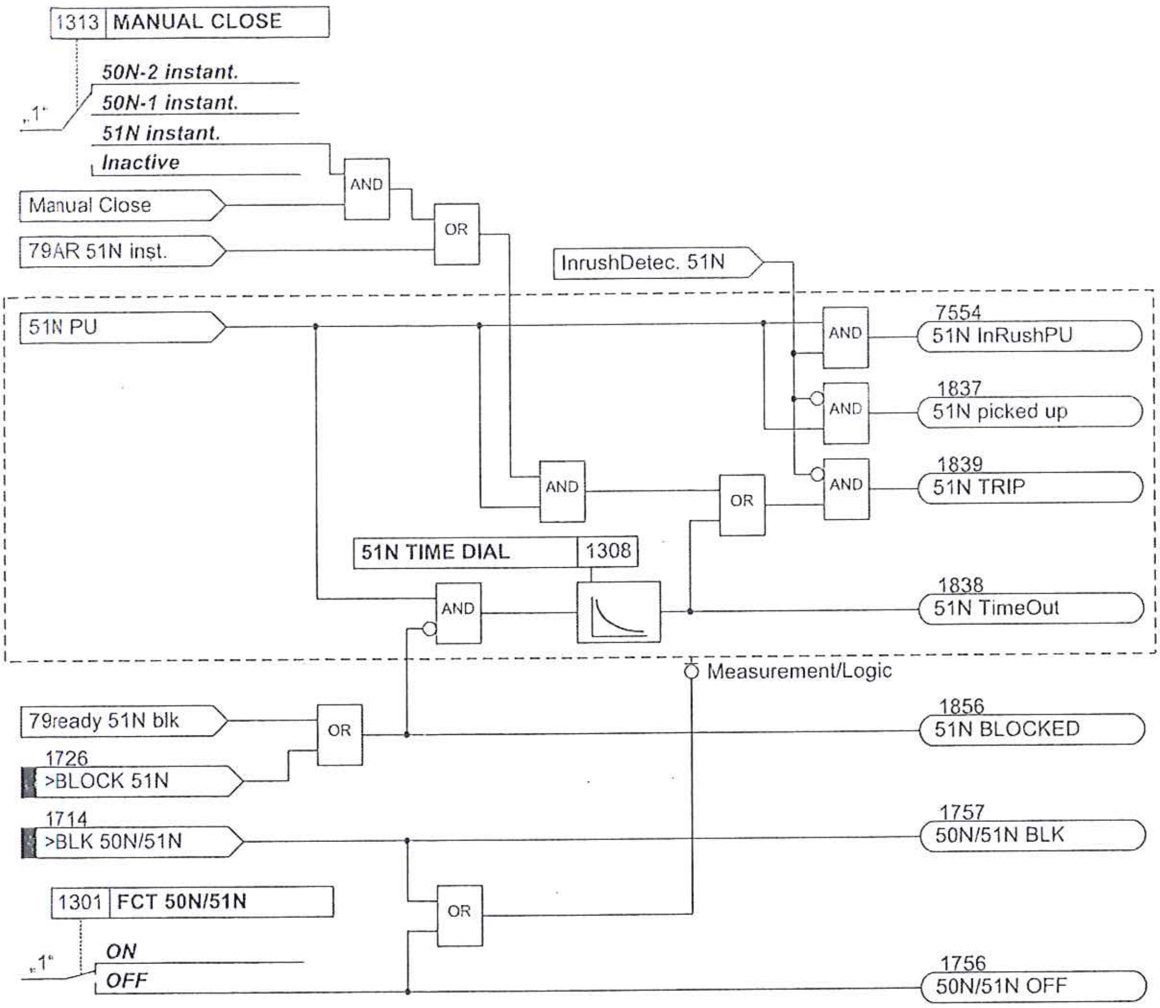



Figure 2-10 Logic diagram of the 51N current element for ground

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

### Dropout Behavior

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

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

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

**User Defined Curves**

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

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

### 2.2.5 Dynamic Cold Load Pickup Function

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

This dynamic pickup value changeover is common to all overcurrent elements and is described in Section 2.3. The alternative pickup values can be set individually for each element of the time overcurrent protection.

### 2.2.6 Inrush Restraint

If the multi-functional protective relay 7SJ61 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 7SJ61 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 all non-directional overcurrent relay 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 (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, numerical filters are used to conduct a Fourier analysis of all three phase currents and the ground current.

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

- The harmonic content is larger than the setting value 2202 **2nd HARMONIC**;
- the currents do not exceed an upper limit value 2205 **I Max**;
- the current of the affected element has exceeded the pickup value.

  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 even 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 are blocked (the so-called **CROSS BLOCK** function, address 2203), if the permissible harmonic component of the current is exceeded for only one phase.

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

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

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

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

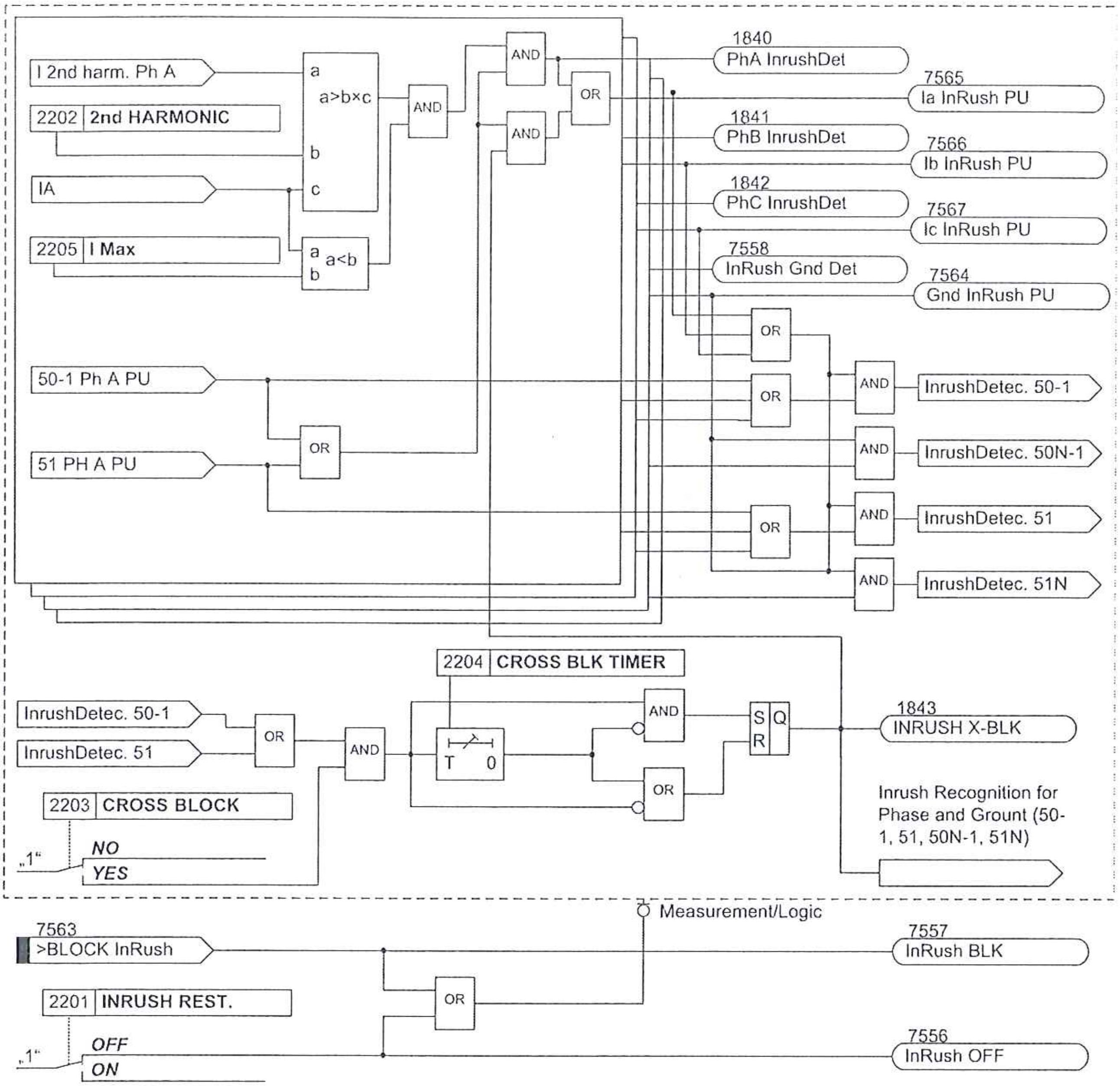



Figure 2-11 Logic diagram for inrush restraint

## 2.2.7 Pickup Logic and Tripping Logic

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

Table 2-2 Pickup annunciations of the time overcurrent protection

| Internal Annunciation | Figure | Output Annunciation | FNo. |
|---|---|---|---|
| 50-2 Ph A PU (Phase A, pickup)<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.

## 2.2.8 Two-phase Time Overcurrent Protection

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 section.

If 250 `50/51 2-ph prot` (can be configured at `P.System Data 1`) is set to ***ON***, $I_B$ will not be used for threshold comparison. No pickup will take place in case of a simple ground fault in B. A double ground fault is assumed only when picking up on A or C. The element picks up and trips after the delay time has expired.

**Note**

If inrush detection is activated and inrush takes place on B only, the other phases will not be cross-blocked. If, however, inrush with cross-blocking takes place on A or C, phase B will be blocked equally.

## 2.2.9 Busbar Protection by Use of Reverse Interlocking

**Application Example**

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

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

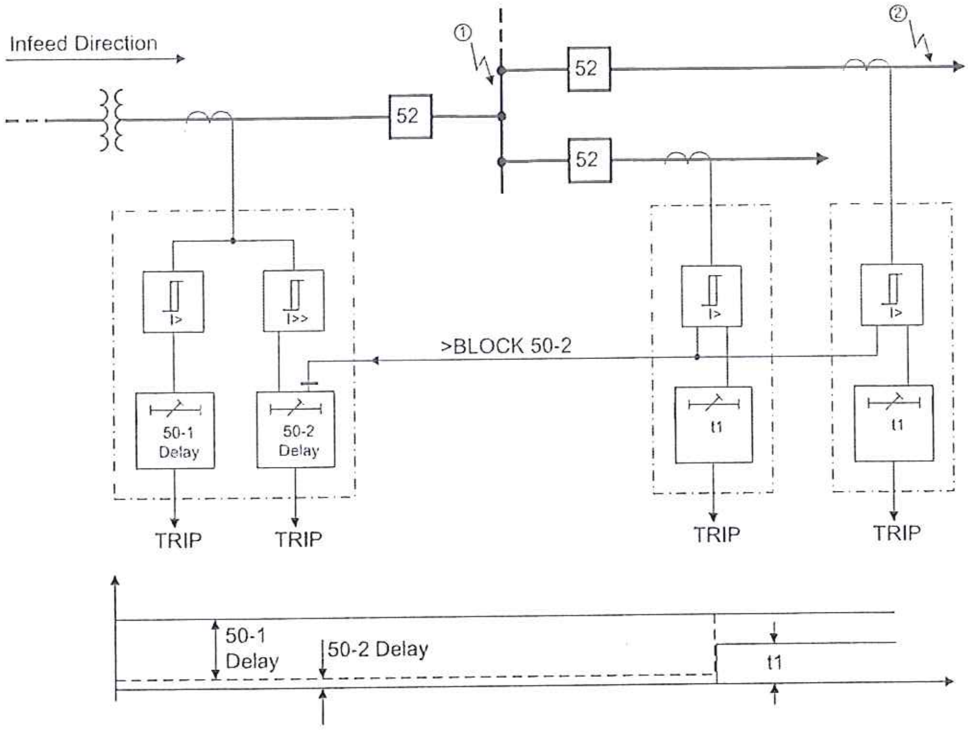



Figure 2-12 Reverse interlocking protection scheme

## 2.2.10 Setting Notes

**General**

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

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

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

**50-2 Element**

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

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

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

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

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

The nominal current of the transformer is:

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

Due to the following definition

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

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

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

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

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

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

The principle of the "reverse interlocking" utilizes the multi-element function of the time overcurrent protection: element 50–2 is used as accelerated busbar protection with a short safety delay **50-2 DELAY** (e.g. 50 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 7SJ61 may be used for the 50N–1 relay element. It can be enabled or disabled for both the phase current and the ground current in address 2201 **INRUSH REST.**. The characteristic values of the inrush restraint are listed in Subsection "Inrush Restraint".

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

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

**Pickup Stabilization (Definite Time)**

The dropout times 1215 `50 T DROP-OUT` or 1315 `50N T DROP-OUT` can be set to implement a uniform dropout behavior 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 characteristics will also be available.

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

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

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

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

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

**51N Element with IEC or ANSI Characteristics**

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

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

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

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

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

**User Defined Characteristics (Phases and ground)**

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

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

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

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

**The following must be observed:**

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

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

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

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

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

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

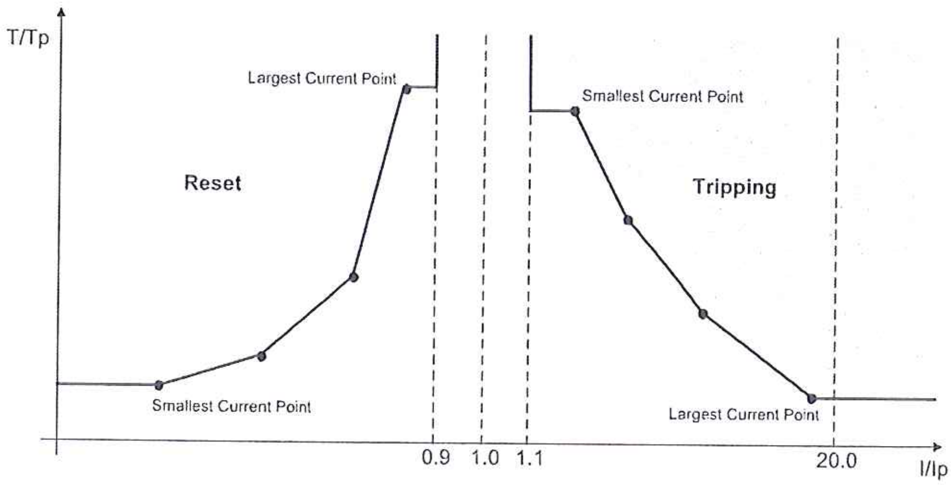



Figure 2-13 Using a user-defined curve

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

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

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

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

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

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

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

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

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

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

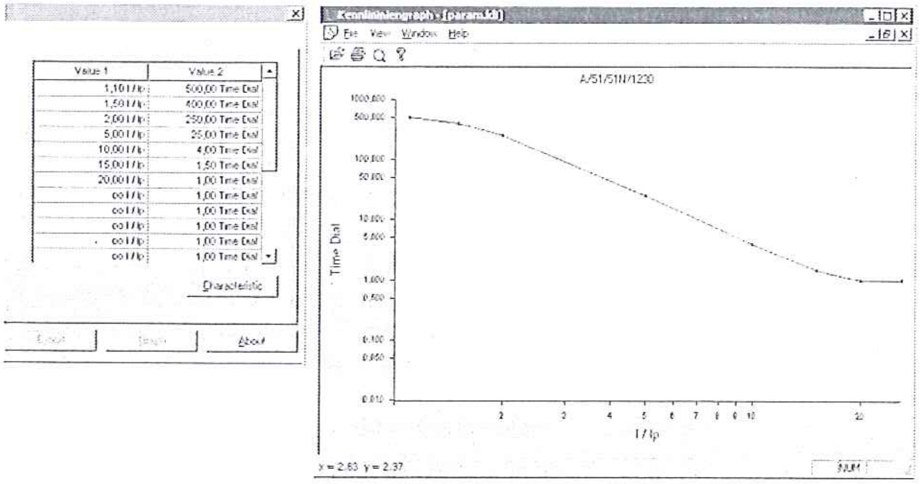


Figure 2-14 Inputting and visualizing a user-defined trip curve with DIGSI® – Example

**Inrush Restraint**

When applying the protection device to transformers where high inrush currents are to be expected, the 7SJ61 can make use of an inrush restraint function for the overcurrent elements 50–1, 51, 50N-1 and 51N as well as the non-directional overcurrent elements.

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

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

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

If the current exceeds the value set in address 2205 **I Max**, no further restraint will take place for the 2nd harmonic.

**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 7SJ61 relay, that is, neither sent via the built-in operator interface nor via a series interface, but, rather, directly from a control discrepancy switch, this signal must be passed to a 7SJ61 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).

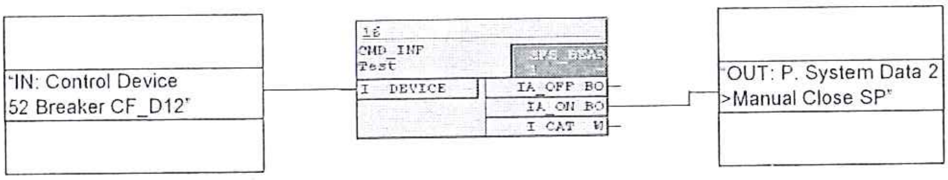



Figure 2-15 Example for manual close feature using the internal control function

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**Note**

For an interaction between the automatic reclosure (AR) and the control function, an extended CFC logic is necessary. See margin heading "CLOSE command: Directly or via control" in the Setting Notes of the AR function (Section 2.11.6).

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**Interaction with Automatic Reclosure Function (Phases)**

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

The integrated automatic reclosing function of 7SJ61 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 2.11).

**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 7SJ61 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 2.11).

## 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 |
| 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 |

| Addr. | Parameter | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|
| 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 |
| 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 |

| Addr. | Parameter | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|
| 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 In-formation | 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 |
| 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 |

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 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 |
| 7563 | >BLOCK InRush | SP | >BLOCK InRush |
| 7564 | Gnd InRush PU | OUT | Ground InRush picked up |
| 7565 | Ia InRush PU | OUT | Phase A InRush picked up |
| 7566 | Ib InRush PU | OUT | Phase B InRush picked up |
| 7567 | Ic InRush PU | OUT | Phase C InRush picked up |

# 2.3 Dynamic Cold Load Pickup

With the cold load pickup function, pickup and delay settings of 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.

## 2.3.1 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 2.11).
- 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 2-17 shows the logic diagram for dynamic cold load pickup function.

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

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

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

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

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

Figure 2-16 illustrates the timing sequence. Figure 2-17 shows the logic diagram of the dynamic cold load pickup feature.

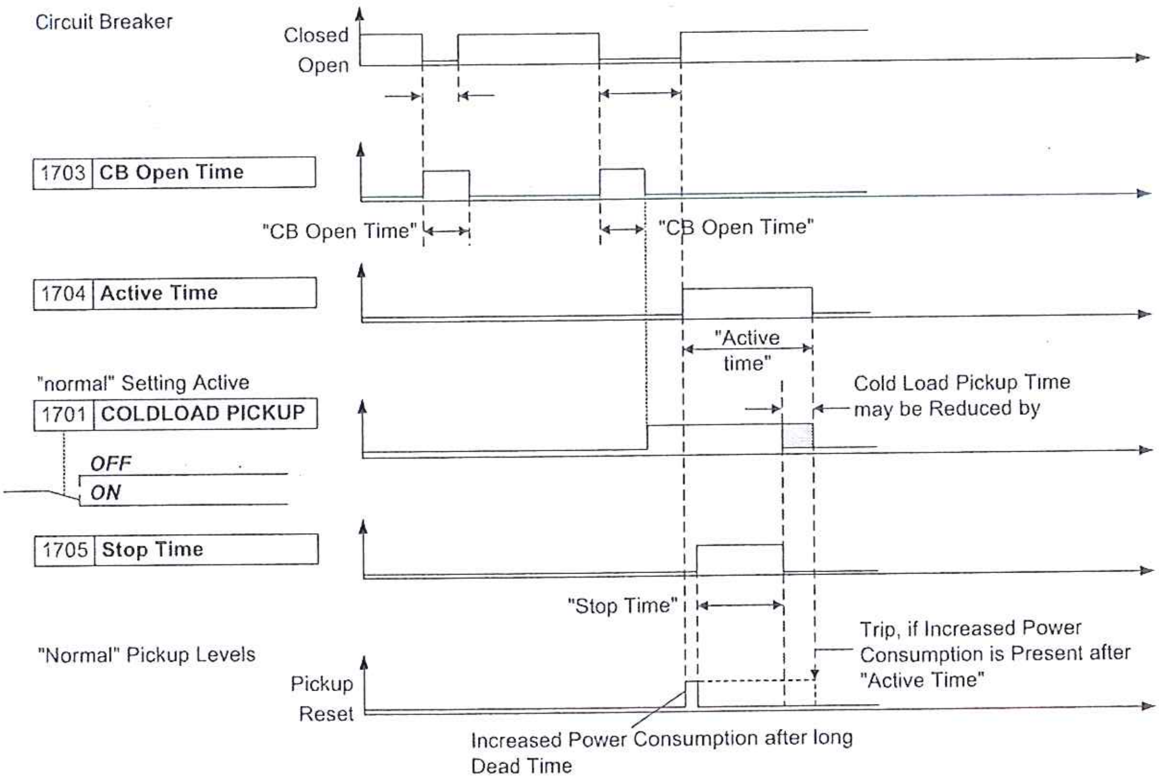


Figure 2-16 Timing charts of the dynamic cold load pickup function

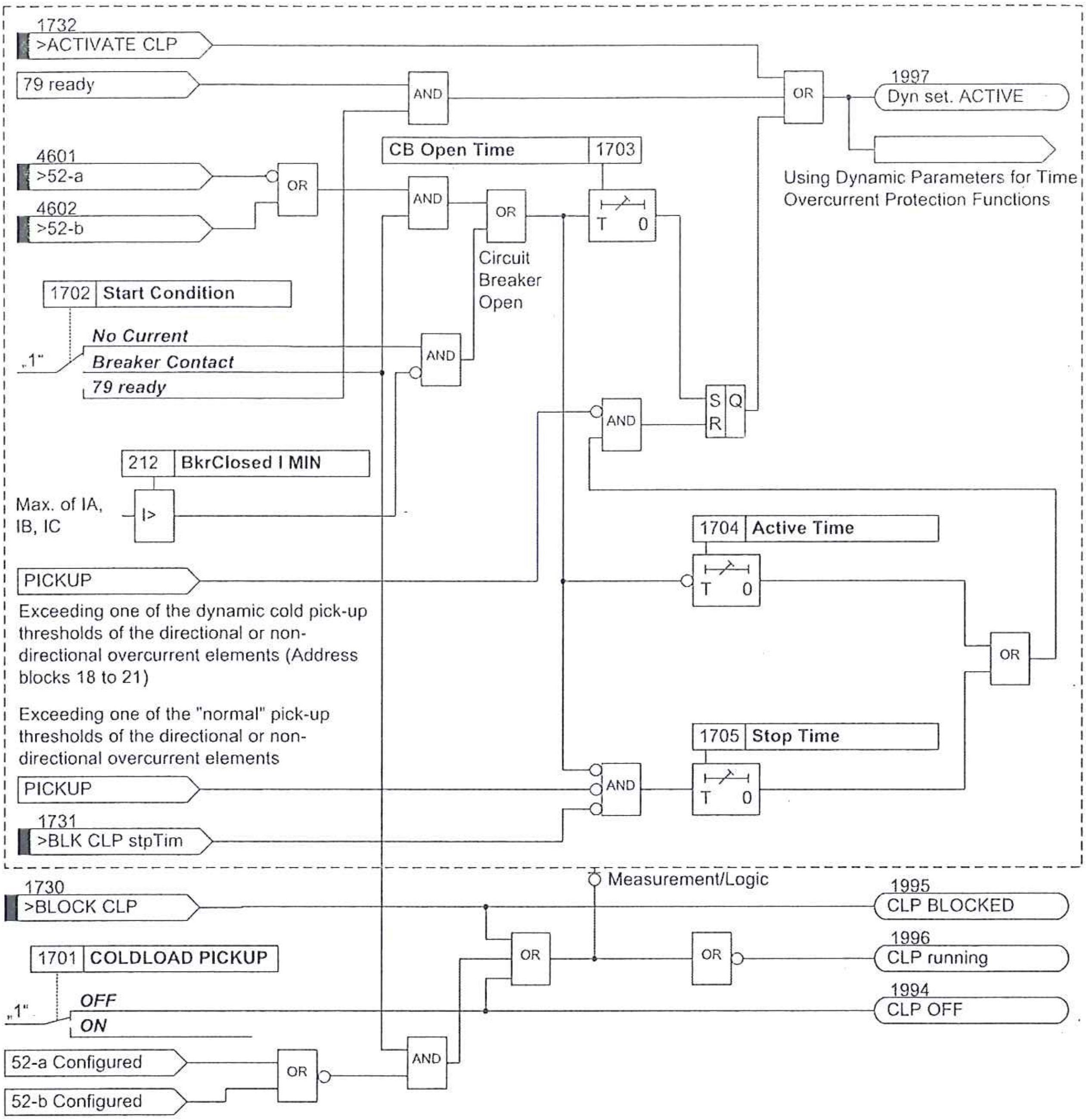


Figure 2-17 Logic diagram of the dynamic cold load pickup function (50c, 50Nc, 51c, 51Nc, 67c, 67Nc)

## 2.3.2 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 conditions 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 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 auto-reclosure is available, activated, unblocked, and ready for a further cycle (see also Subsection 2.11).

**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.

**50/51 Elements (Phases)**

The dynamic pickup values and time delays associated with non-directional time overcurrent protection are set at address block 18 (**U/AMZ Ph dynPar**) 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.

**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.

### 2.3.3 Settings

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

| Addr. | Parameter | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|
| 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 |
| 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 |

### 2.3.4 Information List

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

## 2.4 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 input is used depends on the device version according to the order number.

**Applications**

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

### 2.4.1 Functional Description

The single-phase time overcurrent function yields the tripping characteristic depicted in Figure 2-18. 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 $2 \cdot \sqrt{2}$.

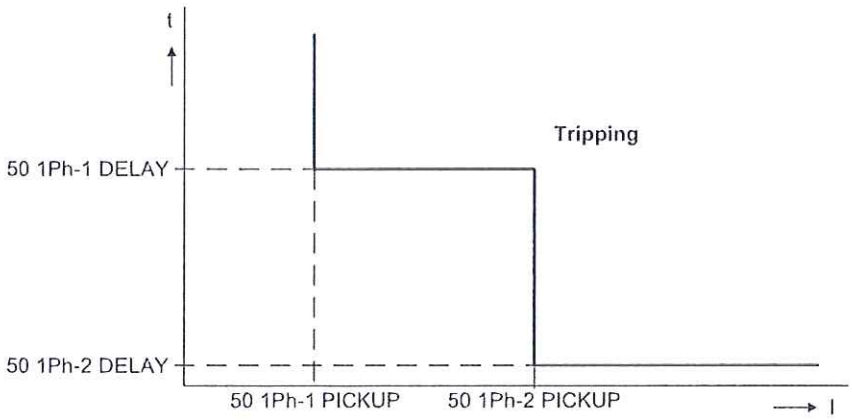


Figure 2-18 Two-stage characteristic of the single-phase time-overcurrent protection

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

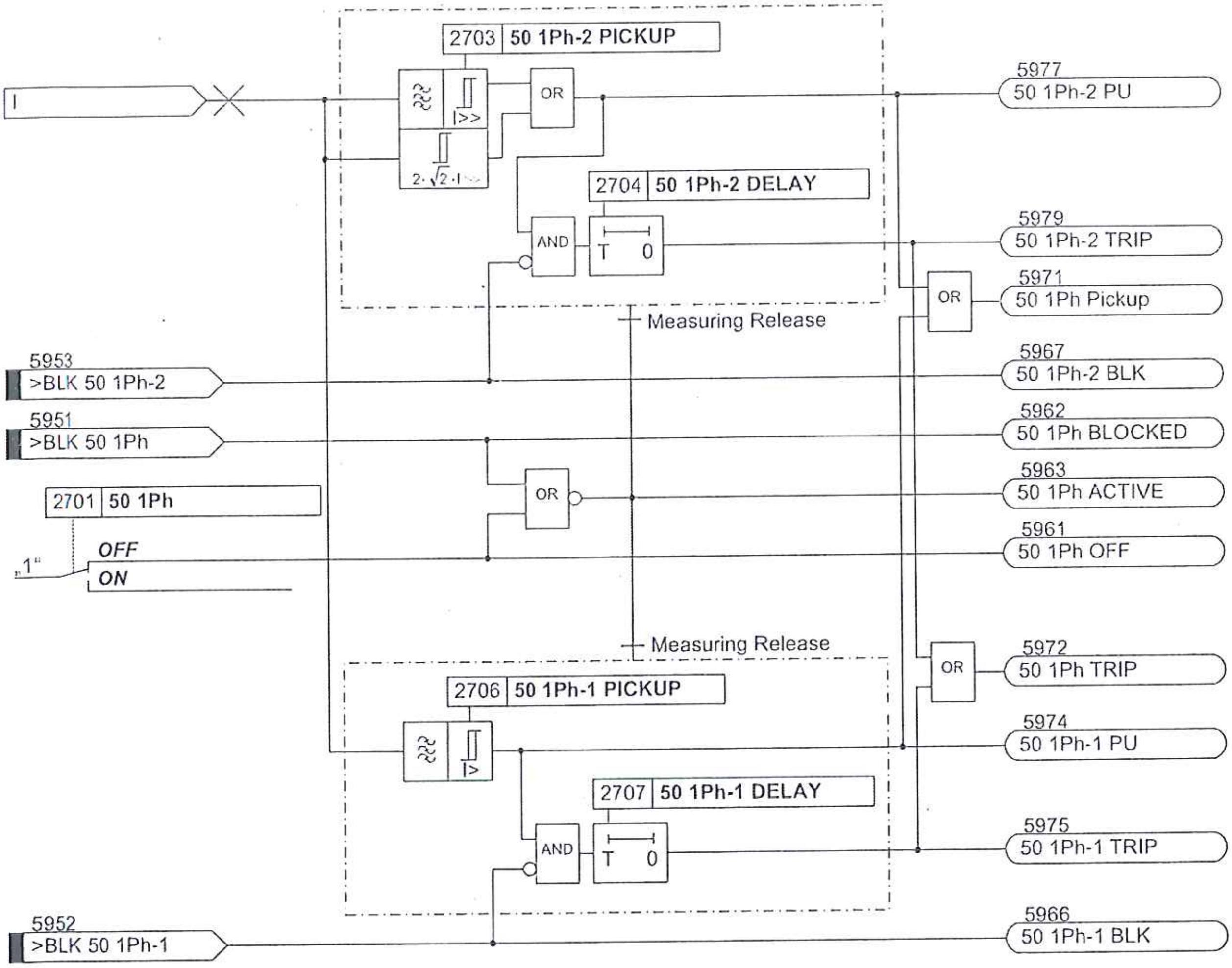


Figure 2-19 Logic diagram of the single-phase time-overcurrent protection

## 2.4.2 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 7SJ61, the high-impedance principle is particularly well suited for detecting ground faults in grounded networks at transformers, generators, motors and shunt reactors.

Figure 2-20 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.

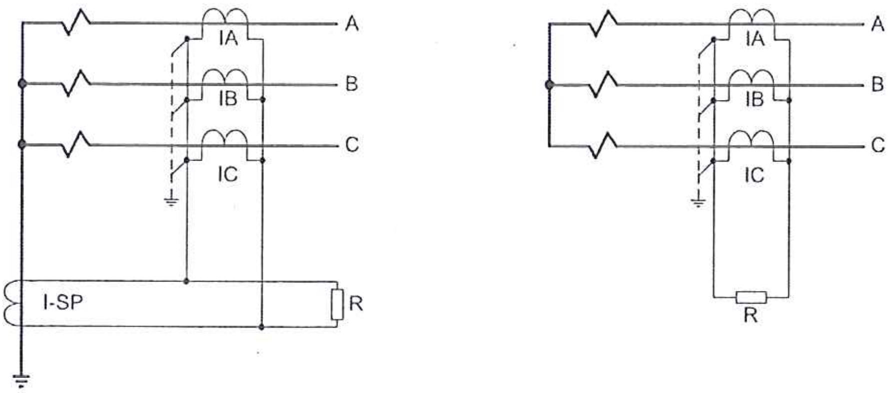


Figure 2-20 Ground fault protection according to the high-impedance principle

**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 2-21, left side), whose fault current is supplied via the grounded starpoint, the same current flows through the transformer starpoint and the phases. The corresponding secondary currents (all current transformers have the same transformation ratio) compensate each other; they are connected in series. Across resistor R only a small voltage is generated. It originates from the inner resistance of the transformers and the connecting cables of the transformers. Even if any current transformer experiences a partial saturation, it will become low-resistive for the period of saturation and creates a low-resistive shunt to the high-resistive resistor R. Thus, the high resistance of the resistor also has a restraining effect (the so-called resistance restraint).

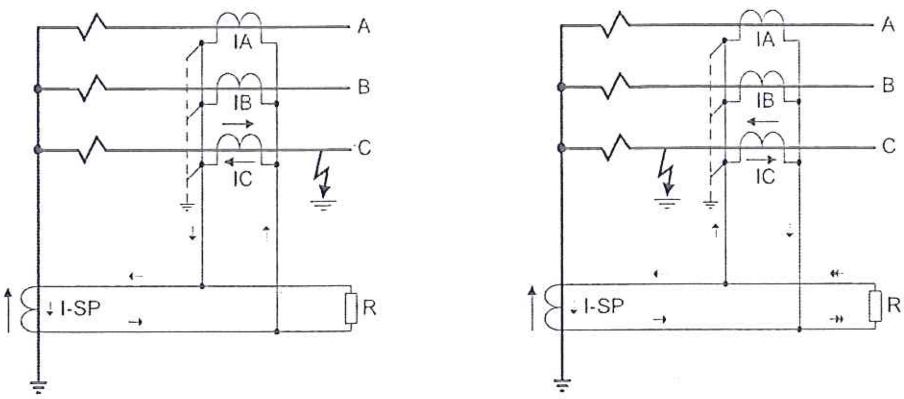


Figure 2-21 Principle of ground fault protection according to the high-impedance principle

When a ground fault occurs in the protected zone (Figure 2-21 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 2.4.4).

**High-impedance Protection with 7SJ61**

With 7SJ61 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 2-22 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.

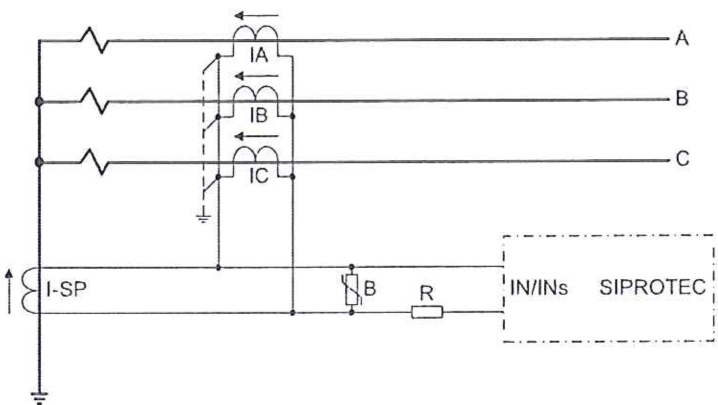


Figure 2-22 Connection diagram of the ground fault differential protection according to the high-impedance principle

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

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

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

## 2.4.3 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.

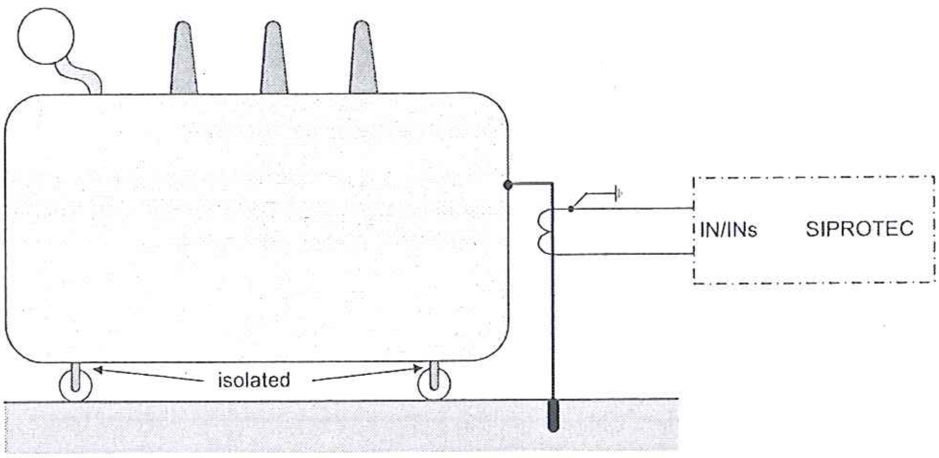


Figure 2-23 Principle of tank-leakage protection

## 2.4.4 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 2-22). 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 7SJ61 device for the current at input $I_N/I_{NS}$.

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

**Current Transformer Data for High-impedance Protection**

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

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

$V_{KPV}$ Knee-point voltage

$R_I$ Internal burden of the CT

$P_{Nom}$ Rated power of the CT

$I_{Nom}$ Secondary nominal current of CT

ALF Rated accuracy limit factor of the CT

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

Current transformer 800/5; 5P10; 30 VA

That means

$I_{Nom}$ = 5 A (from 800/5)

ALF = 10 (from 5P10)

$P_{Nom}$ = 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 7SJ61 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 2-24 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.

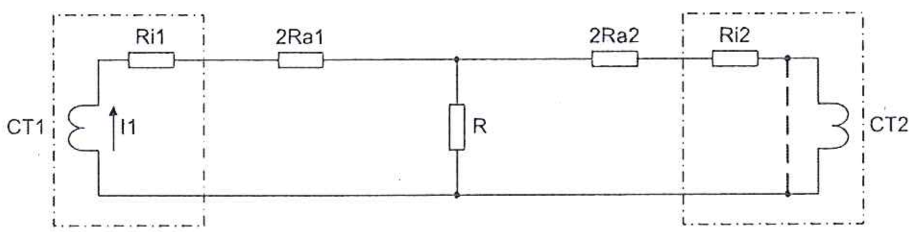


Figure 2-24 Simplified equivalent circuit of a circulating current system for high-impedance protection

The voltage across R is then

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

It is assumed that the pickup value of the 7SJ61 corresponds to half the knee-point voltage of the current transformers. In the balanced case results

$$V_R = V_{KPV} / 2$$

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

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

Calculation Example:

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

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

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

that is 15 × rated current or 12 kA primary.

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

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

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

that is 27 × rated current or 21.6 kA primary.

**Sensitivity with High-impedance Protection**

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

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

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

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

Calculation Example:

For 5-A CT as above

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

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

For 1-A CT as above

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

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

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

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

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

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

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

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

approx. 100 V for 5 A CT,

approx. 500 V for 1 A CT.

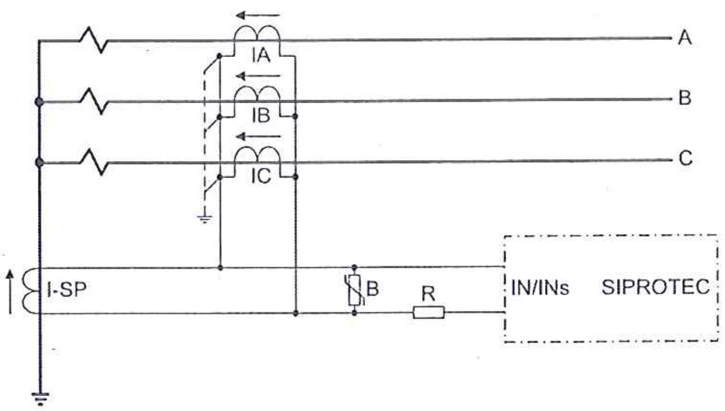


Figure 2-25 Connection diagram of the ground fault differential protection according to the high-impedance principle

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

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

600A/S1/S256 (k = 450, $\beta$ = 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** = ∞ ).

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 7SJ61 device for the current at input $I_N/I_{NS}$.

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

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

**Note**

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

## 2.4.5 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 |

### 2.4.6 Information List

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

## 2.5 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 $I_{Nom}$.

### 2.5.1 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.

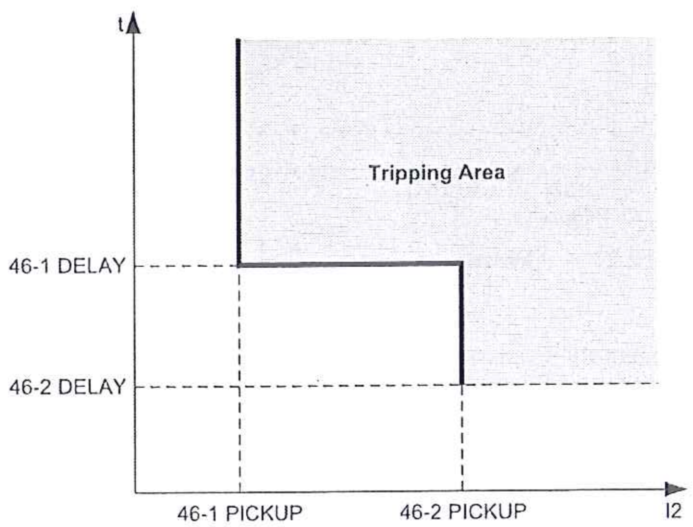


Figure 2-26 Definite time characteristic for negative sequence protection

**Settable Dropout Times**

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

## 2.5.2 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.

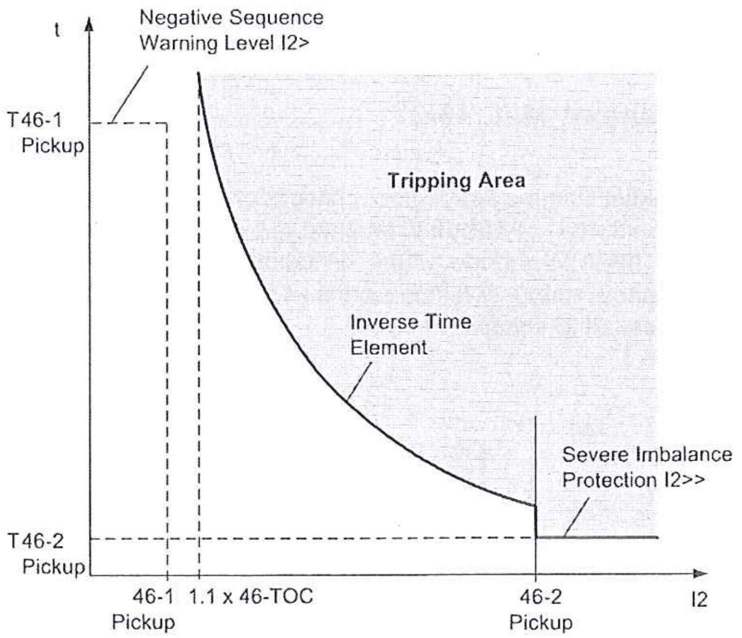


Figure 2-27 Inverse time characteristic for negative sequence protection

**Drop Out for IEC Curves**

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

**Drop Out for ANSI Curves**

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

The disk emulation evokes a dropout process (timer counter is decremented) which begins after de-energization. This process corresponds to the reset rotation of a Ferraris-disk (explaining its denomination "disk emulation"). In case several faults occur successively the "history" is taken into consideration due to the inertia of the Ferraris-disk and the timing response is correspondingly adapted. This ensures a proper simulation of the temperature rise of the protected object even for extremely fluctuating unbalanced load values. Reset begins as soon as 90 % of the setting value is undershot, in correspondence with the dropout curve of the selected characteristic. In the range between the dropout value (95 % of the pickup value) and 90 % of the setting value, the incrementing and the decrementing processes are in idle state. If 5 % of the setting value is undershot, the dropout process is completed, i.e. when a new pickup occurs, the timer starts again at zero.

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

**Logic**

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

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

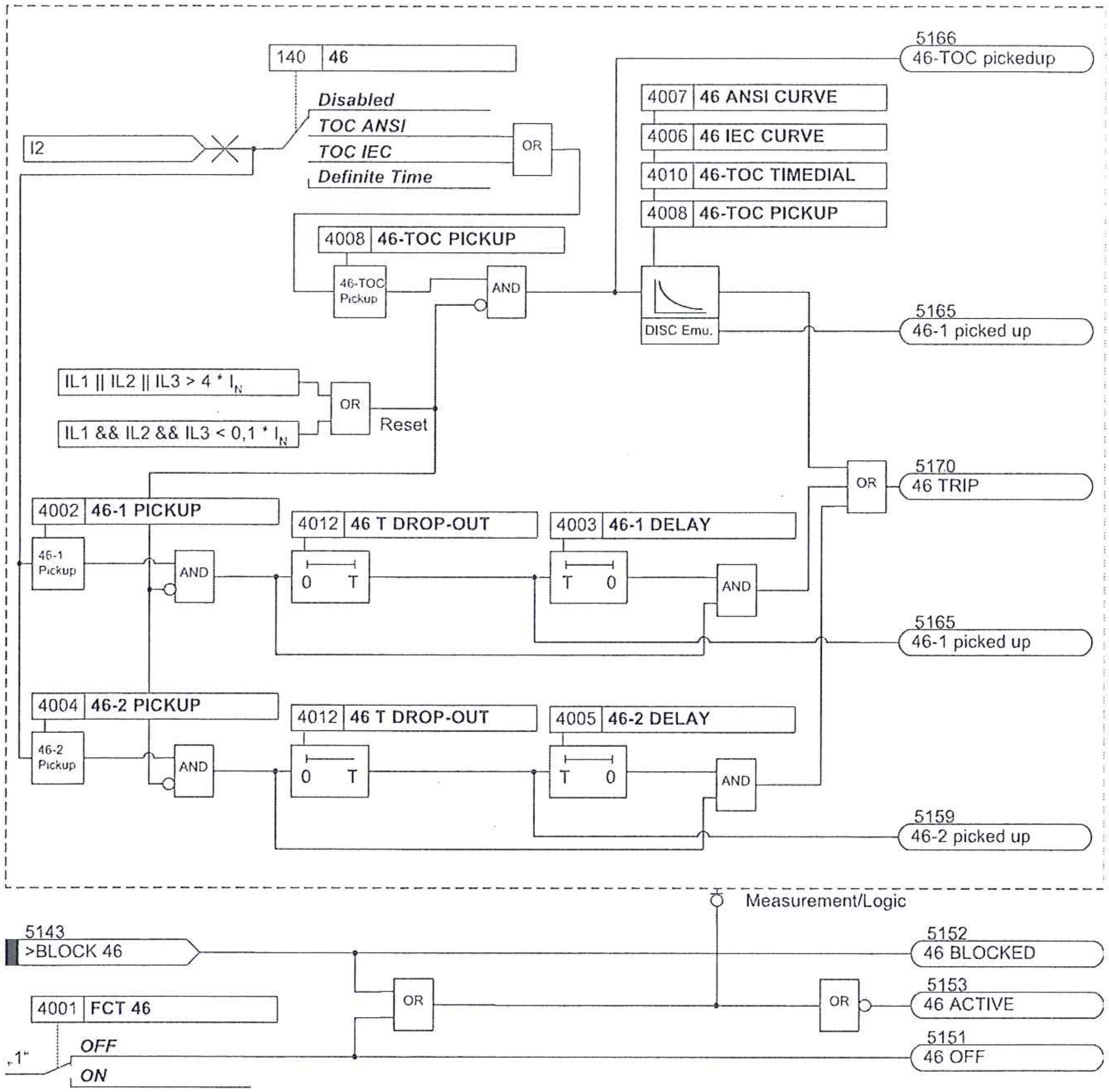


Figure 2-28 Logic diagram of the unbalanced load protection

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

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

### 2.5.3 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:

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

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 overcurrent elements.

Here, the following must be observed:

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

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

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

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

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

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

Consider a transformer with the following data:

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

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

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

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

**Pickup Stabilization (Definite Time)**

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

**IEC Curves (Inverse Time Tripping Curve)**

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

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

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

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

**ANSI Curves (Inverse Time Tripping Curve)**

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

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

**RESET**, reset will occur in accordance with the reset curve as described in the Functional Description.

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

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

## 2.5.4 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 |

### 2.5.5 Information List

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

# 2.6 Motor Protection (Motor Starting Protection 48, Motor Restart Inhibit 66)

For protection of motors the devices 7SJ61 are provided with a motor starting time monitoring feature and a restart inhibit. The first feature mentioned supplements the overload protection (see Section 2.7) 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.

## 2.6.1 Motor Starting Protection 48

By application of devices 7SJ61 to motors, the motor starting time monitoring protects the motor from too long starting attempts and supplements the overload protection (see Section 2.7)

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

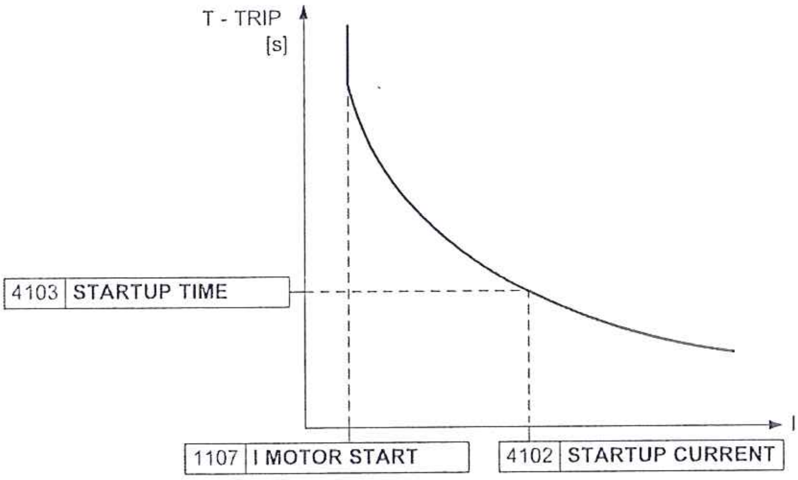


Figure 2-29 Inverse time tripping curve for motor starting current

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 2-29).

**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**) thus blocks the binary input ">Rotor locked". 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 or after the timeout.

**Logic**

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

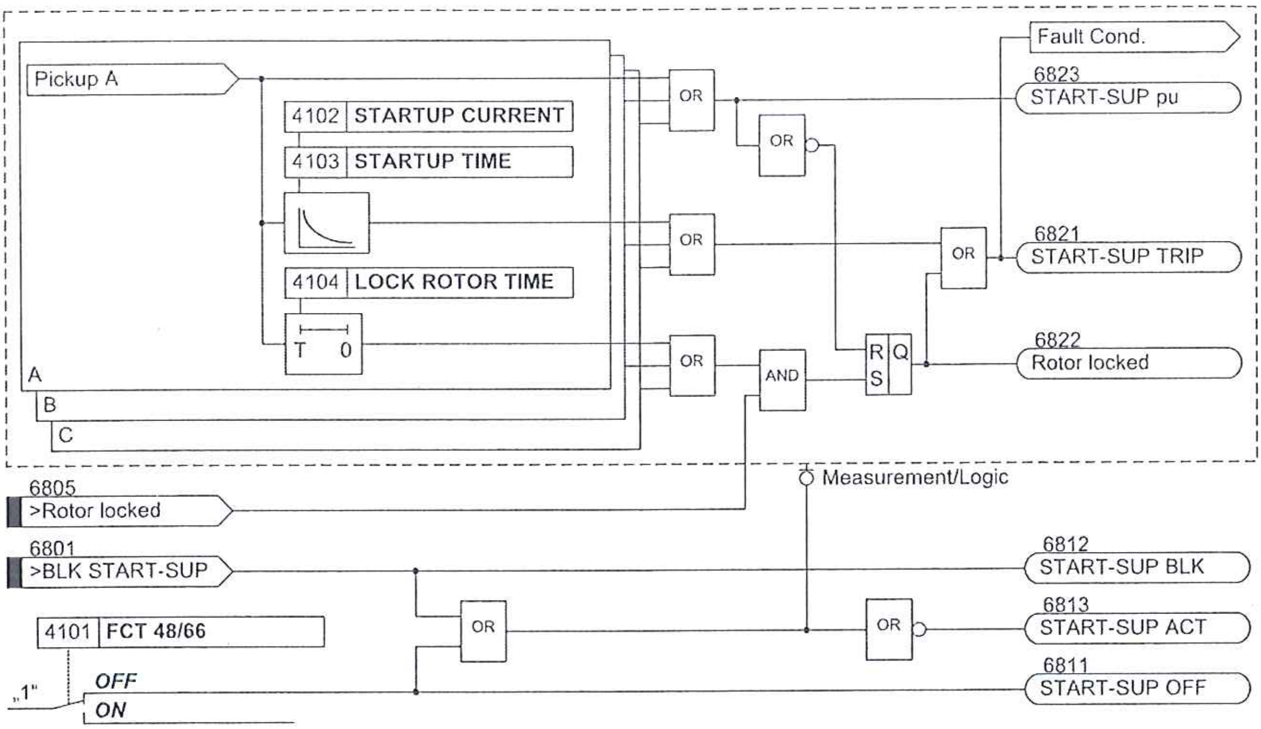


Figure 2-30 Logic diagram of the Motor Starting Time Supervision

### 2.6.1.2 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:

Based on the Long-Term Current Rating:

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

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

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

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

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

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

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

Note

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

## 2.6.2 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.

### 2.6.2.1 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 7SJ61 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.

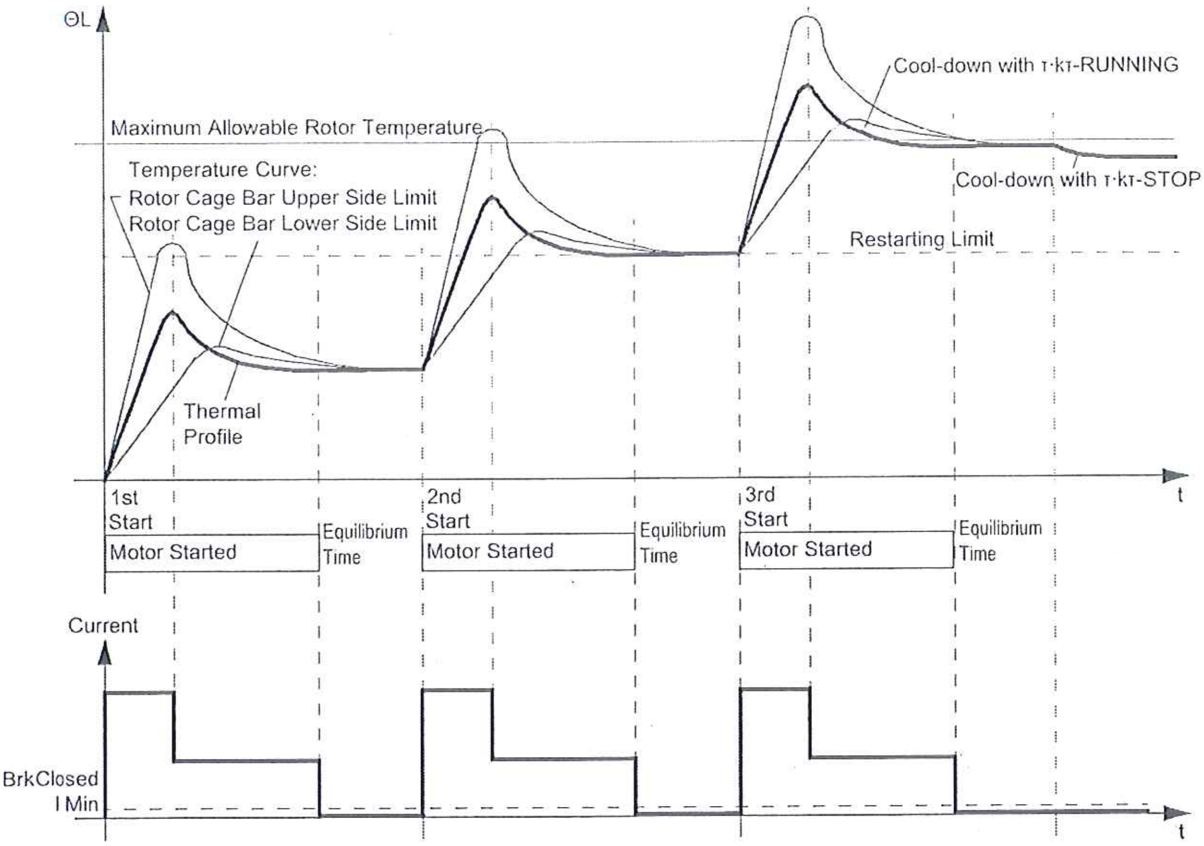


Figure 2-31 Temperature curve at the rotor and the thermal profile during repeated start-up attempts

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 2-31). 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 2-31 shows, as an example, the heating processes during repeated motor starts (three starts from cold operating condition), as well as the thermal profile in the protection relay.

**Restarting Limit**

If the rotor temperature has exceeded the restart threshold, the motor cannot be restarted. The blocking signal is not lifted unless the rotor temperature has fallen below the restarting limit, that is, when exactly one start becomes possible without exceeding the excessive rotor temperature limit. Based on the specified motor parameters the device calculates the normalized restarting limit $\Theta_{Restart}$:

$$\Theta_{Restart} = \left(\frac{I_A}{I_B \cdot k_L}\right)^2 \cdot \left(1 - e^{-\frac{(n_k - 1) \cdot T_m}{\tau_L}}\right)$$

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 |
| $n_{warm}$ | = | Permitted starts with warm motor |

The restarting limit $\Theta_{Restart}$ is displayed as operational measured value in the "thermal measured values".

**Restart Time**

The motor manufacturer allows a maximum allowable cold ($n_{cold}$) and warm ($n_{warm}$) starting attempts. Afterwards the device must be allowed to cool off! A certain time must elapse - restarting time $t_{Restart}$ - to ensure that the rotor has cooled off.

**Equilibrium Time**

This thermal behavior is provided for in the protection as follows: Each time the motor is shutdown, the timer starts (address 4304 `T Equal`). It takes into account the different thermal conditions of the motor parts at the moment of shutdown. During the equilibrium time, the thermal profile of the rotor is not updated. It is maintained constant to replicate the equilization process in the rotor. Then the thermal model with the corresponding time constant (rotor time constant x extension factor) cools down. During the equilibrium time the motor cannot be restarted. As soon as the temperature sinks below the restarting threshold, the next restart attempt can be made.

**Minimum Inhibit Time**

Regardless of thermal profiles, some motor manufacturers require a minimum inhibit time after the maximum number of permissible starting attempts has been exceeded.

The total duration of the inhibit signal depends on which of the times $T_{Min\ Inhibit}$ or $T_{Restart}$ is longer.

**Total Time $T_{Reclose}$**

The total waiting time $T_{Reclose}$, before the motor can be restarted, therefore is composed of the equilibrium time and the time $T_{Restart}$ calculated from the thermal profile, and the value that is needed to drop below the limit for restarting. If the calculated temperature rise of the rotor is above the restarting limit when the motor is shut down, the minimum inhibit time will be started together with the equilibrium time.

Thus the total inhibit time $T_{Reclose}$ can become equal to the minimum inhibit time if it is longer than the sum of the two first mentioned times:

| | |
|---|---|
| $T_{Reclose} = T_{Equal} + T_{Restart}$ | for $T_{Min\ Inhibit} < T_{Equal} + T_{Restart}$ |
| $T_{Reclose} = T_{Min\ Inhibit}$ | for $T_{Min\ Inhibit} \geq T_{Equal} + T_{Restart}$, if the calculated excessive temperature > restarting limit |

The operational measured value $T_{Reclose}$ (visible in the thermal measured values) is the remaining time until the next restart is permissible. When the rotor excessive temperature is below the restarting limit and thus the next restarting attempt is permitted, the operational measured value for the waiting time has reached zero.

**Extension of Cool Down Time Constants**

In order to properly account for the reduced heat exchange when a self-ventilated motor is stopped, the cooling time constants can be increased relative to the time constants for a running machine with the factor `Kτ at STOP` (address 4308). The criterion for the motor stop is the undershooting of a set current threshold `BkrClosed I MIN`. This understands that the motor idle current is greater than this threshold. The pickup threshold `BkrClosed I MIN` affects also the thermal overload protection function (see Section 2.7).

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:

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

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

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) |
| $\tau_L$ | – 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/).

**EmergencyStart**

If, for emergency reasons, motor starting that will exceed the maximum allowable rotor temperature must take place, the motor start blocking signal can be terminated via a binary input (">66 emer.start"), thus allowing a new starting attempt. The thermal rotor profile however continues to function and the maximum allowable rotor temperature will be exceeded. No motor shutdown will be initiated by motor start blocking, but the calculated excessive temperature of the rotor can be observed for risk assessment.

**Blocking**

If the motor restart inhibit function is blocked via binary input ">BLOCK 66" or switched off, the thermal replica of the rotor overtemperature, the equilibrium time **T Equal** and the minimum inhibit time **T MIN. INHIBIT** are reset. Thus any blocking signal that is present or upcoming is disregarded.

Via another binary input (">66 RM th.repl.") the thermal replica can be reset independently. This may be useful for testing and commissioning, and after a power supply voltage failure.

**Logic**

There is no pickup annunciation for the restart inhibit and no trip log is produced. The following figure shows the logic diagram for the restart inhibit.

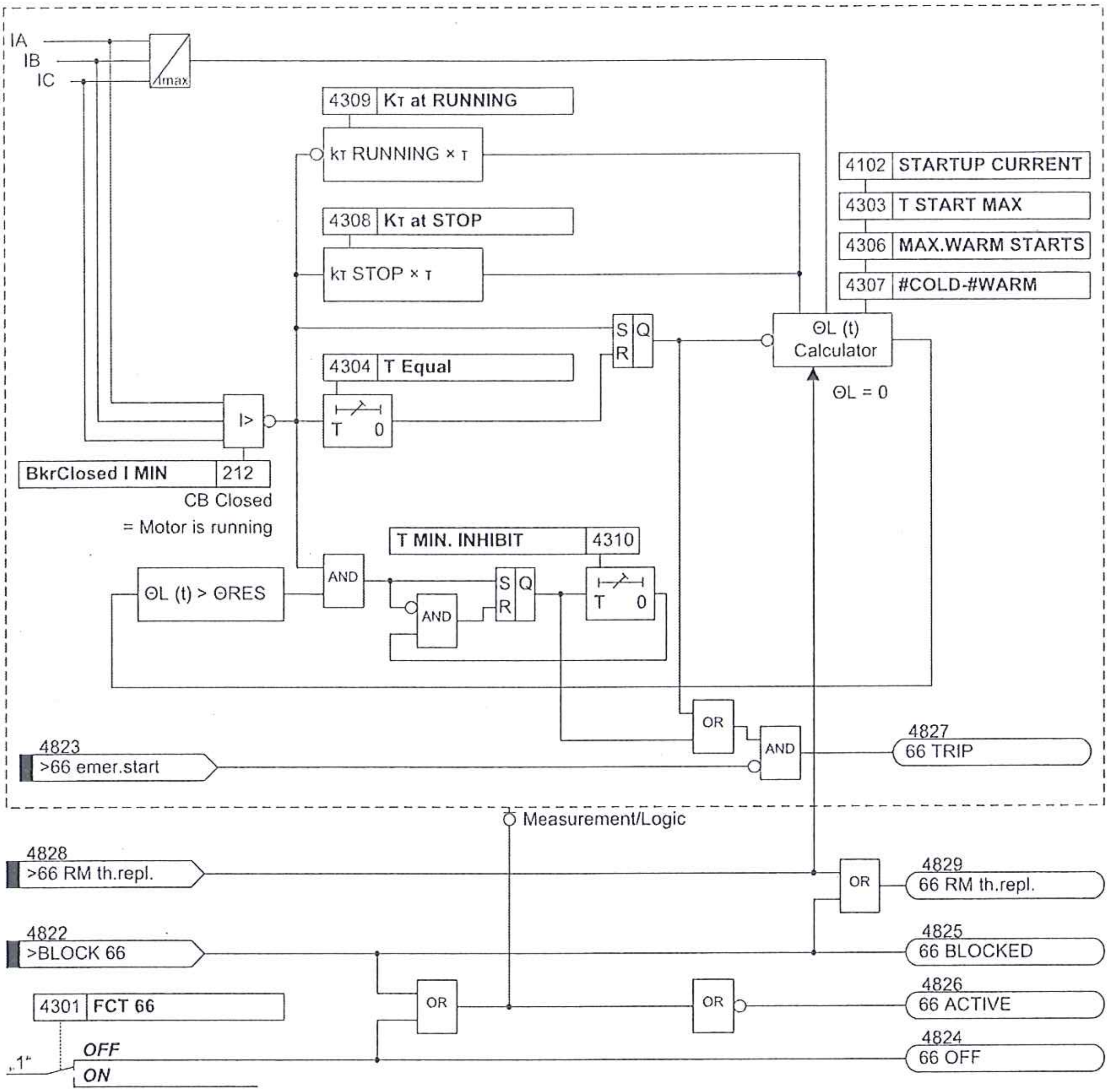


Figure 2-32 Logic diagram of the Restart Inhibit

### 2.6.2.2 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.

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The restart inhibit acts on the starting process of a motor that is shut down. A motor is considered shut down if its current consumption falls below the settable threshold 212 **BkrClosed I MIN**. Therefore, this threshold must set lower than the motor idle current.

**Characteristic Values**

Many of the variables needed to calculate the rotor temperature are supplied by the motor manufacturer. Among these variables are the starting current $I_{STARTUP}$, the nominal motor current $I_{MOT. NOM}$, the maximum allowable starting time **T START MAX** (address 4303), the number of allowable starts from cold conditions ($n_{cold}$), and the number of allowable starts from warm conditions ($n_{warm}$).

The starting current is entered at address 4302 **IStart/IMOTnom** , expressed as a multiple of nominal motor current. In contrast, the nominal motor current is entered as a secondary value, directly in amperes, at address 4305 **I MOTOR NOMINAL**. The number of warm starts allowed is entered at address 4306 (**MAX.WARM STARTS**) and the difference (**#COLD-#WARM**) between the number of allowable cold and warm starts is entered at address 4307.

For motors without separate ventilation, the reduced cooling at motor stop can be accounted for by entering the factor **Kτ at STOP** at address 4308. As soon as the current no longer exceeds the setting value entered at address 212 **BkrClosed I MIN**, motor standstill is detected and the time constant is increased by the extension factor configured.

If no difference between the time constants is to be used (e.g. externally-ventilated motors), then the extension factor **Kτ at STOP** should be set to 1.

The cooling with the motor running is influenced by the extension factor 4309 **Kτ at RUNNING**. This factor considers that motor running under load and a stopped motor do not cool down at the same speed. It becomes effective as soon as the current exceeds the value set at address 212 **BkrClosed I MIN**. With **Kτ at RUNNING** = 1 the heating and the cooling time constant are the same at operating conditions ($I >$ **BkrClosed I MIN**).

Example: Motor with the following data:

| | |
|---|---|
| Nominal Voltage | $V_{Nom}$ = 6600 V |
| Nominal current | $I_{Nom}$ = 126 A |
| Startup current | $I_{STARTUP}$ = 624 A |
| Startup Duration | $T_{STARTUP}$ = 8.5 s |
| Allowable Starts with Cold Motor | $n_{cold}$ = 3 |
| Allowable Starts with Warm Motor | $n_{warm}$ = 2 |
| Current Transformer | 200 A / 1 A |

The following settings are derived from these data:

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

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

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 Behavior 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 2-33, 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 2-33, to the right).

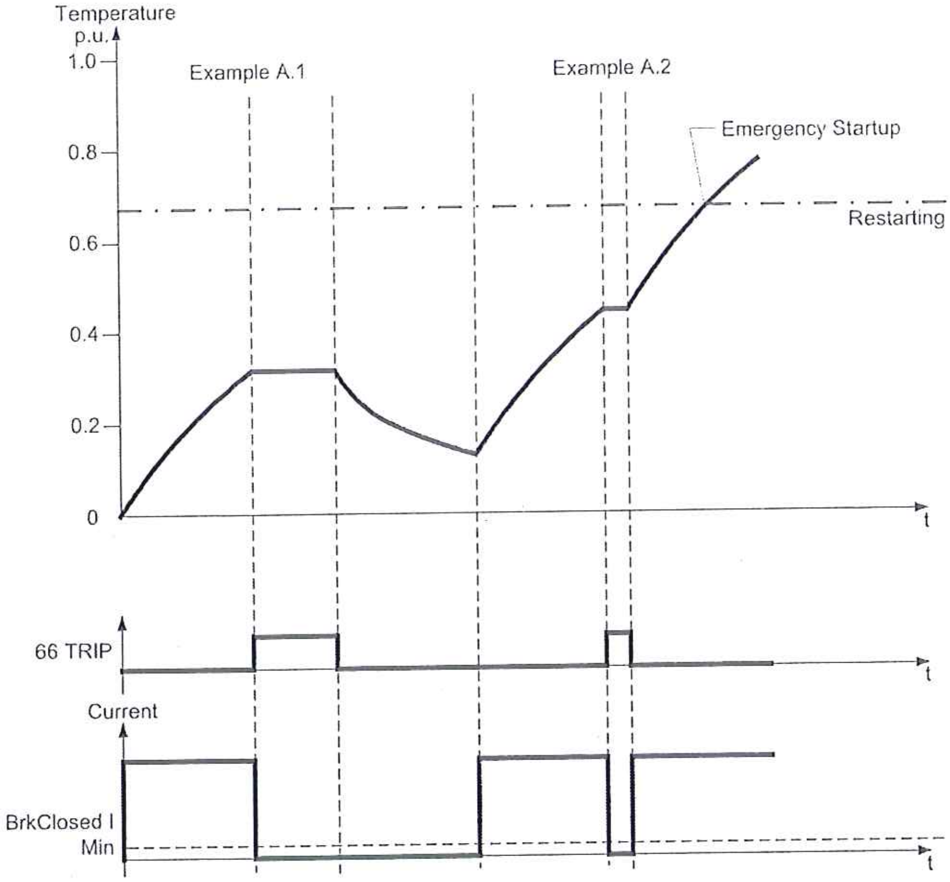



Figure 2-33 Startups according to examples A.1 and A.2

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 2-34, 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 2-34, to the right).

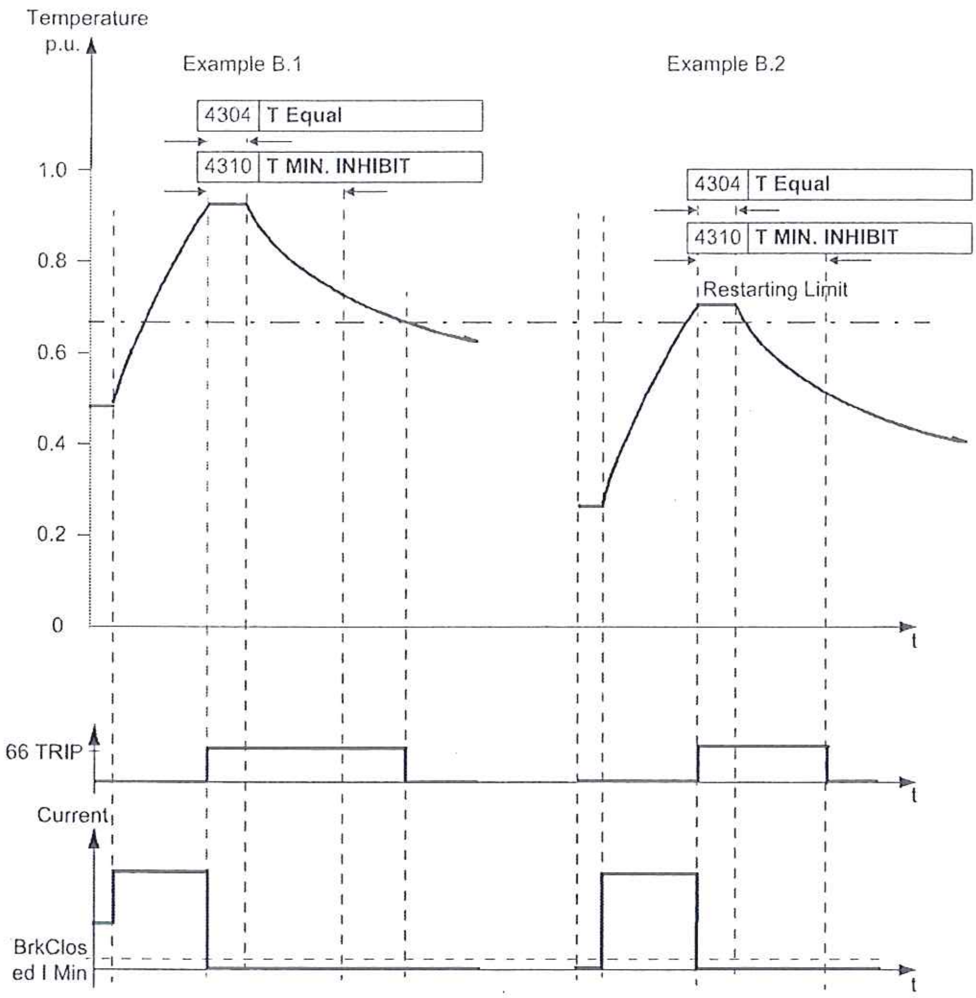



Figure 2-34 Starting up according to examples B.1 and B.2

## 2.6.3 Motor (Motor Starting Protection 48, Motor Restart Inhibit 66)

### 2.6.3.1 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 |

| Addr. | Parameter | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|
| 4302 | IStart/IMOTnom | | 1.10 .. 10.00 | 4.90 | I Start / I Motor nominal |
| 4303 | T START MAX | | 3 .. 320 sec | 10 sec | Maximum Permissible Starting Time |
| 4304 | T Equal | | 0.0 .. 320.0 min | 1.0 min | Temperature Equalizaton Time |
| 4305 | I MOTOR NOMINAL | 1A | 0.20 .. 1.20 A | 1.00 A | Rated Motor Current |
| | | 5A | 1.00 .. 6.00 A | 5.00 A | |
| 4306 | MAX.WARM STARTS | | 1 .. 4 | 2 | Maximum Number of Warm Starts |
| 4307 | #COLD-#WARM | | 1 .. 2 | 1 | Number of Cold Starts - Warm Starts |
| 4308 | Kτ at STOP | | 0.2 .. 100.0 | 5.0 | Extension of Time Constant at Stop |
| 4309 | Kτ at RUNNING | | 0.2 .. 100.0 | 2.0 | Extension of Time Constant at Running |
| 4310 | T MIN. INHIBIT | | 0.2 .. 120.0 min | 6.0 min | Minimum Restart Inhibit Time |

### 2.6.3.2 Information List

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 4822 | >BLOCK 66 | SP | >BLOCK Motor Startup counter |
| 4823 | >66 emer.start | SP | >Emergency start |
| 4824 | 66 OFF | OUT | 66 Motor start protection OFF |
| 4825 | 66 BLOCKED | OUT | 66 Motor start protection BLOCKED |
| 4826 | 66 ACTIVE | OUT | 66 Motor start protection ACTIVE |
| 4827 | 66 TRIP | OUT | 66 Motor start protection TRIP |
| 4828 | >66 RM th.repl. | SP | >66 Reset thermal memory |
| 4829 | 66 RM th.repl. | OUT | 66 Reset thermal memory |
| 6801 | >BLK START-SUP | SP | >BLOCK Startup Supervision |
| 6805 | >Rotor locked | SP | >Rotor locked |
| 6811 | START-SUP OFF | OUT | Startup supervision OFF |
| 6812 | START-SUP BLK | OUT | Startup supervision is BLOCKED |
| 6813 | START-SUP ACT | OUT | Startup supervision is ACTIVE |
| 6821 | START-SUP TRIP | OUT | Startup supervision TRIP |
| 6822 | Rotor locked | OUT | Rotor locked |
| 6823 | START-SUP pu | OUT | Startup supervision Pickup |

## 2.7 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.

### 2.7.1 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 |

$$\Theta_u = \frac{\vartheta_u - 40°C}{k^2 \cdot \vartheta_{Nom}}$$

with

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

If the ambient or coolant temperature is not measured, a constant value of $\vartheta_u$ = 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 threshold, the protected equipment may be disconnected from the system. The highest overtemperature calculated from the three phase currents is used as the criterion.

The maximum thermally-permissible continuous current $I_{max}$ is described as a multiple of the object nominal current $I_{Nom\ Obj.}$:

$I_{max} = k \cdot I_{Nom\ Obj.}$

In addition to the k factor (parameter **49 K-FACTOR**), the **TIME CONSTANT** $\tau_{th}$ 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 $\vartheta_u$ = 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.

**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 7SJ61 increases the time constant $\tau_{th}$ by a programmable factor ($k\tau$ factor). The motor is considered to be off when the motor currents drop below a programmable minimum current setting **BkrClosed I MIN** (refer to "Current Flow Monitoring" in Section 2.1.3). For externally-cooled motors, cables and transformers, the **Kτ-FACTOR** = *1*.

**Blocking**

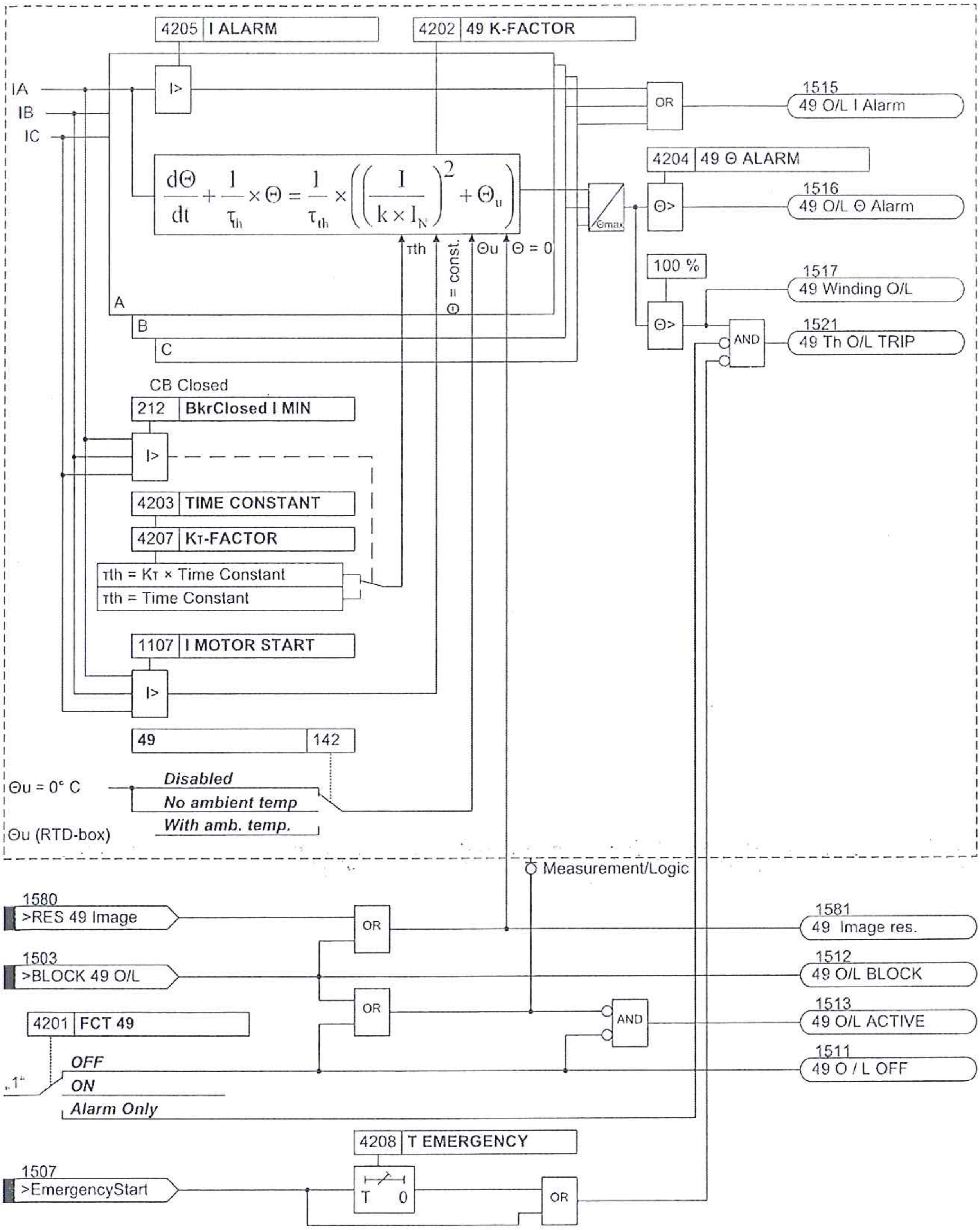
The thermal memory may be reset via a binary input (">RES 49 Image"). The current-related overtemperature value is reset to zero. The same is accomplished via the binary input (">BLOCK 49 O/L"); in this case the entire overload protection is blocked completely, including the current warning stage.

When motors must be started for emergency reasons, temperatures above the maximum permissible overtemperature can be allowed by blocking the tripping signal via a binary input (">EmergencyStart"). Since the thermal profile may have exceeded the tripping temperature after initiation and drop out of the binary input has taken place, the protection function features a programmable run-on time interval (**T EMERGENCY**) which is started when the binary input drops out and continues suppressing a trip signal. Tripping by the overload protection will be defeated until this time interval elapses. The binary input affects only the tripping signal. There is no effect on the trip log nor does the thermal profile reset.

**Behaviour in Case of Power Supply Failure**

Depending on the setting in address 235 **ATEX100** of Power System Data 1 (see Section 2.1.3) the value of the thermal replica is either reset to zero (**ATEX100** = ***NO***) if the power supply voltage fails, or cyclically buffered in a non-volatile memory (**ATEX100** = ***YES***) so that it is maintained in the event of auxiliary supply voltage failure. In the latter case, the thermal replica uses the stored value for calculation and matches it to the operating conditions. The first option is the default setting (see /5/).

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




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

Figure 2-35 Logic diagram of the overload protection

## 2.7.2 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 7SJ61 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.

---

**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:

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 current 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.

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:

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

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

The settings are: **49 K-FACTOR** = *0.83*; **TIME CONSTANT** = *33.7 min*

**Warning Temperature Level**

By setting the thermal warning level **49 Θ ALARM** at address 4204, a warning message can be issued prior to tripping, thus allowing time for load curtailment procedures to be implemented. This warning level simultaneously represents the dropout level for the tripping signal. Only when this threshold is undershot, the tripping command is reset and the protected equipment may be returned to service.

The thermal warning level is given in % of the tripping temperature level.

A current warning level is also available (address 4205 **I ALARM**). The setting corresponds to secondary amperes, and should be set equal to, or slightly less than, permissible continuous current ($k \cdot I_{Nom\ sec}$). It may be used in lieu of the thermal warning level by setting the thermal warning level to 100 % and thereby practically disabling it.

**Extension of Time Constants**

**TIME CONSTANT** set in address 4203 is valid for a running motor. When a motor without external cooling is running down or at standstill, the motor cools down more slowly. This behavior can be modeled by increasing the time constant by factor **Kτ-FACTOR**, set at address 4207. Motor stop is detected if the current falls below the threshold value **BkrClosed I MIN** of the current flow monitoring (see margin heading "Current Flow Monitoring" in Section 2.1.3.2). This assumes that the motor idle current is greater than this threshold. The pickup threshold **BkrClosed I MIN** affects also the following protection functions: breaker failure protection and restart inhibit for motors.

If no differentiation of the time constants is necessary (e.g. externally-cooled motors, cables, lines, etc.) the **Kτ-FACTOR** is set at *1* (default setting value).

**Dropout Time after Emergency Starting**

The dropout time to be entered at address 4208 **T EMERGENCY** must ensure that after an emergency startup and after dropout of the binary input „>EmergencyStart“ the trip command is blocked until the thermal replica is below the dropout threshold again.

**Ambient or Coolant Temperature**

The indications specified up to now are sufficient for a temperature rise replica. The ambient or coolant temperature, however, can also be processed. This has to be communicated to the device as digitized 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.

$$\vartheta_{Nom\ sec} = \vartheta_{Nom\,Mach} \cdot \left(\frac{I_{Nom\,primCT}}{I_{Nom\,Mach}}\right)^2$$

with

| | |
|---|---|
| $\vartheta_{Nom\ sec}$ | Machine temperature with secondary nominal current = setting at the protective relay (address 4209 or 4210) |
| $\vartheta_{Nom\ mach}$ | Machine temperature with nominal machine current |
| $I_{Nom\ CT\ prim}$ | Nominal primary CT current |
| $I_{Nom\ mach}$ | Nominal current of the machine |

If the temperature input is used, the trip times change if the coolant temperature deviates from the internal reference temperature of 104° F or 40° C. The following formula can be used to calculate the trip time:

$$t = \tau_{th} \cdot \ln \frac{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 + \frac{\vartheta_u - 40\ °C}{k^2 \cdot \vartheta_{Nom}} - \left[\left(\frac{I_{pre}}{k \cdot I_N}\right)^2 + \frac{\vartheta_{U_{t-0}} - 40\ °C}{k^2 \cdot \vartheta_{Nom}}\right] \cdot \left(1 - e^{-\frac{t_{pre}}{\tau}}\right)}{\left(\frac{I}{k \cdot I_{Nom}}\right)^2 + \frac{\vartheta_u - 40\ °C}{k^2 \cdot \vartheta_{Nom}} - 1}$$

with

| | |
|---|---|
| $\tau_{th}$ | **TIME CONSTANT** (address 4203) |
| k | **49 K-FACTOR** (address 4202) |
| $I_{Nom}$ | Nominal device current in A |
| I | Fault current through phase in A |
| $I_{Pre}$ | Previous load current |
| $\vartheta_{Ul=0}$ | Coolant temperature input in °C with t=0 |
| $\vartheta_{Nom}$ | Temperature with Nominal Current $I_{Nom}$(Address 4209 **49 TEMP. RISE I**) |
| $\vartheta_u$ | Coolant temperature input (scaling with address 4209 or 4210) |

Example:

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

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

$\vartheta_{Nom\ Mach}$ = 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

$$\text{K-FACTOR} = 1.15 \cdot \frac{483\ \text{A}}{500\ \text{A}} \approx 1.11$$ (to be set in address 4202)

$$\vartheta_{\text{Nom sec}} = 93°\ \text{C} \cdot \left(\frac{500}{483}\right)^2 \approx 100°\ \text{C}$$ (to be set in address 4209 or 4210 49 TEMP. RISE I)

**Motor Starting Recognition**

The motor starting is detected when setting I MOTOR START at address 1107 is exceeded. Information on how to perform the configuration is given under "Recognition of Running Condition (only for motors)" in Subsection2.1.3.2.

## 2.7.3 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. |

## 2.7.4 Information List

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 1503 | >BLOCK 49 O/L | SP | >BLOCK 49 Overload Protection |
| 1507 | >EmergencyStart | SP | >Emergency start of motors |
| 1511 | 49 O / L OFF | OUT | 49 Overload Protection is OFF |
| 1512 | 49 O/L BLOCK | OUT | 49 Overload Protection is BLOCKED |
| 1513 | 49 O/L ACTIVE | OUT | 49 Overload Protection is ACTIVE |
| 1515 | 49 O/L I Alarm | OUT | 49 Overload Current Alarm (I alarm) |
| 1516 | 49 O/L Θ Alarm | OUT | 49 Overload Alarm! Near Thermal Trip |
| 1517 | 49 Winding O/L | OUT | 49 Winding Overload |
| 1521 | 49 Th O/L TRIP | OUT | 49 Thermal Overload TRIP |
| 1580 | >RES 49 Image | SP | >49 Reset of Thermal Overload Image |
| 1581 | 49 Image res. | OUT | 49 Thermal Overload Image reset |

# 2.8 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.

## 2.8.1 Measurement Supervision

### 2.8.1.1 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.

### 2.8.1.2 Hardware Monitoring

**Auxiliary and Reference Voltages**

The processor voltage of 5 VDC is monitored by the hardware since if it goes below the minimum value, the processor is no longer functional. The device is under such a circumstance removed from operation. When the supply voltage returns, the processor system is restarted.

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

The processor monitors the offset and reference voltage of the ADC (analog-digital converter). The protection is suspended if the voltages deviate outside an allowable range, and lengthy deviations are reported.

**Buffer Battery**

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

**Memory Components**

All working memories (RAMs) are checked during start-up. If a fault occurs, the start is aborted and an LED starts flashing. During operation the memories are checked with the help of their checksum. For the program memory, the cross sum is formed cyclically and compared to the stored program cross sum.

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

If a fault occurs the processor system is restarted.

**Scanning**

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

### 2.8.1.3 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.

### 2.8.1.4 Monitoring of the External Transformer Circuits

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

**Measurement Value Acquisition – Currents**

Up to four input currents are measured by the device. If the three phase currents and the ground fault current from the current transformer star point or a separated ground current transformer of the line to be protected are connected to the device, their digitised sum must be zero. Faults in the current circuit are recognised if

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

The factor $k_I$ takes into account a possible difference in the neutral current transformer ratio $I_N$ (e.g. toroidal current transformer see addresses 217, 218, 204 and 205):

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

**Σ I THRESHOLD** and **Σ I FACTOR** are programmable settings. The component **Σ I FACTOR** · Imax takes into account the permissible current proportional ratio errors of the input transformer which are particularly prevalent during large short-circuit currents (Figure 2-36). The dropout ratio is about 97 %. This malfunction is reported as "Failure Σ I".

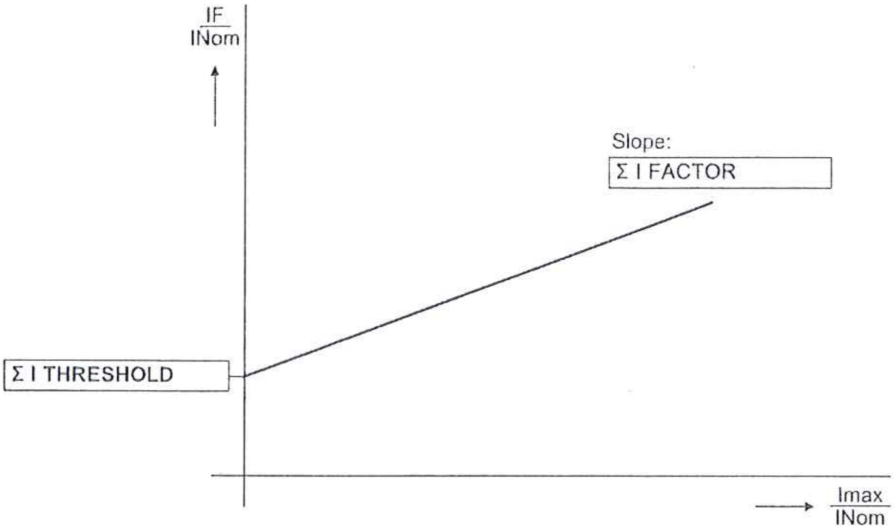



Figure 2-36 Current sum monitoring

**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 2-37). Both parameters can be set. The dropout ratio is about 97%.

This malfunction is reported as "Fail I balance".

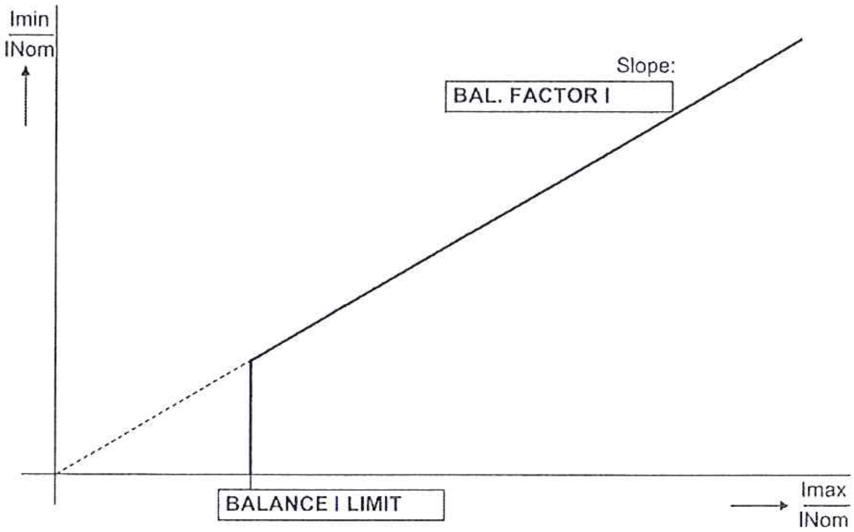



Figure 2-37 Current symmetry monitoring

**Phase Sequence**

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

The unbalanced load detection assumes a clockwise phase sequence. Phase rotation of measured quantities is checked by verifying the phase sequences of the currents.

Currents: $\underline{I}_A$ leads $\underline{I}_B$ leads $\underline{I}_C$

Supervision of current rotation requires a maximum current of

$|I_A|, |I_B|, |I_C| > 0.5\ I_{Nom}$.

For abnormal phase sequence, the message "`Fail Ph. Seq. I`" is issued.

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 2.14.2). The phase-related messages, malfunction values, and measured values are not affected by this.

### 2.8.1.5 Setting Notes

**General**

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

**Measured Value Monitoring**

The sensitivity of measured value monitor can be modified. Default values are set at the factory, which are sufficient in most cases. If an extremely high operational unbalance of the currents is to be expected in the specific application, or if during operation monitoring functions are operated sporadically, the relevant parameters should be set less sensitive.

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 $I_{Nom}$). 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.

---

### 2.8.1.6 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 |
|---|---|---|---|---|---|
| 8101 | MEASURE. SUPERV | | OFF<br>ON | ON | Measurement Supervision |
| 8104 | BALANCE I LIMIT | 1A | 0.10 .. 1.00 A | 0.50 A | Current Threshold for Balance Monitoring |
| | | 5A | 0.50 .. 5.00 A | 2.50 A | |
| 8105 | BAL. FACTOR I | | 0.10 .. 0.90 | 0.50 | Balance Factor for Current Monitor |
| 8106 | Σ I THRESHOLD | 1A | 0.05 .. 2.00 A; ∞ | 0.10 A | Summated Current Monitoring Threshold |
| | | 5A | 0.25 .. 10.00 A; ∞ | 0.50 A | |
| 8107 | Σ I FACTOR | | 0.00 .. 0.95 | 0.10 | Summated Current Monitoring Factor |

### 2.8.1.7 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 |
| 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 |
| 197 | MeasSup OFF | OUT | Measurement Supervision is switched OFF |

## 2.8.2 Trip Circuit Supervision 74TC

Devices 7SJ61 are equipped with an integrated trip circuit supervision. Depending on the number of available binary inputs (not connected to a common potential), supervision with one or two binary inputs can be selected. If the allocation of the required binary inputs does not match the selected supervision type, then a message to this effect is generated (`"74TC ProgFail"`).

**Applications**

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

**Prerequisites**

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

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

#### 2.8.2.1 Description

**Supervision with Two Binary Inputs**

When using two binary inputs, these are connected according to Figure 2-38, parallel to the associated trip contact on one side, and parallel to the circuit breaker auxiliary contacts on the other.

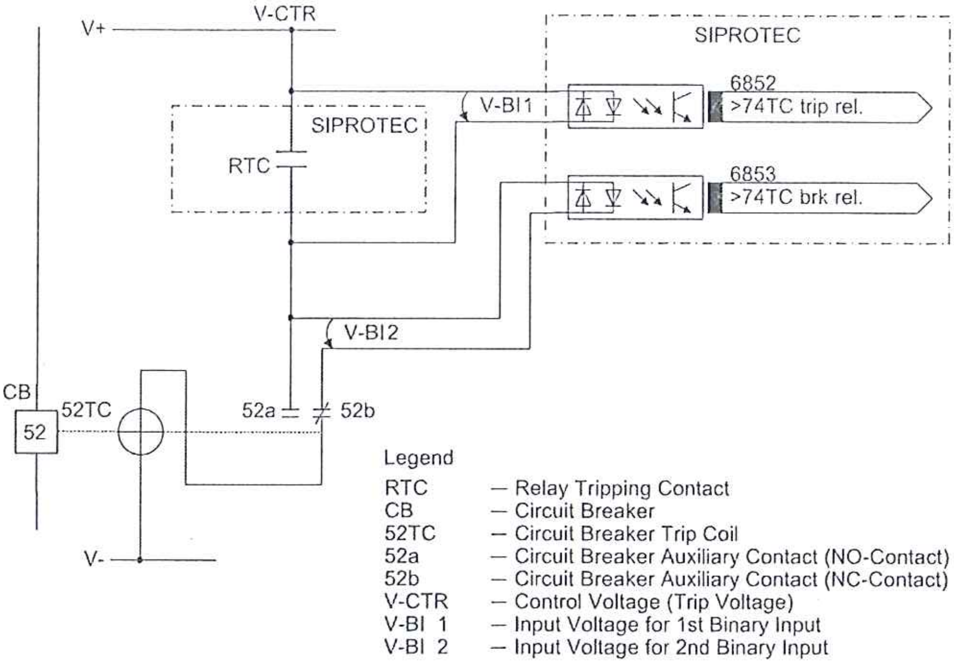



Figure 2-38 Principle of the trip circuit monitoring with two binary inputs

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 2-5), 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 2-5 Condition table for binary inputs, depending on RTC and CB position

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

The conditions of the two binary inputs are checked periodically. A check takes place about every 600 ms. If three consecutive conditional checks detect an abnormality (after 1.8 s), an annunciation is reported (see Figure 2-39). 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.

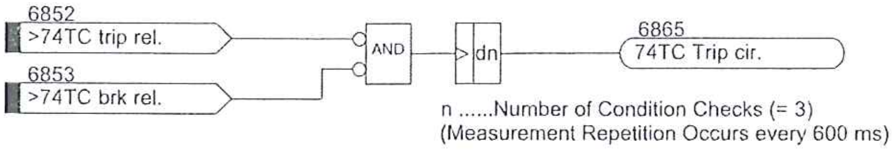



Figure 2-39 Logic diagram of the trip circuit supervision with two binary inputs

**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.

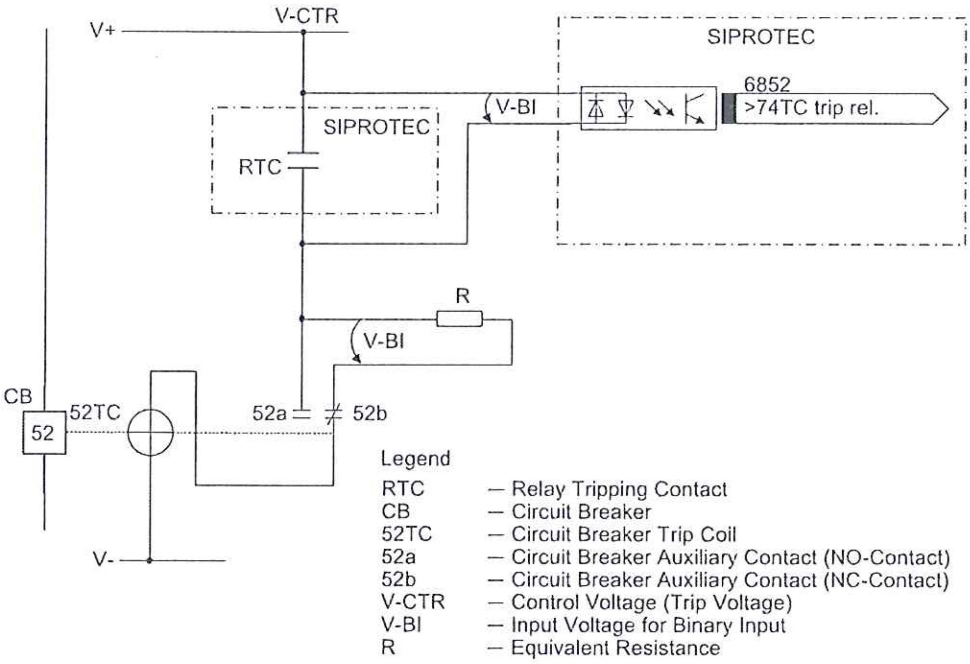



Figure 2-40 Trip circuit supervision with one binary input

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

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

The trip circuit monitor does not operate during system faults. A momentary closed tripping contact does not lead to a failure message. If, however, tripping contacts from other devices operate in parallel in the trip circuit, then the fault annunciation must be delayed (see also Figure 2-41). 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.

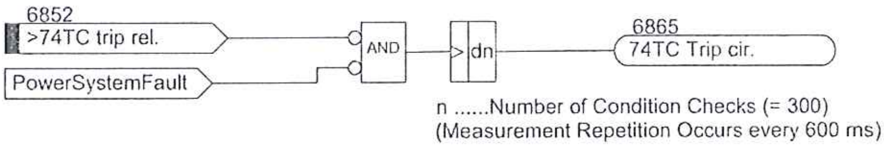



Figure 2-41 Logic diagram for trip circuit monitoring with one binary input

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.

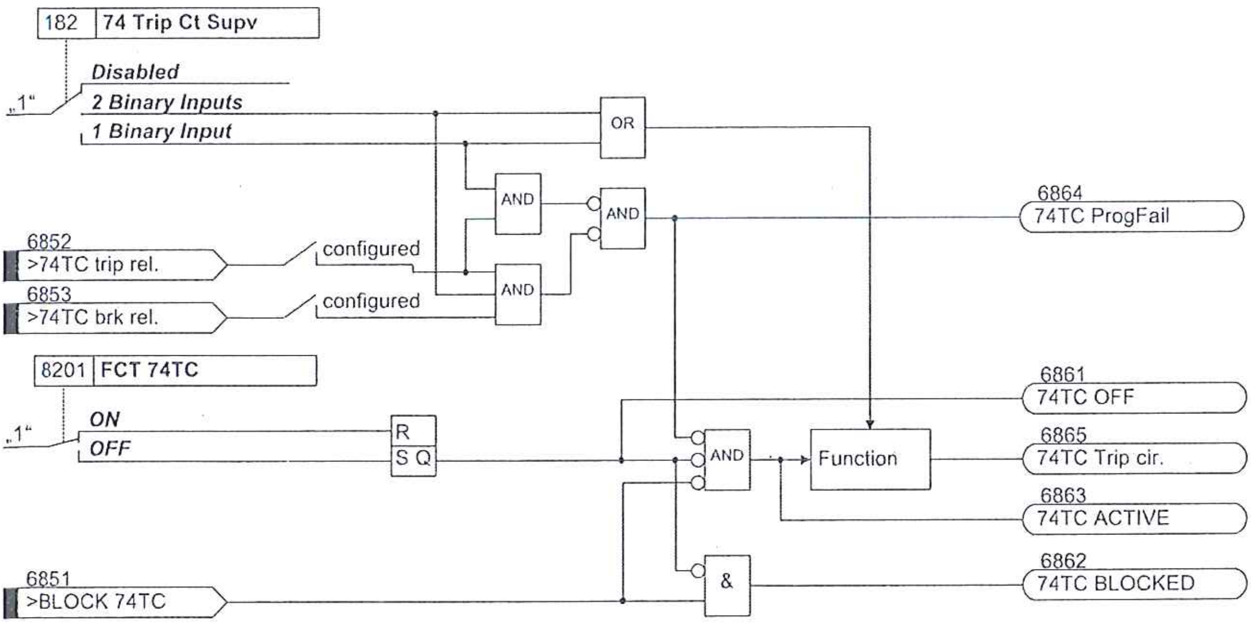



Figure 2-42 Message logic for the trip circuit monitor

### 2.8.2.2 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"

### 2.8.2.3 Settings

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 8201 | FCT 74TC | ON<br>OFF | ON | 74TC TRIP Circuit Supervision |

### 2.8.2.4 Information List

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

## 2.8.3 Malfunction Responses of the Monitoring Functions

In the following malfunction responses of monitoring equipment are clearly listed.

### 2.8.3.1 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 2-6 shows a summary of the monitoring functions and the malfunction responses of the relay.

Table 2-6 Summary of malfunction responses by the protection relay

| Monitoring | Possible Causes | Malfunction Response | Message (No.) | Output |
|---|---|---|---|---|
| Auxiliary supply voltage loss | External (aux. voltage), internal (converter) | Device shutdown | All LEDs dark | DOK[2)] drops out |
| Internal supply voltages | Internal (power supply) | Device shutdown | LED "ERROR" | DOK[2)] drops out |
| Back-up battery | Internal (battery) | Message | "Fail Battery" (177) | |
| Hardware watchdog | Internal (processor failure) | Device shutdown | LED "ERROR" | DOK[2)] drops out |
| Software watchdog | Internal (processor failure) | Restart attempt [1)] | LED "ERROR" | DOK[2)] drops out |
| Working memory | Internal (hardware) | Relay aborts restart, device shutdown | LED flashes | DOK[2)] drops out |
| Program memory | Internal (hardware) | During startup | 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 |
| Scanning 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 |

| Monitoring | Possible Causes | Malfunction Response | Message (No.) | Output |
|---|---|---|---|---|
| Internal supply voltag-es | Internal (hardware) | Device shutdown | "Error PwrSupply" (147), LED "ERROR" | DOK[2] drops out |
| Current sum | Internal (measured value acquisition) | Message | "Failure $\Sigma$ I" (162) | As allocated |
| Current symmetry | External (power system or current transformer) | Message | "Fail I balance" (163) | As allocated |
| Current rotation | External (power system or connection) | Message | "Fail Ph. Seq. I" (175) | As allocated |
| Trip circuit monitoring | External (trip circuit or control voltage) | Message | "74TC Trip cir." (6865) | As allocated |
| Calibration data fault | Internal (Hardware) | Message | "Alarm NO calibr" (193) | DOK[2] drops out |

[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 functions are blocked.

**Group Alarms**

Certain messages of the monitoring functions are already combined to group alarms. A listing of the group alarms and their composition is given in the Appendix A.10. In this case, it must be noted that message 160 "Alarm Sum Event" is only issued when the measured value monitoring functions (8101 **MEASURE. SUPERV**) are switched on.

## 2.9 Ground Fault Protection 50N(s), 51N(s)

Depending on the variant, the fourth current input of the multi-functional protection relays 7SJ61 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.
- 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.

### 2.9.1 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. Analogously to the time overcurrent protection, the high-set current element is designated as **50Ns-2 PICKUP** and **50Ns-2 DELAY** and is provided with a definite time characteristic. The overcurrent element may be operated with either a definite time delay (**50Ns-1 PICKUP** and **50Ns-1 DELAY**) or with a user-defined characteristic (**51Ns PICKUP** and **51NsTIME DIAL**). Additionally, a current element with logarithmic inverse characteristic or logarithmic inverse characteristic with knee point is implemented. The characteristics of these current elements can be configured.

**Settable Dropout Times**

The pickup can be stabilized for ground fault protection with definite time curve by a settable dropout time. This facility is used in power systems with intermittent faults. Used together with electromechanical relays, it allows different dropout responses to be adjusted and time grading of digital and electromechanical relays to be implemented.

## 2.9.2 Logic

The following figure illustrates a state logic of the sensitive ground fault protection. The ground fault detection can be turned ***ON*** or ***OFF*** (address 3101). When ground fault protection is ***ON***, tripping is possible. The entire function may be blocked via binary input. Switching off or blocking means the measurement logic shown in Figure 2-44 is deactivated. Therefore, time delays and pickup messages are reset.

All elements can be blocked individually via binary inputs. In this case, pickups are still reported but tripping is prevented because the time stages are blocked.

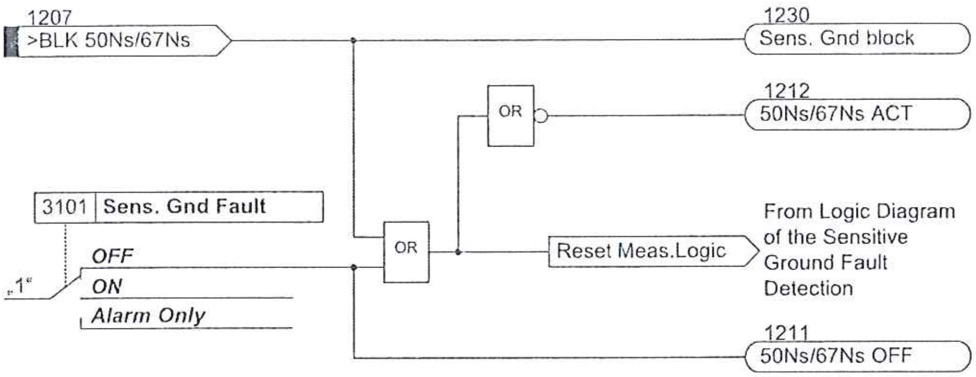



Figure 2-43 Activation of the sensitive ground current protection

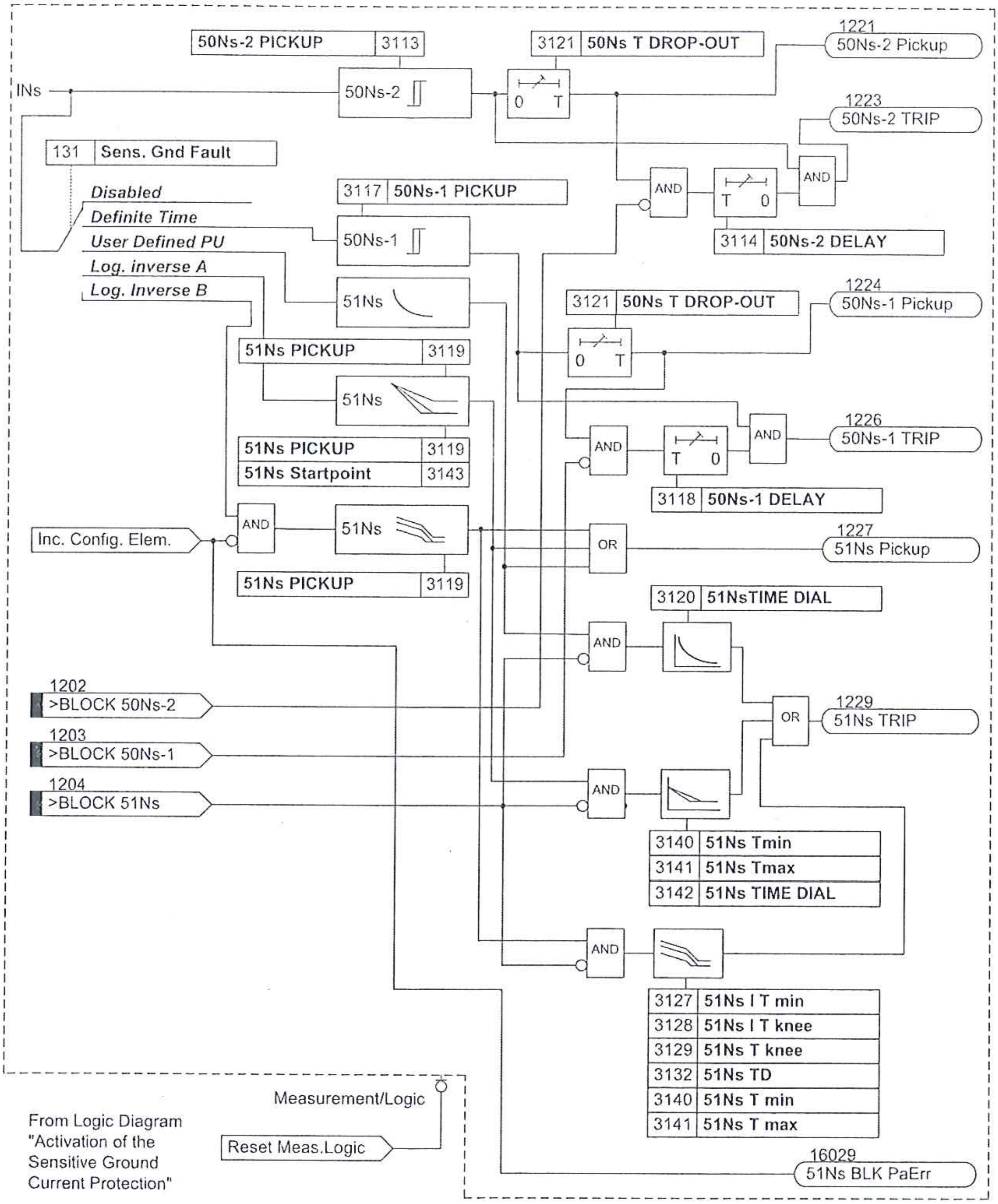



Figure 2-44 Logic diagram of the sensitive ground fault protection

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.

## 2.9.3 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.

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.

A two-stage current/time characteristic may be set at addresses 3113 through 3120. These elements operate with the ground current magnitude. 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-resistant) or on electrical machines which are directly connected to the busbar of an ungrounded power system, when in case of a network ground fault the machine supplies only a negligible ground fault current across the measurement location, which must be situated between the machine terminals and the network, whereas in case of a machine ground fault the total ground fault current produced by the total network is available.

**50Ns–2 Element (Definite Time)**

Similar to the time overcurrent protection function the high set element is named **50Ns-2 PICKUP** (address 3113). It is delayed with **50Ns-2 DELAY** (address 3114) and may be set to generate a message or to trip. The latter is only possible if address 3101 **Sens. Gnd Fault** is set to ***ON***.

**50Ns–1 Element (Definite Time)**

The definite tripping characteristic 50Ns-1 is set with addresses 3117 and 3118 (address 131 **Sens. Gnd Fault** = ***Definite Time***).

**Pickup Stabilization (Definite Time)**

Pickup of the definite time elements can be stabilized by means of a configurable dropout time. This dropout time is set in 3121 **50Ns T DROP-OUT**.

**51Ns Element (Inverse Time)**

The inverse tripping characteristic 51N-TOC is set with addresses 3119 and 3120 (address 131 **Sens. Gnd Fault** = ***User Defined PU***).

**Logarithmic Inverse characteristic (Inverse Time)**

The logarithmic inverse characteristic (see Figure 2-45) 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.

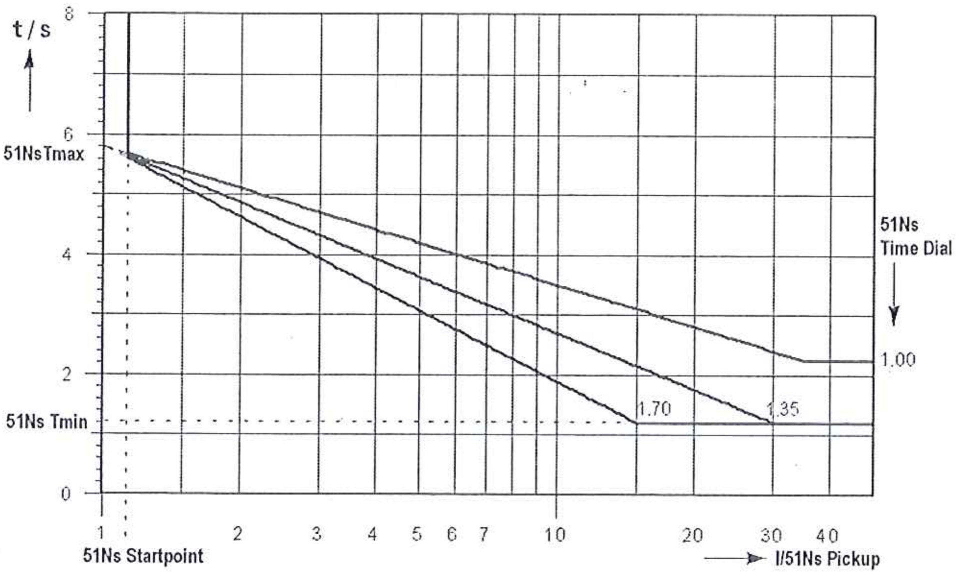



Figure 2-45 Trip-time characteristics of the inverse-time ground fault protection 51Ns with logarithmic inverse characteristic

Logarithmic inverse t = 51Ns MAX. TIME DIAL - 51Ns TIME DIAL·ln(I/51Ns PICKUP)

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

**Logarithmic Inverse characteristic with Knee Point (inverse time)**

The logarithmic inverse characteristic with knee point (see figure 2-46) 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.

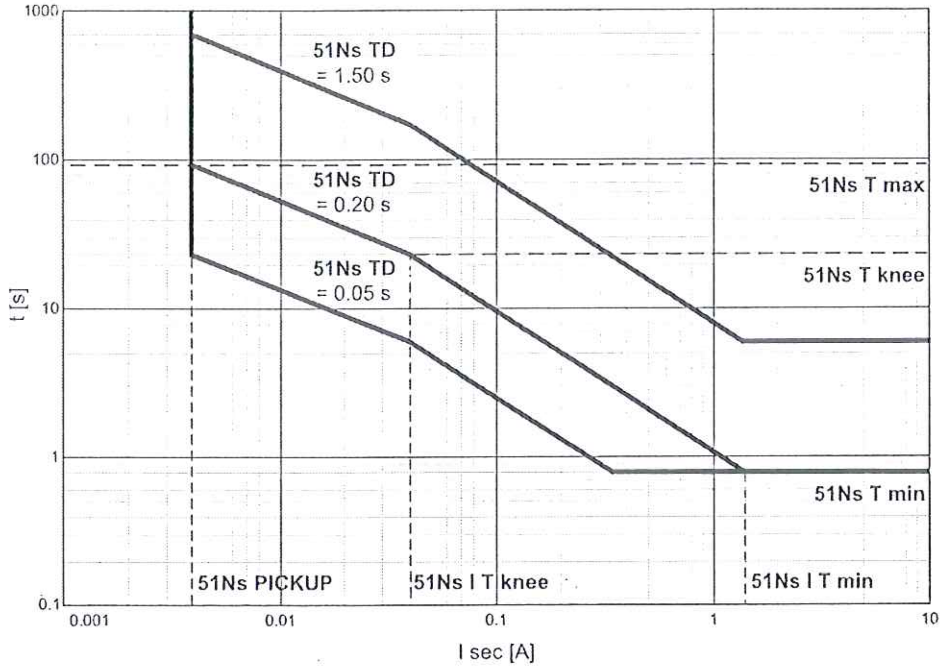



Figure 2-46 Trip-time characteristics of the inverse-time ground fault protection 51Ns with logarithmic inverse characteristic with knee point (example for 51Ns = 0.004 A)

**User Defined characteristics (Inverse Time)**

If a user-defined characteristic is configured at address 131, `Sens. Gnd Fault` *`User Defined PU`*, it should be noted that there is a safety factor of 1.1 between pickup and setting value - as is standard for inverse curves. This means that pickup will only be initiated when current of 1.1 times the setting value flows.

Entry of the value pair (current and time) is a multiple of the settings at addresses 3119 `51Ns PICKUP` and 3120 `51NsTIME DIAL`. Therefore, it is recommended that these addresses are initially set to 1.00 for simplicity. Once the curve is entered, the settings at addresses 3119 and/or 3120 may be modified if necessary.

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

Up to 20 pairs of values (current and time) may be entered at address 3131 `M.of PU TD`. The device then approximates the characteristic, using linear interpolation.

**The following must be observed:**

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

  The current values entered should be those from Table 2-3, along with the matching times. Deviating values MofPU (multiples of PU-values) are rounded. This, however, will not be indicated.

  Currents less than the smallest current value entered will not lead to an extension of the tripping time. The pickup curve (see Figure 2-47) 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 2-47) continues, from the largest current point parallel to the current axis.

Table 2-7 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 | | | | | | |

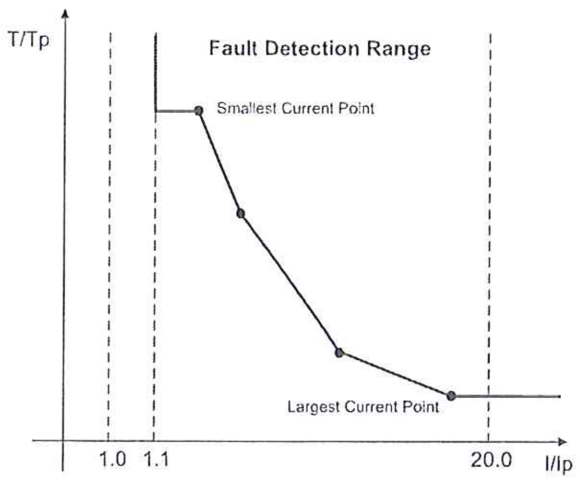



Figure 2-47 Use of a user-defined characteristic

**Note Regarding Settings List for Sensitive Ground Fault Detection**

In devices with sensitive ground fault input, which is independent of the nominal current rating of the device, settings may in general also be entered as primary values under consideration of the current transformer ratio. However, problems related to the resolution of the pickup currents can occur when very small settings and small nominal primary currents are given. The user is therefore encouraged to enter settings for the sensitive ground fault detection in secondary values.

## 2.9.4 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 |
|---|---|---|---|---|---|
| 3101 | Sens. Gnd Fault | | OFF<br>ON | OFF | (Sensitive) Ground Fault |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |

| Addr. | Parameter | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|
| 3141 | 51Ns T max | | 0.50 .. 200.00 sec | 93.00 sec | 51Ns Maximum Time Delay (at 51Ns PU) |
| 3142 | 51Ns TIME DIAL | | 0.05 .. 15.00 sec; ∞ | 1.35 sec | 51Ns Time Dial |
| 3143 | 51Ns Startpoint | | 1.0 .. 4.0 | 1.1 | 51Ns Start Point of Inverse Charac. |

### 2.9.5 Information List

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 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 |
| 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 |
| 16029 | 51Ns BLK PaErr | OUT | Sens.gnd.flt. 51Ns BLOCKED Setting Error |

## 2.10 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 7SJ61 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.

## 2.10.1 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 2-48) is issued. The pickups are also counted; as soon as the counter content has reached the value of parameter **Nos.det.**, the message "Intermitt.EF" is issued. A stabilized pickup is obtained by prolonging the pickup message "IIE Fault det" by a settable time **T-det.ext.**. This stabilization is especially important for the coordination with existing static or electromechanical overcurrent relays.

The duration of the stabilized pickups "IIE stab.Flt" is summated with an integrator **T-sum det.**. If the accumulated pickup time reaches a settable threshold value, a corresponding message is generated ("IEF Tsum exp."). Tripping takes place, however, only while a ground fault is present (message "IEF Trip"). The trip command is maintained during the entire minimum tripping time specified for the device, even if the ground fault is of short duration. After completion of the tripping command all memories are reset and the protection resumes normal condition.

The (much longer) resetting time **T-sum det.** (message **T-reset**) is launched simultaneously with "IEF Tres run." when a ground fault occurs. Unlike **T-sum det.** each new ground fault resets this time to its initial value and it expires anew. If **T-reset** expires and no new ground fault is recorded during that time, all memories are reset and the protection returns to its quiescent state. **T-reset** thus determines the time during which the next ground fault must occur to be processed yet as intermittent ground fault in connection with the previous fault. A ground fault that occurs later will be considered a new fault event.

The message "IIE Fault det" will be entered in the fault log and reported to the system interface only until the message "Intermitt.EF" is issued. This prevents a burst of messages. If the message is allocated to an LED or a relay, this limitation does not apply. This is accomplished by doubling the message (message numbers 6924, 6926).

**Interaction with the Automatic Reclosure Function**

Automatic reclosure is not an effective measure against intermittent ground faults as the function only trips after repeated detection of a fault or after expiration of the summation monitoring time **T-sum det.** and besides this, its basic design is to prevent thermal overload. For these reasons, the intermittent ground fault protection is not implemented as starting feature of the automatic reclosing function.

**Interaction with Breaker Failure Protection**

A pickup that is present when the time delay **TRIP-Timer** has expired is interpreted by the breaker failure protection as a criterion for a tripping failure. Since permanent pickup is not ensured after a tripping command by the intermittent ground fault protection, cooperation with the breaker failure protection is not sensible. Therefore, this function is not activated by the intermittent ground fault protection.

**Logic Diagram**

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

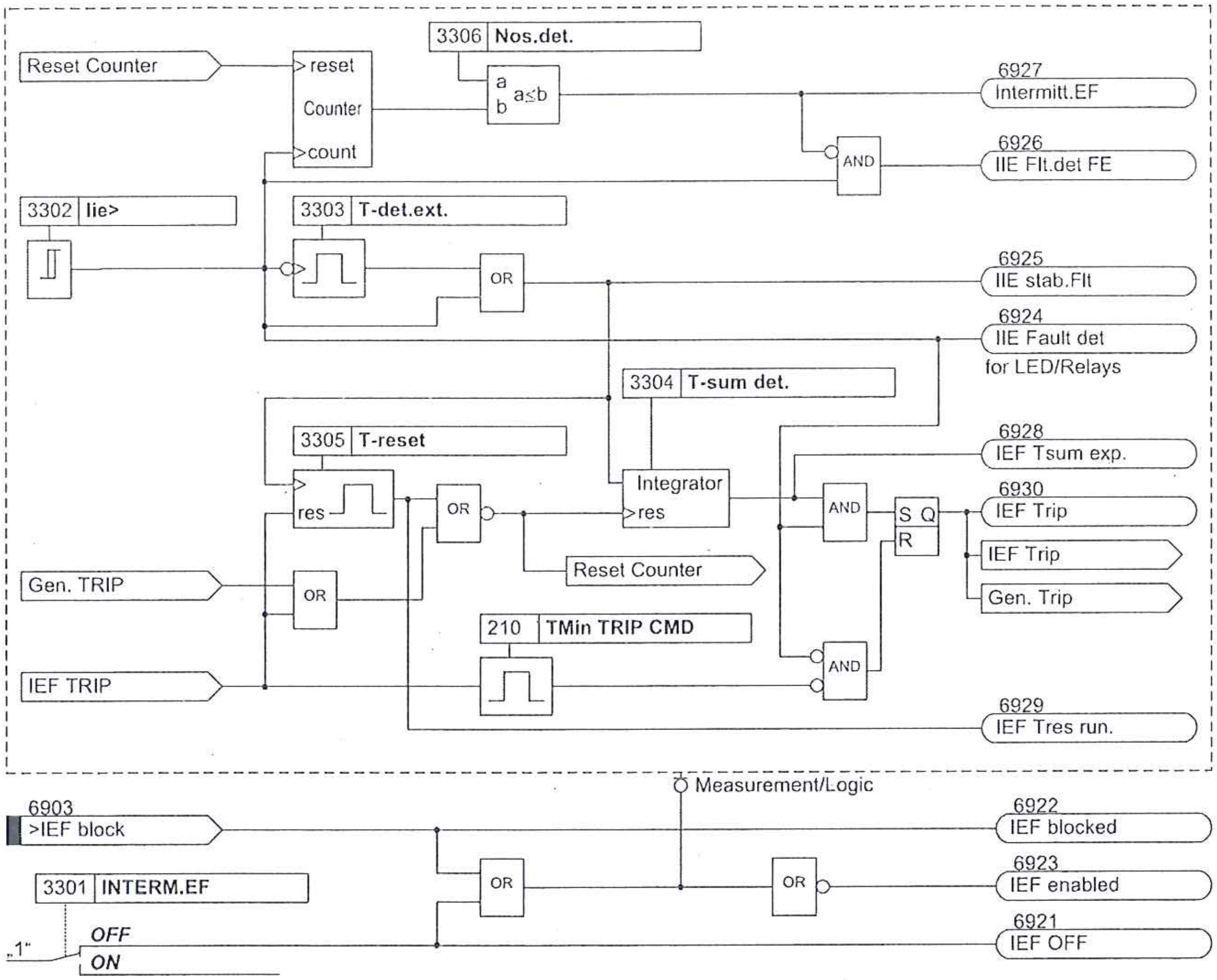



Figure 2-48 Logic diagram of the intermittent ground fault protection – principle

**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 stages to pick up (e.g. 50-1, 50N-1, 50Ns-1) and produce a burst of messages. To avoid overflow of the fault log such 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 2-8):

Table 2-8 Unrestricted messages

| FNo. | Message | Explanation |
|---|---|---|
| 1800 | "50-2 picked up" | 50-2 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 |
| 7565 | "Ia InRush PU" | 50/51 phase A InRush picked up |
| 7566 | "Ib InRush PU" | 50/51 phase B InRush picked up |
| 7567 | "Ic InRush PU" | 50/51 phase C InRush picked up |
| 7564 | "Gnd InRush PU" | Ground InRush picked up |

Table 2-9 shows all messages subject to a restraint mechanism avoiding a message burst during an intermittent ground fault:

Table 2-9 Buffered messages

| FNo. | Message | Explanation |
|---|---|---|
| 1761 | "50(N)/51(N) PU" | 50(N)/51(N) O/C PICKUP |
| 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" | 51-N 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 |
| 1221 | "50Ns-2 Pickup" | 50Ns-2 picked up |
| 1224 | "50Ns-1 Pickup" | 50Ns-1 picked up |
| 1227 | "51Ns Pickup" | 50Ns 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 2-9 are buffered (starting with the first pickup message received after "Intermitt.EF" was signalled). The buffering does not apply for signalling to relays and LEDs as it is required by time-graded protection systems for reverse interlocking. The intermediate buffer can store a maximum of two status changes (the most recent ones) for each message.

Buffered messages are signalled to the fault log, CFC and to the system interface with the original time flag only when a TRIP command is initiated by a protective function other than the intermittent ground fault protection. This ascertains that a pickup, although delayed, is always signalled in association with each TRIP command.

All pickup messages, which usually do not occur during an intermittent ground fault, are not affected by this mechanism. This includes the pickup and TRIP commands of the following protective functions:

- Breaker failure protection,
- Thermal overload protection.

The pickup signals of these functions will still be logged immediately. A TRIP command of one of these protective functions will cause the buffered messages to be cleared since no connection exists between tripping function and buffered message.

A fault event is cleared when the time T-reset has expired or the TRIP command "IEF Trip" has been terminated.

Terminating a fault event for the intermittent ground fault protection thus is a special case. It is the time T-reset that keeps the fault event opened and not the pickup.

## 2.10.2 Setting Notes

**General**

The protection function for intermittent ground faults can only take effect and is only accessible if the current to be evaluated (133, INTERM.EF or *with Ignd*) was configured in address *with 3I0 with Ignd,sens.*. If not required, this function is set to *Disabled*.

The function can be turned *ON* or *OFF* under address 3301 INTERM.EF.

The pickup threshold (r.m.s. value) is set in address 3302 Iie>. A rather sensitive setting is possible to respond also to short ground faults since the pickup time shortens as the current in excess of the setting increases. The setting range depends on the selection of the current to be evaluated at address 133 INTERM.EF.

The pickup time can be prolonged at address 3303 T-det.ext.. This pickup stabilization is especially important for the coordination with existing analog or electromechanical overcurrent relays. The time T-det.ext. can also be disabled (T-det.ext. = 0).

The stabilized pickup starts the counter T-sum det.. This counter is stopped but not reset when the picked up function drops out. Based on the last counter content the counter resumes counting when the stabilized function picks up next. This sum of individual pickup times, which are to initiate tripping, is set at address 3304 T-sum det.. It represents one of the four selectivity criteria (pickup value Iie>, detection extension time T-det.ext., counter T-sum det. and reset time T-reset) for coordinating the relays on adjacent feeders and is comparable to the time grading of the time overcurrent protection. The relay in the radial network which is closest to the intermittent fault and picks up, will have the shortest summation time T-sum det..

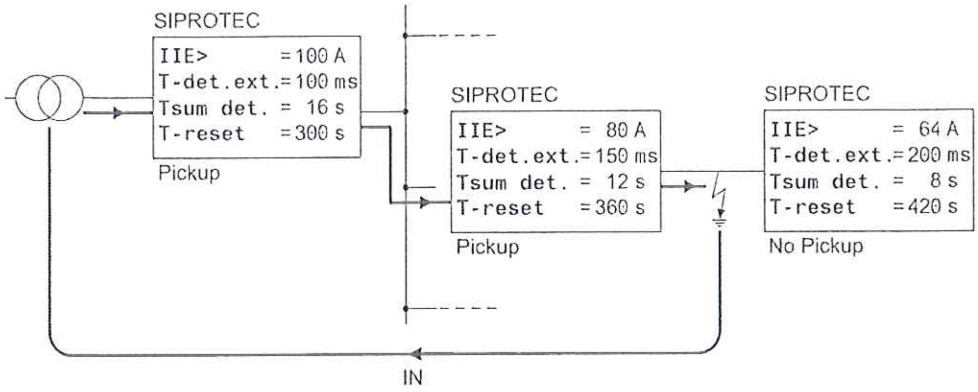



Figure 2-49 Example of selectivity criteria of the intermittent ground fault protection

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.

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

## 2.10.3 Settings

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

| Addr. | Parameter | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|
| 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 |

## 2.10.4 Information List

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 6903 | >IEF block | SP | >block interm. E/F prot. |
| 6921 | IEF OFF | OUT | Interm. E/F prot. is switched off |
| 6922 | IEF blocked | OUT | Interm. E/F prot. is blocked |
| 6923 | IEF enabled | OUT | Interm. E/F prot. is active |
| 6924 | IIE Fault det | OUT | Interm. E/F detection stage Iie> |
| 6925 | IIE stab.Flt | OUT | Interm. E/F stab detection |
| 6926 | IIE Flt.det FE | OUT | Interm.E/F det.stage Iie> f.Flt. ev.Prot |
| 6927 | Intermitt.EF | OUT | Interm. E/F detected |
| 6928 | IEF Tsum exp. | OUT | Counter of det. times elapsed |
| 6929 | IEF Tres run. | OUT | Interm. E/F: reset time running |
| 6930 | IEF Trip | OUT | Interm. E/F: trip |
| 6931 | Iie/In= | VI | Max RMS current value of fault = |
| 6932 | Nos.IIE= | VI | No. of detections by stage Iie>= |

## 2.11 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 7SJ61 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 7SJ61 relay.
- It is also possible to allow the relay 7SJ61 to work in conjunction with an external reclosing device.
- Since the automatic reclosing function is not applied when the 7SJ61 is used to protect generators, motors, transformers, cables and reactors etc., it should be disabled for this application.

## 2.11.1 Program Execution

The 7SJ61 is equipped with three-pole, single-shot and multi-shot automatic reclosure (AR). Figure 2-50 shows an example of a timing diagram for a successful second reclosure.

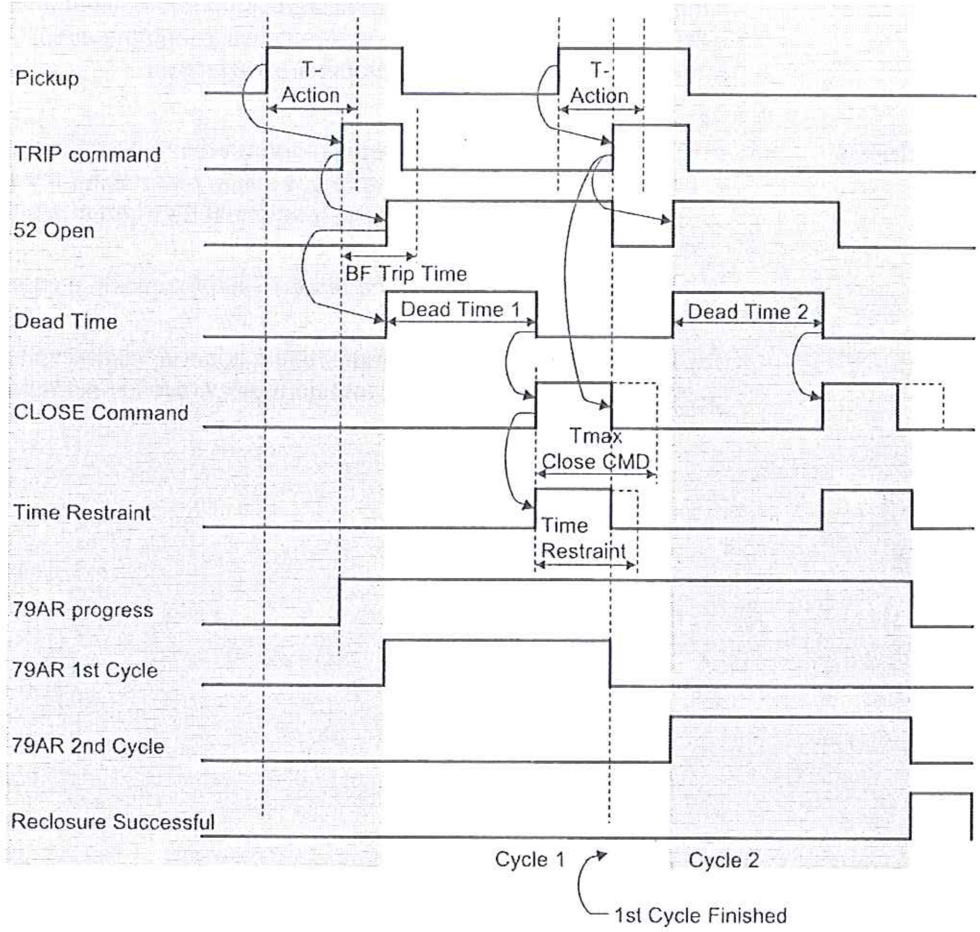



Figure 2-50 Timing diagram showing two reclosing shots, first cycle unsuccessful, second cycle successful

The following figure shows an example of a timing diagram showing for two unsuccessful reclosing shots, with no additional reclosing of the circuit breaker.

The number of reclose commands initiated by the automatic reclosure function are counted. A statistical counter is available for this purpose for the first and all subsequent reclosing commands.

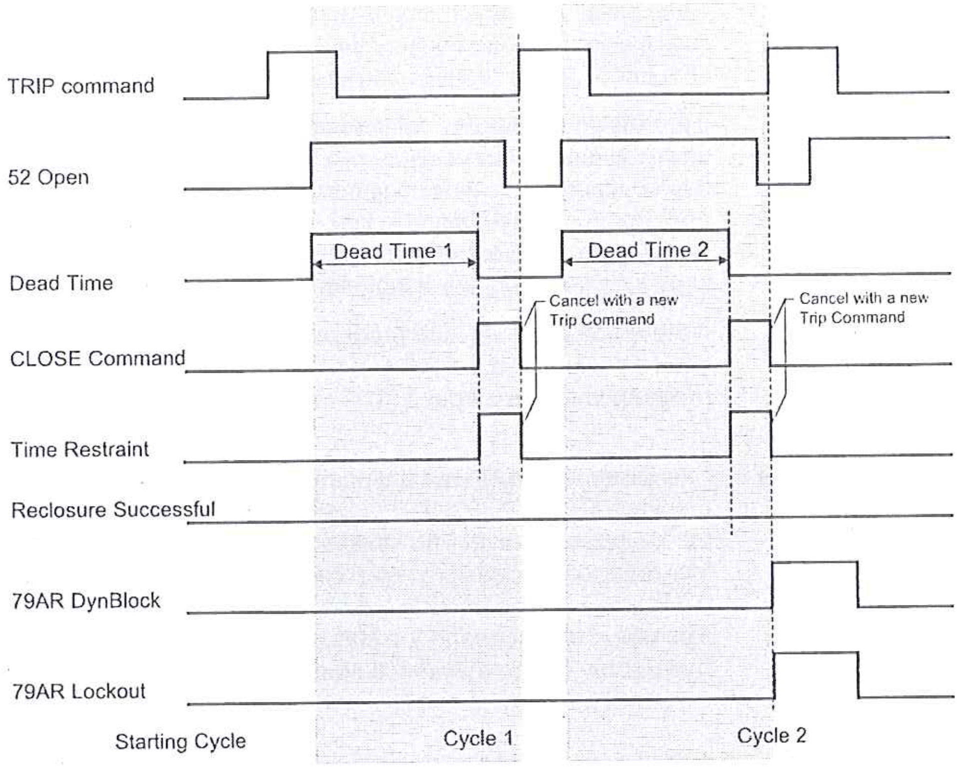



Figure 2-51 Timing diagram showing two unsuccessful reclosing shots

**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 2-10 can initiate (**`Starts 79`**), not initiate (**`No influence`**), or block reclosing (**`Stops 79`**):

Table 2-10 79 start

| Start Time Overcurrent Protection | Start Other |
|---|---|
| 50-1 | SENS. GROUND FLT (50Ns, 51Ns) |
| 50N-1 | 46 |
| 50-2 | BINARY INPUT |
| 50N-2 | |
| 51 | |
| 51N | |

With the initiation the automatic reclosure function is informed that a trip command is output and the appropriate reclosing program is executed.

The binary input messages 2715 ">Start 79 Gnd" and 2716 ">Start 79 Ph" for starting an automatic reclosure program can also be activated via CFC (fast PLC task processing). Automatic reclosure can thus be initiated via any messages (e.g. protective pickup) if address 7164 **BINARY INPUT** is set to ***Starts 79***.

#### Action Time

The action time serves for monitoring the time between a device pickup and the trip command of a protective function configured as starter. The action time is launched when pickup of any function is detected, which is set as source of the automatic reclosure program. Protection functions which are set to ***Alarm Only*** or which in principle should not start a reclosing program do not trigger the action time.

If a protective function configured as starter initiates a trip command during the action time, the automatic reclosure program is started. Trip commands of a protective function configured as starter occurring in the time between expiration of the action time and dropout of the device pickup cause the dynamic blocking of the automatic reclosing program. Trip commands of protective functions which are not configured as starter do not affect the action time.

If the automatic reclosure program interacts with an external protection device, the device pickup for start of the action time is communicated to the automatic reclosing program via binary input 2711 ">79 Start".

#### Delay of Dead Time Start

The initiation of the dead time can be delayed after a 79 start of the binary input message 2754 ">79 DT St.Delay". The dead time is not initiated as long as the binary input is active. The initiation takes place only with dropout of the binary input. The delay of the dead time start can be monitored at parameter 7118 **T DEAD DELAY**. If the time elapses and the binary input is still active, the **Automatic Reclosing System 79** changes to the status of the dynamic blocking via (2785 "79 DynBlock"). The maximal time delay of the dead time start is logged by the annunciation 2753 "79 DT delay ex.".

#### Reclosing Programs

Depending on the type of fault, two different reclosing programs can be used. The following applies:

- The single phase fault (**ground** fault) reclosing program applies when all fault protection functions, which initiate automatic reclosure, detected a phase-to-ground fault. The following conditions must apply: only one phase, only one phase and ground or only ground have picked up. This program can be started via a binary input as well.
- The multiple phase fault (**phase** fault program) reclosing program applies to all other cases. That is, when elements associated with two or more phases pickup, with or without the pickup of ground elements, the phase reclosing program is executed. In addition, when automatic reclosing is initiated by other functions, such as negative sequence elements, this program is started. This program can be started via a binary input as well.

The reclosure program evaluates only elements during pick up as elements dropping out may corrupt the result if they drop out at different times when opening the circuit breaker. Therefore, the ground fault reclosure program is executed only when the elements associated with one particular phase pick up until the circuit breaker is opened; all others conditions will initiate the phase fault program.

For each of the programs, up to 9 reclosing attempts can be separately programmed. The first four reclosing attempts can be set differently for each of the two reclosing programs. The fifth and following automatic reclosures will correspond to the fourth dead time.

**Reclosing Before Selectivity**

For the automatic reclosure sequence to be successful, faults on any part of the line must be cleared from the feeding line end(s) within the same – shortest possible – time. Usually, therefore, an instantaneous protection element is set to operate before an automatic reclosure. Fast fault termination thus has priority over selectivity aspects as the reclosing action aims at maintaining normal system operation. For this purpose all protective functions which can initiate the automatic reclosure function are set such that they may trip instantaneously or with a very small time delay before auto-reclosure.

With the final reclosing attempt, i.e. when no automatic reclosure is expected, protection is to trip with delay according to the grading coordination chart of the network, since selectivity has priority. For details see also information at margin heading "Using the Automatic Reclosure Function" which can be found with the setting notes of the time overcurrent protection functions and the functional description of the intermittent ground fault protection.

**Single-shot Reclosing**

When a trip signal is programmed to initiate the automatic reclosing system, the appropriate automatic reclosing program will be executed. Once the circuit breaker has opened, a dead time interval in accordance with the type of fault is started (see also margin heading "Reclosing Programs"). Once the dead time interval has elapsed, a closing signal is issued to reclose the circuit breaker. A blocking time interval **TIME RESTRAINT** is started at the same time. Within this restraint time it is checked whether the automatic reclosure was performed successfully. If a new fault occurs before the restraint time elapses, the automatic reclosing system is dynamically blocked causing the final tripping of the circuit breaker. The dead time can be set individually for each of the two reclosing programs.

Criteria for opening the circuit breaker may either be the auxiliary contacts of the circuit breaker or the dropout of the general device pickup if auxiliary contacts are not configured.

If the fault is cleared (successful reclosing attempt), the blocking time expires and automatic reclosing is reset in anticipation of a future fault. The fault is cleared.

If the fault is not cleared (unsuccessful reclosing attempt), then a final tripping signal is initiated by one or more protective elements.

**Multi-shot Reclosing**

7SJ61 permits up to 9 reclosings. The number can be set differently for the phase fault reclosing program and the ground fault reclosing program.

The first reclose cycle is, in principle, the same as the single-shot auto-reclosing. If the first reclosing attempt is unsuccessful, this does not result in a final trip, but in a reset of the restraint time interval and start of the next reclose cycle with the next dead time. This can be repeated until the set number of reclosing attempts for the corresponding reclose program has been reached.

The dead time intervals for the first four reclosing attempts can be set differently for each of the two reclosing programs. The dead time intervals from the fifth cycle on will be equal to that of the fourth cycle.

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

If none of the reclosing attempts is successful, then a final circuit breaker trip (according to the grading coordination chart) will take place after the last allowable reclosing attempt has been performed by the protection function. All reclosing attempts were unsuccessful

After the final circuit breaker trip, the automatic reclosing system is dynamically blocked (see below).

**Restraint Time**

The function of the restraint time has already been described in the paragraphs at side title "Single-/Multi-Shot Reclosing". The restraint time can be prolonged when the following conditions are fulfilled.

The time 211 **TMax CLOSE CMD** defines the maximum time during which a close command can apply. If a new trip command occurs before this time has run out, the close command will be aborted. If the time **TMax CLOSE CMD** is set longer than the restraint time **TIME RESTRAINT**, the restraint time will be extended to the remaining close command duration after expiry!

A pickup from a protective function that is set to initiate the automatic reclosing system will also lead to an extension of the restraint time should it occur during this time!

## 2.11.2 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) disappears while the automatic reclosing system is not initiated, thus indicating that the circuit breaker is not ready for a further reclosure,
- 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 7SJ61 is informed of the circuit breaker position via the auxiliary contacts of the circuit breaker.

**Dynamic Blocking**

Dynamic blocking of the automatic reclosure program occurs in those cases where the reclosure program is active and one of the conditions for blocking is fulfilled. The dynamic blocking is signalled by the message "79 DynBlock". The dynamic blocking is associated to the configurable blocking time **SAFETY 79 ready**. This blocking time is usually started by a blocking condition that has been fulfilled. After the blocking time has elapsed the device checks whether or not the blocking condition can be reset. If the blocking condition is still present or if a new blocking condition is fulfilled, the blocking time is restarted. If, however, the blocking condition no longer holds after the blocking time has elapsed, the dynamic blocking will be reset.

Dynamic blocking is initiated if:

- The maximum number of reclosure attempts has been achieved. If a trip command now occurs within the dynamic blocking time, the automatic reclosure program will be blocked dynamically, (indicated by "79 Max. No. Cyc").
- The protection function has detected a three-phase fault and the device is programmed not to reclose after three-phase faults, (indicated by "79 BLK:3ph p.u.").
- When the maximal waiting time **T DEAD DELAY** for the delay of the dead time initiation by binary inputs runs off without that the binary input ">79 DT St.Delay" during this time frame has become inactive.
- The action time has elapsed without a TRIP command being issued. Each TRIP command that occurs after the action time has expired and before the picked-up element drops out, will initiate the dynamic blocking (indicated by "79 Tact expired").
- A protective function trips which is to block the automatic reclosure function (as configured). This applies irrespective of the status of the automatic reclosure system (started / not started) if a TRIP command of a blocking element occurs (indicated by "79 BLK by trip").
- The circuit breaker failure function is initiated.
- The circuit breaker does not trip within the configured time **T-Start MONITOR** after a trip command was issued, thus leading to the assumption that the circuit breaker has failed. (The breaker failure monitoring is primarily intended for commissionnig purposes. Commissionnig safety checks are often conducted with the circuit breaker disconnected. The breaker failure monitoring prevents unexpected reclosing after the circuit breaker has been reconnected, indicated by "79 T-Start Exp").
- The circuit breaker is not ready after the breaker monitoring time has elapsed, provided that the circuit breaker check has been activated (address 7113 **CHECK CB?** = ***Chk each cycle***, indicated by "79 T-CBreadyExp").
- The circuit breaker is not ready after maximum extension of the dead time **Max. DEAD EXT.**. The monitoring of the circuit breaker status and the synchrocheck may cause undesired extension of the dead time. To prevent the automatic reclosure system from assuming an undefined state, the extension of the dead time is monitored. The extension time is started when the regular dead time has elapsed. When it has elapsed, the automatic reclosure function is blocked dynamically and the lock-out time launched. The automatic reclosure system resumes normal state when the lock-out time has elapsed and new blocking conditions do not apply (indicated by "79 TdeadMax Exp").
- Manual closing has been detected (externally) and parameter **BLOCK MC Dur.** (T = 0) was set such that the automatic reclosing system responds to manual closing,
- Via a correspondingly masked binary input (FNo. 2703 ">BLOCK 79"). If the blocking takes places while the automatic recloser is in normal state, the latter will be blocked statically ("79 is NOT ready"). The blocking is terminated immediately when the binary input has been cleared and the automatic reclosure function resumes normal state. If the automatic reclosure function is already running when the blocking arrives, the dynamic blocking takes effect ("79 DynBlock"). In this case the activation of the binary input starts the dynamic blocking time **SAFETY 79 ready**. Upon its expiration the device checks if the binary input is still activated. If this is the case, the automatic reclosure program changes from dynamic blocking to static blocking. If the binary input is no longer active when the time has elapsed and if no new blocking conditions apply, the automatic reclosure system resumes normal state.

## 2.11.3 Status Recognition and Monitoring of the Circuit Breaker

**Circuit Breaker Status**

The detection of the actual circuit breaker position is necessary for the correct functionality of the auto reclose function. The breaker position is detected by the circuit breaker auxiliary contacts and is communicated to the device via binary inputs 4602 ">52-b“ and 4601 ">52-a“.

Here the following applies:

- If binary input 4601 ">52-a“ and binary input 4602 ">52-b“ are used, the automatic reclosure function can detect whether the circuit breaker is open, closed or in intermediate position. If both auxiliary contacts detect that the circuit breaker is open, the dead time is started. If the circuit breaker is open or in intermediate position without a trip command being present, the automatic reclosure function is blocked dynamically if it is already running. If the automatic reclosure system is in normal state, it will be blocked statically. When checking whether a trip command applies, all trip commands of the device are taken into account irrespective of whether the function acts as starting or blocking element on behalf of the automatic reclosure program.
- If binary input 4601 ">52-a“ alone is allocated, the circuit breaker is considered open while the binary input is not active. If the binary input becomes inactive while no trip command of (any) function applies, the automatic reclosure system will be blocked. The blocking will be of static nature if the automatic reclosure system is in normal state at this time. If the automatic reclosing system is already running, the blocking will be a dynamic one. The dead time is started if the binary input becomes inactive following the trip command of a starting element 4601 ">52-a“ = inactive). An intermediate position of the circuit breaker cannot be detected for this type of allocation.
- If binary input 4602 ">52-b“ alone is allocated, the circuit breaker is considered open while the binary input is active. If the binary input becomes active while no trip command of (any) function applies, the automatic reclosure system will be blocked dynamically provided it is already running. Otherwise the blocking will be a static one. The dead time is started if the binary input becomes active following the trip command of a starting element. An intermediate position of the circuit breaker cannot be detected for this type of allocation.
- If neither binary input 4602 ">52-b“ nor 4601 ">52-a“ are allocated, the automatic reclosure program cannot detect the position of the circuit breaker. In this case, the automatic reclosure system will be controlled exclusively via pickups and trip commands. Monitoring for "52-b without TRIP" and starting the dead time in dependence of the circuit breaker feedback is not possible in this case.

### Circuit Breaker Monitoring

The time needed by the circuit breaker to perform a complete reclose cycle can be monitored by the 7SJ61. 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 7SJ61. The monitoring time **CB TIME OUT** expires for as long as the circuit breaker does not indicate that it is ready via binary input ">CB Ready" (FNo. 2730). Meaning that as the binary input ">CB Ready" is cleared, the monitoring time **CB TIME OUT** is started. If the binary input returns before the monitoring time has elapsed, the monitoring time will be cancelled and the reclosure process is continued. If the monitoring time runs longer than the dead time, the dead time will be extended accordingly. If the monitoring time elapses before the circuit breaker signals its readiness, the automatic reclosure function will be blocked dynamically.

Interaction with the synchronism check may cause the dead time to extend inadmissibly. To prevent the automatic reclosure function from remaining in an undefined state, dead time extension is monitored. The maximum extension of the dead time can be set at **Max. DEAD EXT.**. The monitoring time **Max. DEAD EXT.** is started when the regular dead time has elapsed. If the synchronism check responds before the time has elapsed, the monitoring time will be stopped and the close command generated. If the time expires before the synchronism check reacts, the automatic reclosure function will be blocked dynamically.

Please make sure that the above mentioned time is not shorter than the monitoring time **CB TIME OUT**.

The time 7114 **T-Start MONITOR** serves for monitoring the response of the automatic reclosure function to a breaker failure. It is activated by a trip command arriving before or during a reclosing operation and marks the time that passes between tripping and opening of the circuit breaker. If the time elapses, the device assumes a breaker failure and the automatic reclosure function is blocked dynamically. If parameter **T-Start MONITOR** is set to ∞, the start monitoring is disabled.

### 2.11.4 Controlling Protective Elements

Depending on the reclosing cycle it is possible to control elements of the 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 2.11.6 and Section 2.3) regarding thresholds and trip time delays.
3. The time overcurrent address 1x14A 50(N)-2 ACTIVE defines whether the 50(N)2 elements are to operate always or only with "79M Auto Reclosing ready" (see Section 2.2).

**Cyclic Control**

Control of the overcurrent protection elements takes effect by releasing the cycle marked by the corresponding parameter. The cycle zone release is indicated by the messages "79 1.CycZoneRel" to "79 4.CycZoneRel". If the automatic reclosure system is in normal state, the settings for the starting cycle apply. These settings always take effect when the automatic reclosure system assumes normal state.

The settings are released for each following cycle when issuing the close command and starting the blocking time. Following a successful auto reclosing operation (restraint time elapsed) or when reset after blocking, the automatic reclosure system assumes normal state. Control of the protection is again assumed by the parameters for the starting cycle.

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

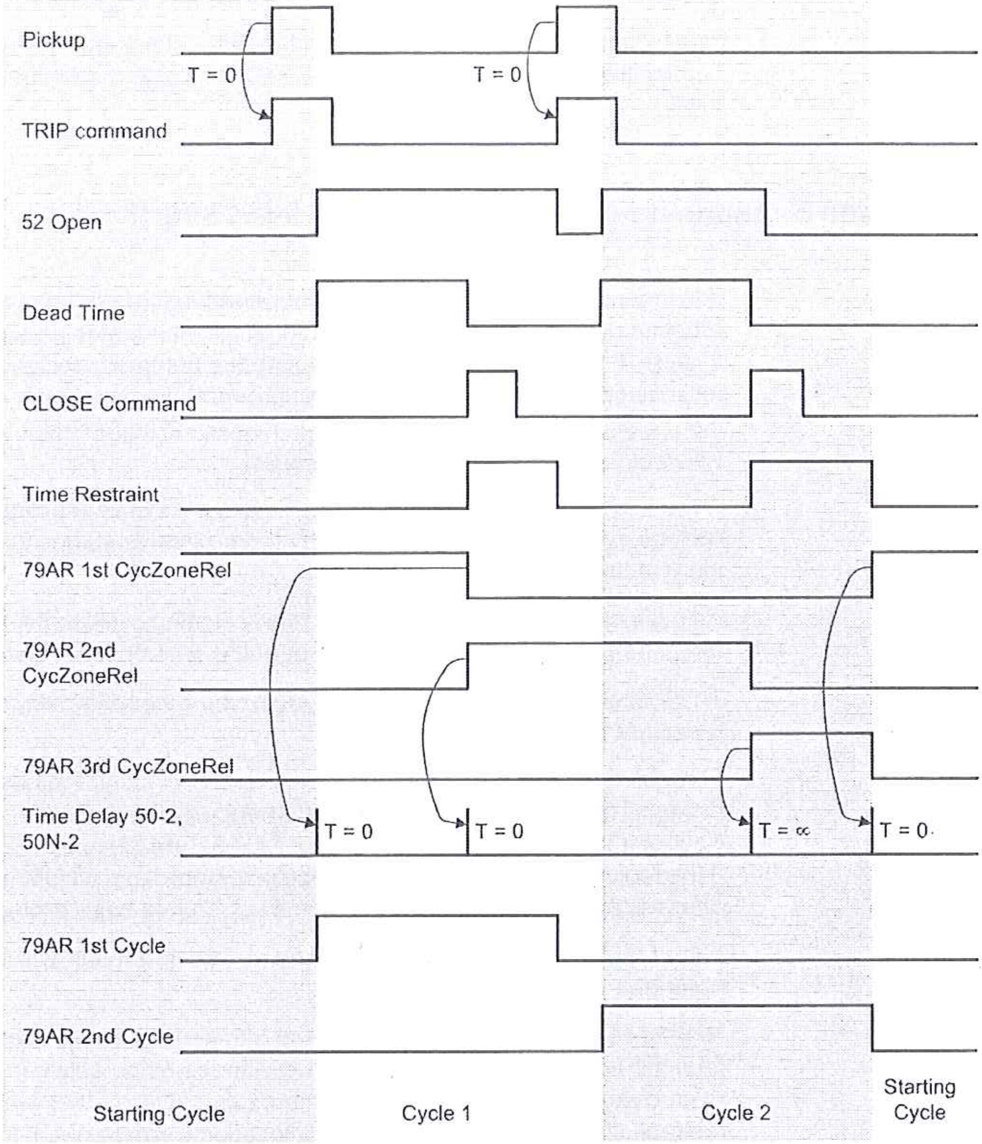



Figure 2-52 Control of protection elements for two-fold, successful auto-reclosure

**Example**

Before the first reclosure faults are to be eliminated quickly applying stages 50-2 or 50N-2. Fast fault termination thus has priority over selectivity aspects as the reclosing action aims at maintaining normal system operation. If the fault prevails, a second tripping is to take place instantaneously and subsequently, a second reclosure.

After the second reclosure, however, elements 50-2 or 50N-2 are to be blocked so the fault can be eliminated applying elements 50-1 or 50N-1 according to the networks time grading schedule giving priority to selectivity concerns.

Addresses 7202 **bef.1.Cy:50-2**, 7214 **bef.2.Cy:50-2** and 7203 **bef.1.Cy:50N-2** and 7215 **bef.2.Cy:50N-2** are set to ***instant.*** *T=0* to enable the stages after the first reclosure. Addresses 7226 **bef.3.Cy:50-2** and 7227 **bef.3.Cy:50N-2**, however, are set to ***blocked*** *T=∞* to ensure that elements 50-2 and 50N-2 are blocked when the second reclosure applies. The back-up stages e.g., 50-1 and 50N-1 must obviously not be blocked (addresses 7200, 7201, 7212, 7213, 7224 and 7225).

The blocking applies only after reclosure according to the settings address. Hence, it is possible to specify again other conditions for a third reclosure.

The blocking conditions are also valid for the zone sequence coordination, provided it is available and activated (address 7140, see also margin heading "Zone Sequencing").

### 2.11.5 Zone Sequencing (not available for models 7SJ6***-**A**-)

It is the task of the zone sequence coordination to harmonize the automatic reclosure function of this device with that of another device that is part of the same power system. It is a complementary function to the automatic reclosure program and allows for example to perform group reclosing operations in radial systems. In case of multiple reclosures, groups may also be in nested arrangement and further high-voltage fuses can be overgraded or undergraded.

Zone sequencing works by blocking certain protective functions depending on the reclose cycle. This is implemented by the protective stages control (see margin heading "Controlling Protective Stages").

As a special feature, changing from one reclosing cycle to the next is possible without trip command only via pickup/dropout of the 50-1 or 50N-1element.

The following figure shows an example of a group reclosure at feeder 3. Assume that reclosure is performed twice.

For fault F1 at Tap Line #5, protection relays protecting the bus supply and Feeder #3 pickup. The time delay of the 50-2 element protecting Feeder #3 is set so that the Feeder #3 circuit breaker will clear the fault before the fuse at Tap Line #5 is damaged. If the fault was cleared, normal service is restored and all functions return to quiescent after restraint time has expired. Thus the fuse has been protected as well.

If the fault continues to exist, a second reclosing attempt will follow in the same manner.

High speed element 50-2 is now being blocked at relay protecting Feeder #3. If the fault still remains, only element 50-1 continues being active in Feeder #3 which, however, **overgrades** the fuse with a time delay of 0.4 s. After the fuse operated to clear the fault, the relays nearer to the fault location will drop out. If the fuse fails to clear the fault, then the 50-1 element protecting Feeder #3 will operate as backup protection.

The 50-2 element at the busbar relay is set with a delay of 0.4 seconds, since it supposed to trip the 50-2 elements and the fuses as well. For the second reclosure, the 50-2 element also has to be blocked to give preference to the feeder relay (element 50-1 with 0.4 s). For this purpose, the device has to "know" that two reclosing attempts have already been performed.

With this device, zone sequence coordination must be switched off: When pickup of 50-1 or 50N-2 drops out, zone sequence coordination provokes that the reclosing attempts are counted as well. If the fault still persists after the second reclosure, the 50-1 element, which is set for 0.9 seconds, would serve as backup protection.

For the busbar fault F2, the 50-2 element at the bus would have cleared the fault in 0.4 seconds. Zone sequence coordination enables the user to set a relative short time period for element 50-2. element 50-2 is only used as backup protection. If zone sequence coordination is not applied, element 50-1 is to be used only with the relative long time period (0.9 s).

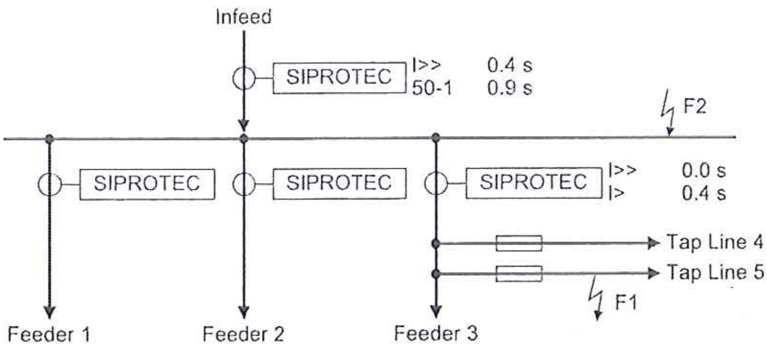



Figure 2-53 Zone sequencing with a fault occurring at Tap Line #5 and the busbar

## 2.11.6 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 7SJ61 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 7SJ61. No messages exist for this purpose and binary inputs for the automatic reclosure function are ignored. All parameters of block 71 are inaccessible and of no significance.

**Blocking Duration for Manual-CLOSE Detection**

Parameter 7103 **BLOCK MC Dur.** defines the reaction of the automatic reclosure function when a manual closing signal is detected. The parameter can be set to specify how long the auto reclose function will be blocked dynamically in case of an external manual close-command being detected via binary input (356 ">Manual Close"). If the setting is 0, the automatic reclosure system will not respond to a manual close-signal.

**Restraint Time and Dynamic Blocking**

The blocking time **TIME RESTRAINT** (address 7105) defines the time that must elapse, after a successful reclosing attempt, before the automatic reclosing function is reset. If a protective function configured for initiation of the auto-reclosure function provokes a new trip before this time elapses, the next reclosing cycle is started in case of multiple reclosures. If no further reclosure is allowed, the last reclosure will be classed as unsuccessful.

In general, a few seconds are sufficient. In areas with frequent thunderstorms or storms, a shorter blocking time may be necessary to avoid feeder lockout due to sequential lightning strikes or flashovers.

A longer restraint time should be chosen if there is no possibility to monitor the circuit breaker (see below) during multiple reclosing (e.g. because of missing auxiliary contacts and and information on the circuit breaker ready status). In this case, the restraint time should be longer than the time required for the circuit breaker mechanism to be ready.

If a dynamic blocking of the automatic reclosing system was initiated, then reclosing functions remain blocked until the cause of the blocking has been cleared. The functional description gives further information on this topic, see marginal heading "Dynamic Blocking". The dynamic blocking is associated with the configurable blocking time **SAFETY 79 ready**. Dynamic blocking time is usually started by a blocking condition that has picked up.

**Circuit Breaker Monitoring**

Reclosing after a fault clearance presupposes that the circuit breaker is ready for at least one TRIP-CLOSE-TRIP cycle at the time when the reclosing function is initiated (i.e. at the beginning of a trip command):

The readiness of the circuit breaker is monitored by the device using a binary input ">CB Ready" (FNo. 2730).

- It is possible to check the status of the circuit breaker before each reclosure or to disable this option (address 7113, **CHECK CB?**):

  **CHECK CB?** = ***No check***, deactivates the circuit breaker check,

  **CHECK CB?** = ***Chk each cycle***, to verify the circuit breaker status before each reclosing command.

  Checking the status of the circuit breaker is usually recommended. Should the breaker not provide such a signal, you can disable the circuit breaker check at address 7113 **CHECK CB?** (***No check***), as otherwise auto-reclosure would be impossible.

  The status monitoring time **CB TIME OUT** can be configured at address 7115 if the circuit breaker check was enabled at address 7113. This time is set slightly higher than the maximum recovery time of the circuit breaker following reclosure. If the circuit breaker is not ready after the time has expired, reclosing is omitted and dynamic blocking is initiated. Automatic reclosure thus is blocked.

Time **Max. DEAD EXT.** serves for monitoring the dead time extension. The extension can be initiated by the circuit breaker monitoring time **CB TIME OUT** and by an external synchronism check.

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 an external synchronism check, **Max. DEAD EXT.** assures that the auto-reclose system does not remain in undefined state when the synchronism check fails to check back.

If external synchrocheck is used (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 external synchronization is used for synchronous/asynchronous networks, the monitoring time must grant sufficient time for determining the time for switching in. This depends on the frequency slip of the two subnetworks. A monitoring time of 100 s should be sufficient to account for most applications for asynchronous networks.

Generally, the monitoring time should be longer than the maximum duration of the synchronization process (parameter 6x12).

The breaker failure monitoring time 7114 **T-Start MONITOR** determines the time between tripping (closing the trip contact) and opening the circuit breaker (checkback of the CB auxiliary contacts). This time is started each time a tripping operation takes place. When time has elapsed, the device assumes breaker failure and blocks the auto-reclose system dynamically.

**Action Time**

The action time monitors the time between interrogation of the device and trip command of a protective function configured as starter while the auto-reclosure system is ready but not yet running. A trip command issued by a protective function configured as starter occurring within the action time will start the automatic reclosing function. If this time differs from the setting value of **T-ACTION** (address 7117), the automatic reclosing system will be blocked dynamically. The trip time of inverse tripping characteristics is considerably determined by the fault location or fault resistance. The action time prevents reclosing in case of far remote or high-resistance faults with long tripping time. Trip commands of protective functions which are not configured as starter do not affect the action time.

**Delay of Dead Time Start**

The dead time start can be delayed by pickup of the binary input message 2754 ">79 DT St.Delay". The maximum time for this can be parameterized under 7118 **T DEAD DELAY**. The binary input message must be deactivated again within this time in order to start the dead time. The exact sequence is described in the functional description at margin heading "Delay of Dead Time Start".

**Number of Reclosing Attempts**

The number of reclosing attempts can be set separately for the "phase program" (address 7136 **# OF RECL. PH**) and "ground program" (address 7135 **# OF RECL. GND**). The exact definition of the programs is described in the functional description at margin heading "Reclosing Programs".

**Close Command: Direct or via Control**

Address 7137 **Cmd.via control** can be set to either generate directly the close command via the automatic reclosing function (setting **Cmd.via control** = ***none***) or have the closing initiated by the control function.

If the AR is to be intended to close via the control function, the Manual Close command has to be suppressed during an automatic reclose command. The example in Section 2.2.10 of a MANUAL CLOSE for commands via the integrated control function, has to be extended in this case (see Fig. 2-54).It is detected via the annunciation 2899 "79 CloseRequest" that a reclose command is requested. The annunciation sets the flipflop and suspends the manual signal until the AR has finished the reclosure attempts. The flipflop is reset via the OR-combination of the annunciations 2784 "79 is NOT ready", 2785 "79 DynBlock" and 2862 "79 Successful". ManCl is initiated if a CLOSE command comes from the control function.

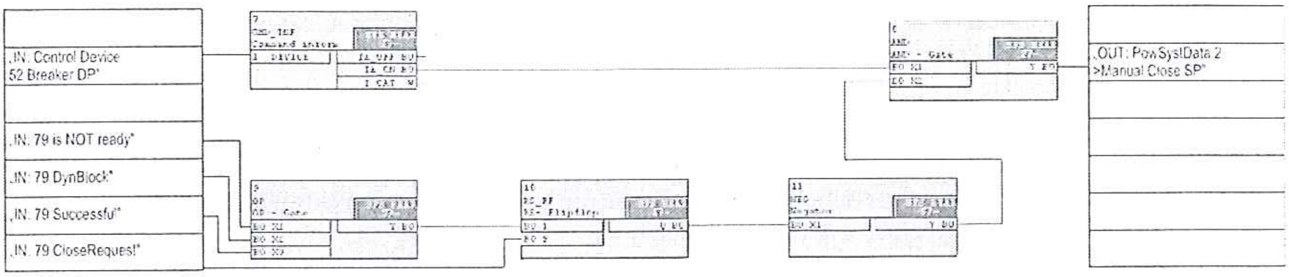



Figure 2-54 CFC Logic for ManCl with AR via Control

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 2-54 is not needed in this case.

#### 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 7SJ61 is linked to the external synchrocheck via the message 2865 "79 Sync.Request" and the binary input ">Sync.release".

#### 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 7205 allow cyclic control of the various protective functions by the automatic reclosing function. Thus protective elements can be blocked selectively, switched instantaneously or according to the configured delay times.

The following options are available:

- ***Set value T=T*** The protective element is delayed as configured i.e., the auto-reclose function does not effect this element;

  ***instant. T=0*** The protective element becomes instantaneous if the auto-reclose function is ready to perform the mentioned cycle;

  ***blocked T=∞*** The protective element is blocked if the auto-reclose function reaches the cycle defined in the parameter.

**Dead Times (2nd to 4th AR)**

If more than one reclosing cycle was set, you can now configure the individual reclosing settings for the 2nd to 4th cycle. The same options are available as for the first cycle.

For the 2nd cycle:

| | | |
|---|---|---|
| Address 7129 | DEADTIME 2: PH | Dead time for the 2nd reclosing attempt "Phase" |
| Address 7130 | DEADTIME 2: G | Dead time for the 2nd reclosing attempt "Ground" |
| Addresses 7212 to 7217 | | 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 3rd reclosing attempt "Ground" |
| Addresses 7224 to 7229 | | 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 7241 | | 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).

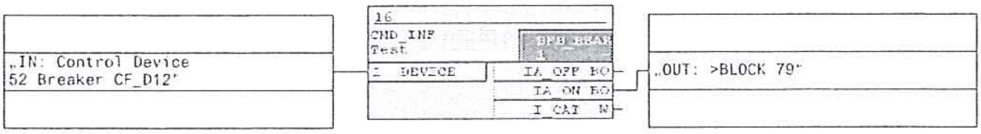



Figure 2-55 Blocking of the automatic reclose function using the internal control function

**Zone Sequencing**

**Not available for models** 7SJ61**-**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 7241 (see paragraph below at "Initiation and Blocking of Reclosing by Protective Functions" and "Controlling 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 Overcurrent Protection Stages via Cold Load Pickup**

The cold load pickup function is another possibility to control the protection behavior via the automatic reclosing system (see also Section 2.3). This function provides the address 1702 **Start Condition**. It determines the starting conditions for the increased pickup values of current and time of the cold load pickup to apply for overcurrent protection.

If address 1702 **Start Condition** = ***79 ready***, the overcurrent protection always employs 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 not AR-cycle-related.

Since control via cold load pickup and cyclic control via auto-reclosing system can run simultaneously, the overcurrent protection must coordinate the input values of the two interfaces. In this context the cyclic auto-reclosing control has the priority and thus overwrites the release of the cold load pickup function.

If the protective elements are controlled via the automatic reclosing function, changing the control variables (e.g. by blocking) has no effect on elements that are already running. The elements in question are continued.

**Note Regarding Settings List for Automatic Reclosure Function**

The setting options of address 7137 `Cmd.via control` are generated dynamically according to the current configuration.

## 2.11.7 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 |
| 7139 | External SYNC | YES<br>NO | NO | External 25 synchronisation |

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 7140 | ZONE SEQ.COORD. | OFF<br>ON | OFF | ZSC - Zone sequence coordination |
| 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 |
| 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 |
| 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 |

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 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 |
| 7217 | bef.2.Cy:51N | Set value T=T<br>instant. T=0<br>blocked T=∞ | Set value T=T | before 2. Cycle: 51N |
| 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 |
| 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 |

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 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 |

## 2.11.8 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 |

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 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 |
| 2892 | 79 4.CycZoneRel | OUT | 79 4th cycle zone extension release |
| 2899 | 79 CloseRequest | OUT | 79: Close request to Control Function |

# 2.12 Breaker Failure Protection 50BF

The breaker failure protection function monitors the reaction of a circuit breaker to a trip signal.

## 2.12.1 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 2-56, as an example).

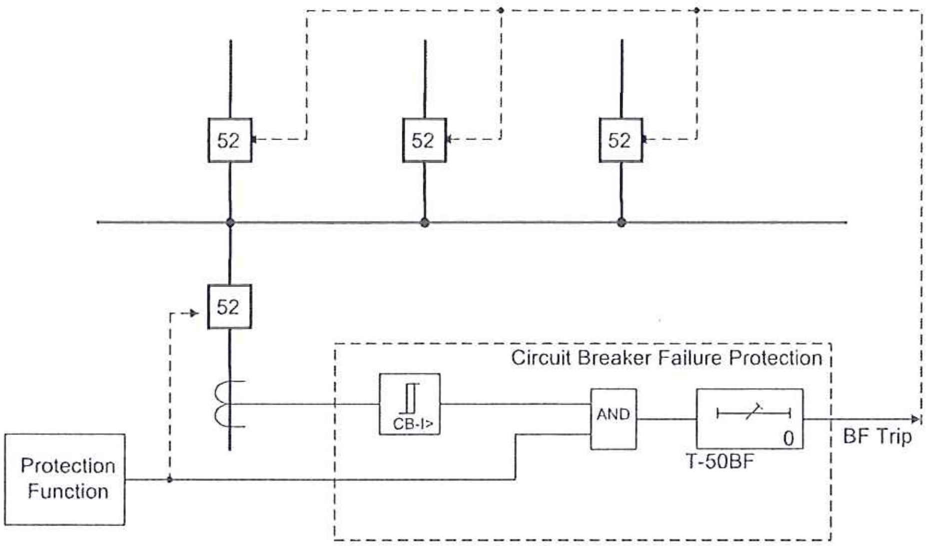



Figure 2-56 Functional principle of the breaker failure protection function

**Initiation**

The breaker failure protection function can be initiated by two different sources:

- Trip signals of internal protective functions of the 7SJ61,
- 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, the current is not a reliable indication as to whether the circuit breaker has 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 short circuit protection functions) both the current criterion and the criterion derived from the circuit breaker auxiliary contact must be fulfilled. Only when the information retrieved by means of the auxiliary contact criterion is contradictory and therefore erroneous, will the current criterion be used as the only criterion.

The current criterion is met if at least one of the three phase currents exceeds a settable threshold (**BkrClosed I MIN**) (see Section 2.1.3.2, margin heading "Current Flow Monitoring"). This pickup threshold is also used by other protective functions.

Evaluation of the circuit breaker auxiliary contacts depends on the type of contacts, and how they are connected to the binary inputs:

- Auxiliary contacts for circuit breaker "open" and "closed" are allocated,
- Only the auxiliary contact for circuit breaker "open" is allocated,
- Only the auxiliary contact for circuit breaker "closed" is allocated,
- No auxiliary contact is allocated.

Feedback information of the auxiliary contact(s) of the circuit breaker is evaluated, depending on the allocation of binary inputs and auxiliary contacts. After a trip command has been issued it is the aim to detect — if possible — by means of the feedback of the circuit breaker's auxiliary contacts whether the breaker is open or in intermediate position. If valid, this information can be used for a proper initiation of the breaker failure protection function.

**Logic**

If breaker failure protection is initiated, an alarm message is generated and a settable delay time is started. If once the time delay has elapsed, criteria for a pick-up are still met, a trip signal is issued to a superordinate circuit breaker. Therefore, the trip signal issued by the circuit breaker failure protection is configured to one of the output relays.

The following figure shows the logic diagram for the breaker failure protection function. The entire breaker failure protection function may be turned on or off, or it can be blocked dynamically via binary inputs.

If one of the criteria (current value, auxiliary contacts) that caused the breaker failure scheme to pickup is no longer met when time delay elapses, pickup drops out and no trip signal is issued by the breaker failure protection function.

To protect against spurious tripping due to excessive contact bounce, a stabilization of the binary inputs for external trip signals takes place. This external signal must be present during the entire period of the delay time, otherwise the timer is reset and no tripping signal is issued.

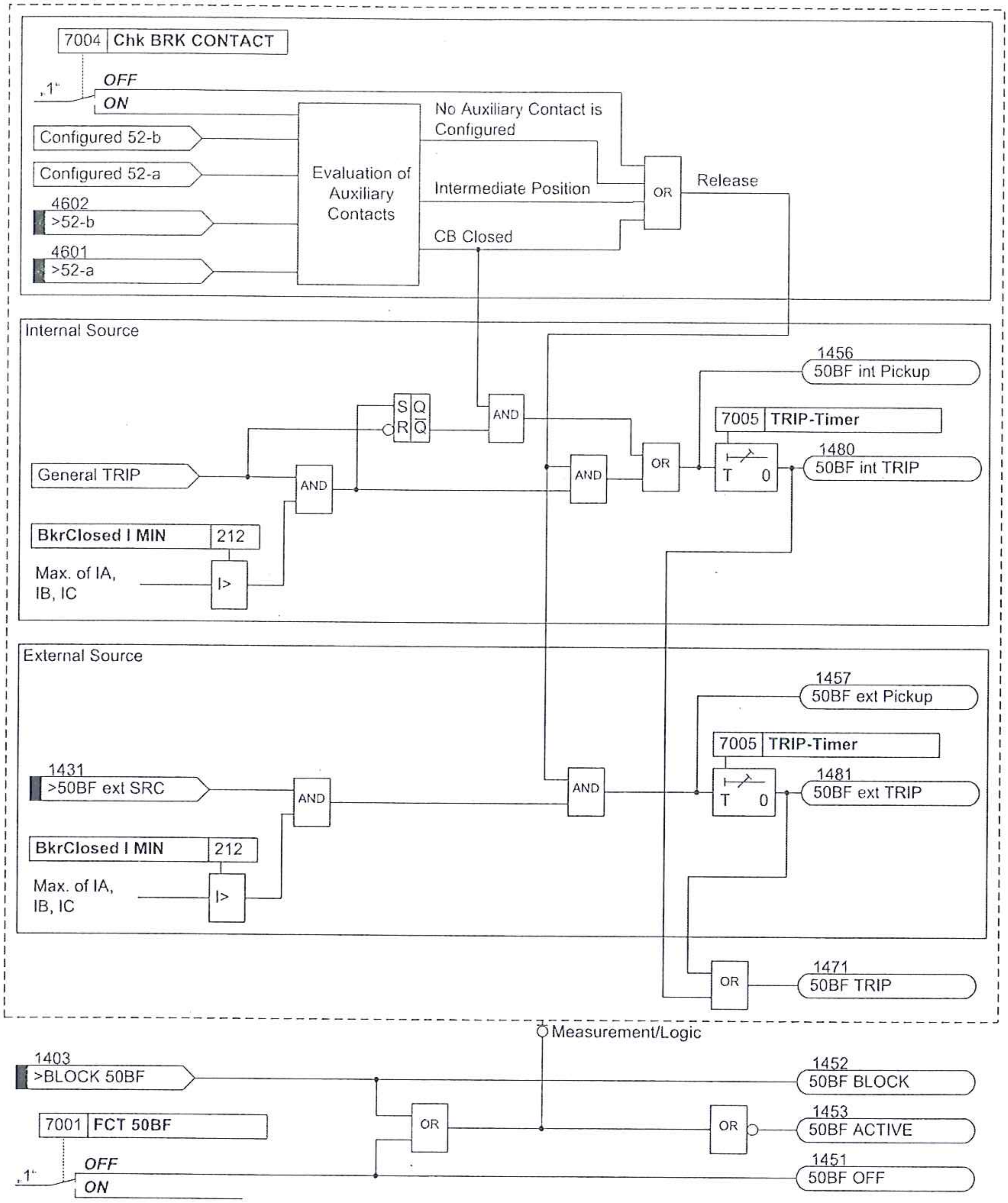



Figure 2-57 Logic diagram for breaker failure protection

## 2.12.2 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 one of the criteria for pickup. If this address is set to ***ON***, then the 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 the fact that the circuit breaker is closed. This may be the case if a fault current was not the cause of tripping. Without the auxiliary contact criterion, the circuit breaker failure protection would not be able to take effect in this case.

If address **Chk BRK CONTACT** is set to ***ON*** and no intermediate position is indicated by the auxiliary contacts, the current and auxiliary contact criteria are linked by a logical AND for all short-circuit protection functions.

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. 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 2-58 illustrates the time sequences.

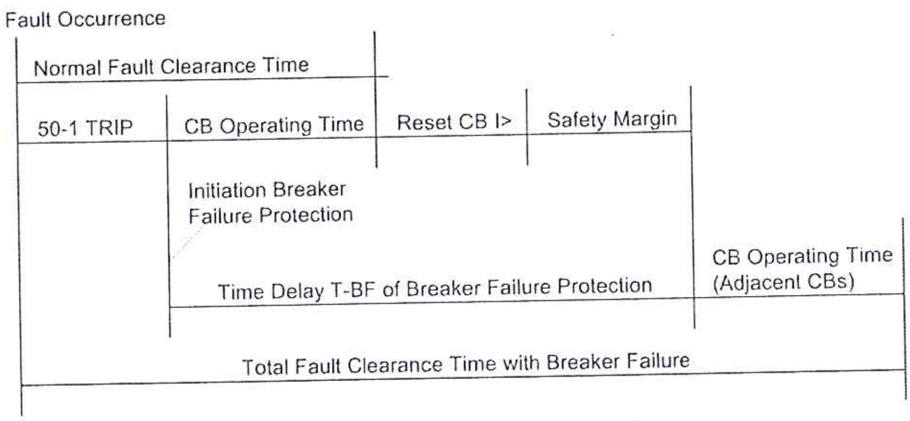



Figure 2-58 Timing for a Typical Breaker Failure Scenario

### 2.12.3 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 |

### 2.12.4 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 |

## 2.13 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.

### 2.13.1 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 with up to 2 RTD-boxes via its service port (port C).

Up to 12 temperature measuring points are available in this way. For greater distances to the protection device the communication via fiber optic cables is recommended. Alternative communication structures are shown in Appendix A.3.

**Processing Temperatures**

The transmitted raw temperature data is converted to a temperature in degrees Celsius or Fahrenheit. The conversion depends on the temperature sensor used.

For each temperature detector two threshold decisions can be performed which are available for further processing. The user can make the corresponding allocations in the configuration matrix.

Each temperature input issues an alarm in case of a short-circuit or an interruption of the sensor circuit or if a sensor is configured, but not assigned. Additionally, a group annunciation is generated via all 6 temperature inputs of an RTD-box (14101 "`Fail: RTD`"). In case of a communication fault, an alarm of the entire RTD-box is issued (264 "`Fail: RTD-Box 1`" or 267 "`Fail: RTD-Box 2`").

The following figure shows the logic diagram for temperature processing.

The manual supplied with the RTD-box contains a connection diagram and dimensioned drawing.

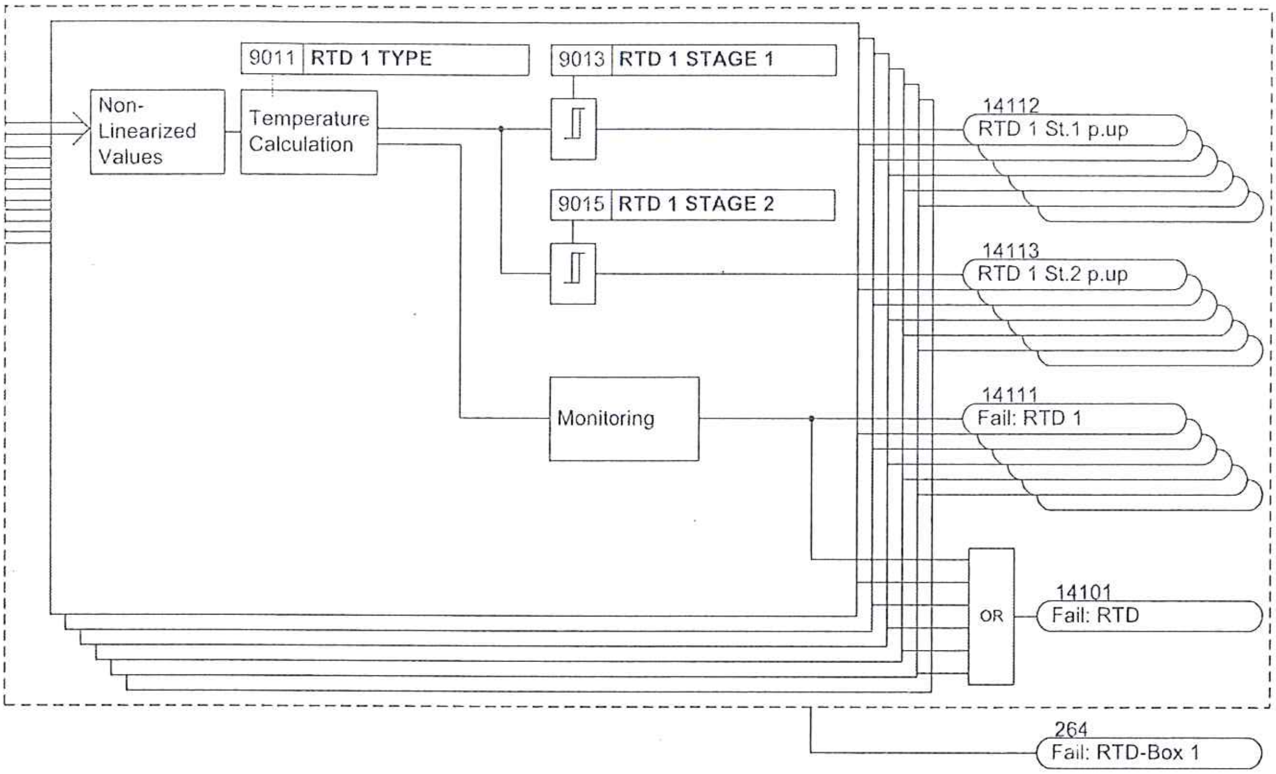



Figure 2-59 Logic diagram of the temperature processing for RTD-box 1

## 2.13.2 Setting Notes

**General**

The temperature detection function is only effective and accessible if it has been assigned to an interface during the configuration of the protection functions (Section 2.1.1). At address 190 **RTD-BOX INPUT** the RTD-box(es) is allocated to the interface at which it will be operated (e.g. port C). The number of sensor inputs and the communication mode were set at address 191 **RTD CONNECTION**. The temperature unit (°C or °F) was set in the Power System Data 1 at address 276 **TEMP. UNIT**.

Operating the RDT boxes in half-duplex mode requires "/CTS controlled by /RTS" to be enabled for CTS (Clear-To-Send) via plug-in jumper (see Section 3.1.2 in Chapter "Mounting and Commissioning").

**Device Settings**

The settings are the same for each input and are here shown at the example of measuring input 1.

Set the type of temperature detector for RTD 1 (temperature sensor for measuring point 1) at address 9011 **RTD 1 TYPE**. You can choose between ***Pt 100*** Ω, ***Ni 120*** Ω and ***Ni 100*** Ω. If no temperature detector is available for RTD 1, set **RTD 1 TYPE** = ***Not connected***. This setting is only possible via DIGSI® at **"Additional Settings"**.

Address 9012 **RTD 1 LOCATION** informs the device on the mounting location of RTD 1. You can choose between ***Oil***, ***Ambient***, ***Winding***, ***Bearing*** and ***Other***. This setting is only possible via DIGSI® at **Additional Settings**.

Furthermore, you can set an alarm temperature and a tripping temperature. Depending on the temperature unit selected in the Power System Data (Section 2.1.1.2 in address 276 **TEMP. UNIT**), the alarm temperature can be expressed in Celsius (°C) (address 9013 **RTD 1 STAGE 1**) or Fahrenheit (°F) (address 9014 **RTD 1 STAGE**

1). The tripping temperature is set at address 9015 **RTD 1 STAGE 2** in degrees Celsius (°C) or Fahrenheit (°F) at address 9016 **RTD 1 STAGE 2**.

The settings for all temperature detectors connected are made accordingly.

### RTD-box Settings

If temperature detectors are used with two-wire connection, the line resistance (for short-circuited temperature detector) must be measured and adjusted. For this purpose, select mode 6 in the RTD-box and enter the resistance value for the corresponding temperature detector (range 0 to 50.6 Ω). If a 3-wire connection is used, no further settings are required to this end.

A baudrate of 9600 bits/s ensures communication. Parity is even. The factory setting of the bus number 0. Modifications at the RTD-box can be made in mode 7. The following convention applies:

Table 2-11 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 7SJ61 protection devices, i.e. messages and measured values appear in the configuration matrix just like those of internal functions, and can be masked and processed in the same way. Messages and measured values can thus be forwarded to the integrated user-defined logic (CFC) and interconnected as desired. Pickup signals "RTD x St. 1 p.up" and "RTD x St. 2 p.up", however, are neither included in the group alarms 501 "Relay PICKUP" and 511 "Relay TRIP" nor do they trigger a trip log.

If it is desired that a message should appear in the event log, a cross must be entered in the intersecting box of column/row.

## 2.13.3 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 |

| 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 |

| 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 |

| 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 |

| 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 |

## 2.13.4 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 |

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 14181 | Fail: RTD 8 | OUT | Fail: RTD 8 (broken wire/shorted) |
| 14182 | RTD 8 St.1 p.up | OUT | RTD 8 Temperature stage 1 picked up |
| 14183 | RTD 8 St.2 p.up | OUT | RTD 8 Temperature stage 2 picked up |
| 14191 | Fail: RTD 9 | OUT | Fail: RTD 9 (broken wire/shorted) |
| 14192 | RTD 9 St.1 p.up | OUT | RTD 9 Temperature stage 1 picked up |
| 14193 | RTD 9 St.2 p.up | OUT | RTD 9 Temperature stage 2 picked up |
| 14201 | Fail: RTD10 | OUT | Fail: RTD10 (broken wire/shorted) |
| 14202 | RTD10 St.1 p.up | OUT | RTD10 Temperature stage 1 picked up |
| 14203 | RTD10 St.2 p.up | OUT | RTD10 Temperature stage 2 picked up |
| 14211 | Fail: RTD11 | OUT | Fail: RTD11 (broken wire/shorted) |
| 14212 | RTD11 St.1 p.up | OUT | RTD11 Temperature stage 1 picked up |
| 14213 | RTD11 St.2 p.up | OUT | RTD11 Temperature stage 2 picked up |
| 14221 | Fail: RTD12 | OUT | Fail: RTD12 (broken wire/shorted) |
| 14222 | RTD12 St.1 p.up | OUT | RTD12 Temperature stage 1 picked up |
| 14223 | RTD12 St.2 p.up | OUT | RTD12 Temperature stage 2 picked up |

## 2.14 Phase Rotation

A phase rotation feature via binary input and parameter is implemented in devices 7SJ61.

**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.

### 2.14.1 Description

**General**

Various functions of the 7SJ61 device only function correctly if the phase rotation of the currents is known, e.g. unbalanced load protection and some measurement quantity monitoring functions.

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.

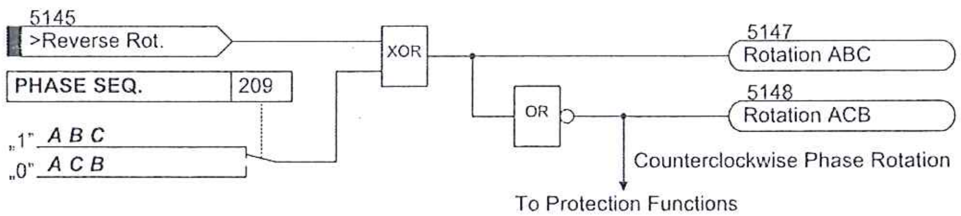



Figure 2-60 Message logic of the phase-sequence reversal

**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 not correct. As stated before, this function influences the negative protection function and some of the monitoring functions that issue messages if the required and calculated phase rotations do not match.

### 2.14.2 Setting Notes

**Programming Settings**

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

# 2.15 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

## 2.15.1 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.

## 2.15.2 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 2-61). At the same time, the minimum trip command duration **`TMin TRIP CMD`** is started. This ensures that the command is transmitted to the circuit breaker for a sufficient amount of time, even if the function which issued the trip signal drops out quickly. The trip commands can be terminated first when the last protection function has dropped out (no function is in pickup mode) AND the minimum trip signal duration has expired.

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

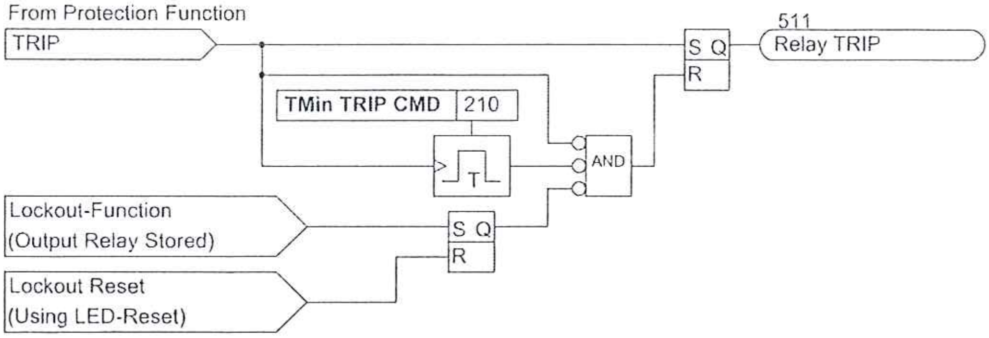



Figure 2-61 Terminating the Trip Signal

## 2.15.3 Setting Notes

**Trip Signal Duration**

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

# 2.16 Auxiliary Functions

The auxiliary functions of the 7SJ61 relay include:

- Message Processing
- Measurements (including acquisition of minimum and maximum values)
- Setting of Limit Values for Measured Values and Statistic Values
- Commissioning Tools

## 2.16.1 Message Processing

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

**Applications**

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

**Prerequisites**

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

### 2.16.1.1 LED Display and Binary Outputs (output relays)

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

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

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

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

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

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

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

### 2.16.1.2 Information on the Integrated Display (LCD) or Personal Computer

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

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

**Classification of Messages**

The messages are categorized as follows:

- Operational messages (event log); messages generated while the device is operating: Information regarding the status of device functions, measured data, power system data, control command logs etc.
- Fault messages (trip log): messages from the last 8 network faults that were processed by the device.
- Ground fault messages (when the device has sensitive ground fault detection).
- Messages of "statistics"; they include a counter for the trip commands initiated by the device, maybe reclose commands as well as values of interrupted currents and accumulated fault currents.

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

**Operational Messages (Buffer: Event Log)**

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

**Fault Messages (Buffer: Trip Log)**

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

**Spontaneous Messages From the Device Front**

After a fault, the device displays automatically and without any operator action on its LCD display the most important fault data from the general device pickup in the sequence shown in Figure 2-62.

| | |
|---|---|
| `50-1 PICKUP` | Protective Function that Picked up First; |
| `50-1 TRIP` | Protective Function that Tripped Last; |
| `T - Pickup` | Operating Time from General Pickup to Dropout; |
| `T - TRIP` | Operating Time from General Pickup to the First Trip Command; |

Figure 2-62 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.

**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.

### 2.16.1.3 Information to a Substation Control Center

If the device has a serial system interface, stored information may additionally be transferred via this interface to a centralized control and storage device. Transmission is possible via different transmission protocols.

## 2.16.2 Statistics

The number of trips initiated by the 7SJ61, 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.

### 2.16.2.1 Description

**Number of Trips**

In order to count the number of trips of the 7SJ61, the position of the circuit breaker must be monitored via breaker auxiliary contacts and binary inputs of the 7SJ61. 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. Simultaneously, it will be reported if the current threshold defined in parameter 212 **BkrClosed I MIN** is exceeded. Alternatively, the counter can be started when the parameter value 212 **BkrClosed I MIN** is undershot. The counter can be set or reset. A CFC application example for such a counter is available on the Internet (SIPROTEC Download Area).

### 2.16.2.2 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 ($\Sigma I$ procedure)
- Summation of tripping powers ($\Sigma I^x$ procedure)
- Two-point procedure for calculating the remaining lifetime (2P procedure)

Measured value acquisition and conditioning operates phase-selective for all four subfunctions. The three results are each evaluated using a threshold which is specific for each procedure (see Figure 2-63).

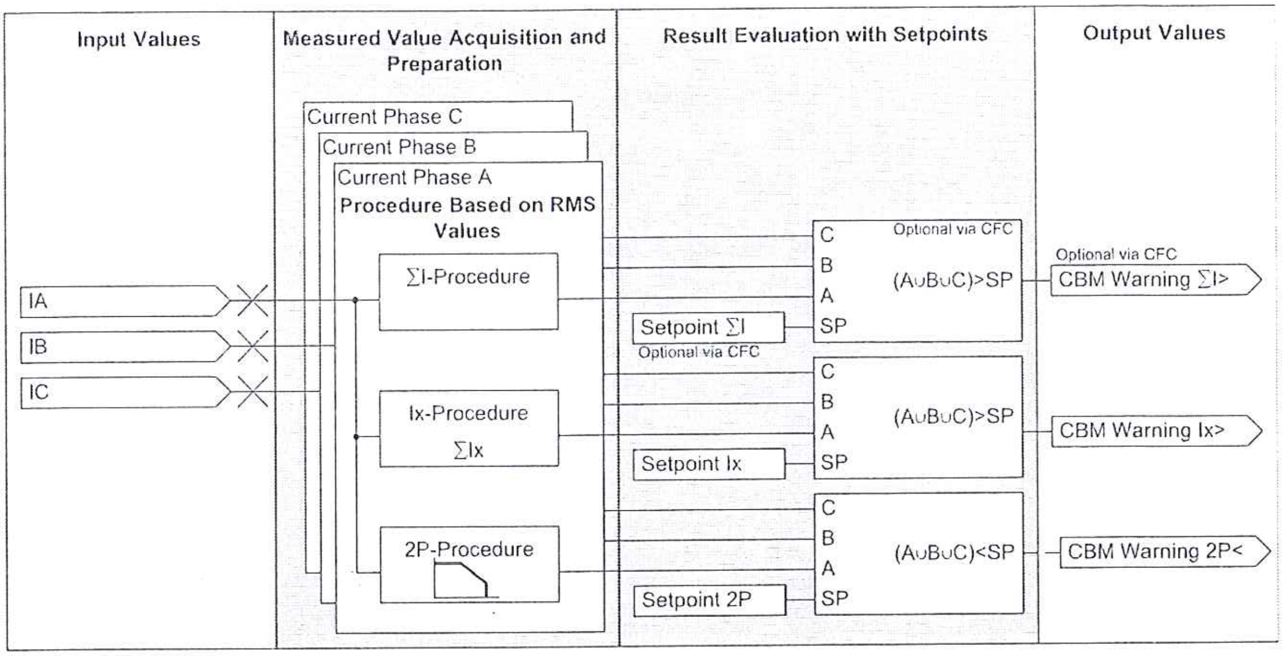



Figure 2-63 Diagram of CB maintenance procedures

Being a basic function, the ΣI procedure is always enabled and active. The other two procedures ($\Sigma I^x$ and 2P ) can be selected by way of a shared configuration parameter.

Significant CB stress comes from the current level and the duration during the actual switching operation including arc extinction. Therefore, major importance is attached to the criteria for start and end. The procedures $\Sigma I^x$ and 2P use the same criteria for this purpose. Figure 2-64 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 taken into account for CB maintenance, provided parameter 265 **Cmd.via control** is set such that the relevant command is generated. A trip command initiated by 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 CB mechanics has initiated pole separation.

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 from being corrupted in the event of CB failure, current criterion 212 **BkrClosed I MIN** checks whether the current has really gone 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 Subsection 2.1.6.2, „Power System Data 2"). The latter two indications can only take effect if the 2P-procedure was configured.

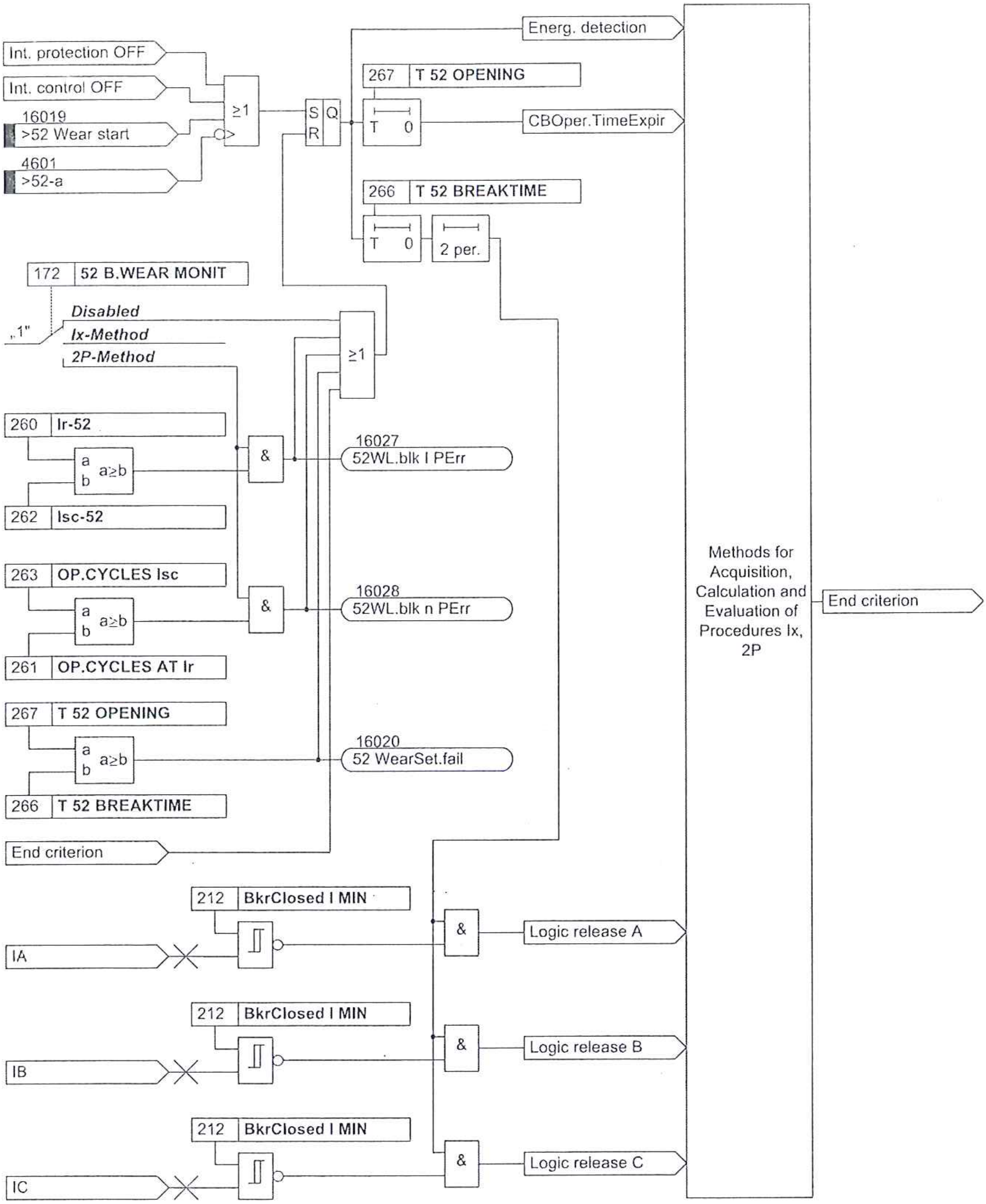



Figure 2-64 Logic of the start and end criterion

**Σ I-Procedure**

Being a basic function, the ΣI-procedure is unaffected by the configuration and does not require any procedure-specific settings. All tripping currents occurring $1^1/_2$ periods after a protective trip, are summed up for each phase. These tripping currents are rms values of the fundamental harmonic.

The interrupted current in each pole is determined for each trip signal. The interrupted fault current is indicated in the fault messages and is added up with previously stored fault current values in the statistic-counters. Measured values are indicated in primary terms.

The ΣI method does not feature integrated threshold evaluation. But using CFC it is possible to implement a threshold, which logically combines and evaluates the three summation currents via an OR operation. Once the summation current exceeds the threshold, a corresponding message will be triggered.

**Σ $I^x$ Procedure**

While the ΣI-procedure is always enabled and active, use of the $\Sigma I^x$-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", 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 2-65). 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.

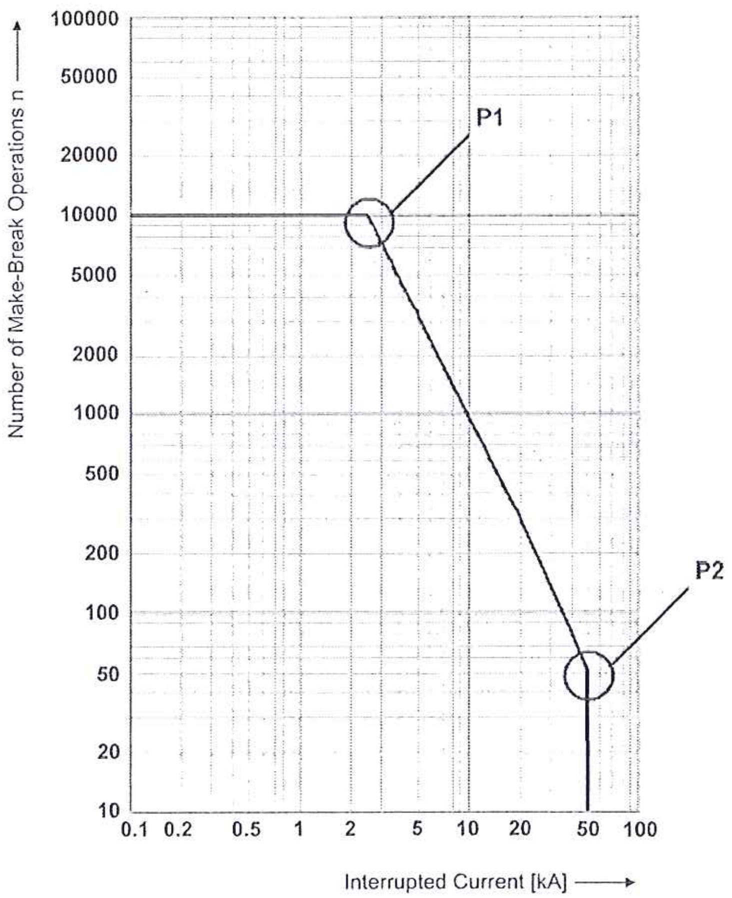



Figure 2-65 Diagram of operating cycles for the 2P procedure

Since figure 2-65 shows a double-logarithmic representation, the line connecting P1 and P2 can be described by means of the following exponential equation:

$n = b \cdot I_b^m$

where n is the number of operating cycles, b the operating cycles at $I_b$ = 1A, $I_b$ the tripping current, and m the directional coefficient.

The general line equation for the double-logarithmic representation can be derived from the exponential function and leads to the coefficients b and m.

**Note**

Since a directional coefficient of m < -4 is technically irrelevant, but could theoretically be the result of incorrect settings, it is limited to -4. If a coefficient is smaller than -4, the exponential function in the operating cycles diagram is deactivated. The maximum number of operating cycles with Isc (263 `OP.CYCLES Isc`) is used instead as the calculation result for the current number of operating cycles, see Figure 2-66.

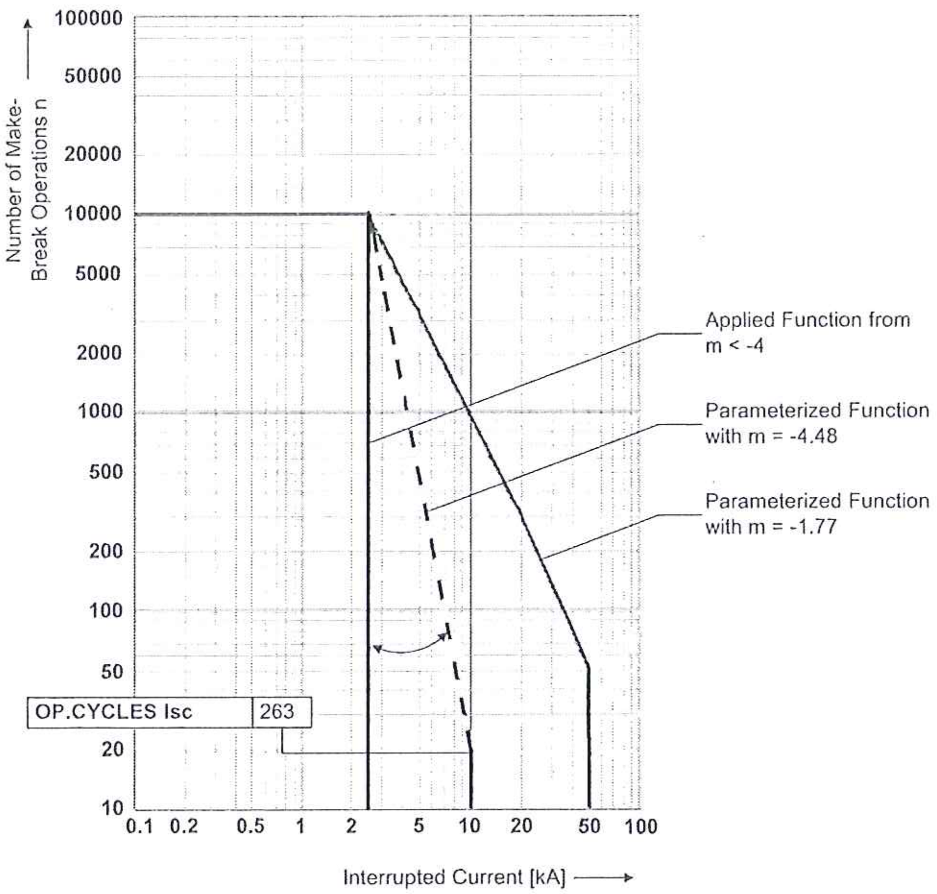



Figure 2-66 Value limitation of directional coefficient

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.

**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.

### 2.16.2.3 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 or ***Disabled*** has been selected for CB maintenance at address 172 **52 B.WEAR MONIT**. All relevant parameters for these functions are available in settings block **P.System Data 1** (see section 2.1.3).

The following setting values are important input values the subfunctions require in order to operate correctly:

The CB Tripping Time is a characteristic value provided by the manufacturer. It covers the entire tripping process from the trip command (applying auxiliary power to the trip element of the circuit breaker) up to arc extinction in all poles. The time is set at address 266 **T 52 BREAKTIME**.

The CB Operating Time **T 52 OPENING** is equally a characteristic value of the circuit breaker. It covers the time span between the trip command (applying auxiliary power to the trip element of the circuit breaker) and separation of CB contacts in all poles. It is entered at address 267 **T 52 OPENING**.

The following diagram illustrates the relationship between these CB times.

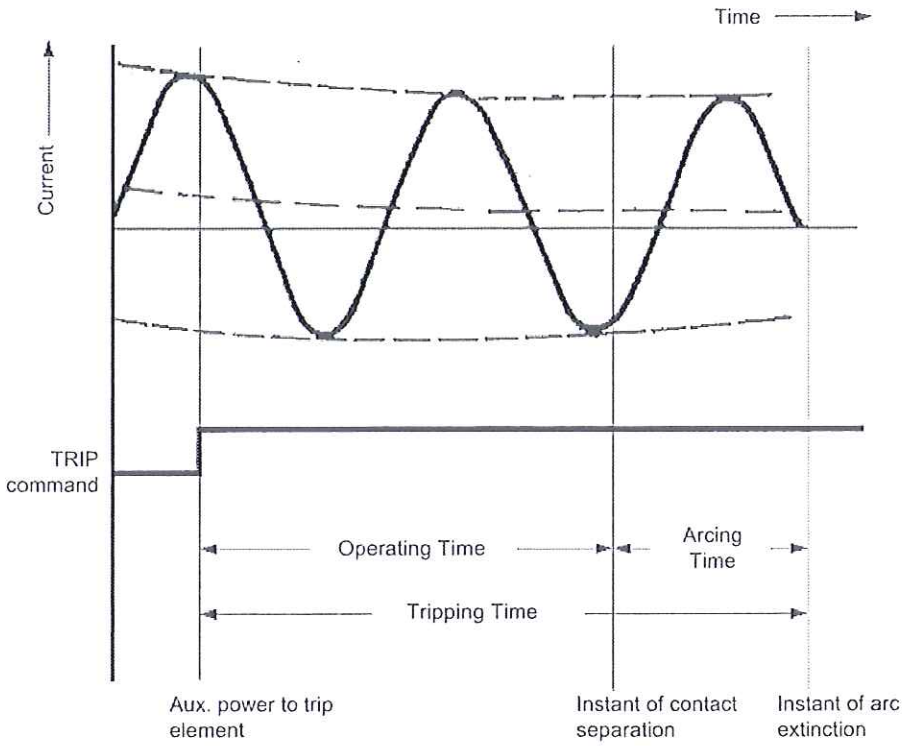



Figure 2-67 Illustration of the CB times

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 Σ$I^x$ 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 Σ$I^x$ 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**.

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**.

### 2.16.2.4 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 |

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 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 |

## 2.16.3 Measurement

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

**Applications**

- Information on the actual status of the system
- Conversion 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 transformer ratios in the ground path 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.

### 2.16.3.1 Display of Measured Values

Table 2-12 Conversion formulae between secondary values and primary/percentage values

| Measured Values | Secondary | Primary | % |
|---|---|---|---|
| $I_A$, $I_B$, $I_C$, $I_1$, $I_2$ | $I_{sec}$ | $\frac{\text{CT PRIMARY}}{\text{CT SECONDARY}} \cdot I_{SEC.}$ | $\frac{I_{prim.}}{\text{FullScaleCurr.}}$ |
| $I_N = 3 \cdot I_0$ (calculated) | $I_{N\ sec}$ | $\frac{\text{CT PRIMARY}}{\text{CT SECONDARY}} \cdot I_{NSEC.}$ | $\frac{I_{Nprim.}}{\text{FullScaleCurr.}}$ |
| $I_N$ = measured value of $I_N$ input | $I_{N\ sec}$ | $\frac{\text{Ignd-CT PRIM}}{\text{Ignd-CT SEC}} \cdot I_{N\ SEC.}$ | $\frac{I_{Nprim.}}{\text{FullScaleCurr.}}$ |
| $I_{Ns}$ | $I_{Ns\ sec.}$ | $\frac{\text{Ignd-CT PRIM}}{\text{Ignd-CT SEC}} \cdot I_{Ns\ SEC.}$ | $\frac{I_{Ns\ prim.}}{\text{FullScaleCurr.}}$ |

Table 2-13 Legend for the conversion formulae

| Parameter | Address | Parameter | Address |
|---|---|---|---|
| CT PRIMARY | 204 | Ignd-CT PRIM | 217 |
| CT SECONDARY | 205 | Ignd-CT SEC | 218 |
| | | FullScaleCurr. | 1102 |

Depending on the type of device ordered and the device connections, some of the operating measured values listed below may not be available. The ground current $I_N$ is either measured directly or calculated from the conductor currents.

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

$$I_N = \frac{3 \cdot I_0}{I_{gnd\text{-}CT}/(CT)}$$

with $3I_0 = (I_a + I_b + I_c)$

$I_{gnd\text{-}CT}$ = 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.

### 2.16.3.2 Transfer of Measured Values

Measured values can be transferred via the interfaces to a central control and storage unit.

### 2.16.3.3 Information List

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 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) |
| 661 | Θ REST. = | MV | Threshold of Restart Inhibit |
| 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) |
| 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 |

## 2.16.4 Average Measurements

The long-term averages are calculated and output by the 7SJ61.

### 2.16.4.1 Description

**Long-Term Averages**

The long-term averages of the three phase currents $I_x$, and the positive sequence components $I_1$ for the three phase currents are calculated within a set period of time and indicated in primary values.

For the long-term average values mentioned above, the length of the time window for averaging and the frequency with which it is updated can be set.

### 2.16.4.2 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.

### 2.16.4.3 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 |

#### 2.16.4.4 Information List

| No. | Information | Type of Information | Comments |
|---|---|---|---|
| 833 | I1 dmd= | MV | I1 (positive sequence) Demand |
| 963 | Ia dmd= | MV | I A demand |
| 964 | Ib dmd= | MV | I B demand |
| 965 | Ic dmd= | MV | I C demand |

### 2.16.5 Min/Max Measurement Setup

Minimum and maximum values are calculated by the 7SJ61. Time and date of the last update of the values can also be read out.

#### 2.16.5.1 Description

**Minimum and Maximum Values**

The minimum and maximum values of the three phase currents $I_A$, $I_B$, $I_C$, the positive sequence components $I_1$ and the thermal measured value of overload protection $\Theta/\Theta_{Trip}$ 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.

#### 2.16.5.2 Setting Notes

**Minimum and Maximum Values**

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

### 2.16.5.3 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 |

### 2.16.5.4 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 |
| 403 | >Idmd MiMaReset | SP | >Idmd 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 |
| 851 | Ia Min= | MVT | Ia Min |
| 852 | Ia Max= | MVT | Ia Max |
| 853 | Ib Min= | MVT | Ib Min |
| 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 |
| 1058 | Θ/ΘTrpMax= | MVT | Overload Meter Max |
| 1059 | Θ/ΘTrpMin= | MVT | Overload Meter Min |

## 2.16.6 Setpoints for Measured Values

SIPROTEC® devices allow limit points (setpoints) to be set for some measured and metered values. If, during operation, a value reaches one of these setpoints, 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 setpoints 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 setpoint limit is repeatedly exceeded, the setpoint 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.

### 2.16.6.1 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.
- IL<: Falling below a preset current in any phase.

### 2.16.6.2 Setting Notes

**Setpoints 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 setpoints defined.

Settings must be applied in percent and usually refer to nominal values of the device.

### 2.16.6.3 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> |
| - | 37-1 | LV | 37-1 under current |
| - | \|PF\|< | LV | \|Power Factor\|< |
| 273 | SP. I A dmd> | OUT | Set Point Phase A dmd> |
| 274 | SP. I B dmd> | OUT | Set Point Phase B dmd> |
| 275 | SP. I C dmd> | OUT | Set Point Phase C dmd> |
| 276 | SP. I1dmd> | OUT | Set Point positive sequence I1dmd> |
| 284 | SP. 37-1 alarm | OUT | Set Point 37-1 Undercurrent alarm |
| 285 | SP. PF(55)alarm | OUT | Set Point 55 Power factor alarm |

## 2.16.7 Setpoints for Statistic

### 2.16.7.1 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.

### 2.16.7.2 Setting Notes

**Setpoints for statistics counters**

Setpoints for the statistic counter are entered in the DIGSI® menu item **Annunciation** → **Statistic** into the submenu **Setpoints 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).

### 2.16.7.3 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 |

## 2.16.8 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

**Prerequisites**

To be able to use the commissioning aids described below, the following must apply:

– The device must be equipped with an interface;

– The device has to be connected to a control center.

### 2.16.8.1 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 center, the DIGSI device operation can be used to test if messages are transmitted correctly.

A dialog box shows the display texts of all messages which were allocated to the system interface in the configuration matrix. In another column of the dialog box you can specify a value for the messages you intend to test (e.g. ON/OFF). Having entered password no. 6 (for hardware test menus) a message can then be generated. The corresponding message is issued and can be read out either from the event log of the SIPROTEC® 4 device or from the substation control system.

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

**Checking the Binary Inputs and Outputs**

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

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

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

**Creating a Test Oscillographic Recording**

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

Along with the capability of storing fault recordings via pickup of the protection function, the 7SJ61 also has the capability of capturing the same data when commands are given to the device via the service program DIGSI, the serial interface, or a binary input. For the latter, event "`>Trig.Wave.Cap.`" must be allocated to a binary input. Triggering for the oscillographic recording then occurs, for instance, via the binary input when the protection object is energized.

An oscillographic recording that is externally triggered (that is, without a protective element pickup or device trip) is processed by the device as a normal oscillographic recording, and has a number for establishing a sequence. However, these recordings are not displayed in the fault log buffer in the display, as they are not network fault events.

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

## 2.17 Breaker Control

A control command process is integrated in the SIPROTEC ® 7SJ61 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.

### 2.17.1 Control Device

Switchgear can be controlled via the device operator panel, 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

#### 2.17.1.1 Description

**Operation Using the Integrated Operator Panel**

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 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).

### 2.17.1.2 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 |
| - | 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= |

## 2.17.2 Types of Commands

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

### 2.17.2.1 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
- Setpoint 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 indications and switching states, e.g. if the communication with the process is interrupted. Manually overridden objects are flagged as such in the information status and can be displayed accordingly.
- Tagging commands (for "Setting") for internal object information values, e.g. deleting / presetting switching authority (remote vs. local), parameter set changeovers, data transmission blockage and metered values.
- Acknowledgment and resetting commands for setting and resetting internal buffers or data states.
- Information status command to set/reset the additional "information status" of a process object, such as:
  - Input blocking
  - Output Blocking

## 2.17.3 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:

### 2.17.3.1 Description

**Check Sequence**

Please observe the following:

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

**Monitoring the Command Execution**

The following is monitored:

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

## 2.17.4 System Interlocking

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

### 2.17.4.1 Description

System interlocking checks in a SICAM®/SIPROTEC® 4 system are usually categorized as follows:

- 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 Manual /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 reconfiguration via password prompt,
- for automatic commands, via command processing. by CFC using non-interlocking detection,
- 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 that the configured interlocking conditions are not checked in the relay.

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

The following table shows some types of commands and messages. 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+/– *) |
| Output Blocking | Output blocking | ST | ST+/– *) |
| Cancel command | Cancel | CA | CA+/– |

The "plus" appearing in the message is a confirmation of the command execution. The command execution was positive as expected. 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 interlockings can be programmed separately for all switching devices and tags that were set with a tagging command. Other internal control actions, such as manual entry or cancel are not tested, 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
```

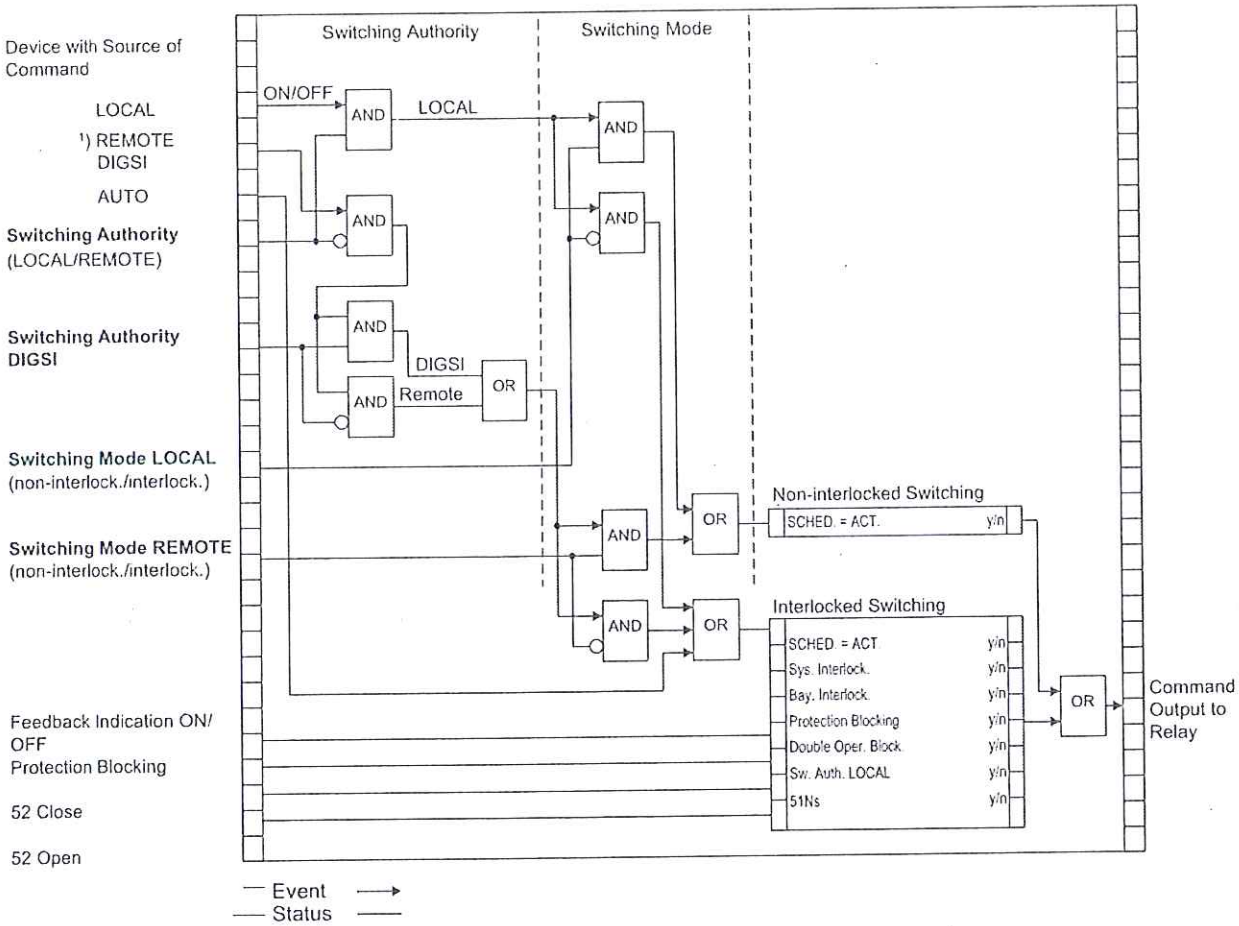
Figure 2-68 Example of an operational annunciation for switching circuit breaker 52 (Q0)

**Standard Interlocking (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.
- System Interlocking: To check 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 in 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 one cannot be carried out.

- Switching Authority LOCAL: A switching command of the local control (command with command source LOCAL) is only allowed if a LOCAL control is allowed at the device (by configuration).
- Switching Authority DIGSI®: Switching commands that are issued locally or remotely via DIGSI® (command with command source DIGSI®) is only allowed if REMOTE control is admissible at the device (by configuration). If a DIGSI® PC connects to the device, it deposits here its virtual device (VD) number. 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 switching control command (command with source of command REMOTE) is only allowed if REMOTE control is admissible at the device (by configuration).




¹) Source REMOTE also includes SAS.
(LOCAL Command using substation controller
REMOTE Command using remote source such as SCADA through controller to device.)

Figure 2-69 Standard interlockings

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

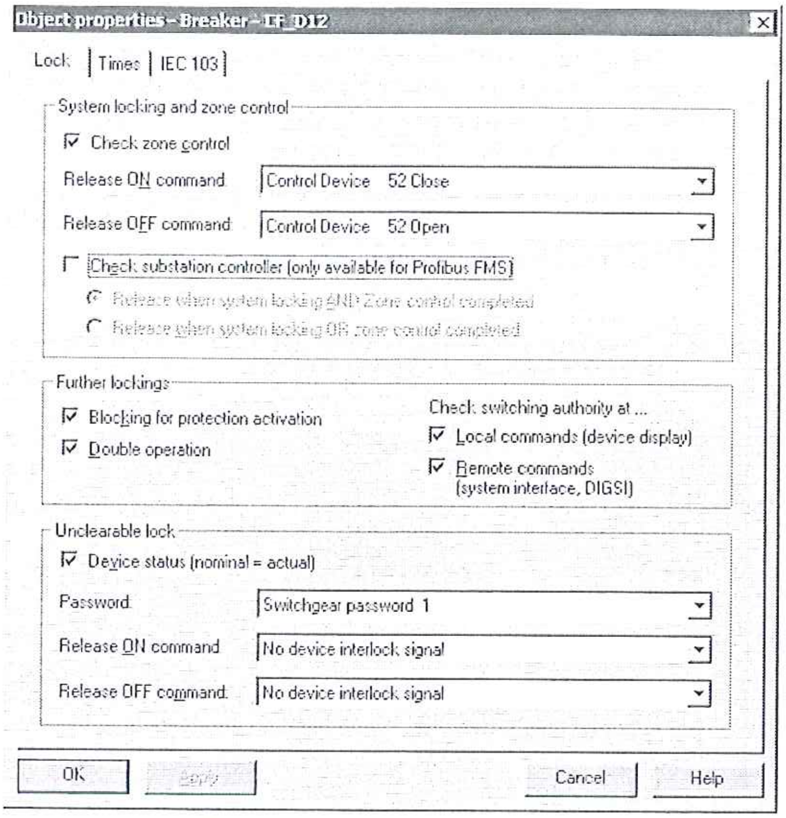



Figure 2-70 DIGSI®–dialog box for setting the interlocking conditions

The configured interlocking causes appear on the device display. They are marked by letters explained in the following table.

Table 2-14 Command types and corresponding messages

| Interlocking Commands | Abbrev. | Message |
|---|---|---|
| Switching authority | L | L |
| System interlocking | S | S |
| Zone controlled | Z | Z |
| SET= ACTUAL (switch direction check) | P | P |
| Protection blockage | B | B |

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

```
Interlocking       01/03
------------------------
Q0 Close/Open S - Z P B
Q1 Close/Open S - Z P B

Q8 Close/Open S - Z P B
```

Figure 2-71 Example of configured interlocking conditions

**Enabling Logic via CFC**

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

**Switching Authority**

The interlocking condition "Switching Authority" serves to determine the switching authorization. It enables the user to select the authorized command source. The following switching authority zones are defined in the following priority sequence:

- LOCAL
- DIGSI®
- REMOTE

The object "Switching Authority" serves to interlock or enable LOCAL control, but not remote or DIGSI ® commands. For the 7SJ61 the switching authority can be changed between "REMOTE" and "LOCAL" in the operator panel by password or by means of CFC also via binary input and function key.

The "Switching authority DIGSI®" is used for interlocking or 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 DIGSI® available | y/n (create appropriate object) |
| Specific Device (e.g. switching device) | Switching authority LOCAL (check for Local status): y/n |
| Specific Device (e.g. switching device) | Switching authority REMOTE (check for LOCAL, REMOTE, or DIGSI ® commands: y/n |

Table 2-15 Interlocking logic

| Current Switching Authority Status | DIGSI® switching authority: | Command issued from SC[3] =Local | Command issued from SC=LOCAL or REMOTE | Command with SC=DIGSI® |
|---|---|---|---|---|
| LOCAL (ON) | not logged on | not allocated | interlocked [2] - "interlocked, since control LOCAL" | interlocked - "DIGSI® not logged on" |
| LOCAL (ON) | logged on | not allocated | interlocked [2] - "interlocked, since control LOCAL" | interlocked [2] - "interlocked, since control LOCAL" |
| REMOTE (OFF) | not logged on | interlocked [1] - "interlocked, since control REMOTE" | not allocated | interlocked "DIGSI® not logged on" |
| REMOTE (OFF) | logged on | interlocked [1] - "interlocked, since DIGSI® control" | interlocked [2] "because of DIGSI®control" | not allocated |

[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® commands): is not marked

[3] SC = Source of command

SC = Auto:

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

**Switching Mode**

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

The following switching modes (local) are defined:

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

For the 7SJ61 the switching authority can be changed between "Interlocked" and "Non-interlocked" in the operator panel by password or by means of CFC also via binary input and function key.

The following switching modes (remote) are defined:

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

**Zone Controlled / Field Interlocking**

Zone controlled / field interlockings (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 open against CB closing).

Interlocking conditions can be programmed separately 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 command".

**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**

Protection functions then block switching operations. Protective elements are configured, separately for each switching component, to block specific switching commands sent in CLOSE and TRIP direction.

When enabled, "Block CLOSE commands" blocks CLOSE commands, whereas "Block TRIP commands" blocks TRIP signals. Switching operations in progress will immediately be aborted by the pickup of a protective element.

**Device Status Check (set = actual)**

For switching commands, a check takes place whether the selected switching device is already in the set/desired position (set/actual comparison). This means, if a circuit breaker is already in the CLOSED position and an attempt is made to issue a closing command, the command will be refused, with the operating message "set condition equals actual condition". If the circuit breaker/switchgear device is in the intermediate position, then this check is not performed.

**Bypassing Interlocking**

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 7SJ61 allows the switching modes "interlocked" or "non-interlocked" to be selected in the operator panel after password entry.
- 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 commands via CFC (automatic command, SC=Auto):
  - Behavior configured in the CFC block ("BOOL to command").

## 2.17.5 Command Logging

During the processing of the commands, independent of the further message routing and processing, command and process feedback information are sent to the message processing center. These messages contain information on the cause. With the corresponding allocation (configuration) these messages are entered in the event list, thus serving as a report.

**Prerequisites**

A listing of possible operating messages and their meaning as well as the command types needed for tripping and closing of the switchgear or for raising and lowering of transformer taps are described in the SIPROTEC®4 System Description.

### 2.17.5.1 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 under configuration in /1/.

■

# Mounting and Commissioning 3

This chapter is intended for experienced commissioning staff. The staff must be familiar with the commissioning of protection and control systems, with the management of power systems and with the relevant safety rules and guidelines. Hardware modifications that might be needed in certain cases are explained. The primary tests require the protected object (line, transformer, etc.) to carry load.

# 3.1 Mounting and Connections

General

## WARNING!

**Warning of improper transport, storage, installation, and application of the device.**

Failure to observe these precautions can result in death, personal injury, or serious material damage.

Trouble free and safe use of this device depends on proper transport, storage, installation, and application of the device according to the warnings in this instruction manual.

Of particular importance are the general installation and safety regulations for work in a high-voltage environment (for example, ANSI, IEC, EN, DIN, or other national and international regulations). These regulations must be observed.

## 3.1.1 Configuration Information

**Prerequisites**

For installation and connections the following requirements and conditions must be met:

The rated device data has been checked as recommended in the SIPROTEC® 4 System Description. Their compliance with the power system data has been verified.

**General Diagrams**

General diagrams for 7SJ61 are shown in Appendix A.2. Connection examples for current transformer circuits are provided in A.3.

**Binary Inputs and Outputs**

The configuration of the binary in- and outputs, i.e. the individual adaptation to the plant conditions, is described in the SIPROTEC® 4 System Description. The connections to the plant are dependent on this actual configuration. The presettings of the device are listed in Appendix A, Section A.5. Check also whether the labelling corresponds to the allocated annunciation functions.

**Changing Setting Groups**

If binary inputs are used to switch setting groups, please observe the following:

- Two binary inputs must be dedicated to the purpose of changing setting groups when four groups are to be switched. One binary input must be set for ">Set Group Bit0", the other input for ">Set Group Bit1". If either of these input functions is not assigned, then it is considered as not controlled.
- To control two setting groups, one binary input set for ">Set Group Bit0" is sufficient since the binary input ">Set Group Bit1", which is not assigned, is considered to be not controlled.
- The status of the signals controlling the binary inputs to activate a particular setting group must remain constant as long as that particular group is to remain active.

The following table shows the allocation of the binary inputs to the setting groups A to D and a simplified connection diagram for the two binary inputs is illustrated in the following figure. The figure illustrates an example in which both Set Group Bits 0 and 1 are configured to be controlled (actuated) when the associated binary input is energized (high).

Where:

no = not energized or not connected

yes = energized

Table 3-1 Changing setting groups using binary inputs

| Binary Input | | Active Group |
|---|---|---|
| >Set Group Bit 0 | >Set Group Bit 1 | |
| No | No | Group A |
| Yes | No | Group B |
| No | Yes | Group C |
| Yes | Yes | Group D |

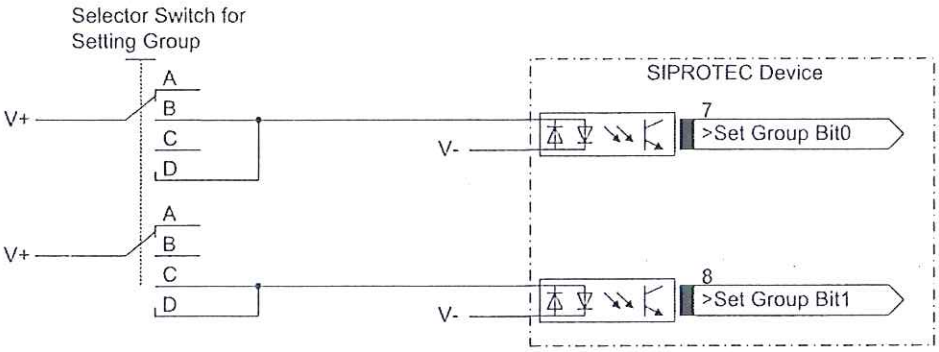



Figure 3-1 Connection diagram (example) for setting group switching using binary inputs

**Trip Circuit Supervision**

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.

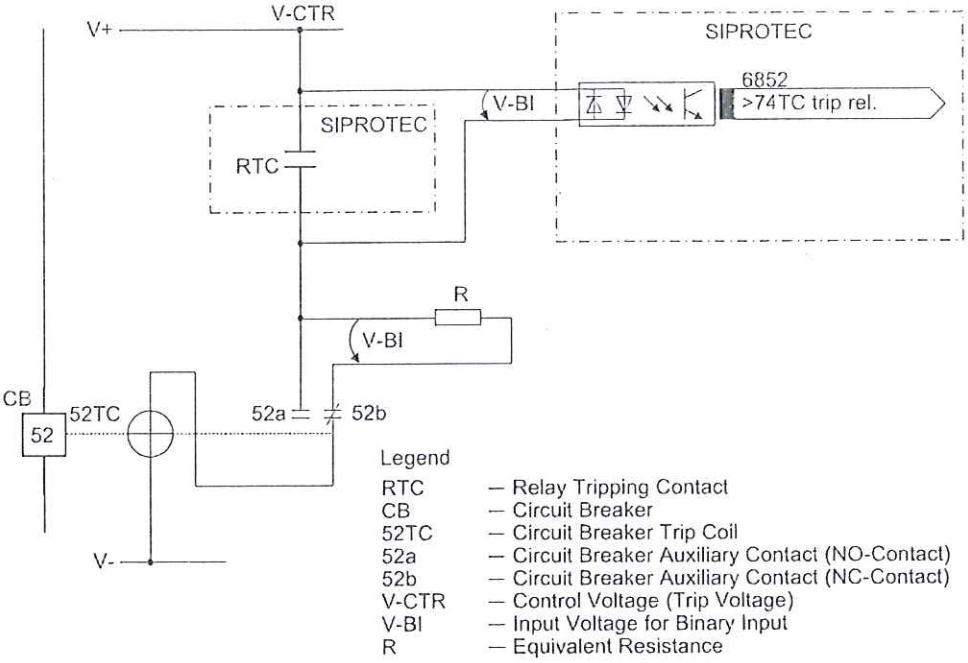



Figure 3-2 Trip circuit supervision with one binary input

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:

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

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® 7SJ61) |
| $V_{BI\ min}$ | 19 V for delivery setting for nominal voltage 24/48/60 V (from 7SJ61)88 V for delivery setting for nominal voltage 110/125/220/250 V) (from 7SJ61) |
| $V_{CTR}$ | 110 V (system / release circuit) |
| $R_{CBTC}$ | 500 Ω (from system / trip circuit) |
| $V_{CBTC\ (LOW)}$ | 2 V (system / release circuit) |

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

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

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

The closest standard value of 39 kΩ is selected; the power is:

$$P_R = \left(\frac{110\ V}{39\ k\Omega + 0.5\ k\Omega}\right)^2 \cdot 39\ k\Omega \geq 0.3\ W$$

## 3.1.2 Hardware Modifications

### 3.1.2.1 General

Hardware modifications concerning, for instance, nominal currents, the control voltage for binary inputs or termination of serial interfaces might be necessary. Follow the procedure described in this section, whenever hardware modifications are done.

**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 are described 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.

**Nominal Currents**

The input transformers of the devices are set to a nominal current of 1 A or 5 A with jumpers. 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 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 (input transformer T4) 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 Binary Inputs**

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 pickup 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 pickup voltage of a binary input. The assignment of the plug-in jumpers to the contact type and the spatial arrangement of the jumpers are described 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 Binary Outputs**

Input/output boards can have relays that are equipped with changeover contacts. Therefore it is necessary to rearrange a jumper. To which relays of which boards this applies is described in the following sections.

**Replacing Interfaces**

Only serial interfaces of devices for panel and cubicle flush mounting are replaceable. Which interfaces can be exchanged, and how this is done, is described in the following section under the margin heading "Exchanging Interface Modules".

**Terminating of Serial Interfaces**

If the device is equipped with a RS485 bus or Profibus, the bus must be terminated with resistors at the last device on the bus to ensure reliable data transmission. Therefore the RS485 or Profibus interface module are fitted with terminating resistors that can be connected via jumpers to the bus. The physical arrangement of the jumpers on the interface modules is described in the following sections, "RS485/RS232" and "Profibus Interface (FMS/DP) DNP3.0/Modbus". Both jumpers must always be plugged identically. The terminating resistors can also be connected externally (e.g. to the terminal block). In this case, the terminating resistors located on the interface module must be disabled.

The termination resistors are disabled on unit delivery.

**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 physical arrangement is shown in the figure of the processor board. The ratings of the fuse are printed on the board next the fuse itself. When exchanging the battery or the fuse, please observe the information in the SIPROTEC® 4 System Manual at "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 required:
  - screwdriver with a 5 to 6 mm wide tip,
  - 1 Phillips screwdriver,
  - socket wrench a/f 5mm.
- Unfasten the screw-posts of the D-subminiature connector on the back panel at location "A". This activity is not necessary if the device is designed for surface mounting.
- If, besides the interface at location "A", there are further interfaces at location "B" and/or "C", also remove the screws located diagonally to the interfaces. This is not necessary if the device is designed for surface mounting.
- Remove the four or six caps on the front cover and loosen the screws that become accessible.
- Carefully take off the front cover.

### 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 A–CPU board (No. 1 in the following figure) on 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.
- Disconnect the ribbon cables between the A-CPU unit (No. 1) and the input/output printed circuit board A-I/O (No. 2).
- 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 that a certain amount of force is required to remove the A-CPU board due to the existing plug connector.
- Check the jumpers according to Figures 3-4 to 3-6 and the following information, and as the case may be change or remove them.

### Board Arrangement

The arrangement of the printed circuit boards (PCBs) can be seen in the following figure.

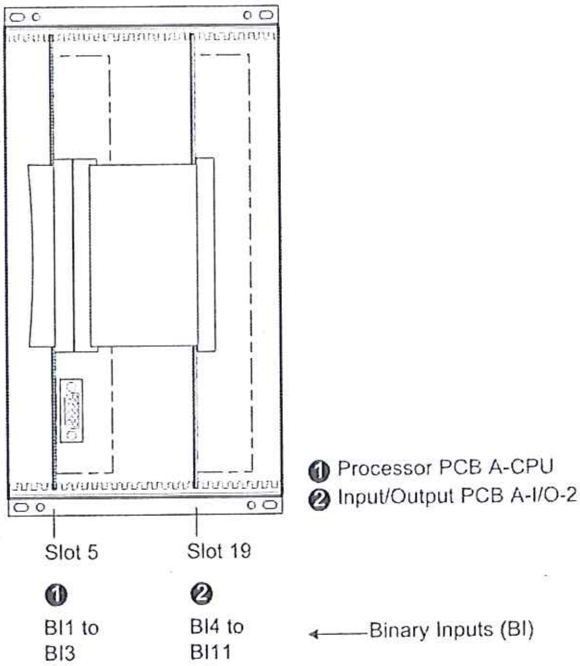



Figure 3-3 Front view of 7SJ61 after removal of the front cover (simplified and scaled down)

### 3.1.2.3 Switch elements on the PCBs

**Processor Board A-CPUfor7SJ61.../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.

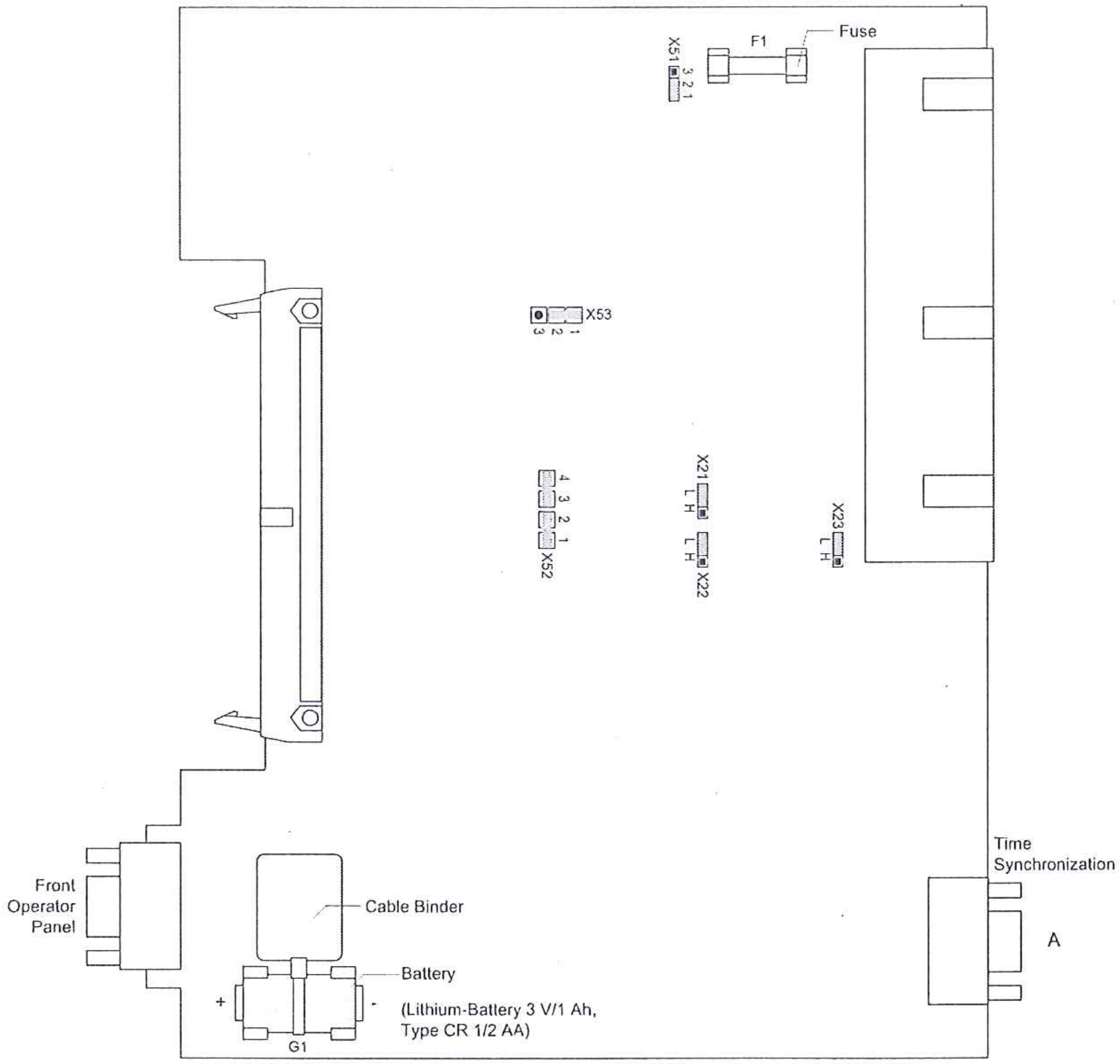



Figure 3-4 Processor printed circuit board A–CPU for devices up to release .../DD with jumpers settings required for the board configuration

The provided nominal voltage of the integrated power supply is checked according to Table 3-2, the selected control voltages of the binary inputs BI1 to BI7 according to Table 3-3. The location and ratings of the miniature fuse (F1) and of the buffer battery (G1) are shown in Figure 3-4.

### Power Supply

Table 3-2 Jumper settings for nominal voltage of the integrated **power supply** on the processor A–CPU for 7SJ61.../DD

| Jumper | Rated voltage | | | |
|---|---|---|---|---|
| | 60 to 125 VDC | 110 to 250 VDC, 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 | |

### Control Voltages of BI1 to BI3

Table 3-3 Jumper settings for the **control voltages** of the binary inputs BI1 to BI3 on the processor A–CPU for 7SJ611.../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 24 VDC to 125 VDC

2) Factory settings for devices with power supply voltages of 110 VDC to 220 VDC and 115/230 VAC

**Processor Board A-CPU for 7SJ61.../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.

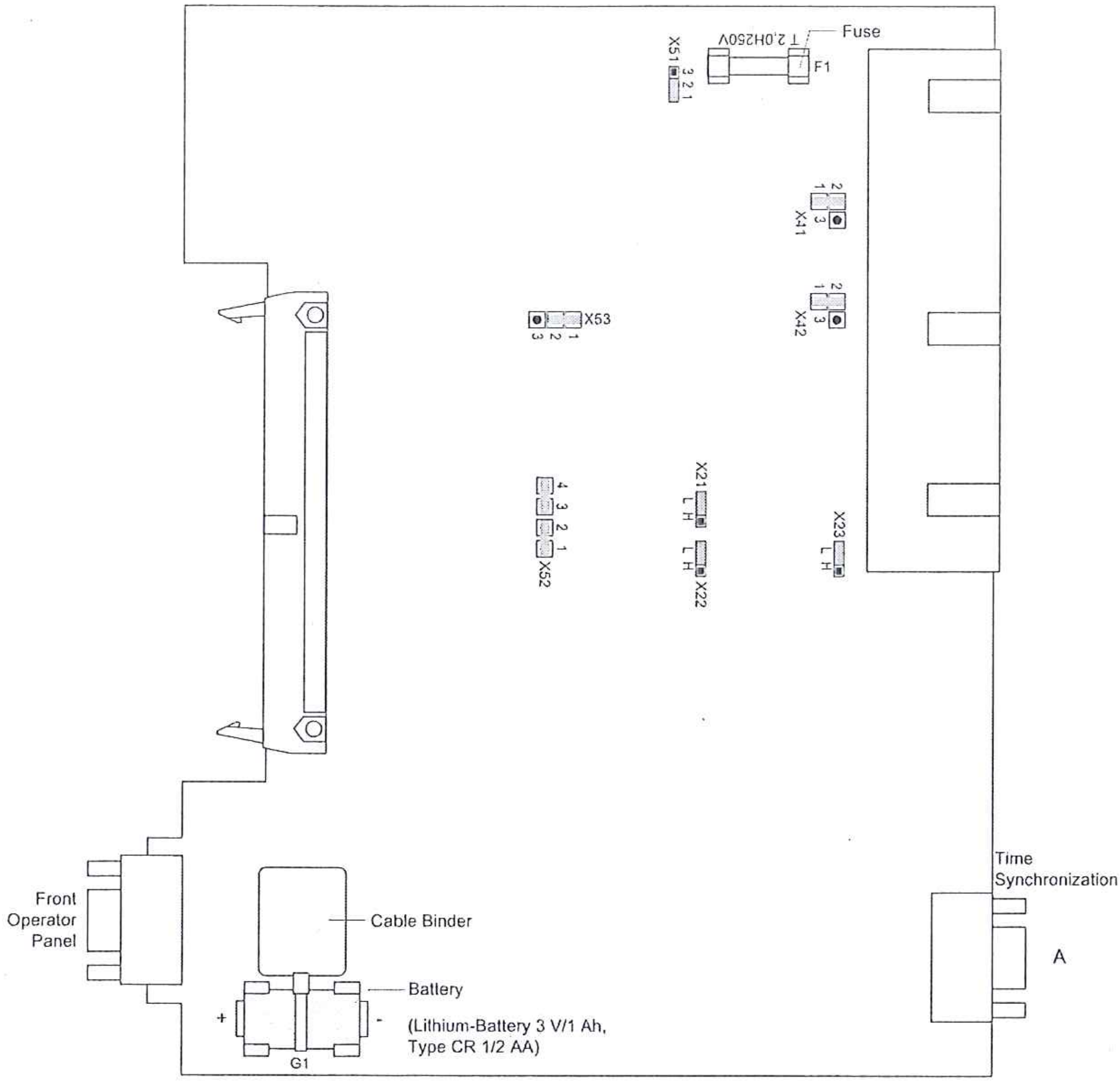



Figure 3-5 Processor printed circuit board A–CPU for devices .../EE and higher with jumpers settings required for the board configuration

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. The location and ratings of the miniature fuse (F1) and of the buffer battery (G1) are shown in Figure 3-5.

### Power Supply

Table 3-4 Jumper settings for nominal voltage of the integrated **power supply** on the processor A–CPU for 7SJ61.../EE

| Jumper | Rated 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 | |

### Control Voltages of BI1 to BI3

Table 3-5 Jumper settings for the **control voltages** of the binary inputs BI1 to BI3 on the processor A–CPU for 7SJ61.../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 7SJ61.../EE

| for | Jumper | Open in quiescent state (NO) | Closed in quiescent state (NC) | Presetting |
|---|---|---|---|---|
| BO1 | X41 | 1–2 | 2–3 | 1–2 |
| BO2 | X42 | 1–2 | 2–3 | 1–2 |

**Input/Output Board A-I/O-2 for 7SJ61**

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.

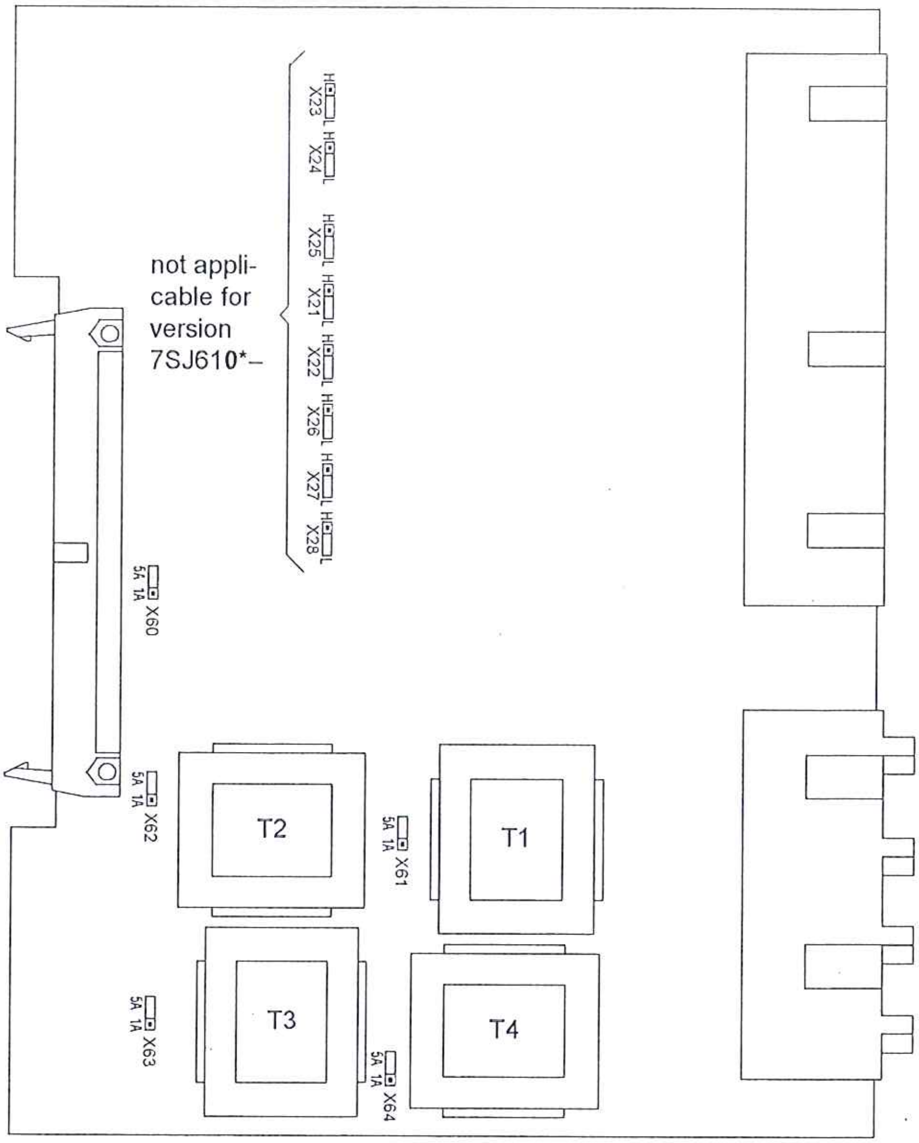



Figure 3-6 Input/output board A–I/O with representation of the jumper settings required for the board configuration

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.

Jumper X64 determines the nominal current for the input $I_N$ and may thus deviate from the phase currents. In models with sensitive ground fault current input there is no jumper X64.

### Control voltages of BI4 to BI11

Table 3-7 Jumper settings for the **control voltages** of the binary inputs BI4 to BI11 on the input/output board A-I/O-2

| 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 |
| BI11 | X28 | L | H |

1) Factory settings for devices with power supply voltages of 24 VDC to 125 VDC

2) Factory settings for devices with power supply voltages of 110 VDC to 220 VDC and 115/230 VAC

### 3.1.2.4 Interface Modules

**Exchanging Interface Modules**

The following figure shows the printed circuit board and arrangement of the modules.

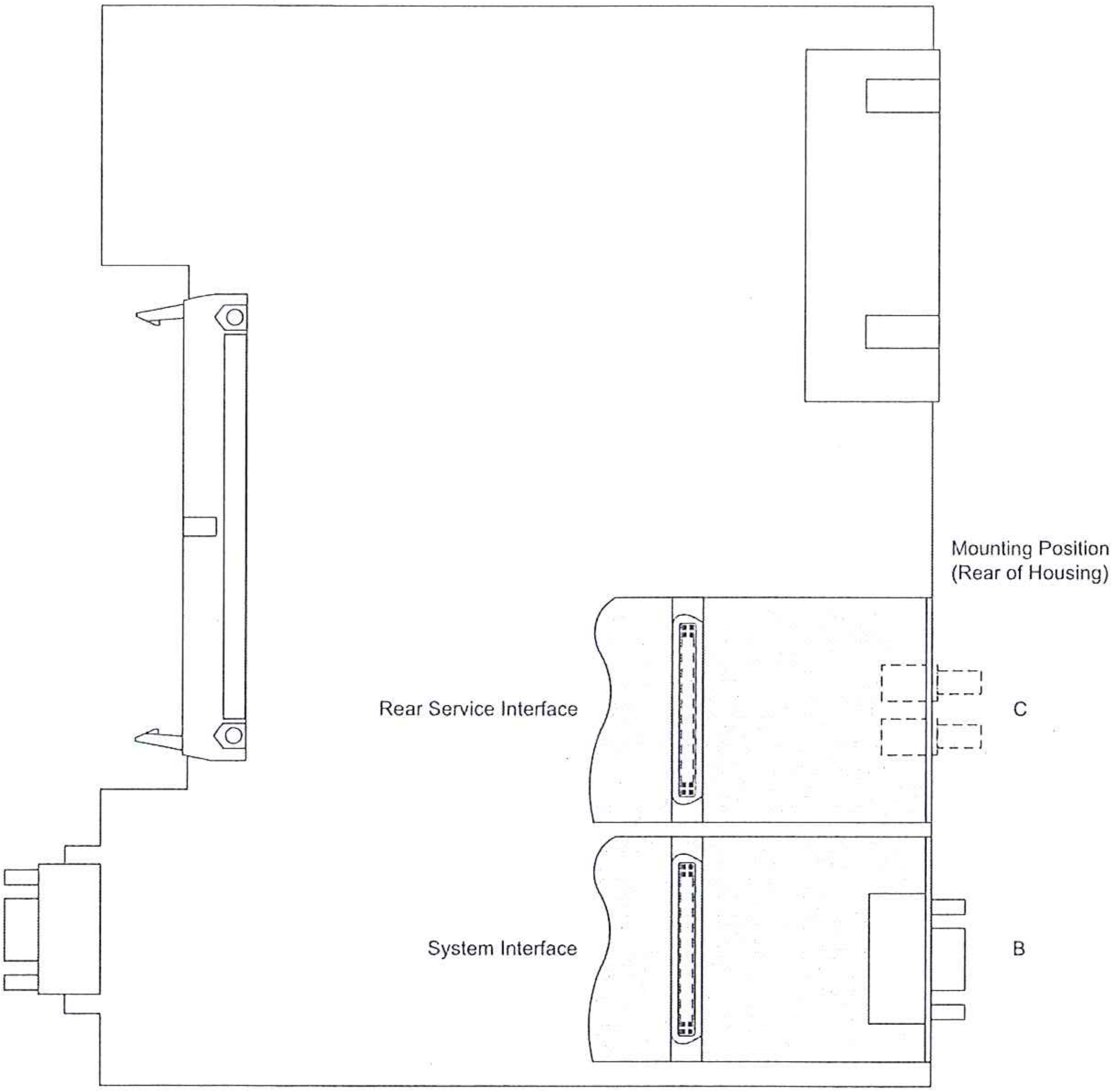



Figure 3-7 Processor printed board A–CPU with interface modules

The interface modules are located on the processor printed circuit boards A-CPU (No.1 in Figure 3-3).

Please note the following:

- Only interface modules of devices for panel and cubicle flush mounting are replaceable. Interface modules of devices in surface mounting housings with two level terminals can only be exchanged in our manufacturing center.
- Use only interface modules that can be ordered in our facilities via the order key, see also Appendix A.1.
- You may have to ensure the termination of the ports featuring bus capability according to the margin heading "Termination".

Table 3-8 Exchangeable interface modules

| Interface | Mounting Location / Interface | Exchange module |
|---|---|---|
| System interface | B | R |
| | | R |
| | | FO 820 nm |
| | | Provide FM R |
| | | 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 | C | RS232 |
| | | RS485 |
| | | FO 820 nm |

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 into interface RS485 and vice versa (see Figures 3-8 and 3-9).

Figure 3-7 shows the printed circuit board of A-CPU and the interface modules.

The following figure shows the location of the jumpers of interface RS232 on the interface module.

Devices in surface mounting housing with fiber optics connection have their fiber optics module housed in the console housing. The fiber optics module is controlled via a RS232 interface module at the associated CPU interface slot. For this application type the jumpers X12 and X13 on the RS232 module are plugged in position 2-3.

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

*) Default Setting

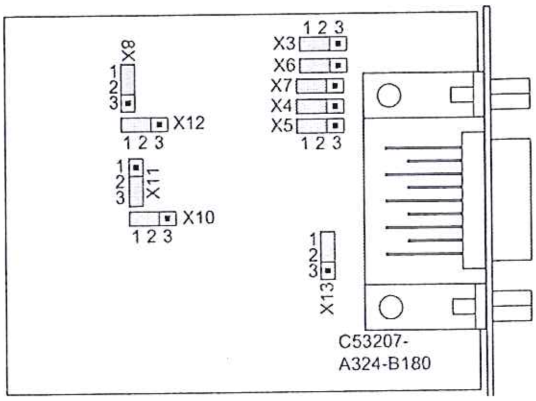



Figure 3-8 Location of the jumpers for configuration of RS232

RS232 does not require terminating resistors. They are always disconnected.

**CTS (Clear to Send)**

Jumper X11 enables the CTS feature (Clear to Send - flow control), which is important for modem communication).

Table 3-9 Jumper setting for **CTS (Clear to Send)** on the interface board

| 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 3-8.

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

*) Default Setting

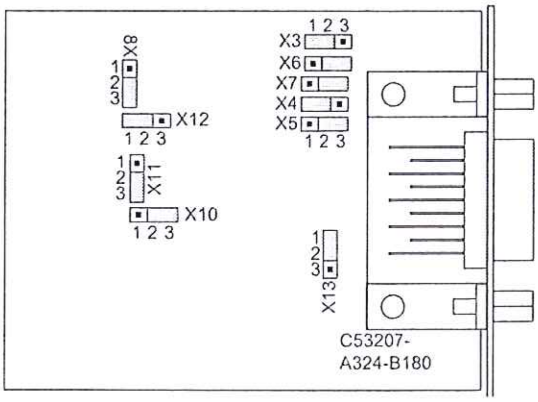



Figure 3-9 Position of terminating resistors and the plug-in jumpers for configuration of the RS485 interface

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

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

*) Default Setting

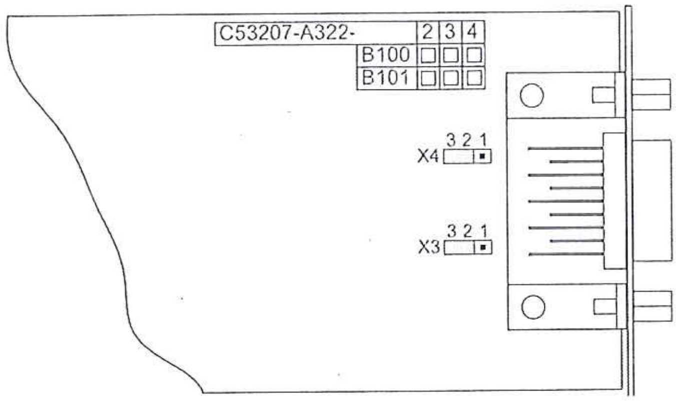



Figure 3-10 Position of the plug-in jumpers for the configuration of the terminating resistors at the Profibus (FMS and DP), DNP 3.0 and Modbus interfaces.

**IEC 61850 Ethernet (EN 100)**

The interface module does not feature any jumpers. Its use does not require any hardware adaptations.

**Termination**

Busbar capable interfaces always require a termination at the last device to the bus, i.e. terminating resistors must be connected. On the 7SJ61 device, this applies to variants with RS485 or PROFIBUS interfaces.

The terminating resistors are located on the RS485 or Profibus interface module mounted on the processor input/output board CPU (serial no. 1 in Figure 3-3).

With default setting the jumpers are set such that the terminating 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 connection module), see Figure 3-11. In this case, the terminating resistors located on the RS485 or Profibus interface module or directly on the PCB of the processor module CPU must be switched OFF.

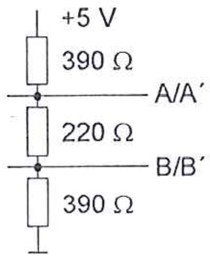



Figure 3-11 Termination of the RS485 interface (external)

#### 3.1.2.5 Reassembly

The device is assembled in the following steps:

- Carefully insert the boards into the case. The mounting locations are shown in figure 3-3. For the model of the device designed for surface mounting, use the metal lever to insert the processor circuit board A-CPU. The installation is easier with the lever.
- First, plug the plug connector of the ribbon cable onto the input/output board I/O and then onto the A-CPU processor board. Do not bend any connector pins! Do not use force!
- Insert the plug connector of the ribbon cable between the processor board A-CPU and the front cover in the socket on the front cover.
- Press the latches of the plug connectors together.
- Replace the front cover and secure to the housing with the screws.
- Mount the covers again.
- 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

For installation proceed as follows:

- Remove the 4 covers on the corners of the front plate. Thus, 4 elongated holes are revealed in the mounting bracket and can be accessed.
- Insert the device into the panel cut-out and fasten it with four screws. For dimensions refer to Section 4.20.
- 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-sectional area of the ground wire must be equal to the cross-sectional area of any other control conductor connected to the device. The cross-section of the ground wire must be at least 2.5 mm $^2$.
- Connections are realized via the plug terminals or screw terminals on the rear side of the device according 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® System Description provides information regarding wire size, lugs, bending radii, etc. which must be observed.

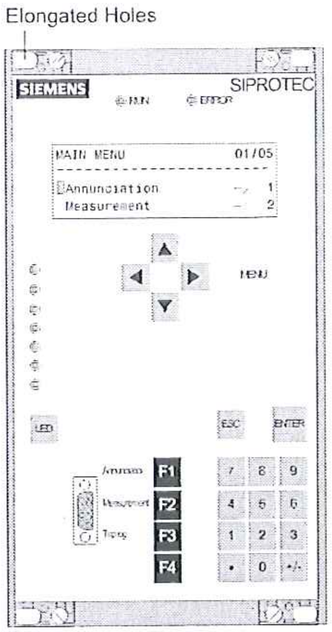



Figure 3-12 Panel flush mounting of a 7SJ61

### 3.1.3.2 Rack Mounting and Cubicle Mounting

To install the device in a frame or cubicle, two mounting brackets are required. The ordering codes are stated in Appendix, Section A.1

- Screw on loosely the two mounting brackets in the rack or cabinet, each with four screws.
- Remove the 4 covers on the corners of the front plate. Thus, 4 elongated holes are revealed in the mounting bracket and can be accessed.
- Tighten the unit with 4 screws at the angle brackets.
- Replace the 4 covers.
- Tighten fast the eight screws of the angle brackets in the rack or cabinet.
- Connect the ground on the rear plate of the device to the protective ground of the rack. Use at least one M4 screw for the device ground. The cross section of the wire must be equal to the maximum connection cross section area but be at least 2.5 $mm^2$.
- Connections are realized via the plug terminals or screw terminals on the rear side of the device according 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 has pertinent information regarding wire size, lugs, bending radii, etc.

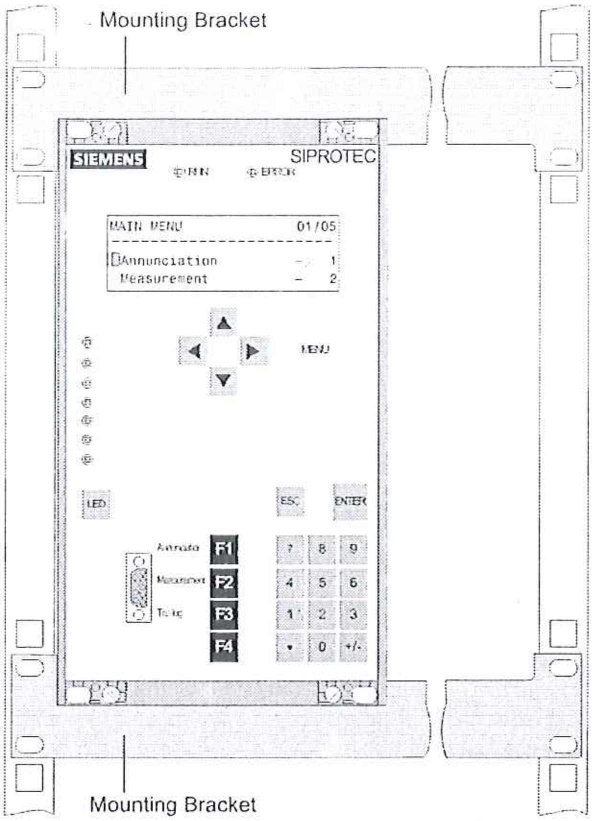



Figure 3-13 Device installation in a rack or cubicle (housing size $^1/_3$)

### 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 4.20.
- Connect the ground terminal of the device with the protective ground of the control panel. The cross-section of the line, here used, must correspond to the maximum connected cross-section, at least 0.10 in$^2$.
- Connect solid, low-impedance operational grounding (cross-sectional area = 0.10 in$^2$) to the grounding surface on the side. Use at least one M4 screw for the device ground.
- Connections according to the circuit diagram via screw terminals, connections for optical fibres and electrical communication modules via the inclined housings. The SIPROTEC® 4 System Description has pertinent information regarding wire size, lugs, bending radii, etc.

# 3.2 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.

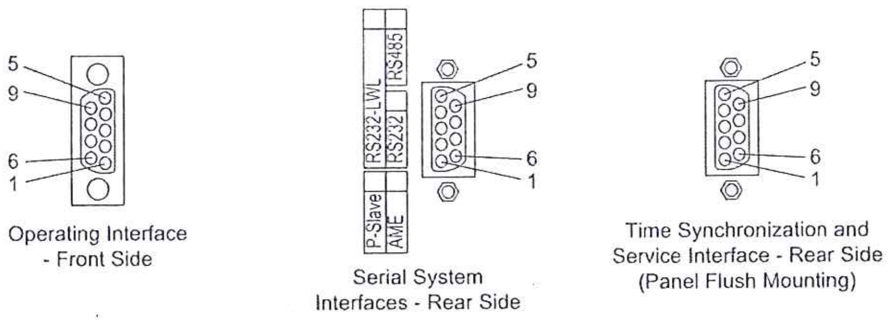



Figure 3-14 9-pin D-subminiature female connectors

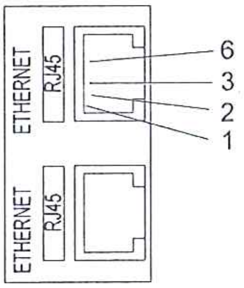



Figure 3-15 Ethernet connection

**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 optical interface, each connection is dedicated to one transmission direction. The data output of one device must be connected to the data input of the other device and vice versa.

With data cables, the connections are designated according to DIN 66020 and ISO 2110

- TxD = Data Output
- RxD = Data Input
- $\overline{RTS}$ = Request to Send
- $\overline{CTS}$ = Clear to Send
- GND = Signal/Chassis Ground

The cable shield is to be grounded at **both ends**. For extreme EMC environments, the GND may be connected via a separate individually shielded wire pair to improve immunity to interference.

Table 3-10 Assignments of the connectors to the various interfaces

| Pin No. | RS232 | RS485 | PROFIBUS FMS Slave, RS485 | Modbus RS485 | Ethernet EN 100 |
|---|---|---|---|---|---|
| | | | PROFIBUS FMS Slave, RS485 | DNP3.0 RS485 | |
| 1 | Shield (with shield ends electrically connected) | | | | Tx+ |
| 2 | RxD | – | – | – | Tx– |
| 3 | TxD | A/A' (RxD/TxD-N) | B/B' (RxD/TxD-P) | A | Rx+ |
| 4 | – | – | CNTR-A (TTL) | RTS (TTL level) | — |
| 5 | GND | C/C' (GND) | C/C' (GND) | GND1 | — |
| 6 | – | – | +5 V (max. load < 100 mA) | VCC1 | Rx– |
| 7 | $\overline{RTS}$ | – [1)] | – | – | — |
| 8 | $\overline{CTS}$ | 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 signal 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 located on the interface module RS485 (see Figure 3-8) or Profibus RS485 (see Figure 3-10). The terminating resistors can also be connected externally (e.g. to the connection module, as illustrated in Figure 3-11). In this case, the terminating resistors located on the module must be disconnected.

If the bus is extended, make sure again that only the last device on the bus has the terminating resistors switched-in, and that all other devices on the bus do not.

**Time Synchronization Interface**

It is optionally possible to process 5 V-, 12 V- or 24 V- time synchronization signals, provided that they are carried to the inputs named in the following table.

Table 3-11 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

**OpticalFibers**

---

## 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).

Verify also the termination: The terminating resistors must be connected to 7SJ61 (see "Termination").

For further information refer to the operating manual of 7XV566. Check the transmission settings at the temperature meter. Besides the baudrate and the parity observe also the bus number.

For connection of RTD-box(es) proceed as follows:

- For connection of **1** RTD-box 7XV566: bus number = **0** (to be set at 7XV566).
- For connection of **2** RTD-boxes 7XV566: bus number = **1** for the 1st RTD-box (to be set at 7XV566 for RTD 1 to 6), bus number = **2** for the 2nd RTD-box (to be set at 7XV566 for RTD 7 to 12).

Please observe that detector input 1 (RTD1) of the first RTD-box is assigned for ambient or coolant temperature of the overload protection.

### 3.2.2 Checking System Connections

## WARNING!

**Warning of dangerous voltages**

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Therefore, only qualified people who are familiar with and adhere to the safety procedures and precautionary measures should perform the inspection steps.

## Caution!

**Take care when operating the device without a battery on a battery charger**

Non-observance of the following measures can lead to unusually high voltages and consequently, the destruction of the device.

Do not operate the device on a battery charger without a connected battery. (For limit values see also Technical Data, Section 4.1).

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 (e.g. test switches, fuses, or miniature circuit breakers) for the power supply must be opened.
- Check the continuity of all current 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?
  - Is the polarity for current input $I_G$ correct (if used)?
- If check switches are used for secondary testing of the device, their functions also must be checked, in particular that in the "check" setting the current transducer secondary lines are automatically shorted.
- 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 in Figure 3-3). Then remove the printed circuit board so that there is no longer any contact 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 consumption 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 supply circuit of the power supply.
- Disconnect the measuring test equipment; restore the normal power supply connections.
- 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.
- Remove the voltage from the power supply by closing the supply circuit of the power supply.

## 3.3 Commissioning

### WARNING!

**Warning of dangerous voltages when operating an electrical device**

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Only qualified people shall work on and around this device. They must be thoroughly familiar with all warnings and safety notices in this instruction manual as well as with the applicable safety steps, safety regulations, and precautionary measures.

The device is to be grounded to the substation ground before any other connections are made.

Hazardous voltages can exist in the power supply and at the connections to current transformers, voltage transformers, and test circuits.

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

After removing voltage from the power supply, wait a minimum of 10 seconds before re-energizing the power supply. This wait allows the initial conditions to be firmly established before the device is re-energized.

The limit values given in Technical Data (Chapter 4) must not be exceeded, neither during testing nor during commissioning.

When testing the device with secondary test equipment, make sure that no other measurement quantities are connected and that the trip and close circuits to the circuit breakers and other primary switches are disconnected from the device.

### DANGER!

**Hazardous voltages during interruptions in secondary circuits of current transformers**

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Short-circuit the current transformer secondary circuits before current connections to the device are opened.

Switching operations have to be carried out during commissioning. A prerequisite for the prescribed tests is that these switching operations can be executed without danger. They are accordingly not meant for operational checks.

## WARNING!

**Warning of dangers evolving from improper primary tests**

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Primary tests are only allowed to be carried out by qualified personnel, who are familiar with the commissioning of protection systems, the operation of the plant and the safety rules and regulations (switching, grounding, etc.).

## 3.3.1 Test Mode and Transmission Block

**Activation and Deactivation**

If the device is connected to a central or main computer system via the SCADA interface, then the information that is transmitted can be influenced. This is only possible with some of the protocols available (see Table "Protocol-dependent functions" in the Appendix A.6).

If **Test mode** is set ON, then a message sent by a SIPROTEC 4® device to the main system has an additional test bit. This bit allows the message to be recognized as resulting from testing and not an actual fault or power system event. Furthermore it can be determined by activating the **Transmission block** that no annunciations at all are transmitted via the system interface during test mode.

The SIPROTEC® 4 System Description describes in detail how to activate and deactivate test mode and blocked data transmission. Note that when DIGSI is being used, the program must be in the **Online** operating mode for the test features to be used.

### 3.3.2 Checking the System (SCADA) Interface

**Prefacing Remarks**

If the device features a system interface and uses it to communicate with the control center, the DIGSI device operation can be used to test if messages are transmitted correctly. This test option should however definitely not be used while the device is in service on a live system.

**DANGER!**

**Danger evolving from operating the equipment (e.g. circuit breakers, disconnectors) by means of the test function**

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Equipment used to allow switching such as circuit breakers or disconnectors is to be checked only during commissioning. Do not under any circumstances check them by means of the test function during real operation by transmitting or receiving messages via the system interface.

**Note**

After termination of the system interface test the device will reboot. Thereby, all annunciation buffers are erased. If required, these buffers should be extracted with DIGSI prior to the test.

The interface test is carried out using DIGSI in the Online operating mode:

- Open the **Online** directory by double-clicking; the operating functions for the device appear.
- Click on **Test**; the function selection appears in the right half of the screen.
- Double-click on **Generate Annunciations** shown in the list view. The dialog box **Generate Annunciations** opens (refer to the following figure).

**Structure of the Test Dialog Box**

In the column **Indication** the display texts of all indications are displayed which were allocated to the system interface in the matrix. In the column **SETPOINT Status** the user has to define the value for the messages to be tested. Depending on annunciation type, several input fields are offered (e.g. message "ON" / message "OFF"). By clicking on one of the fields you can select the desired value from the pull-down menu.

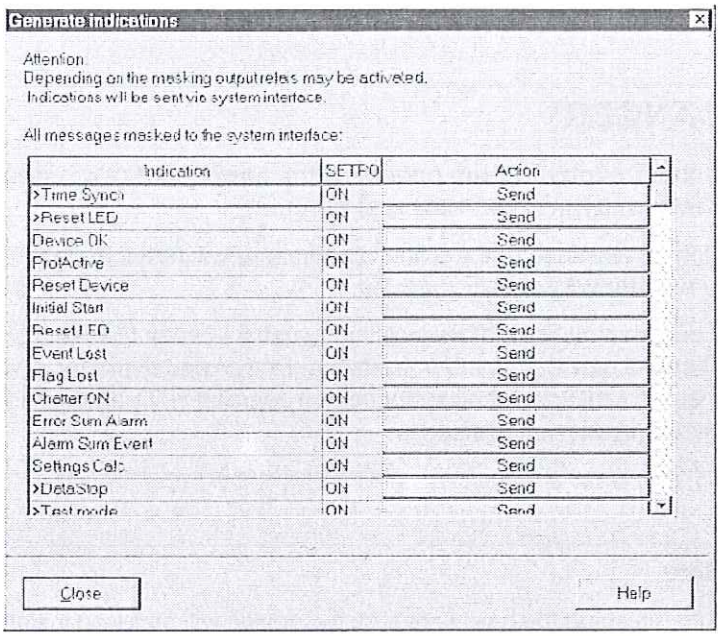



Figure 3-16 System interface test with dialog box: Generate annunciations — example

**Changing the Operating State**

When clicking one of the buttons in the column **Action** for the first time, you will be prompted for the password no. 6 (for hardware test menus). After correct entry of the password, individual annunciations can be initiated. To do so, click on the button **Send** on the corresponding line. The corresponding message is issued and can be read out either from the event log of the SIPROTEC® 4 device or from the substation control system.

As long as the window is open, further tests can be performed.

**Test in Message Direction**

For all information that is transmitted to the central station, test the options in the list which appears in **SETPOINT Status**:

- Make sure that each checking process is carried out carefully without causing any danger (see above and refer to DANGER!)
- Click on Send in the function to be tested and check whether the transmitted information reaches the central station and shows the desired reaction. Data which are normally linked via binary inputs (first character ">") are likewise indicated to the central power system with this procedure. The function of the binary inputs itself is tested separately.

**Exiting the Test Mode**

To end the System Interface Test, click on **Close**. The device is briefly out of service while the start-up routine is executed. The dialog box closes.

**Test in Command Direction**

The information transmitted in command direction must be indicated by the central station. Check whether the reaction is correct.

### 3.3.3 Checking the Status of Binary Inputs and Outputs

**Prefacing Remarks**

The binary inputs, outputs, and LEDs of a SIPROTEC® 4 device can be individually and precisely controlled in DIGSI. This feature is used to verify control wiring from the device to plant equipment (operational checks), during commissioning. This test option should however definitely not be used while the device is in service on a live system.

---

## DANGER!

**Danger evolving from operating the equipment (e.g. circuit breakers, disconnectors) by means of the test function**

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Equipment used to allow switching such as circuit breakers or disconnectors is to be checked only during commissioning. Do not under any circumstances check them by means of the test function during real operation by transmitting or receiving messages via the system interface.

---

**Note**

After finishing the hardware test, the device will make an initial startup. Thereby, all annunciation buffers are erased. If required, these buffers should be extracted with DIGSI prior to the test.

---

The hardware test can be carried out using DIGSI in the Online operating mode:

- Open the **Online** directory by double-clicking; the operating functions for the device appear.
- Click on **Test**; the function selection appears in the right half of the screen.
- Double-click in the list view on **Hardware Test**. The dialog box of the same name opens (see the following figure).

**Structure of the Test Dialog Box**

The dialog box is classified into three groups: **BI** for binary inputs, **REL** for output relays, and **LED** for light-emitting diodes. On the left of each of these groups is an accordingly labelled button. By double-clicking a button, information regarding the associated group can be shown or hidden.

In the column **Status** the present (physical) state of the hardware component is displayed. Indication is made by symbols. The physical actual states of the binary inputs and outputs are indicated by an open or closed switch symbol, the LEDs by a dark or illuminated LED symbol.

The opposite state of each element is displayed in the column **Scheduled**. The display is made in plain text.

The right-most column indicates the commands or messages that are configured (masked) to the hardware components.

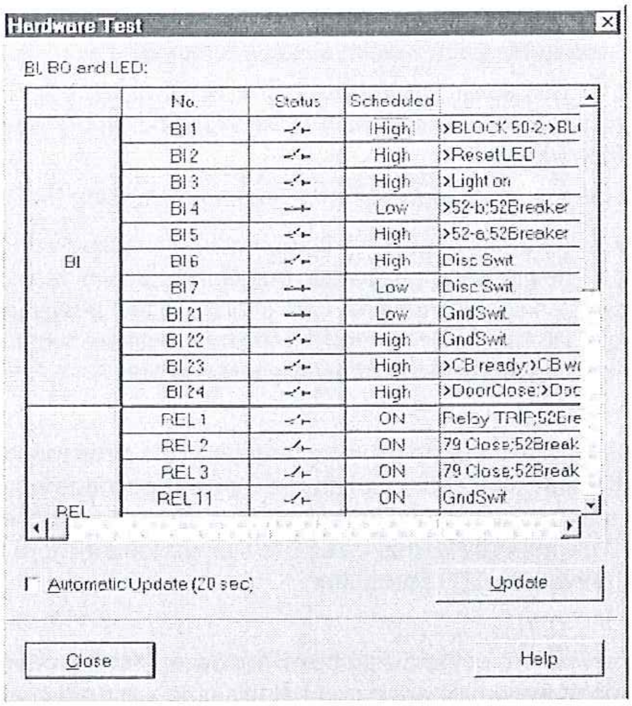



Figure 3-17 Test of the binary inputs and outputs — example

### Changing the Operating State

To change the condition of a hardware component, click on the associated button in the **Scheduled** column.

Password No. 6 (if activated during configuration) will be requested before the first hardware modification is allowed. After entry of the correct password a condition change will be executed. Further condition changes remain possible while the dialog box is open.

### Test of the Output Relays

Each individual output relay can be energized allowing a check of the wiring between the output relay of the 7SJ61 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 7SJ61 the condition in the plant which initiates the binary input must be generated and the response of the device checked.

To do so, the dialog box **Hardware Test** must again be opened to view the physical state of the binary inputs. The password is not yet required.

Proceed as follows in order to check the binary inputs:

- Each state in the plant which causes a binary input to pick up must be generated.
- Check the reaction in the **Status** column of the dialog box. To do this, the dialog box must be updated. The options may be found below under the margin heading "Updating the Display".
- Finish the testing (see margin heading below "Exiting the Test Mode").

If ,however, the effect of a binary input must be checked without carrying out any switching in the plant, it is possible to trigger individual binary inputs with the hardware test function. As soon as the first state change of any binary input is triggered and the password No. 6 has been entered, all binary inputs are separated from the plant and can only be activated via the hardware test function.

**Test of the LEDs**

The LEDs may be tested in a similar manner to the other input/output components. As soon as the first state change of any LED has been triggered, all LEDs are separated from the internal device functionality and can only be controlled via the hardware test function. This means e.g. that no LED is illuminated anymore by a protection function or by pressing the LED reset button.

**Updating the Display**

During the opening of the dialog box **Hardware Test** the operating states of the hardware components which are current at this time are read in and displayed.

An update is made:

- for each hardware component, if a command to change the condition is successfully performed,
- for all hardware components if the **Update** button is clicked,
- for all hardware components with cyclical updating (cycle time is 20 seconds) if the **Automatic Update (20sec)** field is marked.

**Exiting the Test Mode**

To end the hardware test, click on **Close**. The dialog box closes. The device becomes unavailable for a brief start-up period immediately after this. Then all hardware components are returned to the operating conditions determined by the plant settings.

## 3.3.4 Tests for Circuit Breaker Failure Protection

**General**

If the device provides a breaker failure protection and if this is used, the integration of this protection function in the system must be tested under practical conditions.

Due to the variety of application options and the available system configurations, it is not possible to make a detailed description of the necessary tests. It is important to observe local conditions and protection and system drawings.

Before starting the circuit breaker tests it is recommended to isolate the circuit breaker of the tested feeder at both ends, i.e. line isolators and busbar isolators should be open so that the breaker can be operated without risk.

## Caution!

Also for tests on the local circuit breaker of the feeder a trip command to the surrounding circuit breakers can be issued for the busbar.

Non-observance of the following measure can result in minor personal injury or property damage.

Therefore, primarily it is recommended to interrupt the tripping commands to the adjacent (busbar) breakers e.g. by inrupting the corresponding pickup voltage supply.

Before the breaker is finally closed for normal operation, the trip command of the feeder protection routed to the circuit breaker must be disconnected so that the trip command can only be initiated by the breaker failure protection.

Although the following lists do not claim to be complete, they may also contain points which are to be ignored in the current application.

**Auxiliary Contacts of the CB**

The circuit breaker auxiliary contact(s) form an essential part of the breaker failure protection system in case they have been connected to the device. Make sure the correct assignment has been checked.

**External Initiation Conditions**

If the breaker failure protection can be started by external protection devices, the external start conditions must be checked.

In order for the breaker failure protection to be started, a current must flow at least via the monitored phase. This may be a secondary injected current.

- Start by trip command of the external protection: binary input functions ">50BF ext SRC" (FNo 1431) (in spontaneous or fault annunciations).
- After every start, the message "50BF ext Pickup" (FNo 1457) must appear in the spontaneous or fault annunciations.
- After time expiration **TRIP-Timer** (address 7005) tripping command of the circuit breaker failure protection.

Switch off test current.

If start is possible without current flow:

- Closing the circuit breaker to be monitored to both sides with the disconnector switches open.
- Start by trip command of the external protection: Binary input functions ">50BF ext SRC" (FNo 1431) (in spontaneous or fault annunciations).
- After every start, the message "50BF ext Pickup" (FNo 1457) must appear in the spontaneous or fault annunciations.
- After time expiration **TRIP-Timer** (address 7005) tripping command of the circuit breaker failure protection.

Open the circuit breaker again.

**Busbar Tripping**

For testing the distribution of the trip commands in the substation in the case of breaker failures it is important to check that the trip commands to the adjacent circuit breakers is correct.

The adjacent circuit breakers are those of all feeders which must be tripped in order to ensure interruption of the fault current should the local breaker fail. These are therefore the circuit breakers of all feeders which feed the busbar or busbar section to which the feeder with the fault is connected.

A general detailed test guide cannot be specified because the layout of the adjacent circuit breakers largely depends on the system topology.

In particular with multiple busbars, the trip distribution logic for the adjacent circuit breakers must be checked. Here it should be checked for every busbar section that all circuit breakers which are connected to the same busbar section as the feeder circuit breaker under observation are tripped, and no other breakers.

**Tripping of the Remote End**

If the trip command of the circuit breaker failure protection must also trip the circuit breaker at the remote end of the feeder under observation, the transmission channel for this remote trip must also be checked.

**Termination**

All temporary measures taken for testing must be undone, e.g. especially switching states, interrupted trip commands, changes to setting values or individually switched off protection functions.

## 3.3.5 Checking User-Defined Functions

**CFC Logic**

The device has a vast capability for allowing functions to be defined by the user, especially with the CFC logic. Any special function or logic added to the device must be checked.

A general procedure cannot in the nature of things be specified. Configuration of these functions and the set value conditions must be actually known beforehand and tested. Possible interlocking conditions of switching devices (circuit breakers, disconnectors, earth switch) are of particular importance. They must be considered and tested.

## 3.3.6 Current and Phase Rotation Testing

**≥ 10 % of Load Current**

The connections of the current transformers are tested with primary quantities. Secondary load current of at least 10 % of the nominal current of the device is necessary. The line is energized and will remain in this state during the measurements.

With proper connections of the measuring circuits, none of the measured-values supervision elements in the device should pick up. If an element detects a problem, the causes which provoked it may be viewed in the Event Log.

If current sum errors are found, check the matching factors.

Messages from the symmetry monitoring could occur because there actually are asymmetrical conditions in the network. If these asymmetrical conditions are normal service conditions, the corresponding monitoring functions should be made less sensitive.

**Absolute Values**

The currents can be seen in the display field at the front of the device or a PC via the operator interface. 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.

**Phase Rotation**

The phase rotation must correspond to the configured phase rotation, in general a clockwise phase rotation. If the system has a counterclockwise phase sequence, 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.

Switch off the protected power line.

## 3.3.7 Test for High Impedance Protection

**Polarity of Transformers**

When the device is used for high-impedance protection, the current at $I_N$ or $I_{NS}$ is equivalent to the fault current in the protected object. It is essential in this case that all current transformers feeding the resistor whose current is measured at $I_{N(S)}$ have the same polarity. The test currents used for this are through currents. Each CT must be included in a measurement. The current at $I_{N(S)}$ may never exceed half the pickup value of the single-phase time overcurrent protection.

### 3.3.8 Testing the Reverse Interlocking Scheme

**(only if used)**

Testing reverse interlocking is available if at least one of the binary inputs available is configured for this purpose (e.g. presetting of binary input BI1 ">BLOCK 50-2" and ">BLOCK 50N-2" to open circuit system). Tests can be performed with phase currents or ground current. For ground current the corresponding ground current settings apply.

Please note that the blocking function can either be configured for the pickup current connected (open circuit system) or the pickup current missing (closed circuit system). For open circuit system the following tests are to be proceeded:

The feeder protection relays of all associated feeders must be in operation. At the beginning no auxiliary voltage is fed to the reverse interlocking system.

A test current higher than the pickup values of **50-2 PICKUP** and **50-1 PICKUP** or **51 PICKUP** is set. As a result of the missing blocking signal, the protection function trips after (short) time delay **50-2 DELAY**.

---

**Caution!**

Tests with currents that exceed more than 4 times the nominal device current

cause an overload of the input circuits.

Perform test only for a short time (see Technical Data, Section 4.1). Afterwards the device has to cool off !

---

The auxiliary voltage for reverse interlocking is now switched to the line. The precedent test is repeated, the result will be the same.

Subsequently, at each of the protection devices of the feeders, a pickup is simulated. Meanwhile, another fault is simulated for the protection function of the infeed, as described before. Tripping is performed within time **50-1 DELAY** (longer time period) (with definite time overcurrent protection) or according to characteristic (with inverse time overcurrent protection).

These tests also check the proper functioning of the wiring for reverse interlocking.

### 3.3.9 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 3-12 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 |
| 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.

### 3.3.10 Trip/Close Tests for the Configured Operating Devices

**Control by Local Command**

If the configured operating devices were not switched sufficiently in the hardware test already described, all configured switching devices must be switched on and off from the device via the integrated control element. The feedback information of the circuit breaker position injected via binary inputs is read out at the device and compared with the actual breaker position.

The switching procedure is described in the SIPROTEC® 4 System Description. The switching authority must be set in correspondence with the source of commands used. With the switch mode it is possible to select between interlocked and non-interlocked switching. Note that non-interlocked switching constitutes a safety risk.

**Control by Protective Functions**

For OPEN-commands sent to the circuit breaker please take into consideration that if the internal or external automatic reclosure function is used a TRIP-CLOSE test cycle is initiated.

---

## DANGER!

**A test cycle successfully started by the automatic reclosure function can lead to the closing of the circuit breaker !**

Non-observance of the following statement will result in death, severe personal injury or substantial property damage.

Be fully aware that OPEN-commands sent to the circuit breaker can result in a trip-close-trip event of the circuit breaker by an external reclosing device.

---

**Control from a Remote Control Center**

If the device is connected to a remote substation via a system interface, the corresponding switching tests may also be checked from the substation. Please also take into consideration that the switching authority is set in correspondence with the source of commands used.

### 3.3.11 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 behavior 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 7SJ61 also has the capability of capturing the same data when commands are given to the device via the service program DIGSI, the serial interface, or a binary input. For the latter, event ">Trig.Wave.Cap." must be allocated to a binary input. Triggering for the oscillographic recording then occurs, for instance, via the binary input when the protection object is energized.

Those that are externally triggered (that is, without a protective element pickup) are processed by the device as a normal oscillographic record. For each oscillographic record a fault record is created which is given its individual number to ensure that assignment can be made properly. However, these recordings are not displayed in the fault indication buffer, as they are not fault events.

**Triggering Oscillo-graphicRecording**

To trigger test measurement recording with DIGSI, click on **Test** in the left part of the window. Double click the entry **Test Wave Form** in the list of the window.

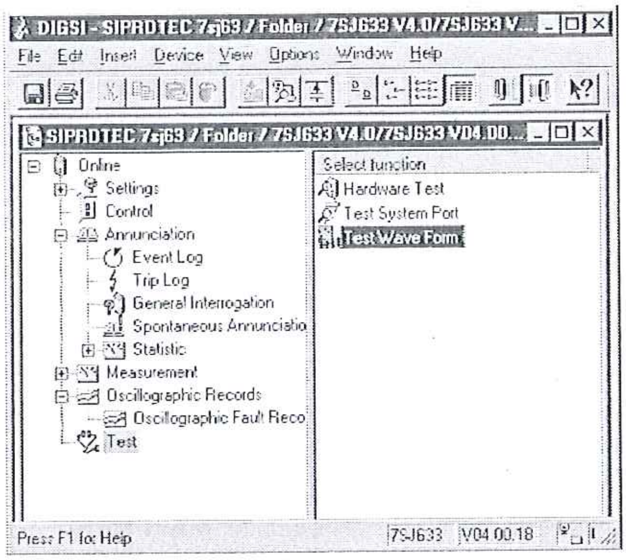



Figure 3-18 Triggering oscillographic recording with DIGSI®

Oscillographic recording is started immediately. During recording, a report is given in the left part of the status bar. Bar segments additionally indicate the progress of the procedure.

The SIGRA or the Comtrade Viewer program is required to view and analyse the oscillographic data.

## 3.4 Final Preparation of the Device

Firmly tighten all screws. Tighten all terminal screws, including those that are not used.

---

### Caution!

**Inadmissable Tightening Torques**

Non-observance of the following measure can result in minor personal injury or property damage.

The tightening torques must not be exceeded as the threads and terminal chambers may otherwise be damaged!

---

The setting values should be checked again, if they were changed during the tests. Check if protection, control and auxiliary functions to be found with the configuration parameters are set correctly (Section 2.1.1, Functions Overview). All desired elements and functions must be set ***ON***. Keep a copy of all of the in-service settings on a PC.

Check the internal clock of the device. If necessary, set the clock or synchronize the clock if the element is not automatically synchronized. For assistance, refer to the SIPROTEC® 4 System Description.

The annunciation buffers are deleted under **MAIN MENU → Annunciations → Set/Reset**, so that future information will only apply for actual events and states (see also SIPROTEC® 4 System Description). The counters in the switching statistics should be reset to the values that were existing prior to the testing (see also SIPROTEC®4 System Description).

Reset the counters of the operational measured values (e.g. operation counter, if available) under **MAIN MENU → Measured Value → Reset** (see also SIPROTEC® 4 System Description).

Press the Esc key (several times if necessary), to return to the default display. The default display appears in the display box (e.g. the display of operational measured values).

Clear the LEDs on the front panel of the device by pressing the LED key, so that they show only real events and states in the future. In this context, also output relays probably memorized are reset. Pressing the LED key also serves as a test for the LEDs on the front panel because they should all light when the button is pushed. Any LEDs that are lit after the clearing attempt are displaying actual conditions.

The green "RUN" LED must light up, whereas the red "ERROR" must not light up.

Close the protective switches. If test switches are available, then these must be in the operating position.

The device is now ready for operation.

■

# Technical Data 4

This chapter provides the technical data of the device SIPROTEC® 7SJ61 and its individual functions, including the limit values that under no circumstances may be exceeded. The electrical and functional data for the maximum functional scope are followed by the mechanical specifications with dimensional diagrams.

# 4.1 General Device Data

## 4.1.1 Analog Inputs

### Current Inputs

| | | | |
|---|---|---|---|
| Nominal Frequency | $f_{Nom}$ | 50 Hz or 60 Hz | (adjustable) |
| Nominal Current | $I_{Nom}$ | 1 A or 5 A | |
| Ground Current, Sensitive | $I_{Ns}$ | ≤ linear range 1.6 A [1] | |
| Burden per Phase and Ground Path<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)

## 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 | |
| Permissible AC ripple voltage,<br>Peak to Peak, IEC 60 255-11 | 15 % of the auxiliary voltage | |
| Power Input | Quiescent | Approx. 3 W |
| | Energized | Approx. 7 W |
| Bridging Time for Failure/Short Circuit,<br>IEC 60255–11<br>(in not energized operation) | ≥ 50 ms at V ≥ 110 VDC<br>≥ 20 ms at V ≥ 24 VDC | |

### AC Voltage

| Voltage supply using integrated converter | | |
|---|---|---|
| Rated auxiliary AC $V_{Aux}$ | 115 VAC | 230 VAC |
| Permissible Voltage Ranges | 92 to 132 VAC | 184 to 265 VAC |
| Power consumption, quiescent | Approx. 3 VA | Approx. 3 VA |
| Power consumption, energized | Approx. 7 VA | Approx. 7 VA |
| Bridging time for failure/short circuit (in not energized operation) | ≥ 200 ms | |

## 4.1.3 Binary Inputs and Outputs

### Binary Inputs

| Variant | Quantity | |
|---|---|---|
| 7SJ610*– | 3 (configurable) | |
| 7SJ611*– | 8 (configurable) | |
| 7SJ612*– | 11 (configurable) | |
| | | |
| Rated Voltage Range | 24 VDC to 250 VDC, bipolar | |
| Current Consumption (independent of the control voltage) | Approx. 1.8 mA | |
| Pickup time | Approx. 4 ms | |
| | | |
| Switching Thresholds | 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 ≤ 44VDC |
| For Nominal Voltages (only for modules with 3 switching thresholds) | 220/250 VDC and 115/230 VAC | V high ≥ 176 VDC<br>V low ≤ 88VDC |
| Maximum admissible voltage | 300 VDC | |
| Impulse Filter on Input | 220 nF Coupling Capacitor at 220 V with recovery time > 60 ms | |

## Output Relays

| Output Relay for Commands/Annunciations, Alarm Relay *) | | |
|---|---|---|
| Number and Information | According to the Order Variant (allocatable); Values in ( ): up to release .../DD | |
| Order variant | NO contact | NO/NC, switch selectable |
| 7SJ610*– | 2 (4) | 3 (1) |
| 7SJ611*– | 6 (8) | 3 (1) |
| 7SJ612*– | 4 (6) | 3 (1) |
| Switching capability CLOSE | 1000 W/VA | |
| Switching capability TRIP | 30 VA 40 W resistive 25 W at L/R ≤ 50 ms | |
| Switching voltage | 250 V | |
| Admissible current per contact (continuous) | 5 A | |
| Adm. current per contact (close and hold) | 30 A for 0.5 s (NO contact) | |
| Total Current on common path | 5 A continuous, 30 A for 0.5 s | |
| | | |
| AC Load (it has to be taken into consideration for the dimensions of external circuits) | | |
| Value of the ANSI capacitor: $4{,}70 \cdot 10^{-9}$ 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, B |
| | 240 VAC | Pilot duty, B |
| | 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)]) |

[1)] FLA = "Full Load Ampere".

## 4.1.4 Communication Interfaces

### Operator Interface

| | |
|---|---|
| Connection | Front side, not blocked, RS232, 9-pin DSUB port for connecting a personal computer |
| Operation | With DIGSI |
| Transmission speed | Min. 4 800 Baud; max. 38 400 Baud; Factory Setting: 38 400 Baud; Parity: 8E1 |
| Bridgeable distance | 49.2 feet (15 m) |

### Service / Modem Interface

| | | |
|---|---|---|
| | Connection | Isolated interface for data transfer |
| | Operation | with DIGSI® |
| | Transmission Speed | Min. 4.800 Bd, max. 38.400 Bd; Factory Setting 38.400 Bd |
| RS232/RS485 | | RS232/RS485 according to the order variant |
| | Connection for panel flush mounting housing | Rear panel, mounting location "C2", 9-pin D-subminiature female connector |
| | Connection for panel surface mounting housing | In the housing at the case bottom; Shielded data cable |
| | Test voltage | 500 V; 50 Hz |
| RS232 | | |
| | Bridgeable distance | 49.2 feet (15 m) |
| RS485 | | |
| | Bridgeable distance | 3,280 feet (1000 m) |
| Fiber optic cable (FO) | | |
| | FO connector type | ST connector |
| | Connection for panel flush mounting housing | Rear panel, mounting location "C" |
| | For panel surface mounting housing | In console housing at 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 |
| | Admissible optical signal attenuation | Max. 8 dB, with glass fiber 62.5/125 µm |
| | Bridgeable distance | Max. 0.93 miles (1.5 km) |
| | Character idle state | Configurable; factory setting "Light off" |

## System Interface

| | | |
|---|---|---|
| IEC 60870-5-103 | | |
| | RS232/RS485/FO according to the order variant | Isolated interface for data transfer to a control terminal |
| RS232 | | |
| | Connection for panel flush mounting housing | Rear panel, mounting location "B", 9-pin D-subminiature female connector |
| | For panel surface mounting housing | In console housing at case bottom |
| | Test voltage | 500 V; 50 Hz |
| | Transmission Speed | Min. 4.800 Bd, max. 38.400 Bd; Factory setting 9600 Baud |
| | Bridgeable distance | 15 m |
| RS485 | | |
| | Connection for panel flush mounting housing | Rear panel, mounting location "B", 9-pin D-subminiature female connector |
| | For panel surface mounting housing | In console housing at case bottom |
| | Test voltage | 500 V; 50 Hz |
| | Transmission Speed | Min. 4.800 Bd, max. 38.400 Bd; Factory setting 9600 Baud |
| | Bridgeable distance | Max. 1 km / 3280 feet / 0.62 miles |
| Fiber optic cable (FO) | | |
| | FO connector type | ST connector |
| | Connection for panel flush mounting housing | Rear panel, slot "B" |
| | Connection for panel surface mounting housing | In console housing at 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 fibre 62.5/125 µm |
| | Admissible optical signal attenuation | Max. 8 dB, with glass fiber 62.5/125 µm |
| | Bridgeable distance | Max. 0.93 miles (1.5 km) |
| | Character idle state | Configurable; factory setting "Light off" |
| Profibus RS485 (FMS and DP) | | |
| | Connection for panel flush mounting housing | Rear panel, slot "B", 9-pin D-SUB miniature connector |
| | Connection for panel surface mounting housing | In console housing at case bottom |
| | Test voltage | 500 V; 50 Hz |
| | Transmission Speed | Up to 1.5 MBd |
| | Bridgeable distance | 1.000 m / 1666 feet at ≤ 93.75 kBd<br>500 m / 1640 feet at ≤ 187.5 kBd<br>200 m / 330 feet at ≤ 1.5 MBd |

| | | |
|---|---|---|
| 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 panel flush mounting housing | Rear panel, slot "B" |
| | Connection for panel surface mounting housing | in console housing on the case bottom via RS485 and external RS485/LWL converter |
| | Transmission Speed | Up to 1.5 MBd |
| | 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 |
| | Admissible optical signal attenuation | Max. 8 dB, with glass fiber 62.5/125 µm |
| | Bridgeable distance | Max. 0.93 miles (1.5 km) |
| DNP3.0 /MODBUS RS485 | | |
| | Connection for panel flush mounting housing | Rear panel, slot "B", 9-pin D-SUB miniature connector |
| | Connection for panel surface mounting housing | In console housing at case bottom |
| | Test voltage | 500 V; 50 Hz |
| | Transmission Speed | Up to 19.200 Baud |
| | Bridgeable distance | Max. 0.62 miles (1 km) |
| DNP3.0/MODBUS Fiber Optical Link | | |
| | FO connector type | ST connector transmitter/receiver |
| | Connection for panel flush mounting housing | Rear panel, slot "B" |
| | Connection for panel surface mounting housing | not available |
| | Transmission Speed | Up to 19.200 Baud |
| | Optical wavelength | $\lambda$ = 820 NM |
| | Laser Class 1 according to EN 60825-1/-2 | Using glass fiber 50/125 µma or using glass fiber 62.5/125 µma |
| | Admissible optical signal attenuation | Max. 8 dB, with glass fiber 62.5/125 µma |
| | Bridgeable distance | Max. 0.93 miles (1.5 km) |
| Ethernet electrical (EN 100) for IEC61850 and DIGSI | | |
| | Connection for flush mounting housing | Rear panel, mounting location "B"<br>2 x RJ45 socket contact<br>100BaseT acc. to IEEE802.3 |
| | Connection for panel surface mounting housing | expected to be available as of 02/2005 |
| | Test voltage (reg. socket) | 500 V; 50 Hz |
| | Transmission speed | 100 MBit/s |
| | Bridgeable distance | 65.62 feet (20 m) |

### Time Synchronization Interface

| | |
|---|---|
| Time Synchronization | DCF 77 / IRIG B Signal (Telegram Format IRIG-B000) |
| Connection for flush-mounted case | Rear panel, mounting location "A" 9-pin D-subminiature female connector |
| Connection for surface mounting housing | at the double-deck terminal on the case bottom |
| Signal Nominal Voltages | selectable 5 V, 12 V or 24 V |

| Signal Levels and Burdens | | | |
|---|---|---|---|
| | Nominal Signal Voltage | | |
| | 5 V | 12 V | 24 V |
| $V_{IHigh}$ | 6.0 V | 15.8 V | 31 V |
| $V_{ILow}$ | 1.0 V at $I_{ILow}$ = 0.25 mA | 1.4 V at $I_{ILow}$ = 0.25 mA | 1.9 V at $I_{ILow}$ = 0.25 mA |
| $I_{IHigh}$ | 4.5 mA to 9.4 mA | 4.5 mA to 9.3 mA | 4.5 mA to 8.7 mA |
| $R_I$ | 890 at $V_I$ = 4 V | 1930 at $V_I$ = 8.7 V | 3780 at $V_I$ = 17 V |
| | 640 at $V_I$ = 6 V | 1700 at $V_I$ = 15.8 V | 3560 at $V_I$ = 31 V |

## 4.1.5 Electrical Tests

### Specifications

| | |
|---|---|
| Standards: | IEC 60255 (product standards)<br>ANSI/IEEE Std C37.90.0/.1/.2<br>U 508<br>DIN 57435 Part 303<br>See also standards for individual tests |

### 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 |
| Voltage Test (routine test) Auxiliary Voltage and Binary Inputs | 3.5 kV DC |
| 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, non-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 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 |
| 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>ANSI/IEEE Std C37.90.1 | | 2.5 to 3 kV (peak value); 1 to 1.5 MHz; damped oscillation; 50 surges per s; test duration 2 s; $R_i$ = 150 Ω to 200 Ω |
| Fast Transient Surge Withstand Cap.<br>ANSI/IEEE Std C37.90.1 | | 4 kV to 5 kV: 10/150 ns: 50 Pulse per s; both polarities: duration 2 s: $R_i$ = 80 Ω |
| Radiated Electromagnetic Interference<br>ANSI/IEEE 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–* (generic standard) |
| Radio Noise Voltage to Lines, Only Power Supply 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 |

### 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 test (acc. IEC 60068-2-1 and -2, Test Bd, for 16 h) | –13° F to +185° F or –25° C to +85° C |
| Admissible temporary operating temperature (tested for 96 h) | –4° 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 |
| Limit Temperatures for Storage | –13° F to +131° F or –25° C to +55° C |
| Limit Temperatures during Transport | –13° F to 158° F or –25° C to +70° C |
| STORE AND TRANSPORT OF THE DEVICE WITH FACTORY PACKAGING! | |
| [1]) UL–certified according to Standard 508 (Industrial Control Equipment): | |
| Limit Temperatures for Normal Operation (i.e. output relays not energized) | –4° F to +158° F or –20° C to +70° C |
| Limit temperatures under maximum load (max. cont. admissible input and output values) | +23° F to +131° F or –5° C to +55° C |

#### Humidity

| | |
|---|---|
| Permissible humidity | Mean value per year ≤ 75 % relative humidity; on 56 days of the year up to 93 % relative humidity; condensation must be avoided! |
| Siemens recommends that all devices be installed such that they are not exposed to direct sunlight, nor subject to large fluctuations in temperature that may cause condensation to occur. | |

### 4.1.8 Service Conditions

The device is designed for installation in normal relay rooms and plants, so that electromagnetic compatibility (EMC) is ensured if installation is done properly.

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 Electrostatic Sensitive Devices) must be observed. They are not endangered when inserted into the case.

### 4.1.9 Certifications

| UL listing | | UL recognition | |
|---|---|---|---|
| 7SJ61**-*B***-**** | Models with threaded terminals | 7SJ61**-*D***-**** | Models with plug–in terminals |
| 7SJ61**-*E***-**** | | | |

### 4.1.10 Design

| | |
|---|---|
| Housing | 7XP20 |
| Dimensions | See dimensional drawings, Section 4.20 |
| Weight (mass) approx. | |
| — Housing for panel surface mounting | 9.9 lb or 4.5 kg |
| — Housing for panel surface mounting | 8.8 lb or 4.0 kg |

| | | |
|---|---|---|
| Protection class acc. to IEC 60529 | | |
| For surface mounting housing equipment | | IP 51 |
| In flush mounted housing | | |
| | Front | IP 51 |
| | Rear | IP 50 |
| For personal protection | | IP 2x with cover cap |
| UL conditions | | "For use on a Flat Surface of a Type 1 Enclosure" |

## 4.2 Definite Time Overcurrent Protection 50, 50N

### Operating Modes

| | |
|---|---|
| Three-phase | Standard |
| Two-phase | Phases A and C |

### Setting Ranges / Increments

| | | | |
|---|---|---|---|
| Pickup current 50–1, 50–2 (phases) | for $I_{Nom}$ = 1 A | 0.10 A to 35.00 A or ∞ (disabled) | Increments 0.01 A |
| | for $I_{Nom}$ = 5 A | 0.50 A to 175.00 A or ∞ (disabled) | |
| Pickup current 50N–1, 50N–2 (ground) | for $I_{Nom}$ = 1 A | 0.05 A to 35.00 A or ∞ (disabled) | Increments 0.01 A |
| | for $I_{Nom}$ = 5 A | 0.25 A to 175.00 A or ∞ (disabled) | |
| Delay times T | | 0.00 s to 60.00 s or ∞ (disabled) | Increments 0.01 s |
| Dropout delay times 50 T DROP-OUT, 50N T DROP-OUT | | 0.00 s to 60.00 s | Increments 0.01 s |

### Times

| Pickup times (without inrush restraint, with restraint add 10 ms) | |
|---|---|
| 50-1, 50-2, 50N-1, 50N-2<br>– Current = 2 x Pickup Value<br>– Current = 5 x Pickup Value | <br>approx. 30 ms<br>approx. 25 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 or 50 mA with $I_{Nom}$ = 5 A |
| Delay times T | 1 % or 10 ms |

### Influencing Variables for Pickup and Dropout

| | |
|---|---|
| Power supply direct voltage in range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$ | 1 % |
| Temperature in range $-5\ °C \leq \Theta_{amb} \leq 55\ °C$ | 0.5 %/10 K |
| Frequency in range $0.95 \leq f/f_{Nom} \leq 1.05$ | 1 % |
| Harmonics<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 % |

## 4.3 Inverse Time Overcurrent Protection 51, 51N

### Operating Modes

| | |
|---|---|
| Three-phase | Standard |
| Two-phase | Phases A and C |

### Setting Ranges / Increments

| | | | |
|---|---|---|---|
| Pickup current 51 (phases) | for $I_{Nom}$ = 1 A | 0.10 A to 4.00 A | Increments 0.01 A |
| | for $I_{Nom}$ = 5 A | 0.50 A to 20.00 A | |
| Pickup current 51N | for $I_{Nom}$ = 1 A | 0.05 A to 4.00 A | Increments 0.01 A |
| | for $I_{Nom}$ = 5 A | 0.25 A to 20.00 A | |
| Time multipliers T for 51, 51N IEC curves | | 0.05 s to 3.20 s or ∞ (disabled) | Increments 0.01 s |
| Time multipliers D for 51, 51N ANSI curves | | 0.50 s to 15.00 s or ∞ (disabled) | Increments 0.01 s |

### Trip Time Curves acc. to IEC

Acc. to IEC 60255-3 or BS 142, Section 3.5.2 (see also Figure 4-1 and 4-2)

NORMAL INVERSE (Type A)

$$t = \frac{0.14}{(I/I_p)^{0.02} - 1} \cdot T_p \ [s]$$

VERY INVERESE (Type B)

$$t = \frac{13.5}{(I/I_p)^{1} - 1} \cdot T_p \ [s]$$

EXTREMELY INV. (Type C)

$$t = \frac{80}{(I/I_p)^{2} - 1} \cdot T_p \ [s]$$

LONG INVERSE (Type B)

$$t = \frac{120}{(I/I_p)^{1} - 1} \cdot T_p \ [s]$$

For All Characteristics

- $t$ trip time in seconds
- $T_p$ setting value of the time multiplier
- $I$ fault current
- $I_p$ setting value of the pickup current

The tripping times for $I/I_p \geq 20$ are identical with those for $I/I_p = 20$.

For zero-sequence current read 3I0p instead of $I_p$ and $T_{3I0p}$ instead of $T_p$; for ground fault read $I_{Ep}$ instead of $I_p$ and $T_{IEp}$ instead of $T_p$

| | |
|---|---|
| Pickup Threshold | approx. 1.10 · $I_p$ |

## Dropout Time Characteristics with Disk Emulation acc. to IEC

| Acc. to IEC 60255-3 or BS 142, Section 3.5.2 (see also Figures 4-1 and 4-2) | |
|---|---|
| NORMAL INVERSE (Type A) | $t_{Reset} = \frac{9.7}{(I/I_p)^2 - 1} \cdot T_p$ [s] |
| VERY INVERSE (Type B) | $t_{Reset} = \frac{43.2}{(I/I_p)^2 - 1} \cdot T_p$ [s] |
| EXTREMELY INV. (Type C) | $t_{Reset} = \frac{58.2}{(I/I_p)^2 - 1} \cdot T_p$ [s] |
| LONG INVERSE (Type B) | $t_{Reset} = \frac{80}{(I/I_p)^2 - 1} \cdot T_p$ [s] |
| | For all Characteristics<br>$t_{RESET}$ = Reset time<br>$T_p$ = 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 $0.05 \leq (I/Ip) \leq 0.90$ | |
| For zero-sequence current read 3I0p instead of $I_p$ and $T_{3I0p}$ instead of $T_p$;<br>for ground fault read $I_{Ep}$ instead of $I_p$ and $T_{IEp}$ instead of $T_p$ | |

## Dropout Setting

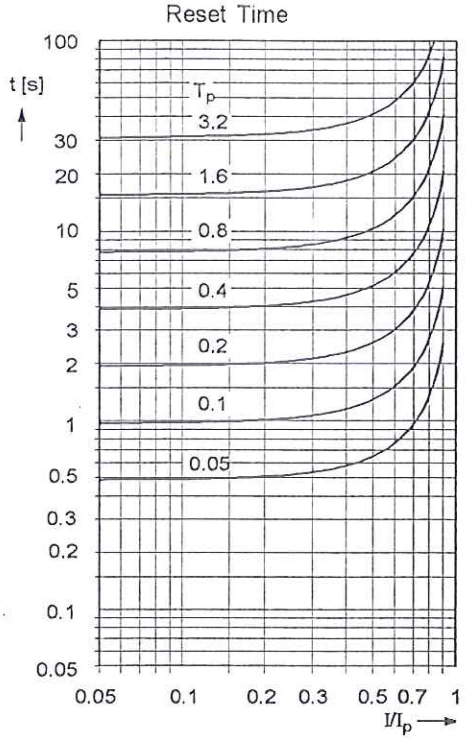
| | |
|---|---|
| IEC without Disk Emulation | approx. 1.05 · set value $I_p$ for $I_p/I_{Nom} \geq 0.3$, corresponds to approx. 0.95 · pickup threshold |
| IEC with Disk Emulation | approx. 0.90 · set value $I_p$ |

## Tolerances

| | |
|---|---|
| Pickup/dropout thresholds $I_p$, $I_{Ep}$ | 2 % of set value or 10 mA for $I_{Nom}$ = 1 A or 50 mA for $I_{Nom}$ = 5 A |
| Pickup time for $2 \leq I/I_p \leq 20$ | 5 % of reference (calculated) value + 2 % current tolerance, respectively 30 ms |
| Dropout ratio for $0.05 \leq I/I_p \leq 0.90$ | 5 % of reference (calculated) value + 2 % current tolerance, respectively 30 ms |

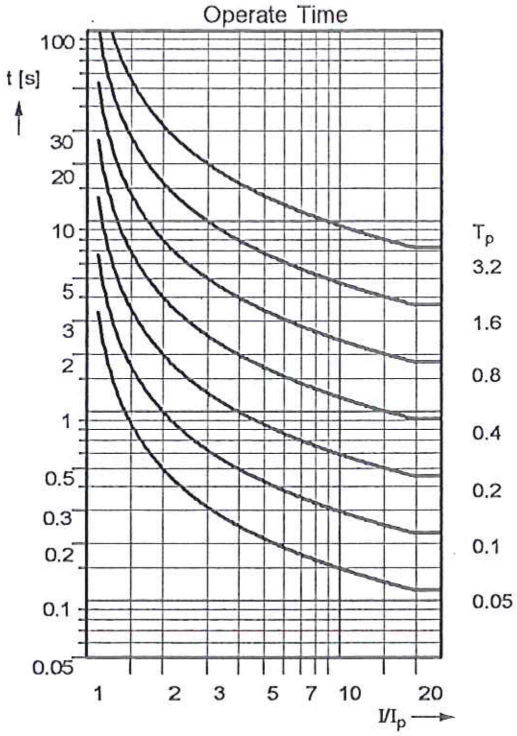
### Influencing Variables for Pickup and Dropout

| | |
|---|---|
| Power supply direct voltage in range 0.8 ≤ $V_{PS}/V_{PSNom}$ ≤ 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 ≤ $f/f_{Nom}$ ≤ 1.05 | 1 % |
| Harmonics<br>Up to 10 % 3rd harmonic<br>Up to 10 % 5th harmonic | <br>1 %<br>1 % |
| Transient overreach for τ > 100 ms (with complete asymmetry) | <5 % |



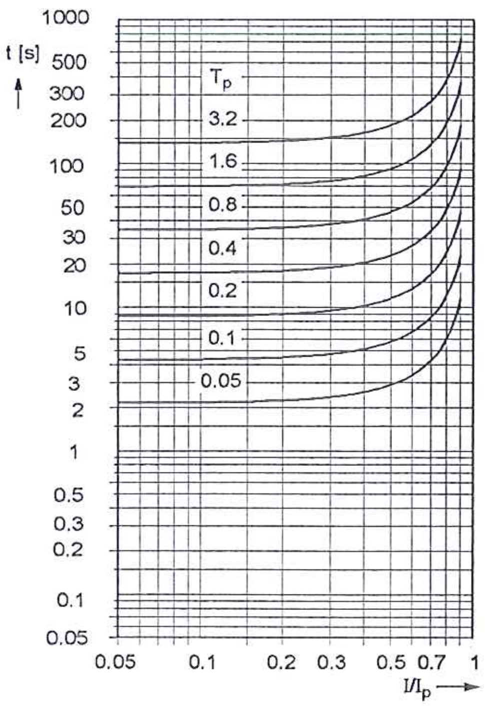

**Reset Normal inverse:**
**(Type A)**

$$t = \frac{9.7}{(I/I_p)^2 - 1} \cdot T_p \quad [s]$$



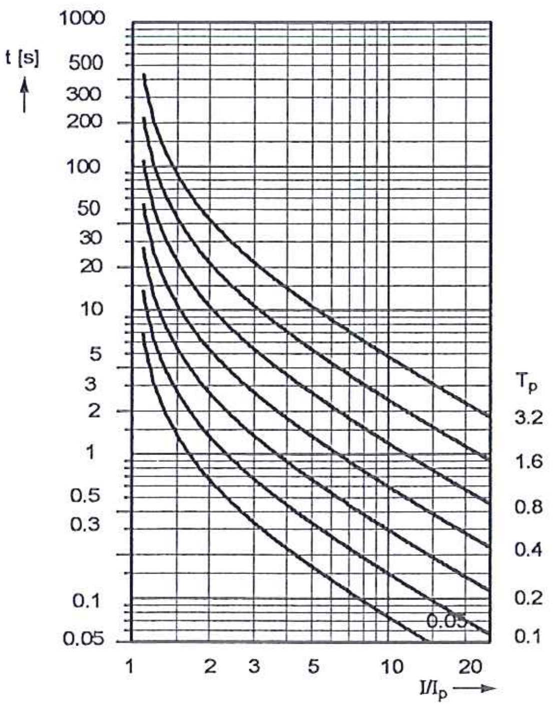

**Normal inverse:**
**(Type A)**

$$t = \frac{0.14}{(I/I_p)^{0.02} - 1} \cdot T_p \quad [s]$$




**Reset Very inverse:**
**(Type B)**

$$t = \frac{43.2}{(I/I_p)^2 - 1} \cdot T_p \quad [s]$$

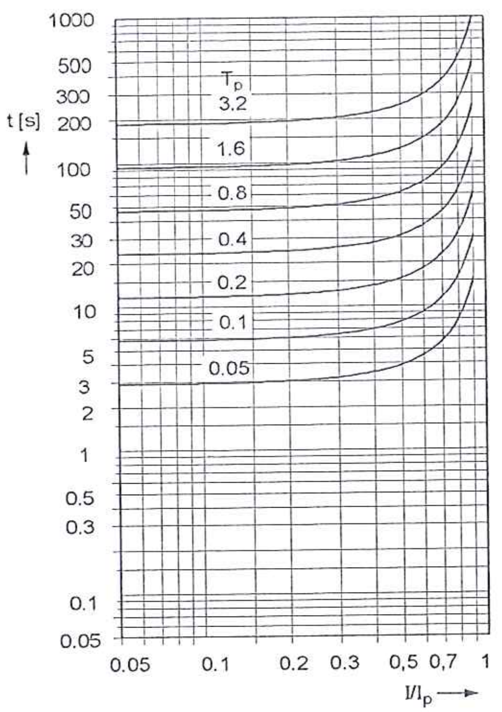



**Very inverse:**
**(Type B)**

$$t = \frac{13.5}{(I/I_p)^1 - 1} \cdot T_p \quad [s]$$

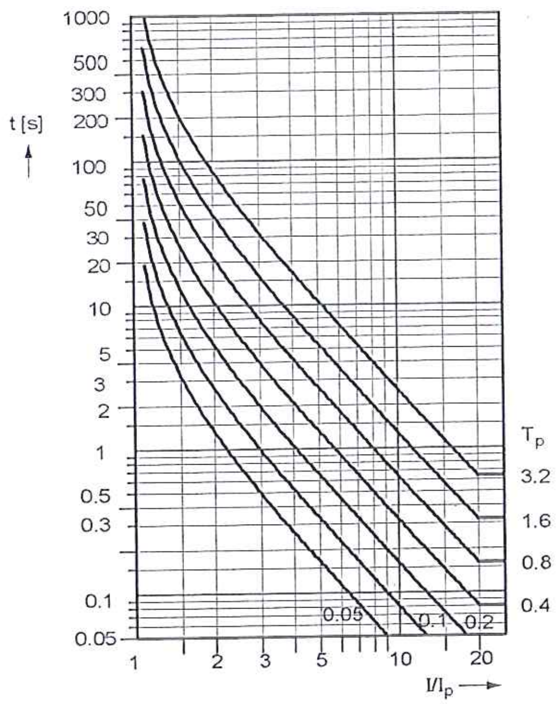
Figure 4-1 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to IEC

Reset Time

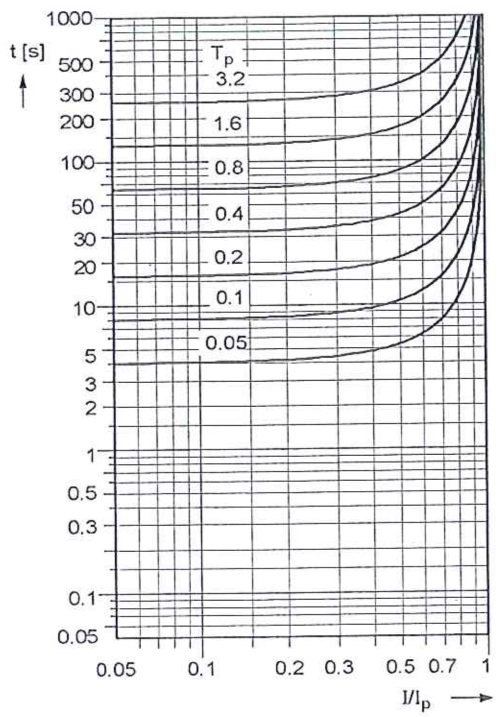



**Reset Extremely inverse:** $t = \frac{58.2}{(I/I_p)^2 - 1} \cdot T_p$ [s]
**(Type C)**

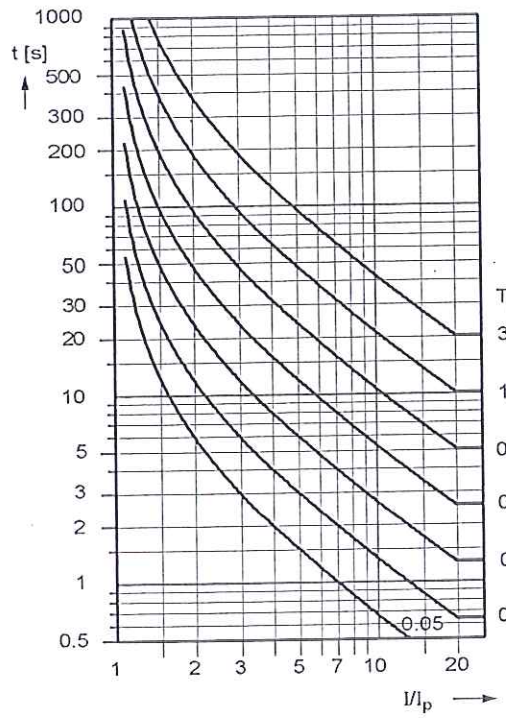
Operate Time




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




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




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

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

## 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<br>t = Trip time in seconds<br>D = Setting value of the time multiplier<br>I = Fault Current<br>$I_p$ = Setting value of the pickup current |
| The tripping times for $I/I_p \geq 20$ are identical with those for $I/I_p = 20$. | |
| For zero-sequence current read 3I0p instead of $I_p$ and $T_{3I0p}$ instead of $T_p$; for ground fault read $I_{Ep}$ instead of $I_p$ and $T_{IEp}$ instead of $T_p$ | |
| Pickup Threshold | approx. $1.10 \cdot I_p$ |

## Dropout Time Characteristics with Disk Emulation acc. to 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 $0.05 \leq (I/Ip) \leq 0.90$

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

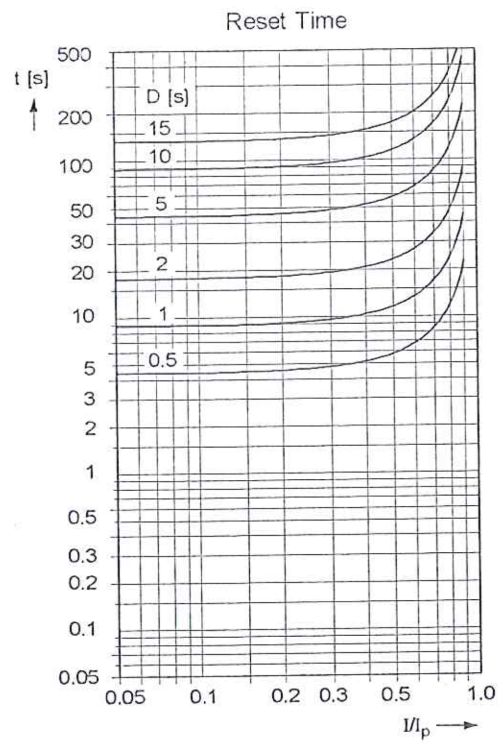
| | |
|---|---|
| IEC without Disk Emulation | approx. 1.05 · set value $I_p$ for $I_p/I_{Nom} \geq 0.3$; corresponds to approx. 0.95 · pickup threshold |
| ANSI with Disk Emulation | approx. 0.90 · set value $I_p$ |

### Tolerances

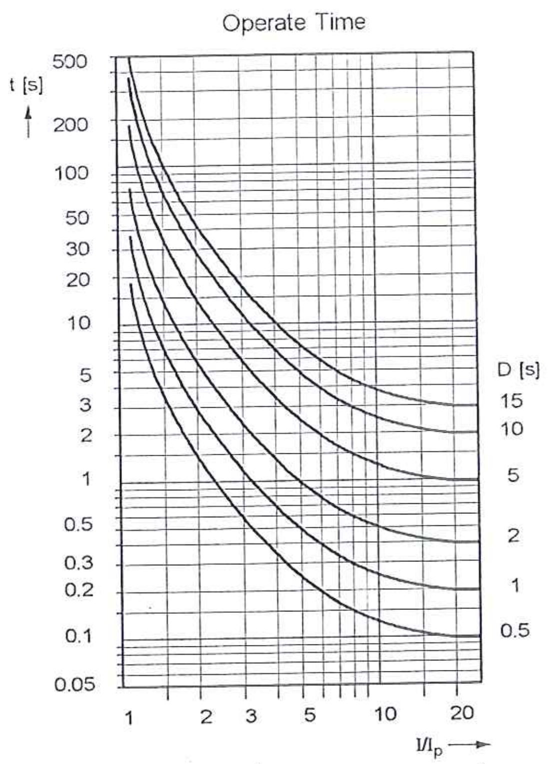
| | |
|---|---|
| Pickup/dropout thresholds $I_p$, $I_{Ep}$ | 2 % of set value or 10 mA for $I_{Nom}$ = 1 A or 50 mA for $I_{Nom}$ = 5 A |
| Pickup time for $2 \leq I/I_p \leq 20$ | 5 % of reference (calculated) value + 2 % current tolerance, respectively 30 ms |
| Dropout time for $0.05 \leq I/I_p \leq 0.90$ | 5 % of reference (calculated) value + 2 % |

### Influencing Variables for Pickup and Dropout

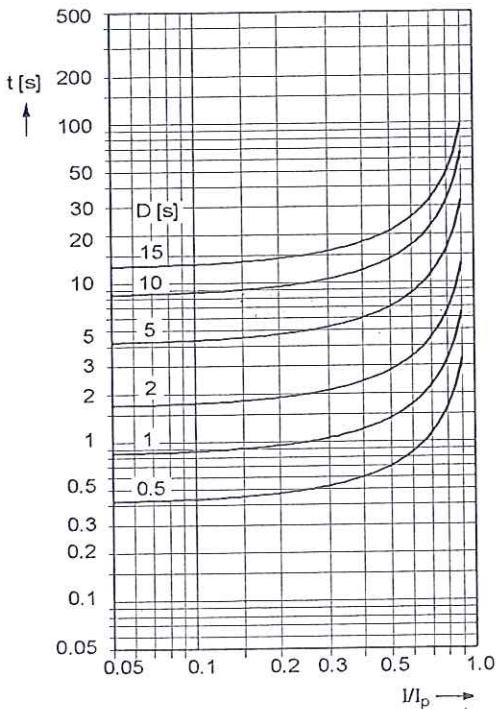
| | |
|---|---|
| Power supply direct voltage in range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$ | 1 % |
| Temperature in range 23.00 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131.00 °F (55 °C) | 0.5 %/10 K |
| Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$ | 1 % |
| Harmonics<br>- up to 10 % 3rd harmonic<br>- up to 10 % 5th harmonic | <br>1%<br>1% |
| Transient overreach for $\tau$ > 100 ms (with complete asymmetry) | <5 % |



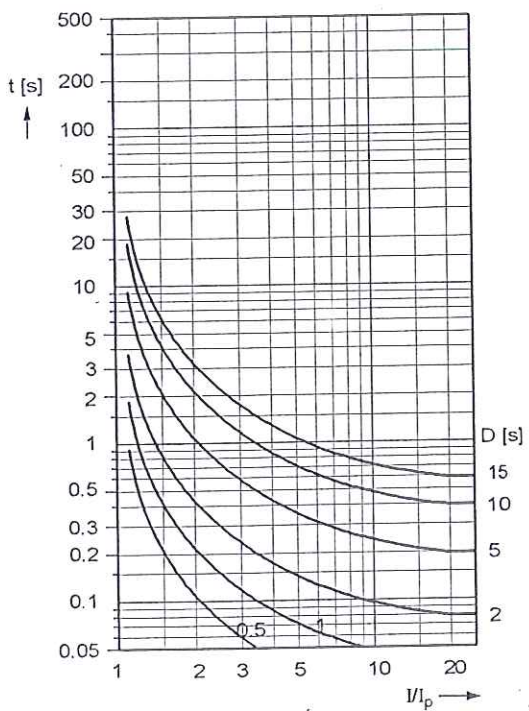

**RESET INVERSE** $t = \left(\frac{8.8}{(I/I_p)^{2.0938} - 1}\right) \cdot D$ [s]




**INVERSE** $t = \left(\frac{8.9341}{(I/I_p)^{2.0938} - 1} + 0.17966\right) \cdot D$ [s]

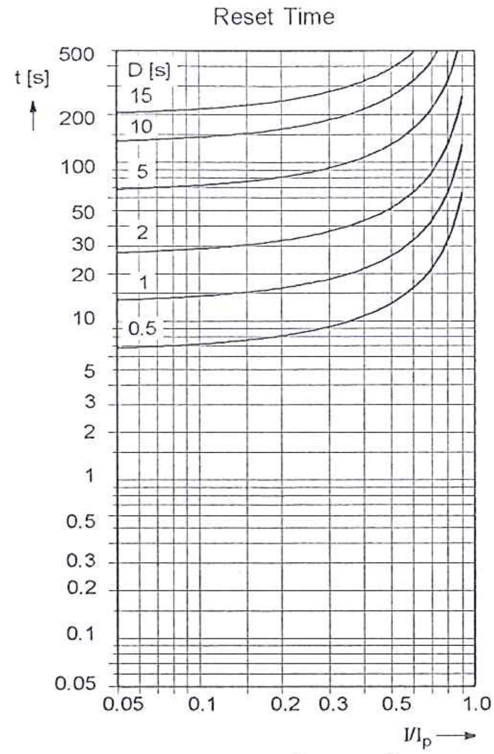



**RESET SHORT INVERSE** $t = \left(\frac{0.831}{(I/I_p)^{1.2969} - 1}\right) \cdot D$ [s]

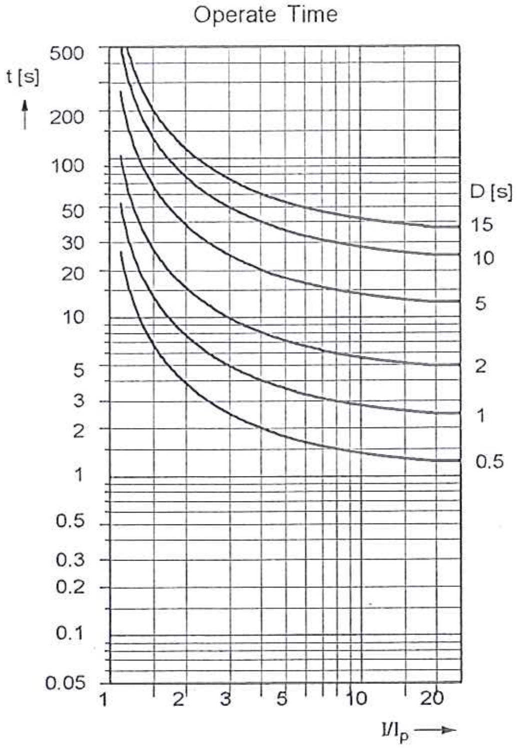



**SHORT INVERSE** $t = \left(\frac{0.2663}{(I/I_p)^{1.2969} - 1} + 0.03393\right) \cdot D$ [s]

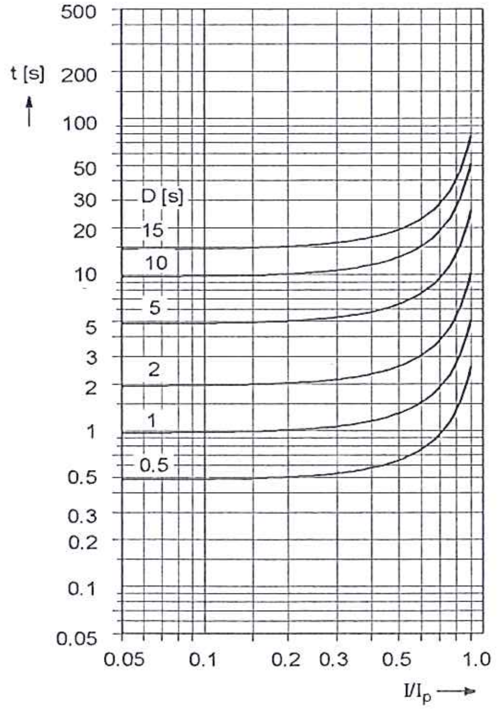
Figure 4-3 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to ANSI/IEEE



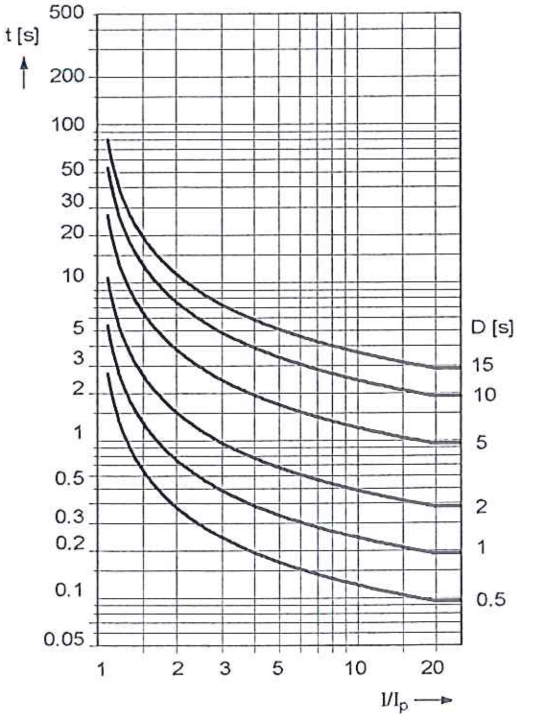

**RESET LONG INVERSE** $t = \left(\dfrac{12.9}{(I/I_p)^1 - 1}\right) \cdot D$ [s]




**LONG INVERSE** $t = \left(\dfrac{5.6143}{(I/I_p) - 1} + 2.18592\right) \cdot D$ [s]

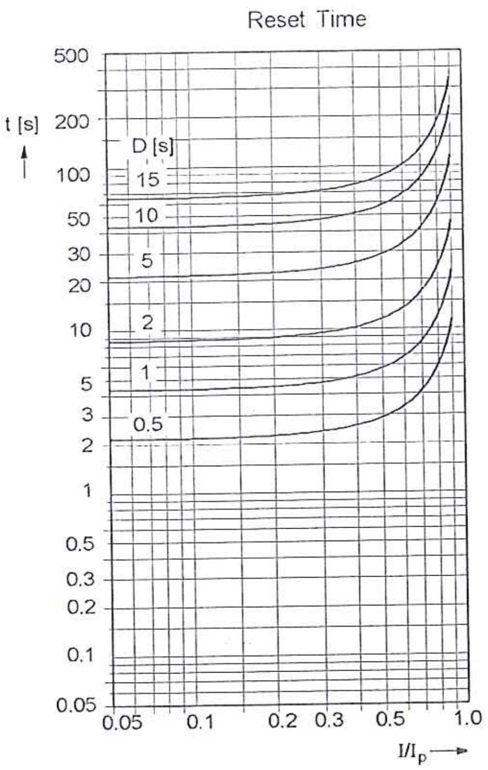



**RESET MODERATELY INVERSE** $t = \left(\dfrac{0.97}{(I/I_p)^2 - 1}\right) \cdot D$ [s]

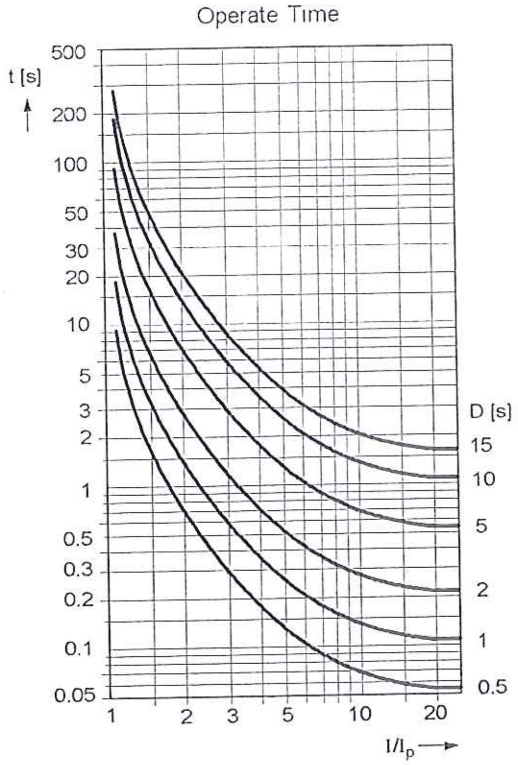



**MODERATELY INVERSE** $t = \left(\dfrac{0.0103}{(I/I_p)^{0.02} - 1} + 0.0228\right) \cdot D$ [s]

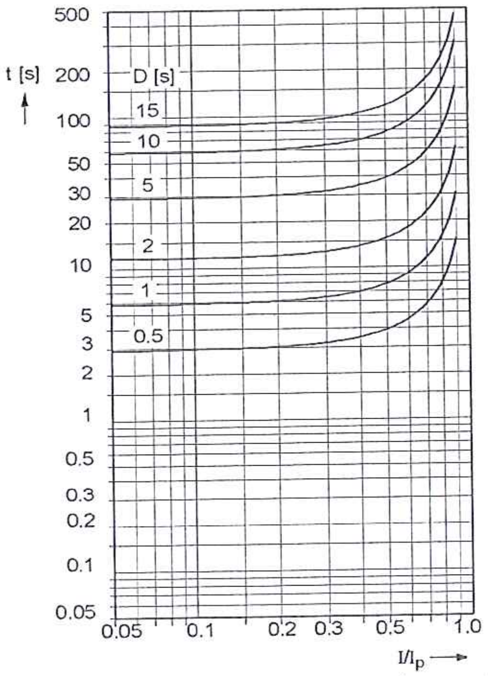
Figure 4-4 Dropout time and trip time curves of the inverse time overcurrent protection, acc. to ANSI/IEEE



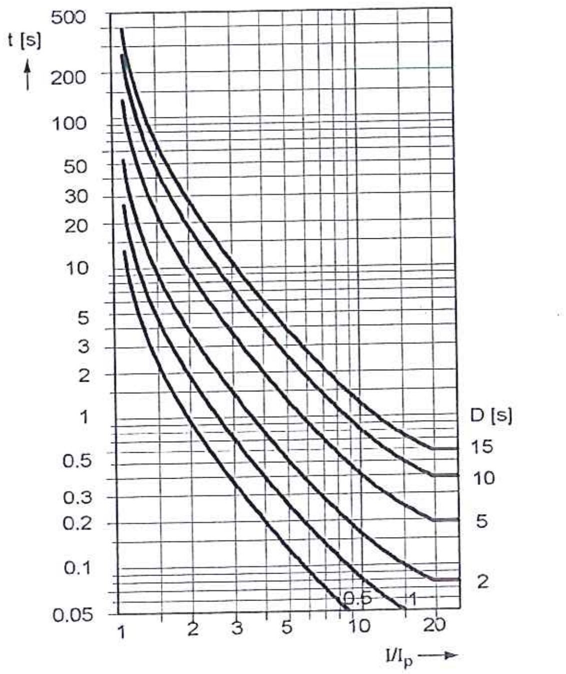

RESET VERY INVERSE $t = \left(\frac{4.32}{(I/I_p)^2 - 1}\right) \cdot D$ [s]




VERY INVERSE $t = \left(\frac{3.922}{(I/I_p)^2 - 1} + 0.0982\right) \cdot D$ [s]

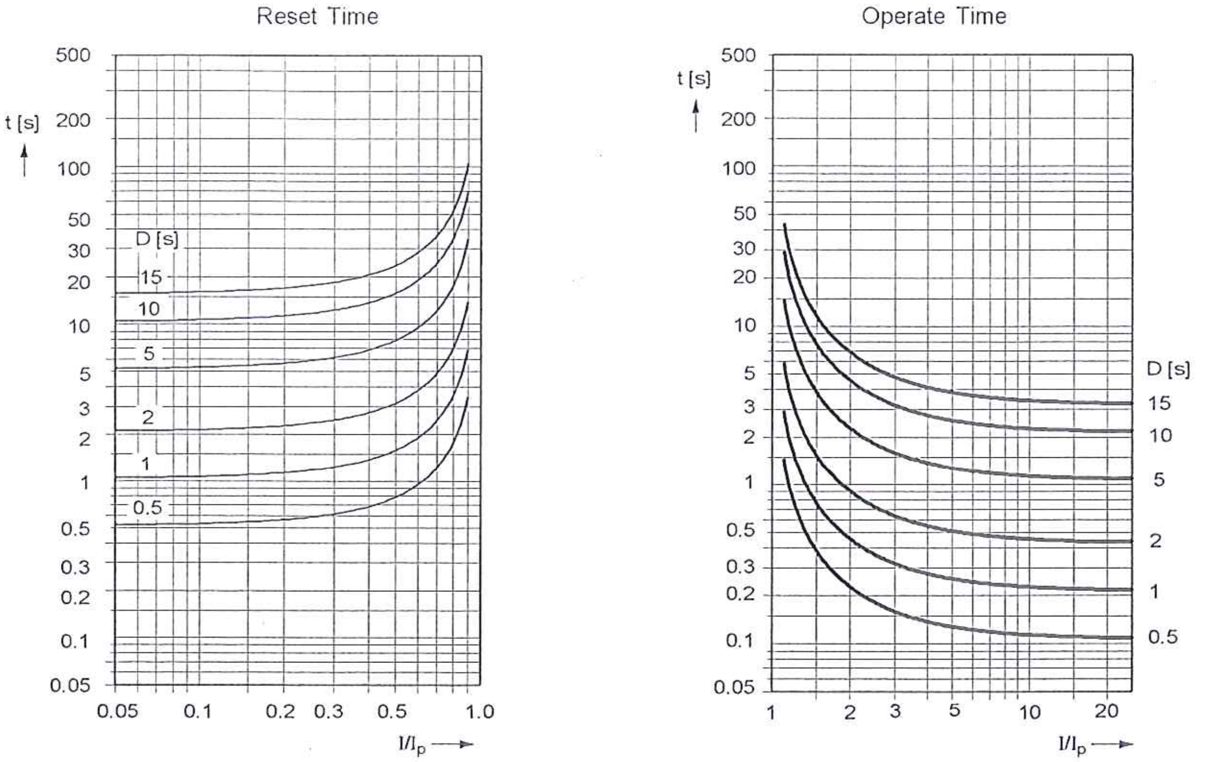



RESET EXTREMELY INVERSE $t = \left(\frac{5.82}{(I/I_p)^2 - 1}\right) \cdot D$ [s]




EXTREMELY INVERSE $t = \left(\frac{5.64}{(I/I_p)^2 - 1} + 0.02434\right) \cdot D$ [s]

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




**RESET DEFINITE INVERSE** $t = \left(\dfrac{1.0394}{(I/I_p)^{1.5625} - 1}\right) \cdot D$ [s]

**DEFINITE INVERSE** $t = \left(\dfrac{0.4797}{(I/I_p)^{1.5625} - 1} + 0.21359\right) \cdot D$ [s]

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

## 4.4 Inrush Restraint

### Controlled Elements

| | |
|---|---|
| Time Overcurrent Elements | 50-1, 50N-1, 51, 51N |

### Setting Ranges / Increments

| | | |
|---|---|---|
| Stabilization factor $I_{2f}/I$ | 10 % to 45 % | Increments 1 % |

### Functional Limits

| | |
|---|---|
| Lower Function Limit<br>Upper Function Limit, Adjustable | At least one phase current ≥ 0.25 · $I_{Nom}$<br>0.30 A to 25.00 A for $I_{Nom}$ = 1 A or<br>1.50 A to 125.00 A for $I_{Nom}$ = 5 A<br>(Increments 0.01 A) |

### Crossblock

| | |
|---|---|
| Crossblock $I_A$, $I_B$, $I_C$ | ON/OFF |

## 4.5 Dynamic Cold Load Pickup Function

### Timed Changeover of Settings

| | |
|---|---|
| Controlled Elements | Time overcurrent protection elements (separate phase and ground settings) |
| Initiation Criteria | Current Criterion 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 time overcurrent protection | |

# 4.6 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 23.00 °F (–5 °C) ≤ $\Theta_{amb}$ ≤ 131.00 °F (55 °C) | 0.5 %/10 K |
| Frequency in range $0.9 \leq f/f_{Nom} \leq 1.1$ | 1 % |
| Harmonics<br>- up to 10 % 3rd harmonic<br>- up to 10 % 5th harmonic | <br>1 %<br>1 % |

## 4.7 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<br>Dropout Times | Approx. 35 ms<br>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 τ > 100 ms (with complete asymmetry) | <5 % |

## 4.8 Negative Sequence Protection 46-TOC

### Setting Ranges / Increments

| | | | |
|---|---|---|---|
| Pickup value 46-TOC | for $I_{Nom}$ = 1 A | 0.10 A to 2.00 A | Increments 0.01 A |
| | for $I_{Nom}$ = 5 A | 0.50 A to 10.00 A | |
| Time Multiplier $T_{I2p}$ (IEC) | | 0.05 s to 3.20 s or ∞ (disabled) | Increments 0.01 s |
| Time Multiplier $D_{I2p}$ (ANSI) | | 0.50 s to 15.00 s or ∞ (disabled) | Increments 0.01 s |

### Functional Limit

| | | |
|---|---|---|
| Functional Limit | for $I_{Nom}$ = 1 A | All phase currents ≤ 4 A |
| | for $I_{Nom}$ = 5 A | All phase currents ≤ 20 A |

### Trip Time Curves acc. to IEC

See also Figure 4-7

NORMAL INVERSE

$$t = \frac{0.14}{(I_2/I_{2p})^{0.02} - 1} \cdot T_{I2p} \quad [s]$$

VERY INVERSE

$$t = \frac{13.5}{(I_2/I_{2p})^{1} - 1} \cdot T_{I2p} \quad [s]$$

EXTREMELY INVERSE

$$t = \frac{80}{(I_2/I_{2p})^{2} - 1} \cdot T_{I2p} \quad [s]$$

Where:

| | |
|---|---|
| $t$ | trip time in seconds |
| $T_{I2p}$ | setting value of the time multiplier |
| $I_2$ | negative sequence currents |
| $I_{2p}$ | setting value of the pickup current |

The trip times for $I_2/I_{2p} \geq 20$ are identical to those for $I_2/I_{2p} = 20$.

| | |
|---|---|
| Pickup Threshold | Approx. $1.10 \cdot I_{2p}$ |

## Trip Time Curves acc. to ANSI

| |
|---|
| It can be selected one of the represented trip time characteristic curves in the figures 4-8 and 4-9 each on the right side of the figure. |

INVERSE

$$t = \left( \frac{8.9341}{(I_2/I_{2p})^{2.0938} - 1} + 0.17966 \right) \cdot D_{I2p} \text{ [s]}$$

MODERATELY INVERSE

$$t = \left( \frac{0.0103}{(I_2/I_{2p})^{0.02} - 1} + 0.0228 \right) \cdot D_{I2p} \text{ [s]}$$

VERY INVERSE

$$t = \left( \frac{3.922}{(I_2/I_{2p})^{2} - 1} + 0.0982 \right) \cdot D_{I2p} \text{ [s]}$$

EXTREMELY INVERSE

$$t = \left( \frac{5.64}{(I_2/I_{2p})^{2} - 1} + 0.02434 \right) \cdot D_{I2p} \text{ [s]}$$

Where:

| | |
|---|---|
| $t$ | trip time in seconds |
| $D_{I2p}$ | setting value of the time multiplier |
| $I_2$ | negative sequence currents |
| $I_{2p}$ | setting value of the pickup current |

The trip times for $I_2/I_{2p} \geq 20$ are identical to those for $I_2/I_{2p} = 20$.

| | |
|---|---|
| Pickup Threshold | Approx. $1.10 \cdot I_{2p}$ |

## Tolerances

| | |
|---|---|
| Pickup Threshold $I_{2p}$ | 3 % of setting value or 10 mA for $I_{Nom} = 1$ A or 50 mA with $I_{Nom} = 5$ A |
| Time for $2 \leq I/I_{2p} \leq 20$ | 5 % of reference (calculated) value + 2 % current tolerance, respectively 30 ms |

### Dropout Time Curves with Disk Emulation acc. to ANSI

| Representation of the possible dropout time curves, see figure 4-8 and 4-9 each on the left side of the figure | |
|---|---|
| ANSI INVERSE | $t_{Reset} = \left(\frac{8.8}{(I_2/I_{2p})^{2.0938} - 1}\right) \cdot D_{I2p}$ [s] |
| ANSI MODERATELY INVERSE | $t_{Reset} = \left(\frac{0.97}{(I_2/I_{2p})^{2} - 1}\right) \cdot D_{I2p}$ [s] |
| ANSI VERY INVERSE | $t_{Reset} = \left(\frac{4.32}{(I_2/I_{2p})^{2} - 1}\right) \cdot D_{I2p}$ [s] |
| ANSI EXTREMELY INVERSE | $t_{Reset} = \left(\frac{5.82}{(I_2/I_{2p})^{2} - 1}\right) \cdot D_{I2p}$ [s] |
| for $0.05 < (I_2/I_{2p}) \leq 0.90$ | Where:<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 $0.05 \leq (I_2/I_{2p}) \leq 0.90$ | |

### Dropout Value

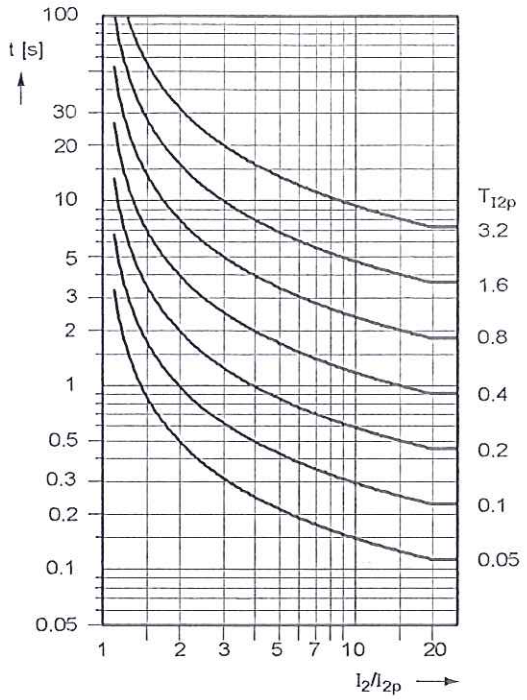
| | |
|---|---|
| IEC and ANSI (without Disk Emulation) | Approx. $1.05 \cdot I_{2p}$ setting value, which is approx. $0.95 \cdot$ pickup threshold $I_2$ |
| ANSI with Disk Emulation | Approx. $0.90 \cdot I_{2p}$ setting value |

### Tolerances

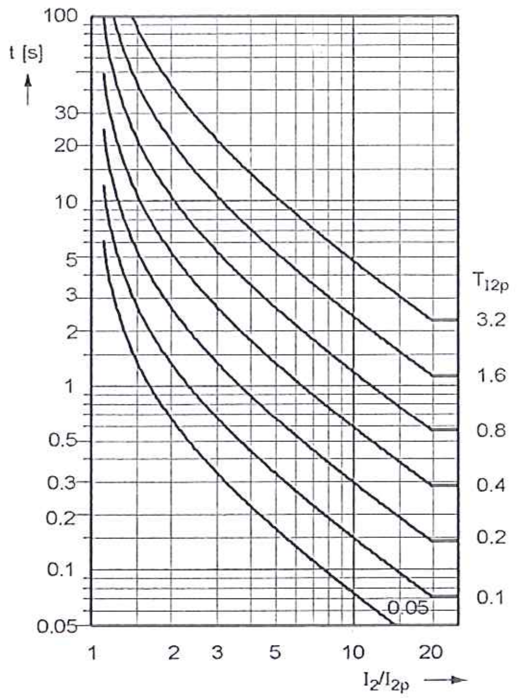
| | |
|---|---|
| Pickup threshold $I_{2p}$ | 2 % of set value or 10 mA for $I_{Nom}$ = 1 A or 50 mA for $I_{Nom}$ = 5 A |
| Time for $0.05 \leq I_2/I_{2p} \leq 0.90$ | 5 % of reference (calculated) value + 2 % current tolerance, respectively 30 ms |

### Influencing Variables for Pickup Values

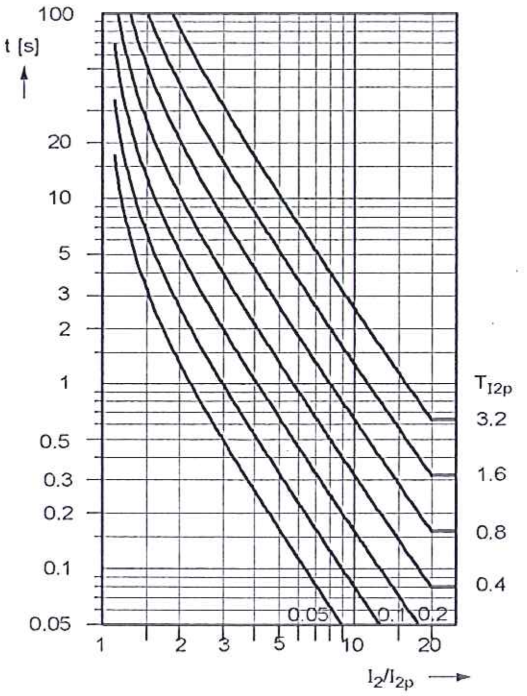
| | |
|---|---|
| Power Supply DC Voltage in Range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$ | 1 % |
| Temperature in range 23 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131 °F (55 °C) | 0.5 %/10 K |
| Frequency in range $0.95 \leq f/f_{Nom} \leq 1.05$ | 1 % |
| Harmonics<br>- Up to 10 % 3rd harmonic<br>- Up to 10 % 5th harmonic | <br>1 %<br>1 % |
| Transient overreach for $\tau$ > 100 ms (with complete asymmetry) | <5 % |




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



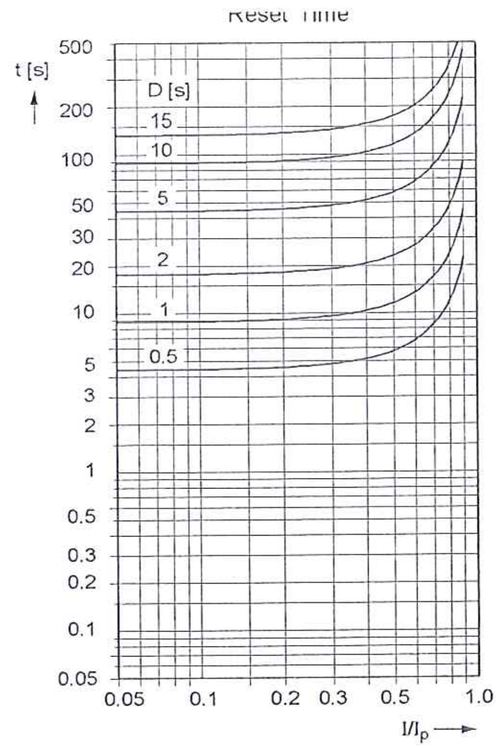

IEC VERY INVERSE: $t = \frac{13.5}{(I_2/I_{2p})^{1} - 1} \cdot T_{I2p}$ [s]



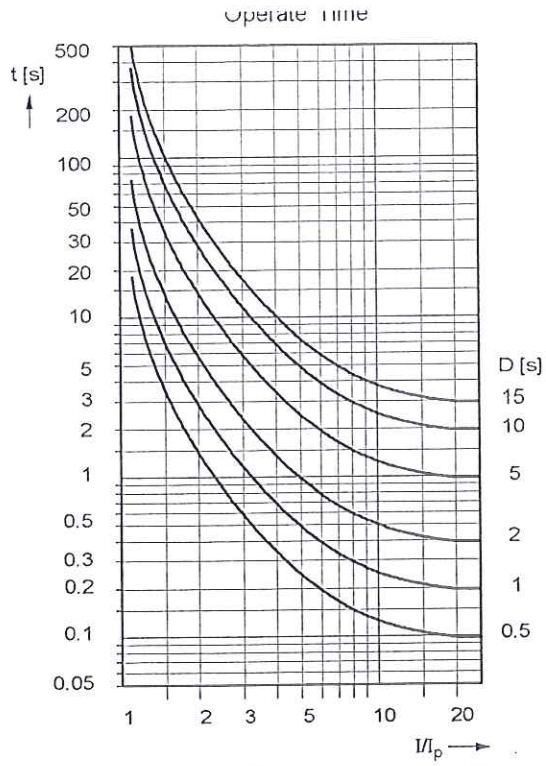

IEC EXTREMELY INVERSE: $t = \frac{80}{(I_2/I_{2p})^{2} - 1} \cdot T_{I2p}$ [s]

t = Trip time in seconds
$T_{I2p}$ = Setting value of the time multiplier
$I_2$ = Negative Sequence Current
$I_{2p}$ = Setting value of the pickup current

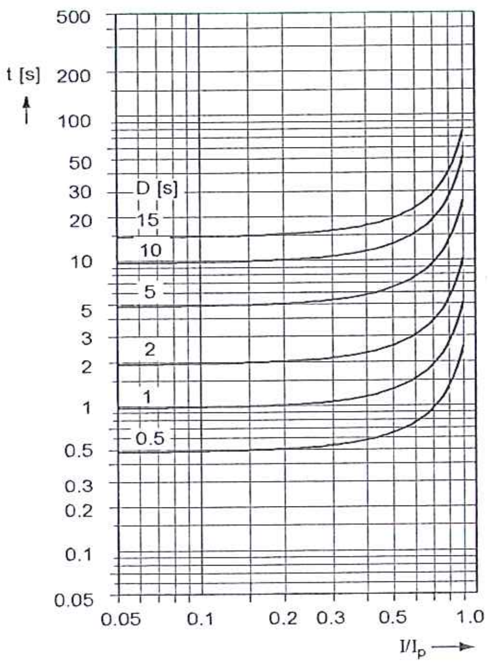
Figure 4-7 Trip time characteristics of the inverse time negative sequence element 46-TOC, acc. to IEC



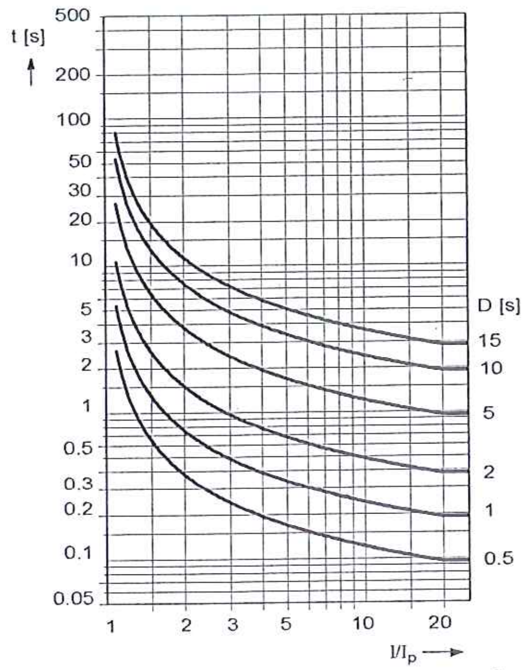

**RESET INVERSE** $t = \left(\dfrac{8.8}{(I/I_p)^{2.0938} - 1}\right) \cdot D$ [s]




**INVERSE** $t = \left(\dfrac{8.9341}{(I/I_p)^{2.0938} - 1} + 0.17966\right) \cdot D$ [s]

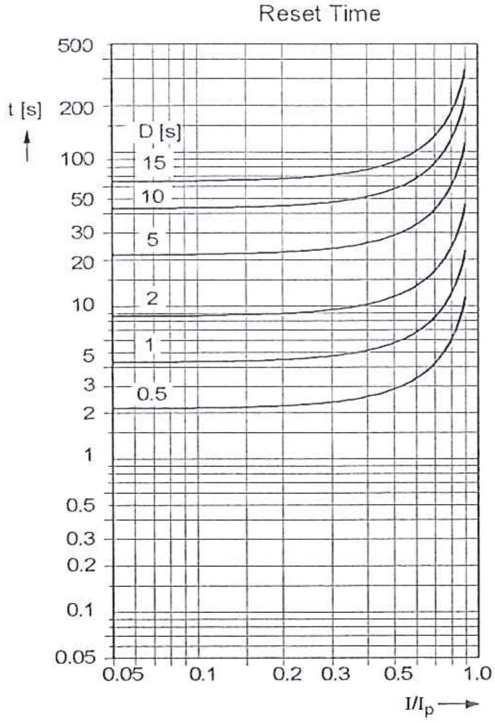



**RESET MODERATELY INVERSE** $t = \left(\dfrac{0.97}{(I/I_p)^{2} - 1}\right) \cdot D$ [s]

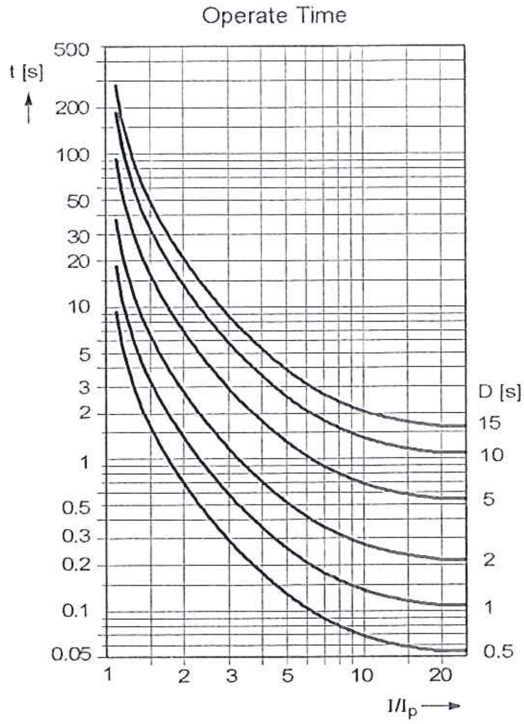



**MODERATELY INVERSE** $t = \left(\dfrac{0.0103}{(I/I_p)^{0.02} - 1} + 0.0228\right) \cdot D$ [s]

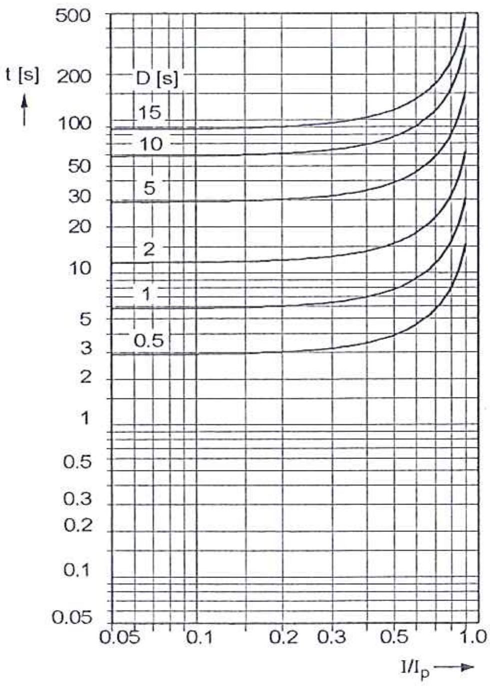
Figure 4-8 Dropout time and trip time characteristics of the inverse time unbalanced load stage, acc. to ANSI



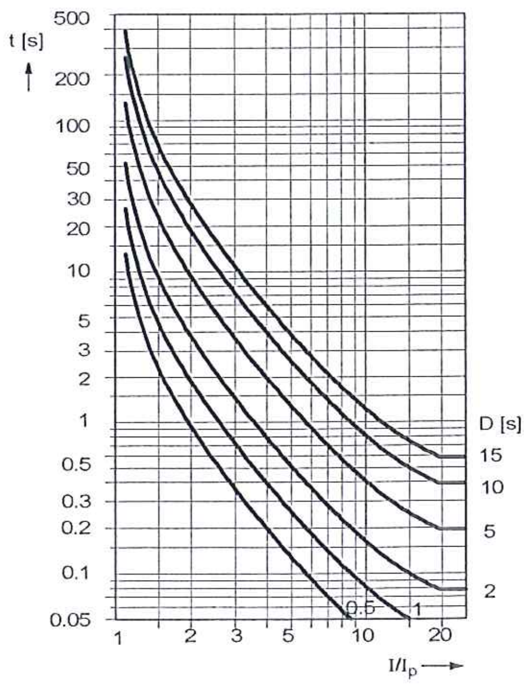

RESET VERY INVERSE $t = \left(\frac{4{,}32}{(I/I_p)^2 - 1}\right) \cdot D$ [s]




VERY INVERSE $t = \left(\frac{3{,}922}{(I/I_p)^2 - 1} + 0{,}0982\right) \cdot D$ [s]




RESET EXTREMELY INVERSE $t = \left(\frac{5{,}82}{(I/I_p)^2 - 1}\right) \cdot D$ [s]




EXTREMELY INVERSE $t = \left(\frac{5{,}64}{(I/I_p)^2 - 1} + 0{,}02434\right) \cdot D$ [s]

Figure 4-9 Dropout time and trip time characteristics of the inverse time unbalanced load stage, acc. to ANSI

## 4.9 Motor Starting Protection 48

### Setting Ranges / Increments

| | | | |
|---|---|---|---|
| Motor Starting Current $I_{STARTUP}$ | for $I_{Nom}$ = 1 A | 0.50 A to 16.00 A | Increments 0.01 A |
| | for $I_{Nom}$ = 5 A | 2.50 A to 80.00 A | |
| Pickup Threshold $I_{MOTOR\ START}$ | for $I_{Nom}$ = 1 A | 0.40 A to 10.0 A | Increments 0.01 A |
| | for $I_{Nom}$ = 5 A | 2.00 A to 50.00 A | |
| Permissible Starting Time $T_{STARTUP}$ | | 1.0 s to 180.0 s | Increments 0.1 s |
| Permissible Blocked Rotor Time $T_{BLOCKED\text{-}ROTOR}$ | | 0.5 s to 120.0 s or ∞ (disabled) | Increments 0.1 s |

### Trip Curve

Trip Time Characteristics for $I_{rms} > I_{MOTOR\ START}$

$$t = \left(\frac{I_{STARTUP}}{I_{rms}}\right)^2 \cdot T_{STARTUP}$$

Where:

| | |
|---|---|
| $I_{STARTUP}$ | Motor starting current setting. |
| $I_{rms}$ | Actual current flowing. |
| $I_{MOTOR\ START}$ | Pickup threshold setting, used to detect motor startup. |
| t | Trip time in seconds. |

### Dropout Ratio

| | |
|---|---|
| Dropout ratio | Approx. 0.95 |

### Tolerances

| | |
|---|---|
| Pickup Threshold | 2 % of set value or 10 mA for $I_{Nom}$ = 1 A or 50 mA for $I_{Nom}$ = 5 A |
| Time Delay | 5 % or 30 ms |

### Influencing Variables

| | |
|---|---|
| Power Supply DC Voltage in Range $0,8 \le V_{PS}/V_{PSNom} \le 1.15$ | 1 % |
| Temperature in range 23.00 °F (–5 °C) ≤ $\Theta_{amb}$ ≤ 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 % |

## 4.10 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

$$\Theta_{Restart} = \left(\frac{I_A}{I_B \cdot k_L}\right)^2 \cdot \left(1 - e^{-\frac{(n_k - 1) \cdot T_{n}}{\tau_L}}\right)$$

| | |
|---|---|
| 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<br>$n_{warm}$ = Max. number of warm starts |

### Influencing Variables

| | |
|---|---|
| Power Supply DC Voltage in Range $0,8 \leq V_{PS}/V_{PSNom} \leq 1.15$ | 1 % |
| Temperature in Range 23 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131 °F (55 °C) | 0.5 %/10 K |
| Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$ | 1 % |
| Frequency out of Range $f_{Nom} \pm 5$ Hz | Increased Tolerances |

# 4.11 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 $(I/k \cdot I_{Nom}) \leq 8$

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

Where:

| | |
|---|---|
| $t$ | Trip time in minutes |
| $\tau$ | Temperature rise time constant |
| $I$ | Load current |
| $\Theta/\Theta_{TRIP}$ | Act. op. temperature/trip temperature |
| $k$ | 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

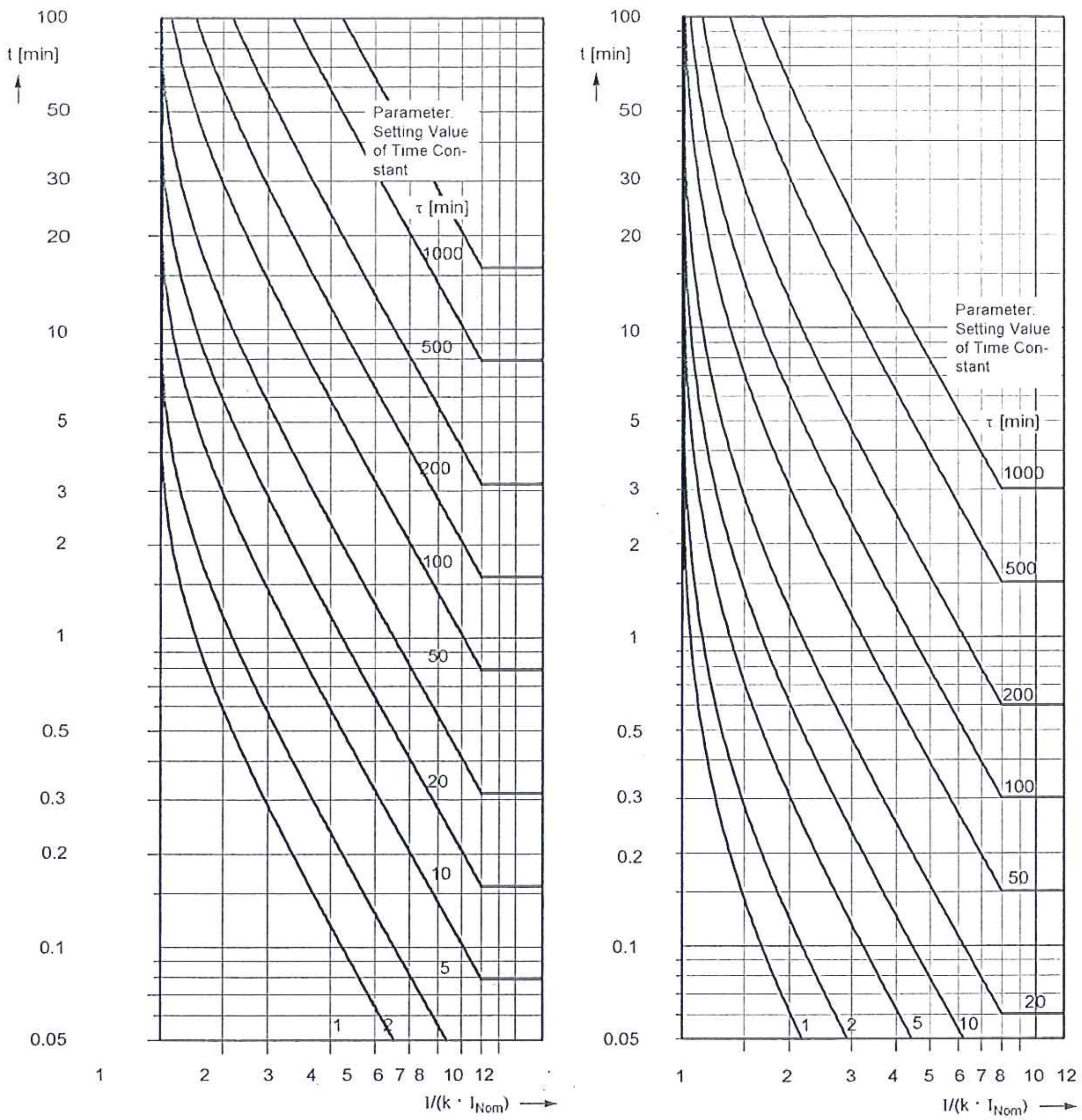
| | |
|---|---|
| $\Theta/\Theta_{Trip}$ | Drops out with $\Theta_{Alarm}$ |
| $\Theta/\Theta_{Alarm}$ | Approx. 0.99 |
| $I/I_{Alarm}$ | Approx. 0.97 |

## Tolerances

| | |
|---|---|
| Referring to $k \cdot I_{Nom}$ | 2 % or 10 mA for $I_{Nom}$ = 1 A, or 50 mA for $I_{Nom}$ = 5 A,<br>2 % class according to IEC 60255-8 |
| Referring to Trip Time | 3 % or 1 s for $I/(k \cdot I_{Nom}) > 1.25$;<br>3 % class according to IEC 60255-8 |

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

| | |
|---|---|
| Power Supply DC Voltage in Range $0.8 \le V_{PS}/V_{PSNom} \le 1.15$ | 1 % |
| Temperature in Range 23 °F (–5 °C) $\le \Theta_{amb} \le$ 131 °F (55 °C) | 0.5 %/10 K |
| Frequency in Range $0.95 \le f/f_{Nom} \le 1.05$ | 1 % |
| Frequency out of Range $f_{Nom}$ ± 5 Hz | Increased Tolerances |




without pre-load:

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

with 90 % pre-load:

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

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

## 4.12 Ground Fault Detection 50N(s), 51N(s)

### Ground Fault Pickup for All Types of Ground Faults (Definite Time Curve)

| | | |
|---|---|---|
| Pickup current 50Ns-2<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 |
| Delay Time $T_{50N-2}$ | 0.00 s to 320.00 s or ∞ (disabled) | Increments 0.01 s |
| Pickup current 50Ns-1<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 |
| Delay Time $T_{50N-1}$ | 0.00 s to 320.00 s or ∞ (disabled) | Increments 0.01 s |
| Dropout delay time 50Ns T DROP-OUT | 0.00 s to 60.00 s | Increments 0.01 s |
| Operating Time | ≤ 60 ms | |
| Dropout ratio | Approx. 0.95 for 50Ns-1 > 50 mA | |
| Measurement Tolerance | 2 % of setting value or 1 mA | |
| Operating Time Tolerance | 1 % of setting value or 20 ms | |

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

| | | |
|---|---|---|
| User-defined Curve (defined by a maximum of 20 value pairs of current and time delay) | | |
| Pickup Current 51Ns<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 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 | 0.003 A to 0.650 A<br>0.05 A to 17.00 A<br>0.25 A to 85.00 A | 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 Times inv. | 5 % ± 15 ms | |
| Tolerances Times def. | 1 % of setting value or 10 ms | |

### Influencing Variables

| | |
|---|---|
| Power Supply DC Voltage in Range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$ | 1 % |
| Temperature in Range 23.00 °F (–5 °C) $\leq \Theta_{amb} \leq$ 131.00 °F (55 °C) | 0.5 %/10 K |
| Frequency in Range $0.95 \leq f/f_{Nom} \leq 1.05$ | 1 % |
| Harmonics<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. | |

### Logarithmic Inverse Trip Time Characteristic

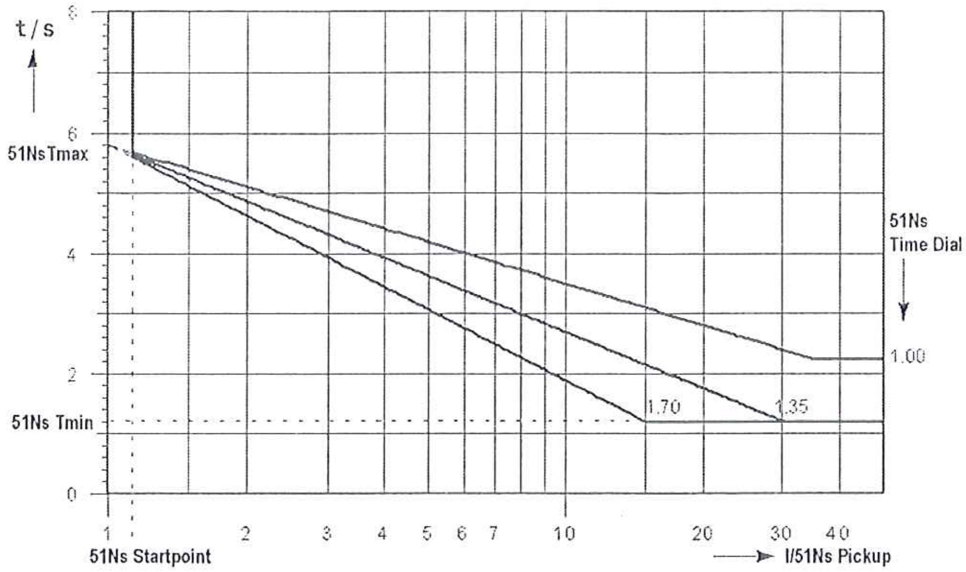



Figure 4-11 Trip time characteristics of inverse time ground fault protection with logarithmic inverse characteristic

Logarithmic inverse t = **51Ns Tmax - 51Ns TIME DIAL** ·ln(I/**51Ns PICKUP**)

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

### Logarithmic Inverse Trip Time Characteristic with knee point

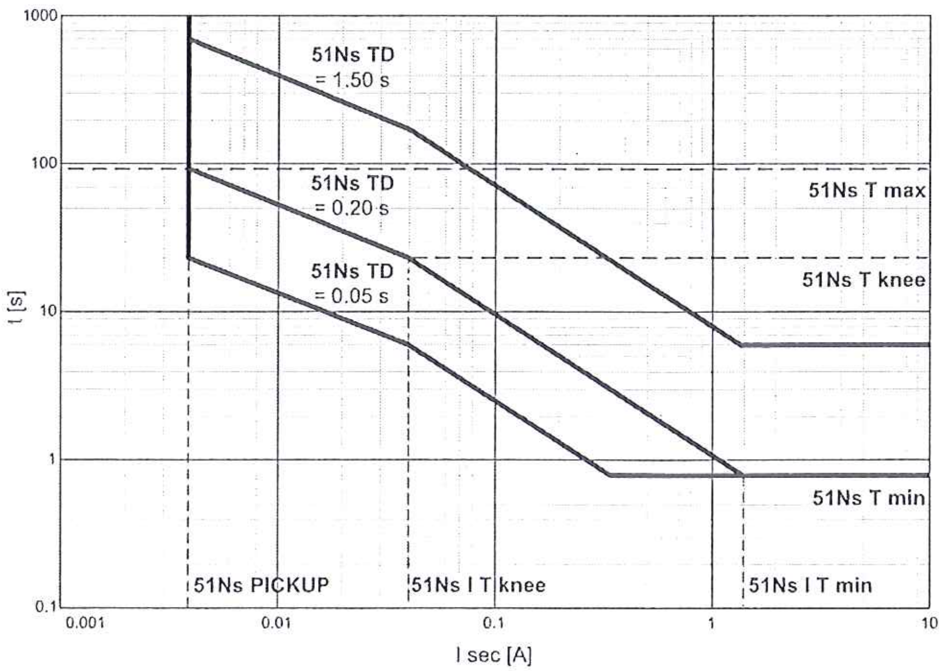



Figure 4-12 Trip-time characteristics of the inverse-time ground fault protection 51Ns with logarithmic inverse characteristic with knee point (example for 51Ns = 0.004 A)

## 4.13 Intermittent Ground Fault Protection

### Setting Ranges / Increments

| | | | |
|---|---|---|---|
| Pickup Threshold | | | |
| with IN | for $I_{Nom}$ = 1 A | 0.05 A to 35.00 A | Increments 0.01 A |
| | for $I_{Nom}$ = 5 A | 0.25 A to 175.00 A | Increments 0.01 A |
| with 3I0 | for $I_{Nom}$ = 1 A | 0.05 A to 35.00 A | Increments 0.01 A |
| | for $I_{Nom}$ = 5 A | 0.25 A to 175.00 A | Increments 0.01 A |
| with INs | | 0.005 A to 1.500 A | Increments 0.001 A |
| Pickup extension time $T_v$ | | 0.00 s to 10.00 s | Increments 0.01 s |
| Ground Fault Accumulation Time $T_{sum}$ | | 0.00 s to 100.00 s | Increments 0.01 s |
| Reset Time for Accumulation $T_{res}$ | | 1 s to 600 s | Increments 1 s |
| Number of Pickups for Intermittent Ground Fault | | 2 to 10 | Increments 1 |

### Times

| | |
|---|---|
| Pickup Times | |
| – Current = 1.25 x Pickup Value | Approx. 30 ms |
| – for ≥ 2 · Pickup Value | Approx. 22 ms |
| Dropout Time (without extension time) | Approx. 22 ms |

### Tolerances

| | |
|---|---|
| Pickup threshold I | 3 % of set value or 10 mA for $I_{Nom}$ = 1 A or 50 mA for $I_{Nom}$ = 5 A |
| Times $T_V$, $T_{sum}$, $T_{res}$ | 1 % of setting value or 10 ms |

### Influencing Variables

| | |
|---|---|
| Power Supply DC Voltage in Range $0.8 \leq V_{PS}/V_{PSNom} \leq 1.15$ | <1 % |
| Temperature in Range $0\ °C \leq \Theta_{amb} \leq 40\ °C$ | <0.5 %/ K |
| Frequency in range $0.98 \leq f/f_N \leq 1.02$ | <5% relating to the set time |

# 4.14 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) | 50-2, 50-1, 51, 50N-2, 50N-1, 51N,<br>Sensitive Ground Fault Protection, 46, Binary Inputs | |
| Blocking of 79 by | Pickup of protective elements for which 79 blocking is set (see above) | |
| | Three phase pickup (optional) | |
| | Binary Input | |
| | Last TRIP command after the reclosing cycles is complete (unsuccessful reclosing) | |
| | CLOSE Command of the breake failure protection | |
| | 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 | 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, 50N-1, 50N-2, 51N | |
| Additional Functions | Lockout (Final Trip)<br>Circuit breaker monitoring using breaker auxiliary contacts | |

## 4.15 Circuit Breaker Failure Protection 50BF

### Setting Ranges / Increments

| | | | |
|---|---|---|---|
| Pickup of Element 50, "BkrClosed I MIN" | for $I_{Nom}$ = 1 A | 0.04 A to 1.00 A | Increments 0.01 A |
| | for $I_{Nom}$ = 5 A | 0.20 A to 5.00 A | |
| Time Delay TRIP-Timer | | 0.06 s to 60.00 s or ∞ | Increments 0.01 s |

### Times

| | |
|---|---|
| Pickup Times | |
| – On Internal Start | included in time delay |
| – Using Controls | included in time delay |
| – For external Start | 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 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 % |

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

## 4.16 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) |

## 4.17 User-defined Functions (CFC)

### Function Modules and Possible Assignments to Task Levels

| Function Module | Explanation | Task Level | | | |
|---|---|---|---|---|---|
| | | MW_ BEARB | PLC1_ BEARB | PLC_ BEARB | SFS_ BEARB |
| ABSVALUE | Magnitude Calculation | X | — | — | — |
| ADD | Addition | X | X | X | X |
| ALARM | Alarm 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 |
| POI_ZW_ST_LNK | — — — | X | X | X | X |
| POO_ZW_ST_LNK | — — — | X | X | X | X |

| Function Module | Explanation | Task Level | | | |
|---|---|---|---|---|---|
| | | MW_ BEARB | PLC1_ BEARB | PLC_ BEARB | SFS_ BEARB |
| REAL_TO_DINT | Adapter | X | X | X | X |
| REAL_TO_INT | Conversion | X | X | X | X |
| 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 inputs of one chart for each task level (number of unequal information items of the left border per task level) | 400 | Only fault annunciation (record in device fault log); here the number of elements of the left border per task level is counted. Since the same information is indicated at the border several times, only unequal information is to be counted. |
| Maximum number of reset-resistant flipflops D_FF_MEMO | 350 | When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up. |

## Device-specific Limits

| Description | Limit | Comments |
|---|---|---|
| Maximum number of synchronous changes of chart inputs per task level | 50 | When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up. |
| Maximum number of chart outputs per task level | 150 | |

## Additional Limits

<table>
<tr><th colspan="4">Additional limits [1)] for the following 4 CFC blocks:</th></tr>
<tr><th>Task Level</th><th colspan="3">Maximum Number of Modules in the Task Levels</th></tr>
<tr><td></td><td>TIMER[2) 3)]</td><td>TIMER_SHORT[2) 3)]</td><td>CMD_CHAIN</td></tr>
<tr><td>MW_BEARB</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>PLC1_BEARB</td><td rowspan="2">15</td><td rowspan="2">30</td><td rowspan="2">20</td></tr>
<tr><td>PLC_BEARB</td></tr>
<tr><td>SFS_BEARB</td><td>—</td><td>—</td><td>—</td></tr>
</table>

1) When the limit is exceeded, 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)] |
|---|---|
| MW_BEARB (Measured Value Processing) | 2536 |
| PLC1_BEARB (Slow PLC processing) | 255 |
| PLC_BEARB (Fast PLC processing) | 130 |
| SFS_BEARB (Interlocking) | 2173 |

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 |
| 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 |

| Individual Element | | Number of TICKS |
|---|---|---|
| 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 |
| 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.

## 4.18 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 $3I_0$ | 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 % $I_{Nom}$ |
| Temperature Overload Protection<br>$\Theta$ /$\Theta_{Trip}$ | in %. |
| Range<br>Tolerance [1] | 0 % to 400 %<br>5% class accuracy per IEC 60255-8 |
| Temperature Restart Inhibit<br>$\Theta_L$ /$\Theta_{L\ Trip}$ | in %. |
| Range<br>Tolerance [1] | 0 % to 400 %<br>5% class accuracy per IEC 60255-8 |
| Restart Threshold<br>$\Theta_{Restart}$/$\Theta_{L\ Trip}$ | in %. |
| Reclose time $T_{Reclose}$ | in min |
| RMS Current Value of Sensitive Ground Fault Detection<br>$I_{Ns}$ | 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 |
| RTD-Box | See section „RTD-Boxes for Temperature Detection" |

[1] At nominal frequency

### Long-Term Averages

| | |
|---|---|
| Time Window | 5, 15, 30 or 60 minutes |
| Frequency of Updates | Adjustable |
| Long-Term Averages<br>$I_{Admd}$; $I_{Bdmd}$; $I_{Cdmd}$; $I_{1dmd}$ | in A; kA |

### Min / Max Report

| | |
|---|---|
| Report 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>Using communication |
| Min/Max Values | $I_A$; $I_B$; $I_C$;<br>$I_1$ (positive sequence component) |

| | |
|---|---|
| Min/Max Values of the Overload Protection | $\Theta/\Theta_{Trip}$ |
| Min/Max Values of Averages | $I_{Admd}$; $I_{Bdmd}$; $I_{Cdmd}$;<br>$I_{1dmd}$ (positive sequence component); |

## Local Measured Values Monitoring

| | |
|---|---|
| Current Asymmetry | $I_{max}/I_{min}$ > balance factor, for $I > I_{balance\ limit}$ |
| Current Sum | $\mid i_A + i_B + i_C + k_I \cdot i_N \mid$ > limit value, with<br>$k_I = \frac{\text{Ignd-CT PRIM / Ignd-CT SEC}}{\text{CT PRIMARY / CT SECONDARY}}$ |
| Current Phase Sequence | Clockwise (ABC) / counter-clockwise (ACB) |
| Limit Value Monitorings | $I_A$ > 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 $I_L$< |

## Fault messages (Trip Log)

| |
|---|
| Recording of indications of the last 8 power system 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 by buffer battery also through auxiliary voltage failure | |
| Memory time | Total 5 s<br>of pre-fault and post-fault recording and memory time adjustable |
| Scanning rate with 50 Hz<br>Scanning rate with 60 Hz | 1 sample/1.25 ms each<br>1 sample/1.04 ms each |

## Statistics

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

## Operating Hours Counter

| | |
|---|---|
| Display Range | Up to 7 digits |
| Criterion | Overshoot of an adjustable current threshold (element 50-1, BkrClosed I MIN) |

## Circuit-Breaker Maintenance

| | |
|---|---|
| Calculation methods | with rms values: $I$, $I^x$, 2P |
| 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) |

### 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)

The communication service GOOSE of IEC 61850 is qualified for switchgear interlocking. Since the transmission time of GOOSE messages in the 7SJ61 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.

## 4.19 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) |

# 4.20 Dimensions

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

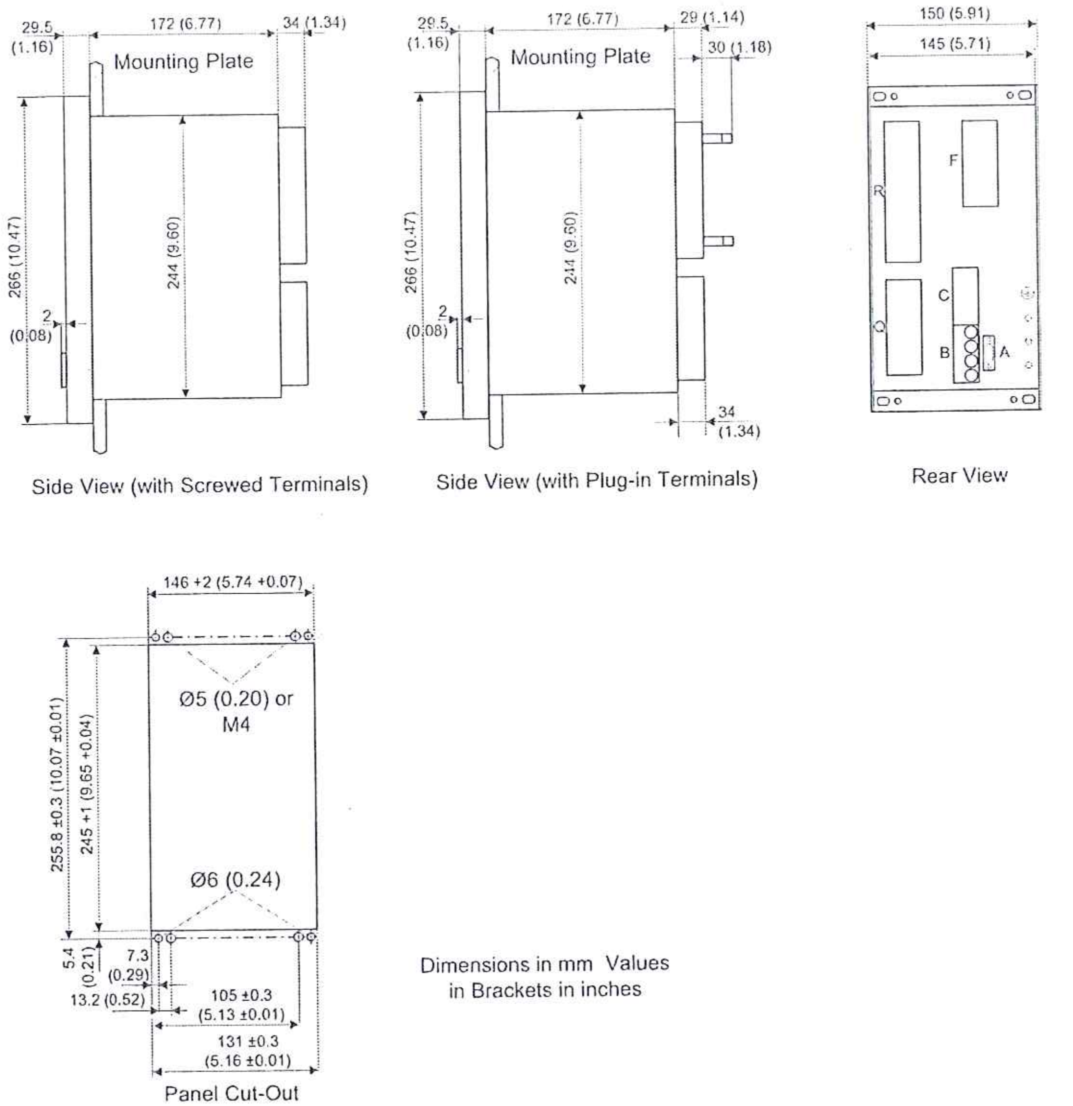



Figure 4-13 Dimensional drawing of a 7SJ61 for panel flush and cubicle mounting (housing size $^1/_3$)

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

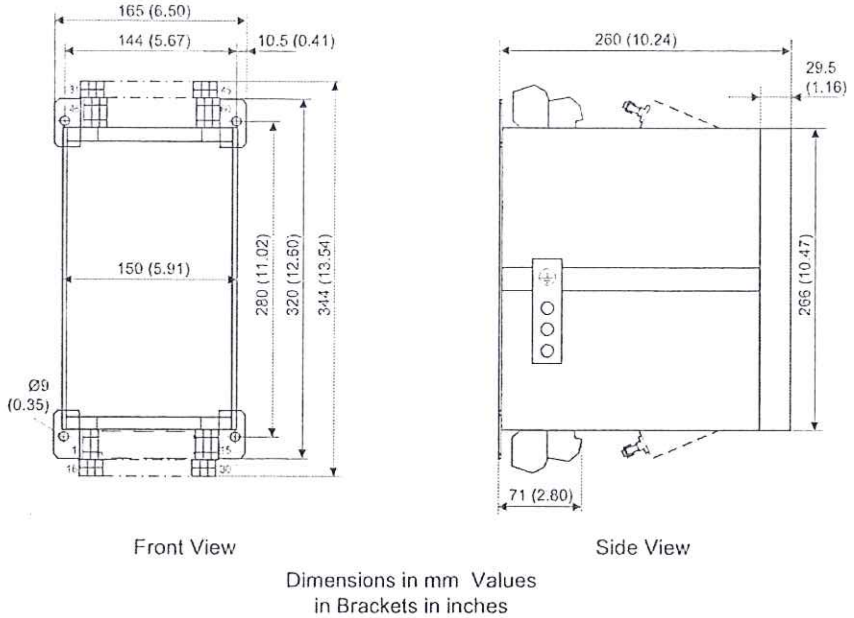



Figure 4-14 Dimensional drawing of a 7SJ61 for panel flush mounting (housing size $^1/_3$)

■

# Appendix A

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

# A.1 Ordering Information and Accessories

## A.1.1 Ordering Information

### A.1.1.1 7SJ61 V4.6

| Multi-Functional Protection with Control | | | | | | 6 | 7 | | 8 | 9 | 10 | 11 | 12 | | 13 | 14 | 15 | 16 | | Supplementary |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 | S | J | 6 | 1 | ☐ | ☐ | – | ☐ | ☐ | ☐ | ☐ | ☐ | – | ☐ | ☐ | ☐ | ☐ | + | ☐ ☐ ☐ |

| Number of Binary Inputs and Outputs | Position 6 |
|---|---|
| 3 Binary Inputs, 4 Binary Outputs, 1 Live Status Contact | 0 |
| 8 Binary Inputs, 8 Binary Outputs, 1 Live Status Contact | 1 |
| 11 Binary Inputs, 6 Binary Outputs, 1 Live Status Contact | 2 |

| Nominal current | Position 7 |
|---|---|
| $I_{ph}$ = 1 A, $I_N$ = 1 A (min. = 0.05 A); 15th position only with A | 1 |
| $I_{ph}$ = 1 A, $I_N$ = sensitive (min. = 0.001 A); 15th position only with B | 2 |
| $I_{ph}$ = 5 A, $I_N$ = 5 A (min. = 0.25 A); 15th position only with A | 5 |
| $I_{ph}$ = 5 A, $I_N$ = sensitive (min. = 0.001 A); 15th position only with B | 6 |
| $I_{ph}$ = 5 A, $I_N$ = 1 A (min. = 0.05 A); 15th position only with A | 7 |

| Auxiliary Voltage (Power Supply, Pickup Threshold of Binary Inputs) | Position 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 | Position 9 |
|---|---|
| Surface-mounting case for panel, 2 tier terminals top/bottom | B |
| Flush mounting case, plug-in terminals (2/3-pole connector) | D |
| Flush mounting case, screw-type terminals (direct connection / ring and spade lugs) | E |

| Region-specific default / language settings and function versions | Position 10 |
|---|---|
| Region DE, 50 Hz, IEC, German Language (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) | Position 11 |
|---|---|
| No system interface | 0 |
| IEC-Protocol, electrical RS232 | 1 |
| 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 | 9 |

| Additional information to further system interfaces (device rear, port B) | Supple-mentary |
|---|---|
| PROFIBUS DP Slave, RS 485 | + L 0 A |
| Profibus DP Slave, 820 nm, Optical Double Ring, ST–Connector [1] | + L 0 B [1] |
| Modbus RS 485 | + L 0 D |
| Modbus, 820 nm, Optical, ST–Connector [2] | + L 0 E [2] |
| DNP3.0, RS 485 | + L 0 G |
| DNP3.0, 820 nm, Optical, ST–Connector [2] | + L 0 H [2] |
| IEC 61850, Ethernet electrical, double, RSJ45-Connector (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 (RS 485) 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 V DC. If the available operating voltage is > 24 V DC the additional power supply 7XV5810–0BA00 is required.

| DIGSI/Modem Interface (Rear Side, Port C) | Position 12 |
|---|---|
| No DIGSI interface at the back | 0 |
| DIGSI/Modem, electrical RS232 | 1 |
| DIGSI/Modem/RTD-Box [1], electrical RS485 | 2 |
| DIGSI/Modem/RDS 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 | Position 13 |
|---|---|
| With fault recording | 1 |
| With fault recording, average values, min/max values | 3 |

| Functions | | | Position 14 and 15 |
|---|---|---|---|
| Description | 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 | Ground fault protection via SGFD 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 | |
| | 50BF | 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 | |
| IEF | — | Intermittent ground fault | P A |
| SGFD | 50Ns/51Ns<br>87N | Sensitive ground fault detection<br>High-impedance ground fault differential protection | F B [1] |
| SGFD IEF | 50Ns/51Ns<br>87N<br>— | Sens. ground fault detection<br>High-impedance ground fault differential protection<br>Intermittent ground fault | P B [1] |
| SGFD IEF Motor | 50Ns/51Ns<br>87N<br>48/14<br>66/86<br>— | Sens. ground fault detection<br>High-impedance ground fault differential protection<br>Motor starting supervision, locked rotor<br>Restart inhibit<br>Intermittent ground fault | R B [1] |
| SGFD Motor | 50Ns/51Ns<br>87N<br>48/14<br>66/86 | Sens. ground fault detection<br>High-impedance ground fault differential protection<br>Motor starting supervision, locked rotor<br>Restart inhibit | H B [1] |
| Motor | 48/14<br>66/86 | Motor starting supervision, locked rotor<br>Restart inhibit | H A |
| SGFD = Sensitive ground fault detection<br>IEF = Intermittent ground (earth) fault protection<br>Motor = Motor 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) | | | Position 16 |
|---|---|---|---|
| | | Without 79 | 0 |
| | 79 | With 79 | 1 |

| Special model | Supplementary |
|---|---|
| with ATEX 100 approval (for the protection of explosion-protected motors of protection type increased safety "e"[1]) | +Z X 9 9[1]) |

1) when ordering ATEX 100, the device will be delivered in version V4.4

## A.1.2 Accessories

**Exchangeable interface modules**

| Name | Order No. |
|---|---|
| RS232 | C53207-A351-D641-1 |
| RS485 | C73207-A351-D642-1 |
| FO 820 nm | C53207-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 RS485 | C53207-A351-D631-3 |
| DNP 3.0 820 nm | C53207-A351-D633-3 |
| 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/Fiber Optic Converter**

| RS485/Fiber Optic Converter | Order No. |
|---|---|
| 820 nm; FC–Connector | 7XV5650–0AA00 |
| 820 nm, with ST–Connector | 7XV5650–0BA00 |

**Cover Caps**

| Terminal Block Covering Cap for Block Type | Order No. |
|---|---|
| 18-pole voltage terminal, 12-pole current terminal | C73334-A1-C31-1 |
| Current connections,12 terminal, or 8 terminal | C73334-A1-C32-1 |

**Short-Circuit Links**

| Short circuit jumpers for terminal type | Order No. |
|---|---|
| Voltage terminal, 18-pole terminal, or 12-pole terminal | C73334-A1-C34-1 |
| Current connections (12 terminal or 8 terminal) | C73334-A1-C33-1 |

**Female Plugs**

| Connector Type | Order No. |
|---|---|
| 2-pole | C73334-A1-C35-1 |
| 3-pole | 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 and SIPROTEC device | Order No. |
|---|---|
| Cable with 9-pole male/female connector | 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 optional 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 distance 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 computers; 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 |

# A.2 Terminal Assignments

## A.2.1 Housing for Panel Flush and Cubicle Mounting

### 7SJ610*-*D/E

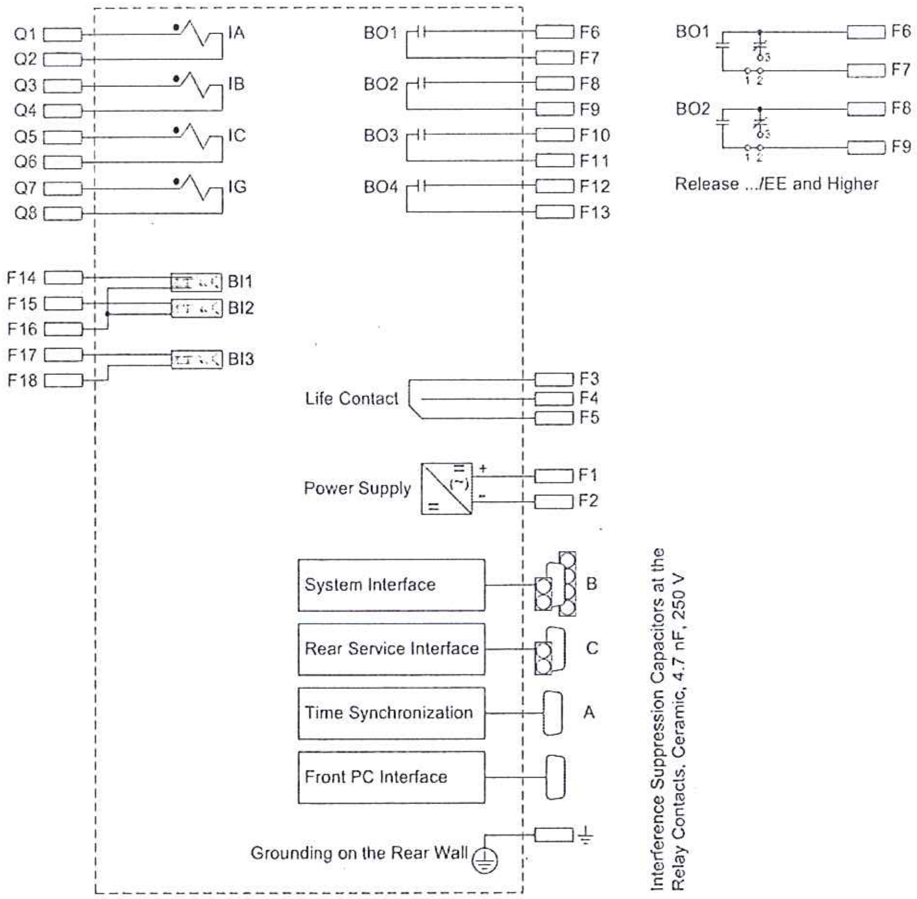



Figure A-1 Connection diagram for 7SJ610*–*D/E (panel flush mounted or cubicle mounted)

7SJ611*-*D/E

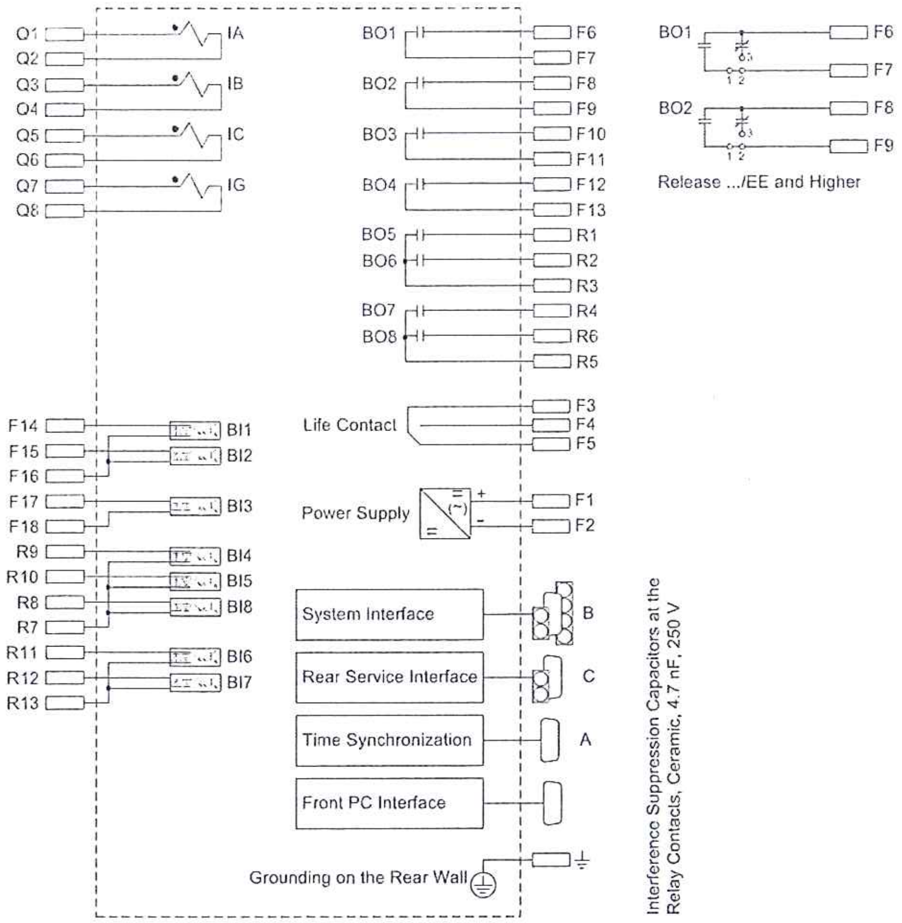



Figure A-2 Connection diagram for 7SJ611*–*D/E (panel flush mounted or cubicle mounted)

## 7SJ612*-*D/E

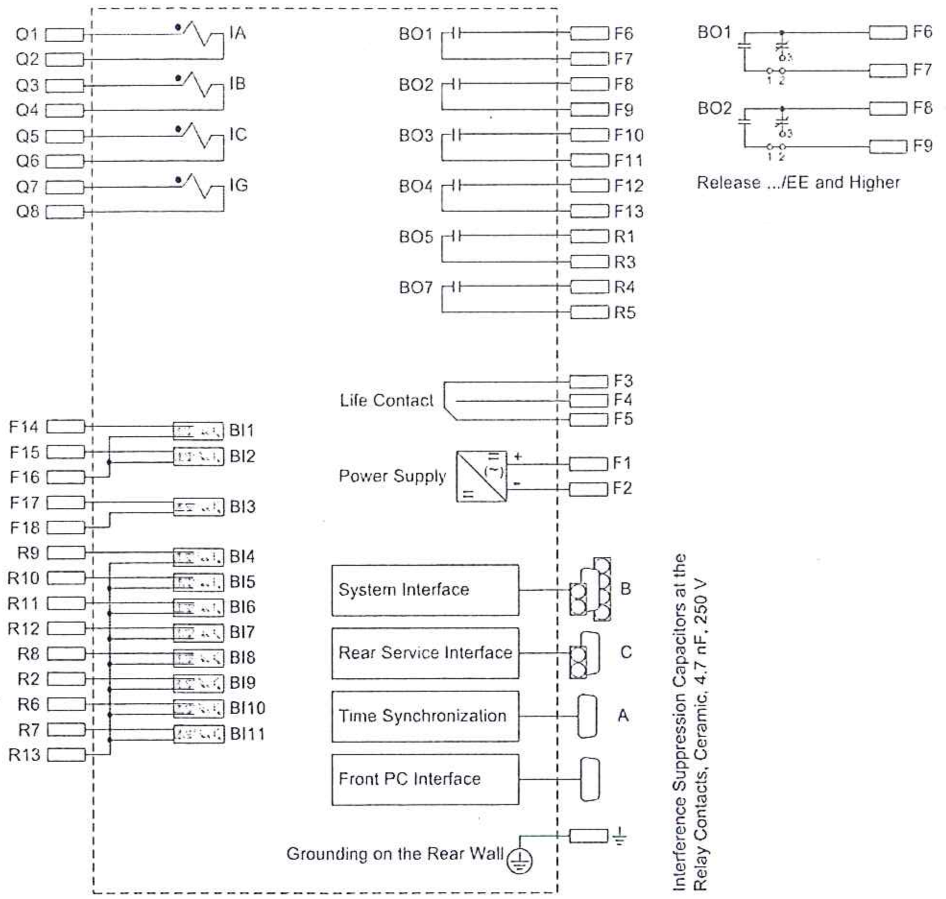



Figure A-3 Connection diagram for 7SJ612*–*D/E (panel flush mounted or cubicle mounted)

Double command to BA5 / BA7 Double commands cannot be directly allocated to BA5 / BA7. If these outputs are used for the setting of a double command, it requires the division into two single commands via a CFC.

## A.2.2 Housing for Panel Surface Mounting

7SJ610*-*B

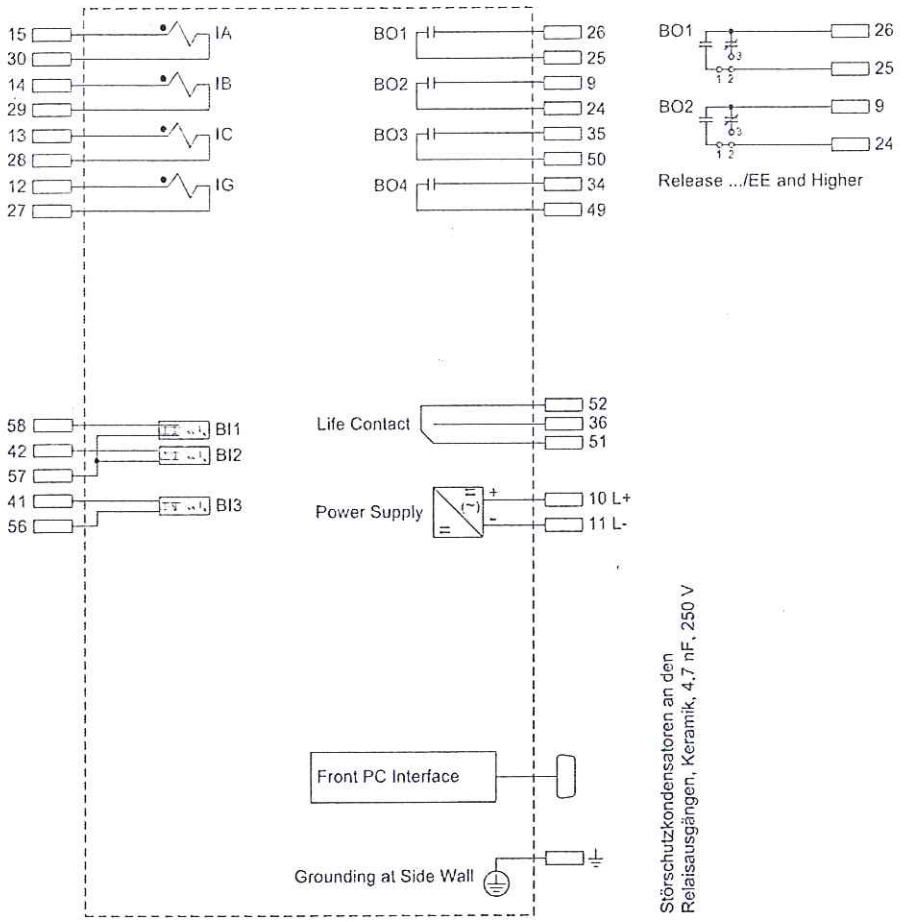



Figure A-4 Connection diagram for 7SJ610*–*B (panel surface mounted)

## 7SJ611*-*B

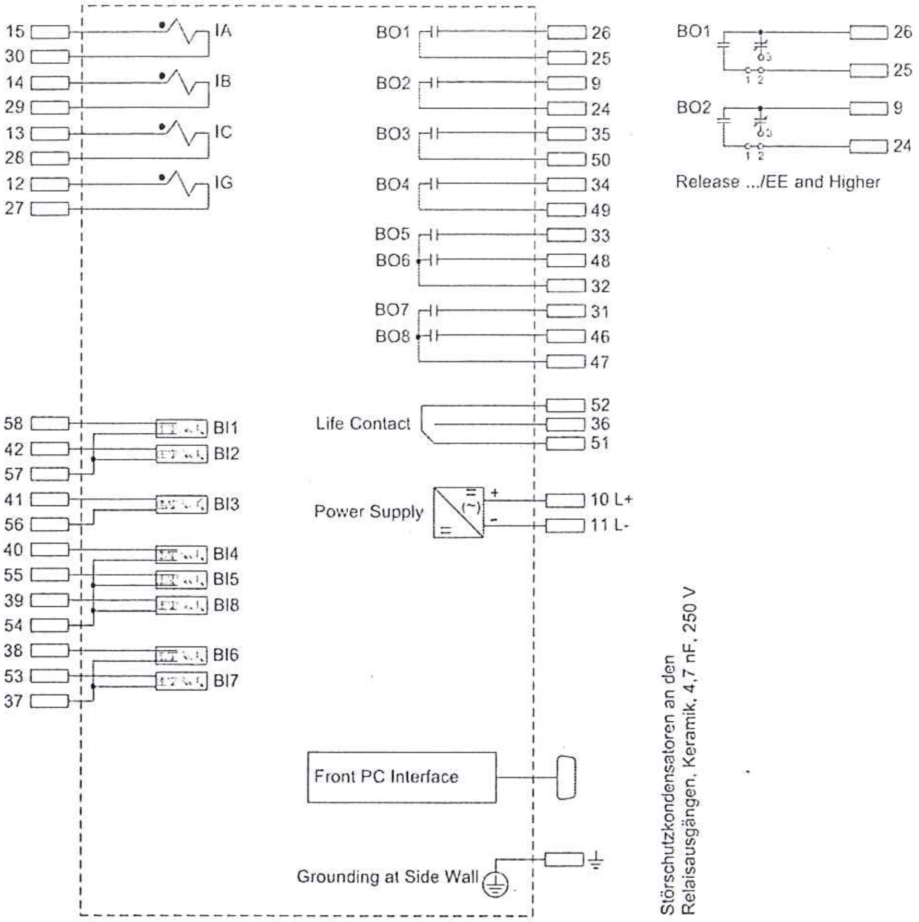



Figure A-5 Connection diagram for 7SJ611*–*B (panel surface mounted)

## 7SJ612*-*B

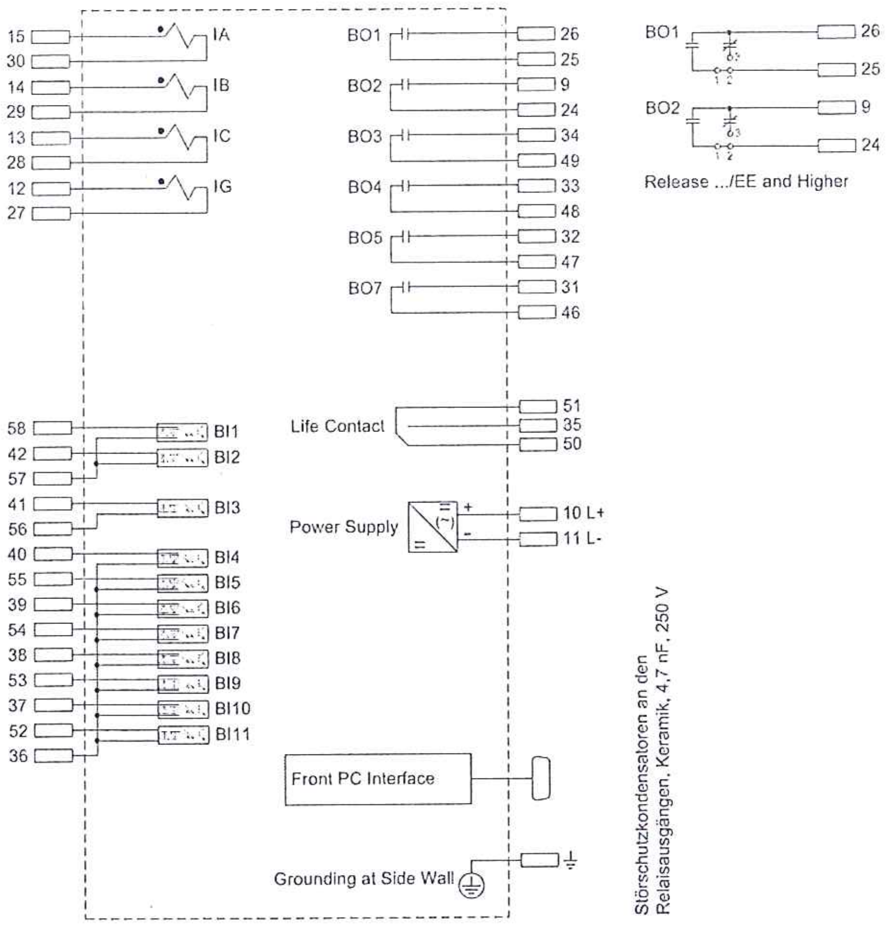



Figure A-6 Connection diagram for 7SJ612*–*B (panel surface mounted)

Double command to BA5 / BA7 Doppelbefehle lassen sich nicht direkt auf BA5 / BA7 rangieren. If these outputs are used for the setting of a double command, it requires the division into two single commands via a CFC.

## A.2.3 Terminal Assignment on Housing for Panel Surface Mounting

7SJ610/1/2*-*B (up to release /CC)

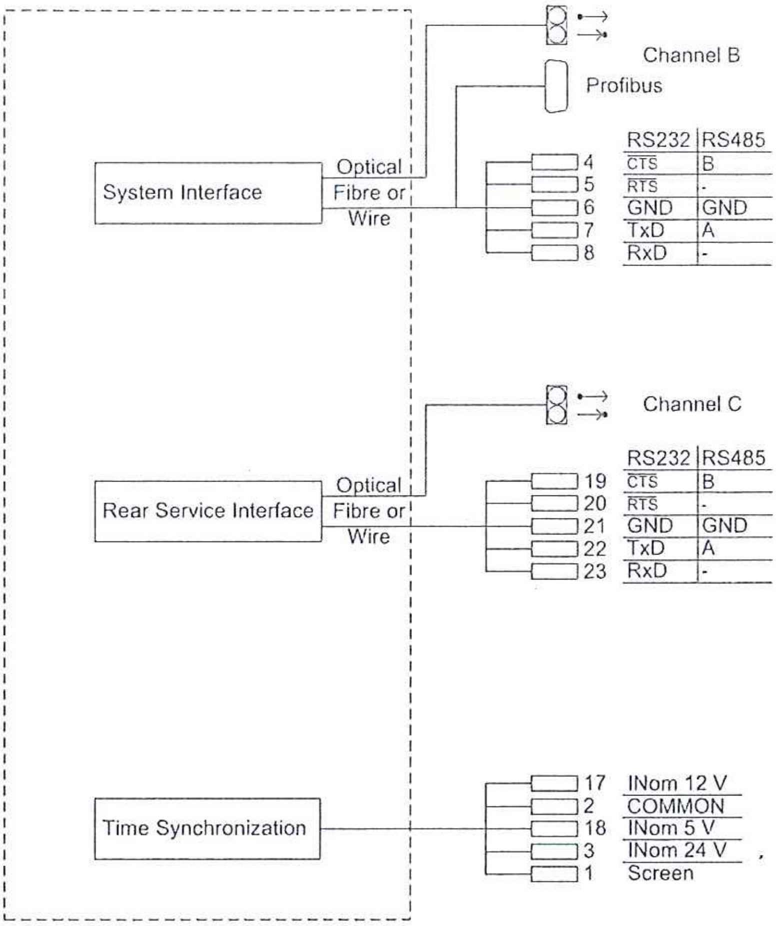



Figure A-7 Connection diagram for 7SJ610/1/2*–*B up to release ... /CC (panel surface mounted)

**7SJ610/1/2*-*B (up to release /DD)**

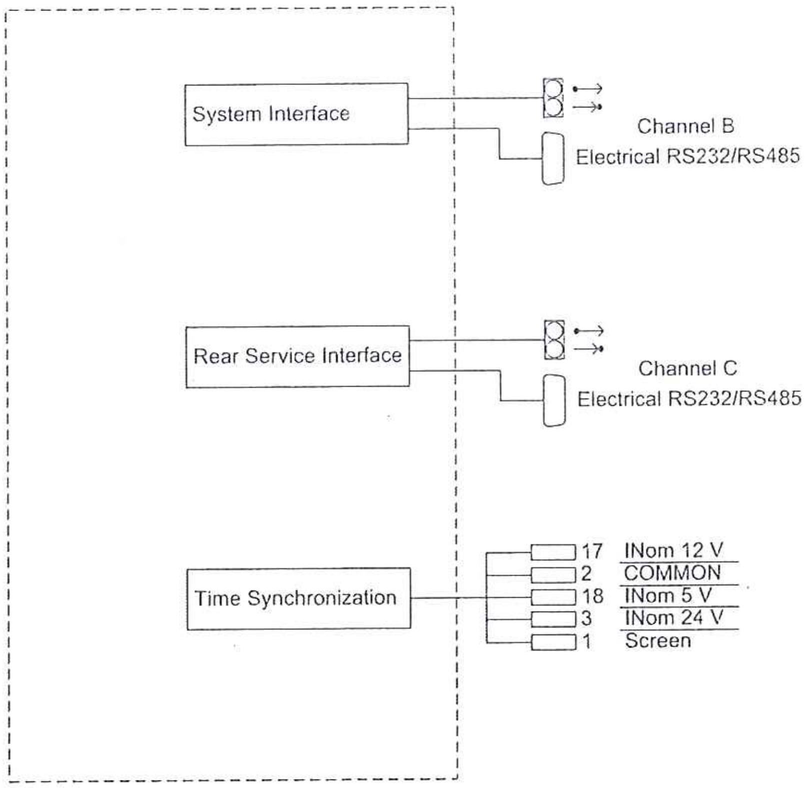



Figure A-8 Connection diagram for 7SJ610/1/2*–*B, release ... /DD and higher (panel surface mounted)

## A.2.4 Connector Assignment

**On the Interfaces**

| | RS232 | RS485 | Profibus FMS Slave, RS485 Profibus DP Slave, RS485 | Modbus, RS485 DNP3.0, RS485 | Ethernet RS232 |
|---|---|---|---|---|---|
| 1 | Shield (electrically connected with shield end) | | | | Tx+ |
| 2 | RxD | — | — | — | Tx- |
| 3 | TxD | A/A' (RxD/TxD-N) | B/B' (RxD/TxD-P) | A | Rx+ |
| 4 | — | — | CNTR-A (TTL) | RTS (TTL level) | — |
| 5 | GND | C/C' (GND) | C/C' (GND) | GND1 | — |
| 6 | — | — | +5 V (max. load <100 mA) | VCC1 | Rx- |
| 7 | RTS | —*) | — | — | — |
| 8 | CTS | B/B' (RxD/TxD-P) | A/A' (RxD/TxD-N) | B | — |
| 9 | — | — | — | — | |

*) Pin 7 also carries the RTS signal with RS232 level when operated as RS485 interface.
Pin 7 must therefore not be connected!

**On the Time Synchronization Interface**

| Pin no. | Designation | Signal Meaning |
|---|---|---|
| 1 | P24_TSIG | Input 24 V |
| 2 | P5_TSIG | Input 5 V |
| 3 | M_TSIG | Return Line |
| 4 | —*) | —*) |
| 5 | Screen | Screen Potential |
| 6 | — | — |
| 7 | P12_TSIG | Input 12 V |
| 8 | P_TSYNC*) | Input 24 V*) |
| 9 | Screen | Screen Potential |

*) assigned, but not available

# A.3 Connection Examples

## A.3.1 Current Transformer Connection Examples

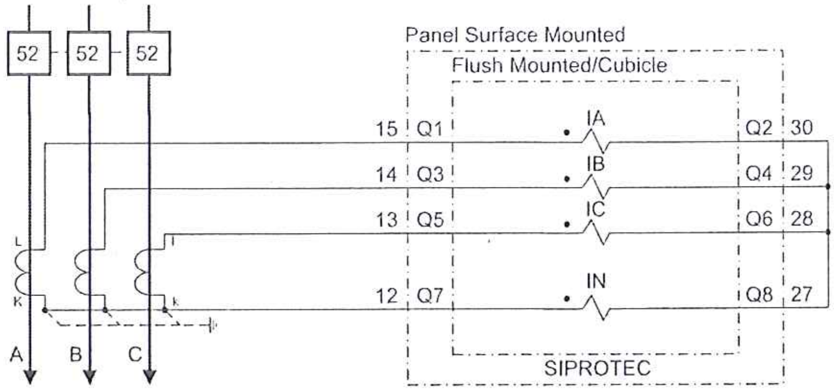



Figure A-9 Current connections to three current transformers with a starpoint connection for ground current (Grounded-Wye connection with residual 3I0 neutral current), normal circuit layout – appropriate for all networks

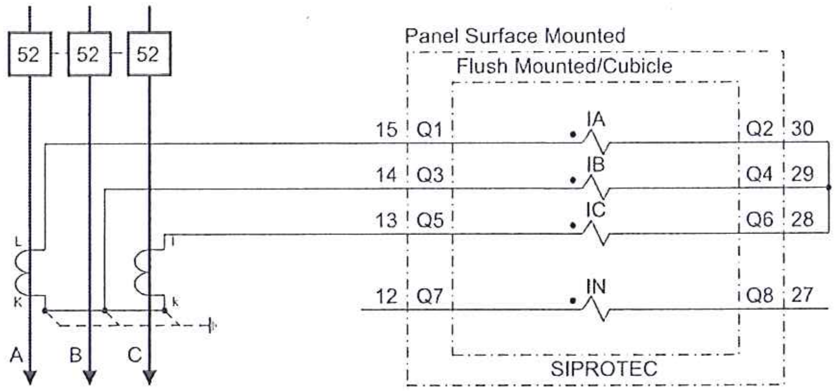
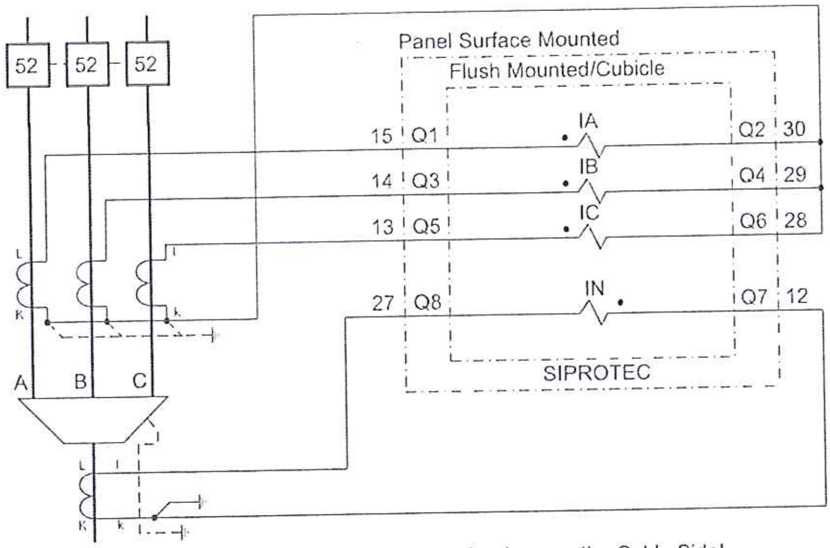
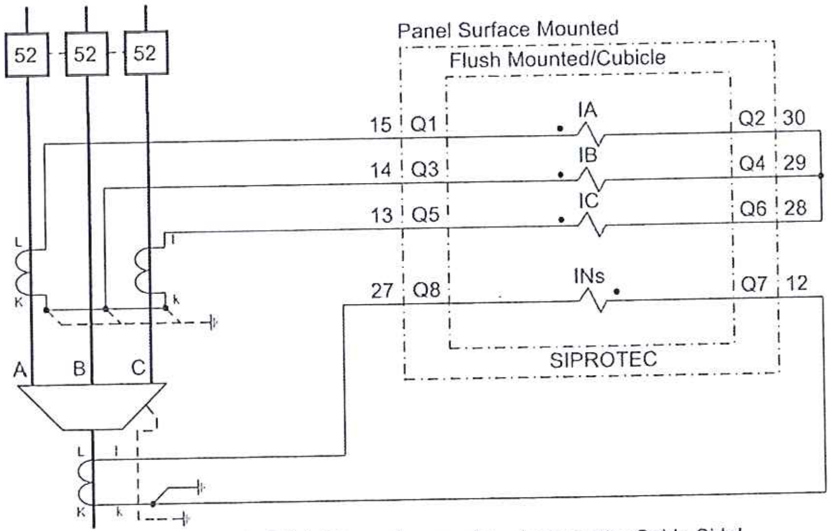



Figure A-10 Current connections to two current transformers - only for ungrounded or compensated networks



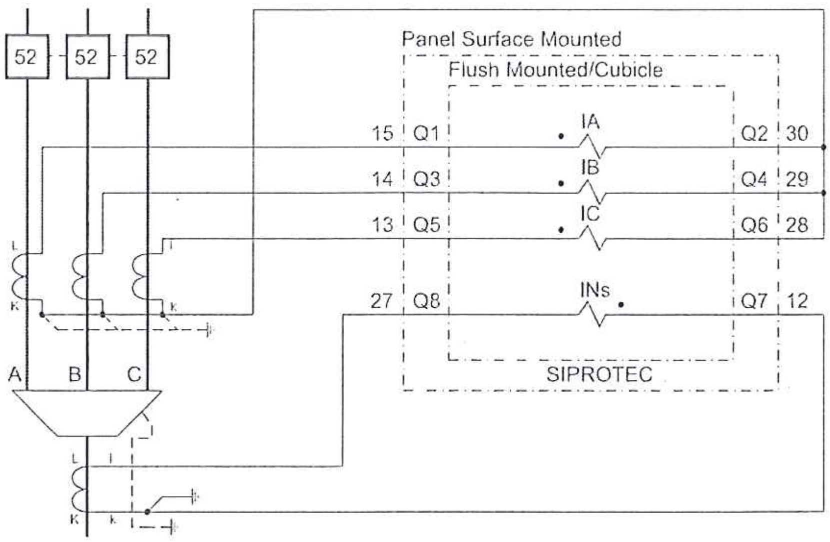

**Important!** Cable Shield Grounding must be done on the Cable Side!
Note: Change of Adress 0201 Setting Change Polarity of 50Ns-1 Current Input!

Figure A-11 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: Change of Address 0201 Setting Change Polarity of 50Ns-2 Current Input!

Figure A-12 Current connections to two current transformers and core balance neutral current transformer for sensitive ground fault detection - only for ungrounded or compensated networks




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

Note: Change of Address 0201 Setting Change Polarity of 50Ns-2 Current Input!

Figure A-13 Current connections to three current transformers – core balance neutral current transformers for sensitive ground fault detection.

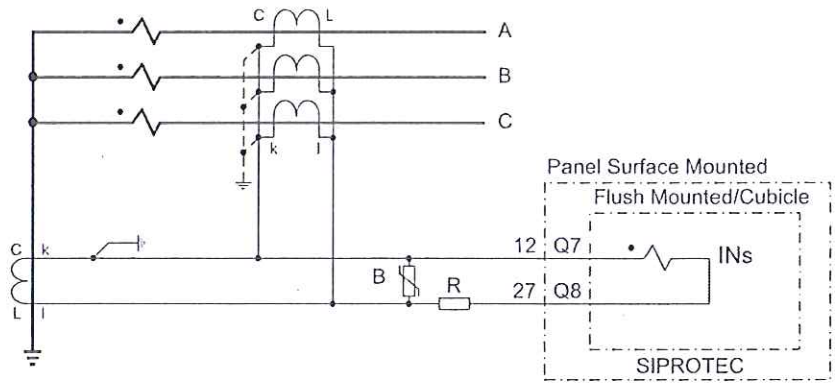



Figure A-14 High-impedance differential protection for a grounded transformer winding (showing the partial connection for the high-impedance differential protection)

## A.3.2 Connection Examples for RTD-Box

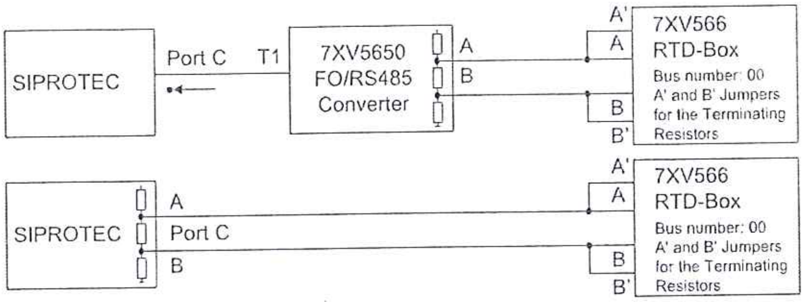



Figure A-15 Simplex operation with one RTD-Box, above: optical design (1 FOs); below: design with RS 485

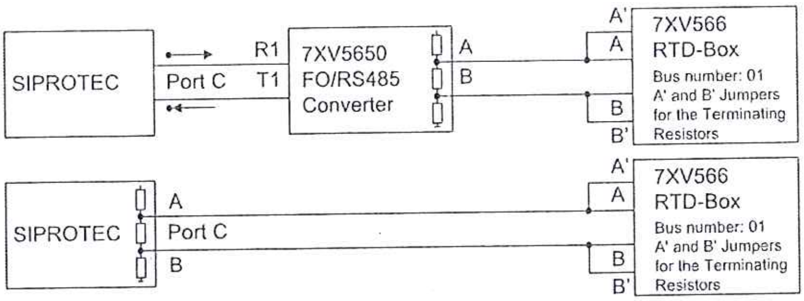



Figure A-16 Half-duplex operation with one RTD-Box, above: optical design (2 FOs); below: design with RS 485

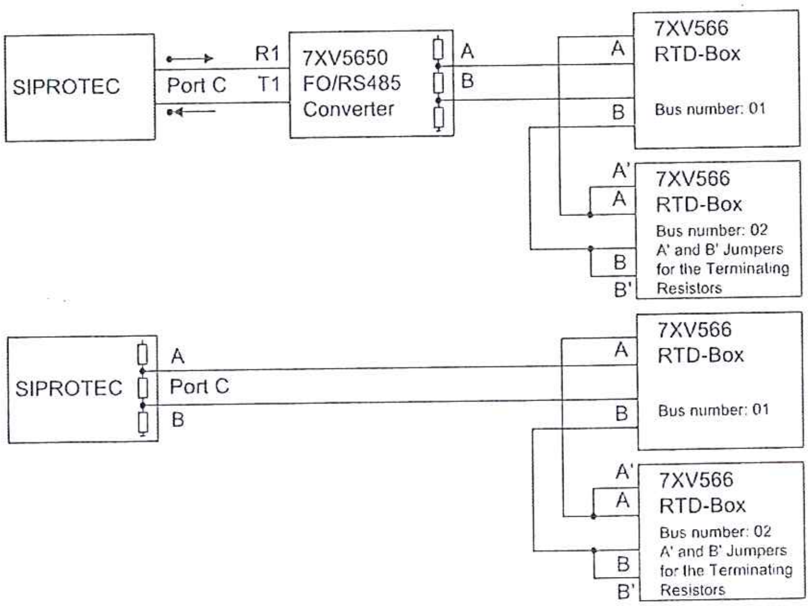



Figure A-17 Half-duplex operation with two RTD-Boxes, above: optical design (2 FOs); below: design with RS 485

# 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>$R_{BC} = 0.6\ \Omega$ (device and cables)<br>$R_{Ct} = 3\ \Omega$<br>$R_{BN} = 5\ \Omega$ (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 | |

## 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>$K \approx 1$<br>$K_{SSC} \approx K_{ALF}$ | |
| Classes TPX, TPY, TPZ | Calculated as in ChapterA.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 |

### 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 |
| Power | 2.5 VA |

**Class accuracy**

Table A-2 Minimum required class accuracy depending on neutral grounding and function operating principle

| Neutral | isolated | compensated | high-resistance grounded |
|---|---|---|---|
| Function non-directional | Class 3 | Class 1 | Class 3 |

For extremely small ground fault currents it may become necessary to correct the angle at the device (see function description of „sensitive ground fault detection").

# A.5 Default Settings

When the device leaves the factory, a large number of LED indications, binary inputs and outputs as well as function keys are already preset. They are summarised 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 | 1762 | 50/51 Phase A picked up |
| LED3 | 50/51 Ph B PU | 1763 | 50/51 Phase B picked up |
| LED4 | 50/51 Ph C PU | 1764 | 50/51 Phase C picked up |
| LED5 | 50N/51NPickedup | 1765 | 50N/51N picked up |
| LED6 | Failure Σ I<br>Fail I balance<br>Fail Ph. Seq. I | 162<br>163<br>175 | Failure: Current Summation<br>Failure: Current Balance<br>Failure: Phase Sequence Current |
| LED7 | 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 |

Table A-5 Further binary input presettings for 7SJ611*- and 7SJ612*-

| Binary Input | Default function | Function No. | Description |
|---|---|---|---|
| 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 |

## A.5.3 Binary Output

Table A-6 Output Relay Presettings for All Devices and Ordering Variants

| 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 |
| BO4 | Failure Σ I<br>Fail I balance<br>Fail Ph. Seq. I | 162<br>163<br>175 | Failure: Current Summation<br>Failure: Current Balance<br>Failure: Phase Sequence Current |

Table A-7 Further Output Relay Presettings for 7SJ611**-, 7SJ612**-

| Binary Output | Default function | Function No. | Description |
|---|---|---|---|
| BO6 | Relay PICKUP | 501 | Relay PICKUP |

## A.5.4 Function Keys

Table A-8 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 preassigned | - | - |

## A.5.5 Default Display

**Measured Value Selection**

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` which is an online parameter; i.e. no parameter set is downloaded.

**Default Display**

Side 1

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

Figure A-18 Default display for configuration without extended measured values (13th position of MLFB = 1)

Side1

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

Side2

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

Figure A-19 Default display for configuration with extended measured values (13th position of MLFB = 3)

**Spontaneous Fault Message Display**

After a fault, the device displays automatically and without any operator action on its LCD display the most important fault data in the sequence shown in the following figure .

```
50-1 PICKUP                  Protective Function that Picked up First;
50-1 TRIP                    Protective Function that Tripped Last;
T - Pickup    = 320 ms       Operating Time from General Pickup to Dropout;
T - TRIP      = 197 ms       Operating Time from General Pickup to the First Trip Command;
```

Figure A-20 Display of spontaneous annunciations in the 4–line display of the device

## A.5.6 Pre-defined CFC Charts

Some CFC Charts are already supplied with the SIPROTEC® device.

**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.

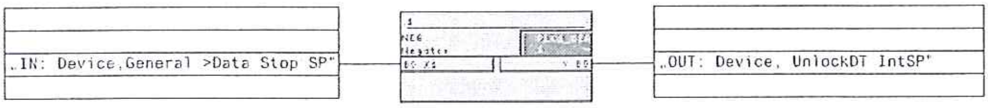



Figure A-21 Logical Link between Input and Output

**Set points 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:

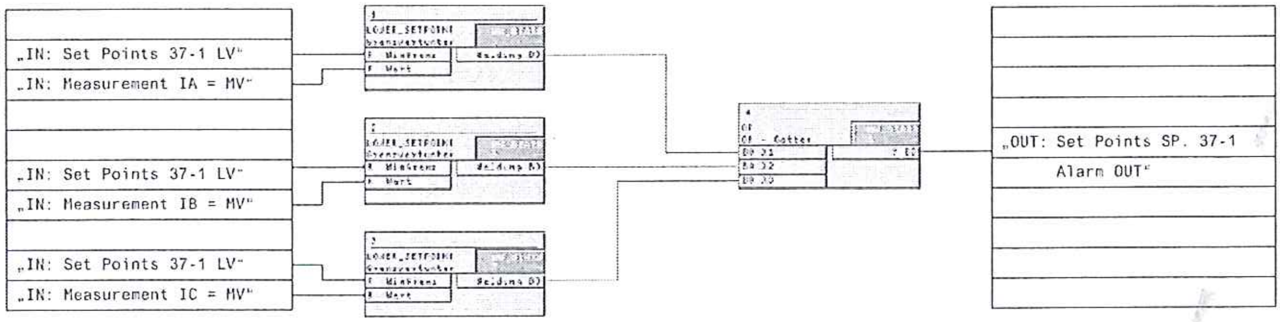



Figure A-22 Undercurrent monitoring

## A.6 Protocol-dependent Functions

| Protocol → <br> 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 | No. Only via additional service interface | 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 | Via Protocol; DCF77/IRIG B; Interface; Binary Inputs | Via protocol (NTP); DCF77/IRIG B; Interface; Binary Input | Via DCF77/IRIG B; Interface; Binary Inputs | Via protocol; DCF77/IRIG B Interface; Binary Input | Via protocol(DNP); DCF77/IRIG B; Interface; Binary Inputs | — |
| Messages with time stamp | Yes | Yes | No | Yes | Yes(DNP) No(Modbus) | 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 | 4800 to 38400 | Up to 100 MBaud | Up to 1.5 MBaud | Up to 1.5 MBaud | 2400 to 19200 | 4800 to 115200 |
| Type | RS232 RS485 Fiber-optic cables | Ethernet TP | RS485 Optical fiber - Double ring | RS485 Optical fiber - Single ring - Double ring | RS 485 Optical fiber | RS232 RS485 Optical fiber |

# A.7 Functional Scope

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 103 | Grp Chge OPTION | Disabled<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 |
| 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 |
| 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 | Disabled | 52 Breaker Wear Monitoring |

| Addr. | Parameter | Setting Options | Default Setting | Comments |
|---|---|---|---|---|
| 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 |

## 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 |
| 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 |
| 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 | |
| 214 | Rated Frequency | P.System Data 1 | | 50 Hz<br>60 Hz | 50 Hz | Rated Frequency |
| 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 |
| 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 |
| 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 |

| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 610 | FltDisp.LED/LCD | Device, General | | Target on PU<br>Target on TRIP | Target on PU | Fault Display on LED / LCD |
| 613A | Gnd O/Cprot. w. | P.System Data 1 | | Ignd (measured)<br>3I0 (calcul.) | Ignd (measured) | Ground Overcurrent protection with |
| 640 | Start image DD | Device, General | | image 1<br>image 2 | image 1 | Start image Default Display |
| 1102 | FullScaleCurr. | P.System Data 2 | | 10 .. 50000 A | 100 A | Measurem:FullScaleCur-rent(Equipm.rating) |
| 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 | |
| 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 |
| 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 Overcur-rent |
| 1302 | 50N-2 PICKUP | 50/51 Overcur. | 1A | 0.05 .. 35.00 A; ∞ | 0.50 A | 50N-2 Pickup |
| | | | 5A | 0.25 .. 175.00 A; ∞ | 2.50 A | |
| 1303 | 50N-2 DELAY | 50/51 Overcur. | | 0.00 .. 60.00 sec; ∞ | 0.10 sec | 50N-2 Time Delay |
| 1304 | 50N-1 PICKUP | 50/51 Overcur. | 1A | 0.05 .. 35.00 A; ∞ | 0.20 A | 50N-1 Pickup |
| | | | 5A | 0.25 .. 175.00 A; ∞ | 1.00 A | |
| 1305 | 50N-1 DELAY | 50/51 Overcur. | | 0.00 .. 60.00 sec; ∞ | 0.50 sec | 50N-1 Time Delay |
| 1307 | 51N PICKUP | 50/51 Overcur. | 1A | 0.05 .. 4.00 A | 0.20 A | 51N Pickup |
| | | | 5A | 0.25 .. 20.00 A | 1.00 A | |
| 1308 | 51N TIME DIAL | 50/51 Overcur. | | 0.05 .. 3.20 sec; ∞ | 0.20 sec | 51N Time Dial |
| 1309 | 51N TIME DIAL | 50/51 Overcur. | | 0.50 .. 15.00 ; ∞ | 5.00 | 51N Time Dial |
| 1310 | 51N Drop-out | 50/51 Overcur. | | Instantaneous<br>Disk Emulation | Disk Emulation | Drop-Out Characteristic |

| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 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 |
| 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 |
| 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 |

| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 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 | OFF | (Sensitive) Ground Fault |
| 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 |
| 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 |
| 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 |
| 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 |

| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 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 |
| 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 | $K_T$-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 | $K_T$ at STOP | 48/66 Motor | | 0.2 .. 100.0 | 5.0 | Extension of Time Constant at Stop |
| 4309 | $K_T$ 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 |
| 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 |

| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 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 |
| 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 |
| 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 |
| 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 |

| 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 |
| 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 |
| 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 |
| 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 |

| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 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 |
| 8101 | MEASURE. SUPERV | Measurem.Superv | | OFF<br>ON | ON | Measurement Supervision |
| 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 |
| 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 |

| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 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 |
| 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 |

| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 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 |
| 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 |

| Addr. | Parameter | Function | C | Setting Options | Default Setting | Comments |
|---|---|---|---|---|---|---|
| 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 |

# 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 (DataS-top) | 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 (HWTest-Mod) | Device, General | IntSP | On Off | * | | * | LED | | | BO | | | | | |
| - | Clock Synchronization (Synch-Clock) | Device, General | IntSP _Ev | * | * | | * | | | | | | | | | |
| - | Error FMS FO 1 (Error FMS1) | Device, General | OUT | On Off | * | | | LED | | | BO | | | | | |
| - | Error FMS FO 2 (Error FMS2) | Device, General | OUT | On Off | * | | | LED | | | BO | | | | | |
| - | Disturbance CFC (Distur.CFC) | Device, General | OUT | On Off | * | | | LED | | | BO | | | | | |
| - | Fault Recording Start (FltRecSta) | Osc. Fault Rec. | IntSP | On Off | * | | m | LED | | | BO | | | | | |
| - | Group A (Group A) | Change Group | IntSP | On Off | * | | * | LED | | | BO | | 160 | 23 | 1 | Yes |

| No. | Description | Function | Type of Information | Log Buffers | | | | Configurable in Matrix | | | | | IEC 60870-5-103 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Event Log ON/OFF | Trip (Fault) Log ON/OFF | Ground Fault Log ON/OFF | Marked in Oscill. Record | LED | Binary Input | Function Key | Relay | Chatter Suppression | Type | Information Number | Data Unit | General Interrogation |
| - | Group B (Group B) | Change Group | IntSP | On Off | * | | * | LED | | | BO | | 160 | 24 | 1 | Yes |
| - | Group C (Group C) | Change Group | IntSP | On Off | * | | * | LED | | | BO | | 160 | 25 | 1 | Yes |
| - | Group D (Group D) | Change Group | IntSP | On Off | * | | * | LED | | | BO | | 160 | 26 | 1 | Yes |
| - | Controlmode REMOTE (ModeR-EMOTE) | Cntrl Authority | IntSP | On Off | * | | | LED | | | BO | | | | | |
| - | Control Authority (Cntrl Auth) | Cntrl Authority | IntSP | On Off | * | | | LED | | | BO | | 101 | 85 | 1 | Yes |
| - | Controlmode LOCAL (ModeLO-CAL) | Cntrl Authority | IntSP | On Off | * | | | LED | | | BO | | 101 | 86 | 1 | Yes |
| - | 52 Breaker (52Breaker) | Control Device | CF_D 12 | On Off | | | | 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 | | | | |
| - | >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. | Description | Function | Type of Information | Log Buffers: Event Log ON/OFF | Log Buffers: Trip (Fault) Log ON/OFF | Log Buffers: Ground Fault Log ON/OFF | Log Buffers: Marked in Oscill. Record | Configurable in Matrix: LED | Configurable in Matrix: Binary Input | Configurable in Matrix: Function Key | Configurable in Matrix: Relay | Configurable in Matrix: Chatter Suppression | IEC 60870-5-103: Type | IEC 60870-5-103: Information Number | IEC 60870-5-103: Data Unit | IEC 60870-5-103: General Interrogation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | >No Voltage (Fuse blown) (>No Volt.) | Process Data | SP | On Off | • | | • | LED | BI | | BO | CB | 160 | 38 | 1 | Yes |
| - | >Error Motor Voltage (>Err Mot V) | Process Data | SP | On Off | • | | • | LED | BI | | BO | CB | 240 | 181 | 1 | Yes |
| - | >Error Control Voltage (>ErrCntrlV) | Process Data | SP | On Off | • | | • | LED | BI | | BO | CB | 240 | 182 | 1 | Yes |
| - | >SF6-Loss (>SF6-Loss) | Process Data | SP | On Off | • | | • | LED | BI | | BO | CB | 240 | 183 | 1 | Yes |
| - | >Error Meter (>Err Meter) | Process Data | SP | On Off | • | | • | LED | BI | | BO | CB | 240 | 184 | 1 | Yes |
| - | >Transformer Temperature (>Tx Temp.) | Process Data | SP | On Off | • | | • | LED | BI | | BO | CB | 240 | 185 | 1 | Yes |
| - | >Transformer Danger (>Tx Danger) | Process Data | SP | On Off | • | | • | LED | BI | | BO | CB | 240 | 186 | 1 | Yes |
| - | Reset Minimum and Maximum counter (ResMinMax) | Min/Max meter | IntSP_Ev | ON | | | | | | | | | | | | |
| - | Reset meter (Meter res) | Energy | IntSP_Ev | ON | | | | | BI | | | | | | | |
| - | Error Systeminterface (SysIntErr.) | Protocol | IntSP | On Off | • | • | | LED | | | BO | | | | | |
| - | Threshold Value 1 (ThreshVal1) | Thresh.-Switch | IntSP | On Off | | | | LED | | FC TN | BO | CB | | | | |
| 1 | No Function configured (Not configured) | Device, General | SP | • | • | | | | | | | | | | | |
| 2 | Function Not Available (Non Existent) | Device, General | SP | • | • | | | | | | | | | | | |
| 3 | >Synchronize Internal Real Time Clock (>Time Synch) | Device, General | SP_Ev | • | • | | | LED | BI | | BO | | 135 | 48 | 1 | Yes |
| 4 | >Trigger Waveform Capture (>Trig.Wave.Cap.) | Osc. Fault Rec. | SP | • | • | | m | LED | BI | | BO | | 135 | 49 | 1 | Yes |
| 5 | >Reset LED (>Reset LED) | Device, General | SP | • | • | | • | LED | BI | | BO | | 135 | 50 | 1 | Yes |
| 7 | >Setting Group Select Bit 0 (>Set Group Bit0) | Change Group | SP | • | • | | • | LED | BI | | BO | | 135 | 51 | 1 | Yes |
| 8 | >Setting Group Select Bit 1 (>Set Group Bit1) | Change Group | SP | • | • | | • | LED | BI | | BO | | 135 | 52 | 1 | Yes |
| 009.0100 | Failure EN100 Modul (Failure Modul) | EN100-Modul 1 | IntSP | On Off | • | | • | LED | | | BO | | | | | |
| 009.0101 | Failure EN100 Link Channel 1 (Ch1) (Fail Ch1) | EN100-Modul 1 | IntSP | On Off | • | | • | LED | | | BO | | | | | |
| 009.0102 | Failure EN100 Link Channel 2 (Ch2) (Fail Ch2) | EN100-Modul 1 | IntSP | On Off | • | | • | LED | | | BO | | | | | |
| 15 | >Test mode (>Test mode) | Device, General | SP | • | • | | • | LED | BI | | BO | | 135 | 53 | 1 | Yes |
| 16 | >Stop data transmission (>DataStop) | Device, General | SP | • | • | | • | LED | BI | | BO | | 135 | 54 | 1 | Yes |
| 51 | Device is Operational and Protecting (Device OK) | Device, General | OUT | On Off | • | | • | LED | | | BO | | 135 | 81 | 1 | Yes |
| 52 | At Least 1 Protection Funct. is Active (ProtActive) | Device, General | IntSP | On Off | • | | • | LED | | | BO | | 160 | 18 | 1 | Yes |
| 55 | Reset Device (Reset Device) | Device, General | OUT | on | • | | • | | | | | | | | | |
| 56 | Initial Start of Device (Initial Start) | Device, General | OUT | on | • | | • | LED | | | BO | | 160 | 5 | 1 | No |
| 67 | Resume (Resume) | Device, General | OUT | on | • | | • | LED | | | BO | | | | | |
| 68 | Clock Synchronization Error (Clock SyncError) | Device, General | OUT | On Off | • | | • | LED | | | BO | | | | | |
| 69 | Daylight Saving Time (DayLightSavTime) | Device, General | OUT | On Off | • | | • | LED | | | BO | | | | | |

| No. | Description | Function | Type of Information | Log Buffers | | | | Configurable in Matrix | | | | | IEC 60870-5-103 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Event Log ON/OFF | Trip (Fault) Log ON/OFF | Ground Fault Log ON/OFF | Marked in Oscill. Record | LED | Binary Input | Function Key | Relay | Chatter Suppression | Type | Information Number | Data Unit | General Interrogation |
| 70 | Setting calculation is running (Settings Calc.) | Device, General | OUT | On Off | * | | * | LED | | | BO | | 160 | 22 | 1 | Yes |
| 71 | Settings Check (Settings Check) | Device, General | OUT | * | * | | * | LED | | | BO | | | | | |
| 72 | Level-2 change (Level-2 change) | Device, General | OUT | On Off | * | | * | LED | | | BO | | | | | |
| 73 | Local setting change (Local change) | Device, General | OUT | * | * | | * | | | | | | | | | |
| 110 | Event lost (Event Lost) | Device, General | OUT_Ev | on | * | | | LED | | | BO | | 135 | 130 | 1 | No |
| 113 | Flag Lost (Flag Lost) | Device, General | OUT | on | * | | m | LED | | | BO | | 135 | 136 | 1 | Yes |
| 125 | Chatter ON (Chatter ON) | Device, General | OUT | On Off | * | | * | LED | | | BO | | 135 | 145 | 1 | Yes |
| 126 | Protection ON/OFF (via system port) (ProtON/OFF) | P.System Data 2 | IntSP | On Off | * | | * | LED | | | BO | | | | | |
| 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 |
| 170 | VT Fuse Failure (alarm instantaneous) (VT FuseFail) | Measurem.Superv | 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 |
| 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 | | | | | |
| 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 | | | | | |

| 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 |
| 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 | * | | | | | | | | | | | |
| 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 | | | | | |
| 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 |
| 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 |
| 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 | | | | | |
| 403 | >Idmd MIN/MAX Buffer Reset (>Idmd MiMaReset) | Min/Max meter | SP | on | * | | * | LED | BI | | BO | | | | | |

| No. | Description | Function | Type of Information | Log Buffers | | | | Configurable in Matrix | | | | | IEC 60870-5-103 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Event Log ON/OFF | Trip (Fault) Log ON/OFF | Ground Fault Log ON/OFF | Marked in Oscill. Record | LED | Binary Input | Function Key | Relay | Chatter Suppression | Type | Information Number | Data Unit | General Interrogation |
| 409 | >BLOCK Op Counter (>BLOCK Op Count) | Statistics | SP | On<br>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<br>Off | | | | | | | | 150 | 177 | 4 | No |
| 534 | Primary fault current Ib (Ib =) | P.System Data 2 | VI | | On<br>Off | | | | | | | | 150 | 178 | 4 | No |
| 535 | Primary fault current Ic (Ic =) | P.System Data 2 | VI | | On<br>Off | | | | | | | | 150 | 179 | 4 | No |
| 561 | Manual close signal detected (Man.Clos.Detect) | P.System Data 2 | OUT | On<br>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 | | | | | | | | | | | | | |
| 1023 | Accumulation of interrupted current Ph C (Σ Ic =) | Statistics | VI | | | | | | | | | | | | | |
| 1202 | >BLOCK 50Ns-2 (>BLOCK 50Ns-2) | Sens. Gnd Fault | SP | On<br>Off | • | | • | LED | BI | | BO | | 151 | 102 | 1 | Yes |
| 1203 | >BLOCK 50Ns-1 (>BLOCK 50Ns-1) | Sens. Gnd Fault | SP | On<br>Off | • | | • | LED | BI | | BO | | 151 | 103 | 1 | Yes |
| 1204 | >BLOCK 51Ns (>BLOCK 51Ns) | Sens. Gnd Fault | SP | On<br>Off | • | | • | LED | BI | | BO | | 151 | 104 | 1 | Yes |
| 1207 | >BLOCK 50Ns/67Ns (>BLK 50Ns/67Ns) | Sens. Gnd Fault | SP | On<br>Off | • | | • | LED | BI | | BO | | 151 | 107 | 1 | Yes |
| 1211 | 50Ns/67Ns is OFF (50Ns/67Ns OFF) | Sens. Gnd Fault | OUT | On<br>Off | • | | • | LED | | | BO | | 151 | 111 | 1 | Yes |
| 1212 | 50Ns/67Ns is ACTIVE (50Ns/67Ns ACT) | Sens. Gnd Fault | OUT | On<br>Off | • | | • | LED | | | BO | | 151 | 112 | 1 | Yes |
| 1221 | 50Ns-2 Pickup (50Ns-2 Pickup) | Sens. Gnd Fault | OUT | • | On<br>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<br>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<br>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<br>Off | On<br>Off | | • | LED | | | BO | | 151 | 130 | 1 | Yes |
| 1403 | >BLOCK 50BF (>BLOCK 50BF) | 50BF BkrFailure | SP | On<br>Off | • | | • | LED | BI | | BO | | 166 | 103 | 1 | Yes |

| No. | Description | Function | Type of Information | Log Buffers | | | | Configurable in Matrix | | | | | IEC 60870-5-103 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Event Log ON/OFF | Trip (Fault) Log ON/OFF | Ground Fault Log ON/OFF | Marked in Oscill. Record | LED | Binary Input | Function Key | Relay | Chatter Suppression | Type | Information Number | Data Unit | General Interrogation |
| 1431 | >50BF initiated externally (>50BF ext SRC) | 50BF BkrFailure | SP | On<br>Off | * | | * | LED | BI | | BO | | 166 | 104 | 1 | Yes |
| 1451 | 50BF is switched OFF (50BF OFF) | 50BF BkrFailure | OUT | On<br>Off | * | | * | LED | | | BO | | 166 | 151 | 1 | Yes |
| 1452 | 50BF is BLOCKED (50BF BLOCK) | 50BF BkrFailure | OUT | On<br>Off | On<br>Off | | * | LED | | | BO | | 166 | 152 | 1 | Yes |
| 1453 | 50BF is ACTIVE (50BF ACTIVE) | 50BF BkrFailure | OUT | On<br>Off | * | | * | LED | | | BO | | 166 | 153 | 1 | Yes |
| 1456 | 50BF (internal) PICKUP (50BF int Pickup) | 50BF BkrFailure | OUT | * | On<br>Off | | * | LED | | | BO | | 166 | 156 | 2 | Yes |
| 1457 | 50BF (external) PICKUP (50BF ext Pickup) | 50BF BkrFailure | OUT | * | On<br>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<br>Off | * | | * | LED | BI | | BO | | 167 | 7 | 1 | Yes |
| 1511 | 49 Overload Protection is OFF (49 O / L OFF) | 49 Th.Overload | OUT | On<br>Off | * | | * | LED | | | BO | | 167 | 11 | 1 | Yes |
| 1512 | 49 Overload Protection is BLOCKED (49 O/L BLOCK) | 49 Th.Overload | OUT | On<br>Off | On<br>Off | | * | LED | | | BO | | 167 | 12 | 1 | Yes |
| 1513 | 49 Overload Protection is ACTIVE (49 O/L ACTIVE) | 49 Th.Overload | OUT | On<br>Off | * | | * | LED | | | BO | | 167 | 13 | 1 | Yes |
| 1515 | 49 Overload Current Alarm (I alarm) (49 O/L I Alarm) | 49 Th.Overload | OUT | On<br>Off | * | | * | LED | | | BO | | 167 | 15 | 1 | Yes |
| 1516 | 49 Overload Alarm! Near Thermal Trip (49 O/L Θ Alarm) | 49 Th.Overload | OUT | On<br>Off | * | | * | LED | | | BO | | 167 | 16 | 1 | Yes |
| 1517 | 49 Winding Overload (49 Winding O/L) | 49 Th.Overload | OUT | On<br>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 |
| 1580 | >49 Reset of Thermal Overload Image (>RES 49 Image) | 49 Th.Overload | SP | On<br>Off | * | | * | LED | BI | | BO | | | | | |
| 1581 | 49 Thermal Overload Image reset (49 Image res.) | 49 Th.Overload | OUT | On<br>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<br>Off | * | | * | LED | BI | | BO | | 60 | 243 | 1 | Yes |
| 1732 | >ACTIVATE Cold-Load-Pickup (>ACTIVATE CLP) | ColdLoadPickup | SP | On<br>Off | * | | * | LED | BI | | BO | | | | | |

| No. | Description | Function | Type of Information | Log Buffers | | | | Configurable in Matrix | | | | | IEC 60870-5-103 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Event Log ON/OFF | Trip (Fault) Log ON/OFF | Ground Fault Log ON/OFF | Marked in Oscill. Record | LED | Binary Input | Function Key | Relay | Chatter Suppression | Type | Information Number | Data Unit | General Interrogation |
| 1751 | 50/51 O/C switched OFF (50/51 PH OFF) | 50/51 Overcur. | OUT | On<br>Off | * | | * | LED | | | BO | | 60 | 21 | 1 | Yes |
| 1752 | 50/51 O/C is BLOCKED (50/51 PH BLK) | 50/51 Overcur. | OUT | On<br>Off | On<br>Off | | * | LED | | | BO | | 60 | 22 | 1 | Yes |
| 1753 | 50/51 O/C is ACTIVE (50/51 PH ACT) | 50/51 Overcur. | OUT | On<br>Off | * | | * | LED | | | BO | | 60 | 23 | 1 | Yes |
| 1756 | 50N/51N is OFF (50N/51N OFF) | 50/51 Overcur. | OUT | On<br>Off | * | | * | LED | | | BO | | 60 | 26 | 1 | Yes |
| 1757 | 50N/51N is BLOCKED (50N/51N BLK) | 50/51 Overcur. | OUT | On<br>Off | On<br>Off | | * | LED | | | BO | | 60 | 27 | 1 | Yes |
| 1758 | 50N/51N is ACTIVE (50N/51N ACT) | 50/51 Overcur. | OUT | On<br>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<br>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<br>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<br>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<br>Off | | m | LED | | | BO | | 160 | 66 | 2 | Yes |
| 1765 | 50N/51N picked up (50N/51NPickedup) | 50/51 Overcur. | OUT | * | On<br>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<br>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<br>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<br>Off | | * | LED | | | BO | | 60 | 77 | 2 | Yes |
| 1824 | 51 Time Out (51 Time Out) | 50/51 Overcur. | OUT | * | * | | * | LED | | | BO | | 60 | 57 | 2 | Yes |
| 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<br>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<br>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<br>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<br>Off | | * | LED | | | BO | | 60 | 101 | 2 | Yes |
| 1841 | Phase B inrush detection (PhB InrushDet) | 50/51 Overcur. | OUT | * | On<br>Off | | * | LED | | | BO | | 60 | 102 | 2 | Yes |
| 1842 | Phase C inrush detection (PhC InrushDet) | 50/51 Overcur. | OUT | * | On<br>Off | | * | LED | | | BO | | 60 | 103 | 2 | Yes |

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

| No. | Description | Function | Type of Information | Log Buffers: Event Log ON/OFF | Log Buffers: Trip (Fault) Log ON/OFF | Log Buffers: Ground Fault Log ON/OFF | Log Buffers: Marked in Oscill. Record | Configurable in Matrix: LED | Configurable in Matrix: Binary Input | Configurable in Matrix: Function Key | Configurable in Matrix: Relay | Configurable in Matrix: Chatter Suppression | IEC 60870-5-103: Type | IEC 60870-5-103: Information Number | IEC 60870-5-103: Data Unit | IEC 60870-5-103: General Interrogation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2784 | 79 Auto recloser is NOT ready (79 is NOT ready) | 79M Auto Recl. | OUT | On Off | * | | * | LED | | | BO | | 160 | 130 | 1 | Yes |
| 2785 | 79 - Auto-reclose is dynamically BLOCKED (79 DynBlock) | 79M Auto Recl. | OUT | On Off | on | | * | LED | | | BO | | 40 | 85 | 1 | Yes |
| 2788 | 79: CB ready monitoring window expired (79 T-CBreadyExp) | 79M Auto Recl. | OUT | on | * | | * | LED | | | BO | | | | | |
| 2801 | 79 - in progress (79 in progress) | 79M Auto Recl. | OUT | * | on | | * | LED | | | BO | | 40 | 101 | 2 | Yes |
| 2808 | 79: CB open with no trip (79 BLK: CB open) | 79M Auto Recl. | OUT | On Off | * | | * | LED | | | BO | | | | | |
| 2809 | 79: Start-signal monitoring time expired (79 T-Start Exp) | 79M Auto Recl. | OUT | on | * | | * | LED | | | BO | | | | | |
| 2810 | 79: Maximum dead time expired (79 TdeadMax Exp) | 79M Auto Recl. | OUT | on | * | | * | LED | | | BO | | | | | |
| 2823 | 79: no starter configured (79 no starter) | 79M Auto Recl. | OUT | On Off | * | | * | LED | | | BO | | | | | |
| 2824 | 79: no cycle configured (79 no cycle) | 79M Auto Recl. | OUT | On Off | * | | * | LED | | | BO | | | | | |
| 2827 | 79: blocking due to trip (79 BLK by trip) | 79M Auto Recl. | OUT | on | * | | * | LED | | | BO | | | | | |
| 2828 | 79: blocking due to 3-phase pickup (79 BLK:3ph p.u.) | 79M Auto Recl. | OUT | on | * | | * | LED | | | BO | | | | | |
| 2829 | 79: action time expired before trip (79 Tact expired) | 79M Auto Recl. | OUT | on | * | | * | LED | | | BO | | | | | |
| 2830 | 79: max. no. of cycles exceeded (79 Max. No. Cyc) | 79M Auto Recl. | OUT | on | * | | * | LED | | | BO | | | | | |
| 2844 | 79 1st cycle running (79 1stCyc. run.) | 79M Auto Recl. | OUT | * | on | | * | LED | | | BO | | | | | |
| 2845 | 79 2nd cycle running (79 2ndCyc. run.) | 79M Auto Recl. | OUT | * | on | | * | LED | | | BO | | | | | |
| 2846 | 79 3rd cycle running (79 3rdCyc. run.) | 79M Auto Recl. | OUT | * | on | | * | LED | | | BO | | | | | |
| 2847 | 79 4th or higher cycle running (79 4thCyc. run.) | 79M Auto Recl. | OUT | * | on | | * | LED | | | BO | | | | | |
| 2851 | 79 - Close command (79 Close) | 79M Auto Recl. | OUT | * | on | | m | LED | | | BO | | 160 | 128 | 2 | No |
| 2862 | 79 - cycle successful (79 Successful) | 79M Auto Recl. | OUT | on | on | | * | LED | | | BO | | 40 | 162 | 1 | Yes |
| 2863 | 79 - Lockout (79 Lockout) | 79M Auto Recl. | OUT | on | on | | * | LED | | | BO | | 40 | 163 | 2 | Yes |
| 2865 | 79: Synchro-check request (79 Sync.Request) | 79M Auto Recl. | OUT | * | on | | * | LED | | | BO | | | | | |
| 2878 | 79-A/R single phase reclosing sequence (79 L-N Sequence) | 79M Auto Recl. | OUT | * | on | | * | LED | | | BO | | 40 | 180 | 2 | Yes |
| 2879 | 79-A/R multi-phase reclosing sequence (79 L-L Sequence) | 79M Auto Recl. | OUT | * | on | | * | LED | | | BO | | 40 | 181 | 2 | Yes |
| 2883 | Zone Sequencing is active (ZSC active) | 79M Auto Recl. | OUT | On Off | on | | * | LED | | | BO | | | | | |
| 2884 | Zone sequence coordination switched ON (ZSC ON) | 79M Auto Recl. | OUT | on | * | | * | LED | | | BO | | | | | |
| 2885 | Zone sequence coordination switched OFF (ZSC OFF) | 79M Auto Recl. | OUT | on | * | | * | LED | | | BO | | | | | |
| 2889 | 79 1st cycle zone extension release (79 1.CycZoneRel) | 79M Auto Recl. | OUT | * | * | | * | LED | | | BO | | | | | |
| 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 | | | | | |

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

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

| No. | Description | Function | Type of Information | Log Buffers: Event Log ON/OFF | Log Buffers: Trip (Fault) Log ON/OFF | Log Buffers: Ground Fault Log ON/OFF | Log Buffers: Marked in Oscill. Record | Configurable in Matrix: LED | Configurable in Matrix: Binary Input | Configurable in Matrix: Function Key | Configurable in Matrix: Relay | Configurable in Matrix: Chatter Suppression | IEC 60870-5-103: Type | IEC 60870-5-103: Information Number | IEC 60870-5-103: Data Unit | IEC 60870-5-103: General Interrogation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| 7558 | InRush Ground detected (InRush Gnd Det) | 50/51 Overcur. | OUT | * | On Off | | * | LED | | | BO | | 60 | 94 | 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 | | | | | |

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

| No. | Description | Function | Type of Information | Log Buffers: Event Log ON/OFF | Log Buffers: Trip (Fault) Log ON/OFF | Log Buffers: Ground Fault Log ON/OFF | Log Buffers: Marked in Oscill. Record | Configurable in Matrix: LED | Configurable in Matrix: Binary Input | Configurable in Matrix: Function Key | Configurable in Matrix: Relay | Configurable in Matrix: Chatter Suppression | IEC 60870-5-103: Type | IEC 60870-5-103: Information Number | IEC 60870-5-103: Data Unit | IEC 60870-5-103: General Interrogation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | | | | |
| 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 | | | | | | | | | | | | | |
| 16019 | >52 Breaker Wear Start Criteria (>52 Wear start) | P.System Data 2 | SP | On Off | * | | * | LED | BI | | BO | | | | | |
| 16020 | 52 Wear blocked by Time Setting Failure (52 WearSet.fail) | P.System Data 2 | OUT | On Off | * | | * | LED | | | BO | | | | | |
| 16027 | 52 Breaker Wear Logic blk Ir-CB>=Isc-CB (52WL.blk I PErr) | P.System Data 2 | OUT | On Off | * | | * | LED | | | BO | | | | | |
| 16028 | 52 Breaker W.Log.blk SwCyc.Isc>=SwCyc.Ir (52WL.blk n PErr) | P.System Data 2 | OUT | On Off | * | | * | LED | | | BO | | | | | |
| 16029 | Sens.gnd.flt. 51Ns BLOCKED Setting Error (51Ns BLK PaErr) | Sens. Gnd Fault | OUT | On Off | * | | * | LED | | | BO | | | | | |
| 30053 | Fault recording is running (Fault rec. run.) | Osc. Fault Rec. | OUT | * | * | | * | LED | | | BO | | | | | |
| 31000 | Q0 operationcounter= (Q0 OpCnt=) | Control Device | VI | * | | | | | | | | | | | | |
| 31001 | Q1 operationcounter= (Q1 OpCnt=) | Control Device | VI | * | | | | | | | | | | | | |
| 31002 | Q2 operationcounter= (Q2 OpCnt=) | Control Device | VI | * | | | | | | | | | | | | |
| 31008 | Q8 operationcounter= (Q8 OpCnt=) | Control Device | VI | * | | | | | | | | | | | | |
| 31009 | Q9 operationcounter= (Q9 OpCnt=) | Control Device | VI | * | | | | | | | | | | | | |

## A.10 Group Alarms

| No. | Description | Function No. | Description |
|---|---|---|---|
| 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 |
| 160 | Alarm Sum Event | 162 | Failure Σ I |
| | | 163 | Fail I balance |
| | | 175 | Fail Ph. Seq. I |
| | | 191 | Error Offset |
| | | 193 | Alarm NO calibr |
| | | 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 |

# 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 |
| - | 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 |
| 601 | Ia (Ia =) | Measurement | 134 | 137 | No | 9 | 1 | CFC | CD | DD |
| 602 | Ib (Ib =) | Measurement | 160 | 144 | Yes | 3 | 1 | CFC | CD | DD |
| | | | 134 | 137 | No | 9 | 2 | | | |
| 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 |
| 661 | Threshold of Restart Inhibit (Θ REST. =) | Measurement | - | - | - | - | - | 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 | - | - | - | - | - | CFC | CD | DD |
| 831 | 3Io (zero sequence) (3Io =) | Measurement | - | - | - | - | - | CFC | CD | DD |
| 833 | I1 (positive sequence) Demand (I1 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 |
| 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 |
| 888 | Pulsed Energy Wp (active) (Wp(puls)) | Energy | 133 | 55 | No | 205 | - | CFC | CD | DD |
| 889 | Pulsed Energy Wq (reactive) (Wq(puls)) | Energy | 133 | 56 | No | 205 | - | CFC | CD | DD |
| 924 | Wp Forward (WpForward) | Energy | 133 | 51 | No | 205 | - | CFC | CD | DD |
| 925 | Wq Forward (WqForward) | Energy | 133 | 52 | No | 205 | - | CFC | CD | DD |

| No. | Description | Function | IEC 60870-5-103 | | | | | Configurable in Matrix | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Type | Information Number | Compatibility | Data Unit | Position | CFC | Control Display | Default Display |
| 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 |
| 1058 | Overload Meter Max (Θ/ΘTrpMax=) | Min/Max meter | - | - | - | - | - | CFC | CD | DD |
| 1059 | Overload Meter Min (Θ/ΘTrpMin=) | Min/Max meter | - | - | - | - | - | CFC | CD | DD |
| 1068 | Temperature of RTD 1 (Θ RTD 1 =) | Measurement | 134 | 146 | No | 9 | 1 | CFC | CD | DD |
| 1069 | Temperature of RTD 2 (Θ RTD 2 =) | Measurement | 134 | 146 | No | 9 | 2 | CFC | CD | DD |
| 1070 | Temperature of RTD 3 (Θ RTD 3 =) | Measurement | 134 | 146 | No | 9 | 3 | CFC | CD | DD |
| 1071 | Temperature of RTD 4 (Θ RTD 4 =) | Measurement | 134 | 146 | No | 9 | 4 | CFC | CD | DD |
| 1072 | Temperature of RTD 5 (Θ RTD 5 =) | Measurement | 134 | 146 | No | 9 | 5 | CFC | CD | DD |
| 1073 | Temperature of RTD 6 (Θ RTD 6 =) | Measurement | 134 | 146 | No | 9 | 6 | CFC | CD | DD |
| 1074 | Temperature of RTD 7 (Θ RTD 7 =) | Measurement | 134 | 146 | No | 9 | 7 | CFC | CD | DD |
| 1075 | Temperature of RTD 8 (Θ RTD 8 =) | Measurement | 134 | 146 | No | 9 | 8 | CFC | CD | DD |
| 1076 | Temperature of RTD 9 (Θ RTD 9 =) | Measurement | 134 | 146 | No | 9 | 9 | CFC | CD | DD |
| 1077 | Temperature of RTD10 (Θ RTD10 =) | Measurement | 134 | 146 | No | 9 | 10 | CFC | CD | DD |
| 1078 | Temperature of RTD11 (Θ RTD11 =) | Measurement | 134 | 146 | No | 9 | 11 | CFC | CD | DD |
| 1079 | Temperature of RTD12 (Θ RTD12 =) | Measurement | 134 | 146 | No | 9 | 12 | CFC | CD | DD |
| 16004 | Threshold Sum Current Exponentiation (ΣI^x>) | SetPoint(Stat) | - | - | - | - | - | CFC | CD | DD |
| 16009 | Lower Threshold of CB Residual Endurance (Resid.Endu. <) | SetPoint(Stat) | - | - | - | - | - | CFC | CD | DD |

# Literature


/1/ SIPROTEC System Description; 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 "e"; C53000–B1174–C158

# Glossary

| | |
|---|---|
| **Battery** | The buffer battery ensures that specified data areas, flags, timers and counters are retained retentively. |
| **Bay controllers** | Bay controllers are devices with control and monitoring functions without protective functions. |
| **Bit pattern indication** | Bit pattern indication is a processing function by means of which items of digital process information applying across several inputs can be detected together in parallel and processed further. The bit pattern length can be specified as 1, 2, 3 or 4 bytes. |
| **BP_xx** | → Bit pattern indication (Bitstring Of x Bit), x designates the length in bits (8, 16, 24 or 32 bits). |
| **C_xx** | Command without feedback |
| **CF_xx** | Command with feedback |
| **CFC** | Continuous Function Chart. CFC is a graphics editor with which a program can be created and configured by using ready-made blocks. |
| **CFC blocks** | Blocks are parts of the user program delimited by their function, their structure or their purpose. |
| **Chatter blocking** | A rapidly intermittent input (for example, due to a relay contact fault) is switched off after a configurable monitoring time and can thus not generate any further signal changes. The function prevents overloading of the system when a fault arises. |
| **Combination devices** | Combination devices are bay devices with protection functions and a control display. |
| **Combination matrix** | DIGSI V4.6 and higher allows up to 32 compatible SIPROTEC 4 devices to communicate with each other in an inter-relay communication network (IRC). The combination matrix defines which devices exchange which information. |
| **Communication branch** | A communications branch corresponds to the configuration of 1 to n users which communicate by means of a common bus. |
| **Communication reference CR** | The communication reference describes the type and version of a station in communication by PROFIBUS. |

**Component view** — In addition to a topological view, SIMATIC Manager offers you a component view. The component view does not offer any overview of the hierarchy of a project. It does, however, provide an overview of all the SIPROTEC 4 devices within a project.

**COMTRADE** — Common Format for Transient Data Exchange, format for fault records.

**Container** — If an object can contain other objects, it is called a container. The object Folder is an example of such a container.

**Control display** — The image which is displayed on devices with a large (graphic) display after pressing the control key is called control display. It contains the switchgear that can be controlled in the feeder with status display. It is used to perform switching operations. Defining this diagram is part of the configuration.

**Data pane** — → The right-hand area of the project window displays the contents of the area selected in the → navigation window, for example indications, measured values, etc. of the information lists or the function selection for the device configuration.

**DCF77** — The extremely precise official time is determined in Germany by the "Physikalisch-Technischen-Bundesanstalt PTB" in Braunschweig. The atomic clock unit of the PTB transmits this time via the long-wave time-signal transmitter in Mainflingen near Frankfurt/Main. The emitted time signal can be received within a radius of approx. 1,500 km from Frankfurt/Main.

**Device container** — In the Component View, all SIPROTEC 4 devices are assigned to an object of type Device container. This object is a special object of DIGSI Manager. However, since there is no component view in DIGSI Manager, this object only becomes visible in conjunction with STEP 7.

**Double command** — Double commands are process outputs which indicate 4 process states at 2 outputs: 2 defined (for example ON/OFF) and 2 undefined states (for example intermediate positions)

**Double-point indication** — Double-point indications are items of process information which indicate 4 process states at 2 inputs: 2 defined (for example ON/OFF) and 2 undefined states (for example intermediate positions).

**DP** — → Double-point indication

**DP_I** — → Double point indication, intermediate position 00

**Drag-and-drop** — Copying, moving and linking function, used at graphics user interfaces. Objects are selected with the mouse, held and moved from one data area to another.

**Electromagnetic compatibility** — Electromagnetic compatibility (EMC) is the ability of an electrical apparatus to function fault-free in a specified environment without influencing the environment unduly.

**EMC** — → Electromagnetic compatibility

**ESD protection** ESD protection is the total of all the means and measures used to protect electrostatic sensitive devices.

**ExBPxx** External bit pattern indication via an ETHERNET connection, device-specific → Bit pattern indication

**ExC** External command without feedback via an ETHERNET connection, device-specific

**ExCF** External command with feedback via an ETHERNET connection, device-specific

**ExDP** External double point indication via an ETHERNET connection, device-specific → Double-point indication

**ExDP_I** External double-point indication via an ETHERNET connection, intermediate position 00, → Double-point indication

**ExMV** External metered value via an ETHERNET connection, device-specific

**ExSI** External single-point indication via an ETHERNET connection, device-specific → Single-point indication

**ExSI_F** External single point indication via an ETHERNET connection, device-specific, → Fleeting indication, → Single-point indication

**Field devices** Generic term for all devices assigned to the field level: Protection devices, combination devices, bay controllers.

**Floating** → Without electrical connection to the → ground.

**FMS communication branch** Within an FMS communication branch the users communicate on the basis of the PROFIBUS FMS protocol via a PROFIBUS FMS network.

**Folder** This object type is used to create the hierarchical structure of a project.

**General interrogation (GI)** During the system start-up the state of all the process inputs, of the status and of the fault image is sampled. This information is used to update the system-end process image. The current process state can also be sampled after a data loss by means of a GI.

**GOOSE message** GOOSE messages (Generic Object Oriented Substation Event) according to IEC 61850 are data packets which are cyclic transferred event-controlled via the Ethernet communication system. They serve for direct information exchange among the relays. This mechanism implements cross-communication between bay units.

**GPS**

Global Positioning System. Satellites with atomic clocks on board orbit the earth twice a day in different parts in approx. 20,000 km. They transmit signals which also contain the GPS universal time. The GPS receiver determines its own position from the signals received. From its position it can derive the running time of a satellite and thus correct the transmitted GPS universal time.

**Ground**

The conductive ground whose electric potential can be set equal to zero in any point. In the area of ground electrodes the ground can have a potential deviating from zero. The term "Ground reference plane" is often used for this state.

**Grounding**

Grounding means that a conductive part is to connect via a grounding system to → ground.

**Grounding**

Grounding is the total of all means and measured used for grounding.

**Hierarchy level**

Within a structure with higher-level and lower-level objects a hierarchy level is a container of equivalent objects.

**HV field description**

The HV project description file contains details of fields which exist in a ModPara project. The actual field information of each field is memorized in a HV field description file. Within the HV project description file, each field is allocated such a HV field description file by a reference to the file name.

**HV project description**

All data are exported once the configuration and parameterization of PCUs and submodules using ModPara has been completed. This data is split up into several files. One file contains details about the fundamental project structure. This also includes, for example, information detailing which fields exist in this project. This file is called a HV project description file.

**ID**

Internal double-point indication → Double-point indication

**ID_S**

Internal double point indication intermediate position 00 → Double-point indication

**IEC**

International Electrotechnical Commission

**IEC Address**

Within an IEC bus a unique IEC address has to be assigned to each SIPROTEC 4 device. A total of 254 IEC addresses are available for each IEC bus.

**IEC communication branch**

Within an IEC communication branch the users communicate on the basis of the IEC60-870-5-103 protocol via an IEC bus.

**IEC61850**

Worldwide communication standard for communication in substations. This standard allows devices from different manufacturers to interoperate on the station bus. Data transfer is accomplished through an Ethernet network.

**Initialization string**

An initialization string comprises a range of modem-specific commands. These are transmitted to the modem within the framework of modem initialization. The commands can, for example, force specific settings for the modem.

**Inter relay communication** → IRC combination

**IRC combination** Inter Relay Communication, IRC, is used for directly exchanging process information between SIPROTEC 4 devices. You require an object of type IRC combination to configure an Inter Relay Communication. Each user of the combination and all the necessary communication parameters are defined in this object. The type and scope of the information exchanged among the users is also stored in this object.

**IRIG-B** Time signal code of the Inter-Range Instrumentation Group

**IS** Internal single-point indication → Single-point indication

**IS_F** Internal indication fleeting → Fleeting indication, → Single-point indication

**ISO 9001** The ISO 9000 ff range of standards defines measures used to ensure the quality of a product from the development to the manufacturing.

**Link address** The link address gives the address of a V3/V2 device.

**List view** The right pane of the project window displays the names and icons of objects which represent the contents of a container selected in the tree view. Because they are displayed in the form of a list, this area is called the list view.

**LV** Limit value

**LVU** Limit value, user-defined

**Master** Masters may send data to other users and request data from other users. DIGSI operates as a master.

**Metered value** Metered values are a processing function with which the total number of discrete similar events (counting pulses) is determined for a period, usually as an integrated value. In power supply companies the electrical work is usually recorded as a metered value (energy purchase/supply, energy transportation).

**MLFB** MLFB is the acronym of "MaschinenLesbare FabrikateBezeichnung" (machine-readable product designation). It is equivalent to the order number. The type and version of a SIPROTEC 4 device are coded in the order number.

**Modem connection** This object type contains information on both partners of a modem connection, the local modem and the remote modem.

**Modem profile** A modem profile consists of the name of the profile, a modem driver and may also comprise several initialization commands and a user address. You can create several modem profiles for one physical modem. To do so you need to link various initialization commands or user addresses to a modem driver and its properties and save them under different names.

**Modems** Modem profiles for a modem connection are saved in this object type.

**MV** Measured value

**MVMV** Metered value which is formed from the measured value

**MVT** Measured value with time

**MVU** Measured value, user-defined

**Navigation pane** The left pane of the project window displays the names and symbols of all containers of a project in the form of a folder tree.

**Object** Each element of a project structure is called an object in DIGSI.

**Object properties** Each object has properties. These might be general properties that are common to several objects. An object can also have specific properties.

**Off-line** In offline mode a link with the SIPROTEC 4 device is not necessary. You work with data which are stored in files.

**OI_F** Output indication fleeting → Transient information

**On-line** When working in online mode, there is a physical link to a SIPROTEC 4 device which can be implemented in various ways. This link can be implemented as a direct connection, as a modem connection or as a PROFIBUS FMS connection.

**OUT** Output indication

**Parameter set** The parameter set is the set of all parameters that can be set for a SIPROTEC 4 device.

**Phone book** User addresses for a modem connection are saved in this object type.

**PMV** Pulse metered value

**Process bus** Devices featuring a process bus interface can communicate directly with the SICAM HV modules. The process bus interface is equipped with an Ethernet module.

**PROFIBUS** PROcess FIeld BUS, the German process and field bus standard, as specified in the standard EN 50170, Volume 2, PROFIBUS. It defines the functional, electrical, and mechanical properties for a bit-serial field bus.

**PROFIBUS Address** Within a PROFIBUS network a unique PROFIBUS address has to be assigned to each SIPROTEC 4 device. A total of 254 PROFIBUS addresses are available for each PROFIBUS network.

| | |
|---|---|
| **Project** | Content-wise, a project is the image of a real power supply system. Graphically, a project is represented by a number of objects which are integrated in a hierarchical structure. Physically, a project consists of a series of folders and files containing project data. |
| **Protection devices** | All devices with a protective function and no control display. |
| **Reorganizing** | Frequent addition and deletion of objects creates memory areas that can no longer be used. By cleaning up projects, you can release these memory areas. However, a clean up also reassigns the VD addresses. As a consequence, all SIPROTEC 4 devices need to be reinitialized. |
| **RIO file** | Relay data Interchange format by Omicron. |
| **RSxxx-interface** | Serial interfaces RS232, RS422/485 |
| **SCADA Interface** | Rear serial interface on the devices for connecting to a control system via IEC or PROFIBUS. |
| **Service port** | Rear serial interface on the devices for connecting DIGSI (for example, via modem). |
| **Setting parameters** | General term for all adjustments made to the device. Parameterization jobs are executed by means of DIGSI or, in some cases, directly on the device. |
| **SI** | → Single point indication |
| **SI_F** | → Single-point indication fleeting → Transient information, → Single-point indication |
| **SICAM SAS** | Modular substation automation system based on the substation controller → SICAM SC and the SICAM WinCC operator control and monitoring system. |
| **SICAM SC** | Substation Controller. Modularly substation control system, based on the SIMATIC M7 automation system. |
| **SICAM WinCC** | The SICAM WinCC operator control and monitoring system displays the condition of your network graphically, visualizes alarms and indications, archives the network data, allows to intervene manually in the process and manages the system rights of the individual employee. |
| **Single command** | Single commands are process outputs which indicate 2 process states (for example, ON/OFF) at one output. |
| **Single point indication** | Single indications are items of process information which indicate 2 process states (for example, ON/OFF) at one output. |
| **SIPROTEC** | The registered trademark SIPROTEC is used for devices implemented on system base V4. |

**SIPROTEC 4 device** This object type represents a real SIPROTEC 4 device with all the setting values and process data it contains.

**SIPROTEC 4 variant** This object type represents a variant of an object of type SIPROTEC 4 device. The device data of this variant may well differ from the device data of the source object. However, all variants derived from the source object have the same VD address as the source object. For this reason, they always correspond to the same real SIPROTEC 4 device as the source object. Objects of type SIPROTEC 4 variant have a variety of uses, such as documenting different operating states when entering parameter settings of a SIPROTEC 4 device.

**Slave** A slave may only exchange data with a master after being prompted to do so by the master. SIPROTEC 4 devices operate as slaves.

**Time stamp** Time stamp is the assignment of the real time to a process event.

**Topological view** DIGSI Manager always displays a project in the topological view. This shows the hierarchical structure of a project with all available objects.

**Transformer Tap Indication** Transformer tap indication is a processing function on the DI by means of which the tap of the transformer tap changer can be detected together in parallel and processed further.

**Transient information** A transient information is a brief transient → single-point indication at which only the coming of the process signal is detected and processed immediately.

**Tree view** The left pane of the project window displays the names and symbols of all containers of a project in the form of a folder tree. This area is called the tree view.

**TxTap** → Transformer Tap Indication

**User address** A user address comprises the name of the station, the national code, the area code and the user-specific phone number.

**Users** DIGSI V4.6 and higher allows up to 32 compatible SIPROTEC 4 devices to communicate with each other in an inter-relay communication network. The individual participating devices are called users.

**VD** A VD (Virtual Device) includes all communication objects and their properties and states that are used by a communication user through services. A VD can be a physical device, a module of a device or a software module.

**VD address** The VD address is assigned automatically by DIGSI Manager. It exists only once in the entire project and thus serves to identify unambiguously a real SIPROTEC 4 device. The VD address assigned by DIGSI Manager must be transferred to the SIPROTEC 4 device in order to allow communication with DIGSI Device Editor.

**VFD** A VFD (Virtual Field Device) includes all communication objects and their properties and states that are used by a communication user through services.

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