Handbook

REF542 bay control and protection unit (SCU)

ABB Calor Emag Mittelspannung GmbH
ABB Sécheron SA
ABB SACE T.M.S. S.p.A.
BA 452/00 E
Applicable from V2C.02, as of July 1999

Structure, function, technical data, configuration program, configuration, installation, commissioning, operation, maintenance, troubleshooting, decommissioning, storage

ABB Calor Emag Mittelspannung GmbH

Documentation prepared by:

Technische Dokumentationen
T. Platte
Brockenberg 4
52223 Stolberg

Table of Contents

List of Illustrations

List of Tables

1 Introduction

This section will show the following:

- How this documentation is structured, its details and the best way to use it.
- The principal tasks the REF542 can be used for.
- What the operator needs to know to ensure smooth operation.
- Our guarantee provisions.

REF542: The made-to-measure protection for your substation

This is the fully revised documentation for the microprocessor-controlled REF542 bay control and protection unit (formerly SCU: Switchbay Control Unit). Open Chapter "1.1 Operation of the REF542" on page 1-2 first to find an overview of the basic functions of your new unit. Please also read Chapter "1.2 How to use this documentation" on page 1-3. It outlines the basic concept of this documentation and is intended to assist in optimum usage of the unit.

Figure 1: Front view of the local command unit (LCU)

The above illustration shows the REF542 local command unit. The REF542 control panel is also referred to as the LCU (Local Command Unit). All other differences in design are in the “interior values”, the functions and the equipment of the unit. Detailed information on the designs can be found in Chapter "3.6 Overview of the technical data" on page 3-45.

1.1 Operation of the REF542

The REF542 bay control and protection unit is a microprocessor-controlled multi-function module. Installed in an air or gas-insulated switchbay, it controls the following primary functions:

- Measurement
- Monitoring
- Control
- Protection
- Communication and
- Substation Automation.

The REF542 is typically used in various switchbay types in medium-voltage substations, industry, marine substations and power supply companies. It is also used as backup protection in high-voltage substations or also for simple high-voltage bays. It is a component of the ABB PYRAMID®-substation control system.

The many and varied uses of the REF542 are controlled by the real-time capable microprocessor system. It consists of three self-monitoring microprocessors in continuous communication with one another. The following interfaces to the monitored bay are available:

- Binary inputs, electrically insulated by optocoupler for acquisition of external signals
- Binary output for sending signals (electrically insulated)
- Analog inputs for measuring current and voltage
- Process bus for data connections to external sensors
- Communications interface to connect to higher-order control systems and an
- interface for data exchange with the configuration PC.

The control panel can be supplied with a backlit LC display screen and nine keys as an option (LC is liquid crystal and refers to the functional principle of the display). In combination these components provide an easily understandable, self-explanatory operator view.

The REF542's variety of functions are precisely programmed for the requirements and the substation. The user-specific programming (application) is set up with the configuration program under Microsoft Windows®.

The various functions of the unit are shown by function blocks in a function chart (FUPLA) and linked to one another. The application is imported to the REF542 when the unit is commissioned.

The following protection and monitoring functions may be incorporated, depending on the application:

Current protection functions

- Inrush blocking
- Overcurrent definite time protection (directional, two-stage)
- Overcurrent definite time protection (non-directional, three-stage)
- IDMT protection (four characteritic curve sets)
- Earth-fault protection (GFP) (non-directional, two-stage)
- Earth-fault protection (GFP) (directional, two-stage)
- Earth fault AMZ: Earth fault-dependent maximum current time protection (four trip curve sets)

Voltage protection functions

- Overvoltage definite time protection (three-stage)
- Undervoltage definite time protection (three-stage)
- Residual voltage definite time protection (two-stage)

Motor protection functions

- Thermal overload protection
- Motor start protection
- Blocking rotor
- Number of starts

Additional protective functions

- Distance protection
- Transformer differential protection
- Thermal supervision
- unbalanced load
- Directional Power
- Low load
- Frequency supervision
- Synchrocheck
- Automatic reclosing (component of some protective functions)

Further information

A detailed description of all components of the REF542 and their functions can be found in Chapter "3 Design, Function and Technical Data" on page 3-1. What components can be combined in one device can be found in "Table 1: Combination options of the components/boards" on page 3-4.

Chapter "5.4 Function and configuration of the function blocks" on page 5-20 includes comprehensive information on the function and configuration of the protective functions. There is an overview of the allowable combination options for protective functions in Chapter "5.4.7 General Information on the protective functions" on page 5-87. This explains the limitations to which the protective functions are subject when preparing the function chart.

1.2 How to use this documentation

The modular structure of the documentation enables the required information to be found quickly in the day-to-day operation of the device. This is aided by the finely detailed table of contents, the index and cross-references in the text.

To a large extent, the information required to conduct specific activities has been collected in separate sections. This avoids time wasted in searching and flipping back and forth through pages. However, this documentation should be read completely. This is the only way to achieve an overview of the operation and the variety of functions of the REF542 bay control and protection unit.

Some additional information to assist in using this manual follows:

- Every main section (1 to 11) is preceded by an overview of its contents. This will enable you to find out quickly whether the desired information is in this section.

- References to a section where additional information on the same subject can be found are always in italic. In addition, if they are not in the middle of a section, references are preceded by the following character: ␦ This character means “See also...”.

  Example: ␦Section “15.3.3 There is more” on p. 1234.

- Safety information is graded according the degree of danger and therefore is shown differently.

  ␦Chapter "2.1 Appearance of Safety Notes" on page 2-1

- The following characters are used in tables as required:

Characters	Meaning
✓	Yes. / OK. / Function available.
—	No. / Not OK. / Function not available.

- All variations and components of the REF542 are described in this documentation. Information that is not relevant to your equipment may also be found. Your order documentation will show what components are included in your specific unit.

The following two subsections include additional special designations or illustrations in the documentation that refer to the local command unit or the configuration program. All terms in use are summarized there.

1.2.1 Special designations in the program documentation

Specific elements of the configuration program interface must be shown in a unified manner. This will ensure that the instructions are understood. Not all dialogue windows are described exactly in the corresponding sections. The structure of save and print dialogs is usually highly dependent on the operating system in use. Relevant information must be found in the online help or the manuals.

The graphics clarify the corresponding terms:

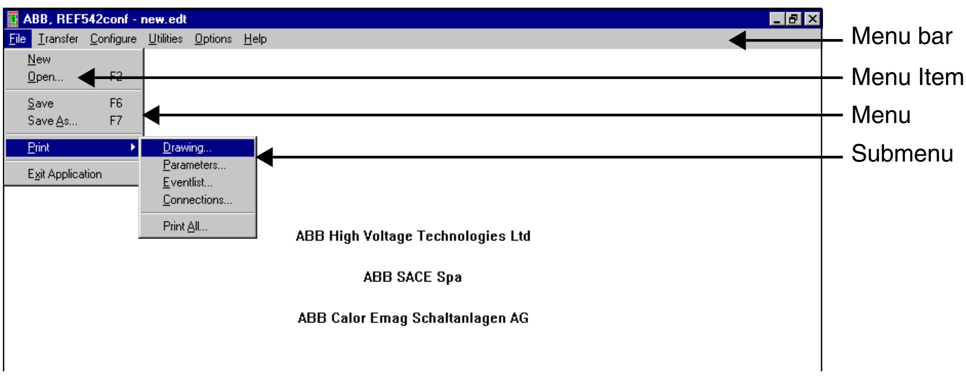


Figure 2: The menu structure as exemplified by the configuration program

The individual components are described below:

- The menu bar; click on the individual menus with the mouse cursor.
  The configuration program has two different menu bars, which are displayed on the upper border of the screen. After starting the program the main program menu bar (`Main menu`) is displayed. If the function chart editor is open, the other menu bar (`Drawing menu`) is displayed.
- The menu items; a menu is a combination of one or more menu items. They are selected with the mouse cursor and initiate an action.
- A submenu; after selecting a menu item a new menu with additional different menu items opens.

The individual menu items generally open dialog windows, which may appear as shown below and in part include the components described below.

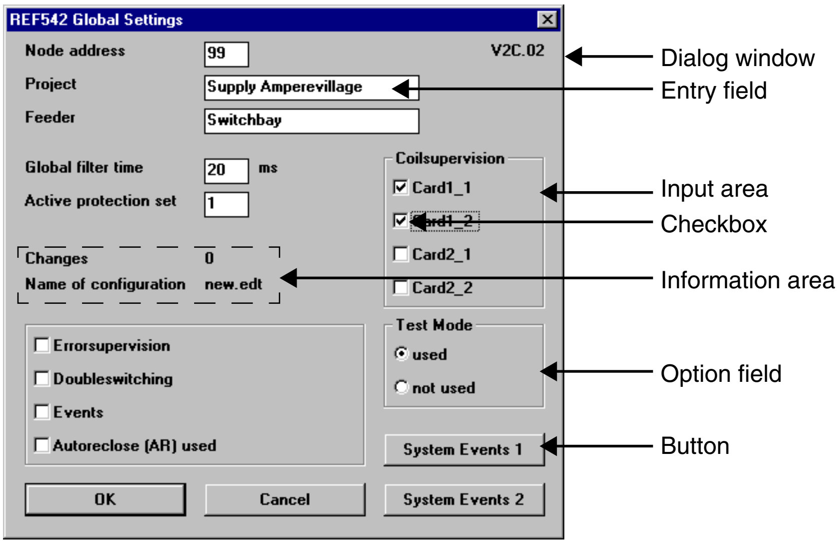


Figure 3: Dialog window for setting the REF542 unit as an example of the window components

The individual components of the complete dialog window are described as follows:

- Entry fields; an entry of restricted length relevant to the context can be made here.
- Input area; this contains several checkboxes and/or option fields to which specific functions are assigned. Input areas are always indicated by a surrounding frame.
- A checkbox; they are marked with the mouse cursor. The mouse cursor is moved to the checkbox and the left mouse button clicked. The function is then activated (marked with an X) or deactivated (empty box).
- Information area; information that cannot be changed at this point or not at all is shown here.
- An option field; only one option can be marked here at any point (filled circle). Any option can be marked; it then excludes the other.
- The button; it can be clicked with the mouse cursor and then opens additional dialog windows, acknowledges various inputs or cancels a process. It is labeled with its function.

The screenshot below shows additional dialog window components.

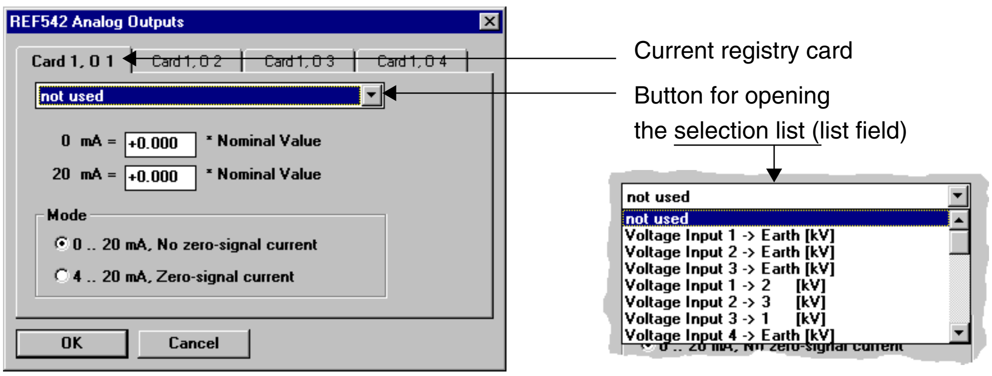


Figure 4: Section of a dialog window with a list field

- A selection from a list of options can be made in list fields. The following illustration shows an example of a list field: Left in the form as first shown in the dialog window and then right in its “open“ form. A selection list is opened by clicking the mouse cursor on the button with the down arrow.

- Registry cards combine different setting options. To bring a a desired registry card to the foreground, click the mouse cursor on the visible part (the “tab“ at the top) of the otherwise concealed card.
- Text or terms taken from the dialog windows or the configuration program are shown in a non-proportional font.
  Example: Click the `Accept` button to implement the set values.
- If menu items or submenus are to be activated in menus, this is described as follows:
  E.g. Select the menu item `Main Menu/File/Print/Connections...`.
  First select the `File` menu from the menu bar of the main menu. Then select the `Print` submenu and then the menu item `Connections...`. The matching dialog is then shown.

Note: Typical Windows save or print dialogs are not described in greater detail in this documentation, because they depend on the operating system in use. However, they do use the control components that have been described above.
Detailed explanations on using windows and the Windows operating system can be found in the Windows manual or Windows online help.

1.2.2 Special designations in the LCU documentation

The following symbols and designations for the switching elements on the LCU (local command unit) can be found in the descriptive text. The key symbols in the text are all set in pointed brackets and in bold.

Example: Press the <✓> keys to confirm the input.

The following graphic shows the arrangements of the control elements on the LCU.

Figure 5: Front view of the local command unit (LCU) with its control elements

The description or display of the control elements shown above can be found in the diagram below.

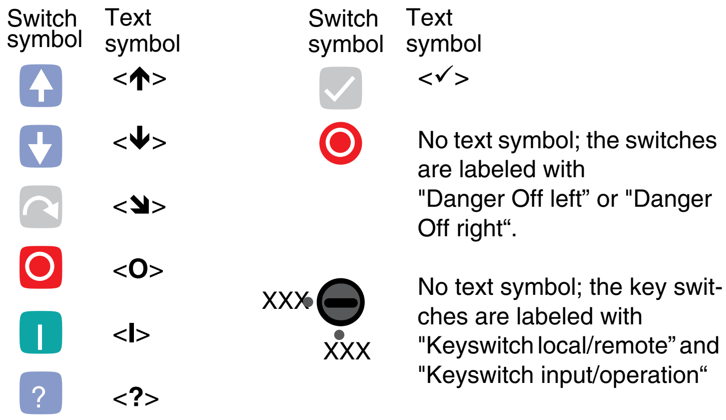


Figure 6: The switch symbols on the LCU and the symbols assigned to them in the text

1.3 Operator's responsibilities

Please observe the following information for the operator:

- The operating personnel for the REF542 must have the appropriate qualifications for work on the unit.
- Your operating personnel must be authorized to work with or on REF542. (E.g. switching authorization in substations)
- Changes to the application as delivered may be made only by ABB personnel.
- For guarantee reasons, changes to the application as delivered made by the customer must always be approved by the appropriate ABB sales department.
- We recommend that only ABB personnel make adjustments to the unit. Once the guarantee has expired, the unit is opened at your own risk and is permitted after consultation with the ABB office that sold the unit.

1.4 Guarantee Provisions

The data provided in this documentation is intended solely to describe the product and must not be considered as assured properties. In the interest of clients, we are continually striving to bring our products up to the latest state of the art in technology. For this reason there may be differences between the product and the product description and the Handbook.

If the instructions and recommendations of our documentation are observed, then, according to our experience, the best possible operational reliability of our products is guaranteed.

It is virtually impossible for comprehensive documentation to cover every possible event that may possibly occur when using technical devices and apparatus. We therefore request that we or our representatives be consulted in the event of any unusual incidents and in cases for which this Handbook do not provide comprehensive information.

We explicitly refuse to accept any responsibility for all direct damages that occur as a result of erroneous usage of our devices, even if no special instructions on this are included in the Handbook.

The documentation has been carefully checked. If the user should find any defects in spite of this, we request that you inform us as quickly as possible.

↳Chapter "9.4.1 ACE Center" on page 9-39
↳Section "11.12 Feedback Form“ on page 11-90

We, ABB Calor Emag Schaltanlagen AG, provide a 1 year guarantee for the functioning of the REF542.

The guarantee provisions are a component of the related contract documents.

Note Special arrangements may be made in consultation with the operator and will be specified in the contract documentation.
In general, all agreements, assurances, legal relationships and all ABB Calor Emag Schaltanlagen AG obligations arise from the current valid contract documentation, including any reference to the warranty provisions, which are not influenced by the content of this documentation.

Note ABB Calor Emag Schaltanlagen AG assumes no responsibility for damages resulting from improper use of REF542.

In the event of a guarantee claim, please contact the ABB office that sold the unit.
↳Chapter "9.4 Further information" on page 9-38.

2 Safety Regulations

In this chapter you will find the following information:

- The layout of safety notes in this documentation
- General safety notes
- Special safety warnings that must always be observed when working with the REF542.

The safety notes in the following chapters represent only a general selection of the points that must be observed. Additional safety notes applicable to the actual content of the chapter can be found in the specific chapters referring to the functions described or the Handbook.

Safety notes are either at the beginning of the section or directly at the relevant position in the text.

2.1 Appearance of Safety Notes

There are notes and warnings on hazards at the beginning of every section and also in the text. They are in a different font to distinguish them from normal text.

The safety warnings must be observed in all circumstances. If they are not observed, no guarantee claims will be accepted.

Note

A note indicates items that are significant in the specific context. A note may contain information on the interplay of various software components and appears as shown below.

Example:

Note — Please read this section completely for information on the various formats for safety notes.

Hazard information level 1

Level 1 hazard information indicates hazards affecting substations and devices. It should always be observed, because otherwise function interruptions or malfunctions may occur. An example is shown below:

Caution — **Do not make any changes to the function chart unless you are familiar with the REF542 and the configuration software.**

Hazard information level 2

Level 2 hazard information indicates hazards affecting life and limb. It must be observed to avoid injury to the operator or other personnel.

Example:

Warning! — **Never attempt to remove the protective covers on the busbars by force.**

2.2 General safety notes

Documentation

Note

The content of the documentation supplied with the device must be followed in all circumstances when the device is in operation.

Operating an electrical device

Warning!

When any electrical device is being operated, specific parts of the device are subject to voltage. If safety warnings are not followed, hazards to personnel and property will result. Personal injury and damage to property may also occur.

Safe Operation

Note

The device must be properly transported and stored to ensure fault-free and safe operation. In addition, commissioning, control, service and maintenance must be properly and thoroughly conducted.

Please also observe the following requirements for the operator:
↳Chapter "1.3 Operator's responsibilities" on page 1-7

2.3 Specific safety information

Five safety rules

Warning!

The five safety rules according the so called "VBG4 Electrical Substations and Equipment“ must be observed in all circumstances for personal safety:
1) Isolate the system before beginning work.
2) Secure against reactivation.
3) Ensure that there is no voltage.
4) Ground and short circuit.
5) Cover or shut out neighboring parts under power.

Additional safety standards

Warning!

The following safety standards must be observed in all circumstances:
1) DIN VDE 0435 electrical relays in high-voltage substations
2) DIN VDE 0627 plug connections

Working on and operating the device

Note

Only qualified personnel may work on and operate the device.

Qualified personnel are:

- Entrusted with the setup, installation, commissioning and operation of the device and the system in which it is installed.
- Qualified and authorized to conduct switching operations in accordance with the standards of safety engineering. This specifically includes switching on and off, isolating, grounding and signage.
- Trained in safety engineering standards and are familiar with the maintenance and use of safety equipment.
- Trained in first aid.

3 Design, Function and Technical Data

In this chapter you will find the following information:

- How to conducting the basic functions of measurement, monitoring, control and protection on the device
- How the REF542 operates in detail and its capabilities
- Its components
- What specific components do
- The control components of the REF542 bay control and protection unit
- The technical data of the unit and its components
- The tests and standards to which the unit or individual components are subject.

This chapter should be read through in full to become familiar with the unit and its functions and its options.

Chapter "3.6 Overview of the technical data" on page 3-45 provides an overview of the technical data of all possible components of the REF542. Chapter "3.2.2 Combination options for the components/boards" on page 3-4 explains how components can be combined.

This information and knowledge of the scope of delivery of the reader's own unit, which can be found in the delivery documents, will enable the reader to find specific information on his own unit in Chapter "3.4 Components: Function and Technical Data" on page 3-12. Finally, Chapter "3.5 Principles of LCU control" on page 3-42 provides information on the principles of control of the REF542 bay control and protection unit.

3.1 Basic Information

Measuring, monitoring, control and protection

The REF542 acquires various measured quantities from the bay being monitored via the binary and the analog inputs. They are converted to digital values and filtered. The filters remove harmonics and other high-frequency signals (> 350 Hz) and also low-frequency signals (< 45 Hz).
Unfiltered signals are used for impedance protection to guarantee its proper functioning.

The current values and the calculated rms values (rms values: root mean square values) are saved in a buffer memory. All currents, voltages, outputs, energies and the frequency are saved there. The buffer memory is scanned at regular intervals and the protection unit calculates whether a protective function should be started. If necessary a trip signal is generated. The buffer memory ensures that the processor holds constant measured values for the duration of the calculation. The following diagram clarifies the principal procedure.

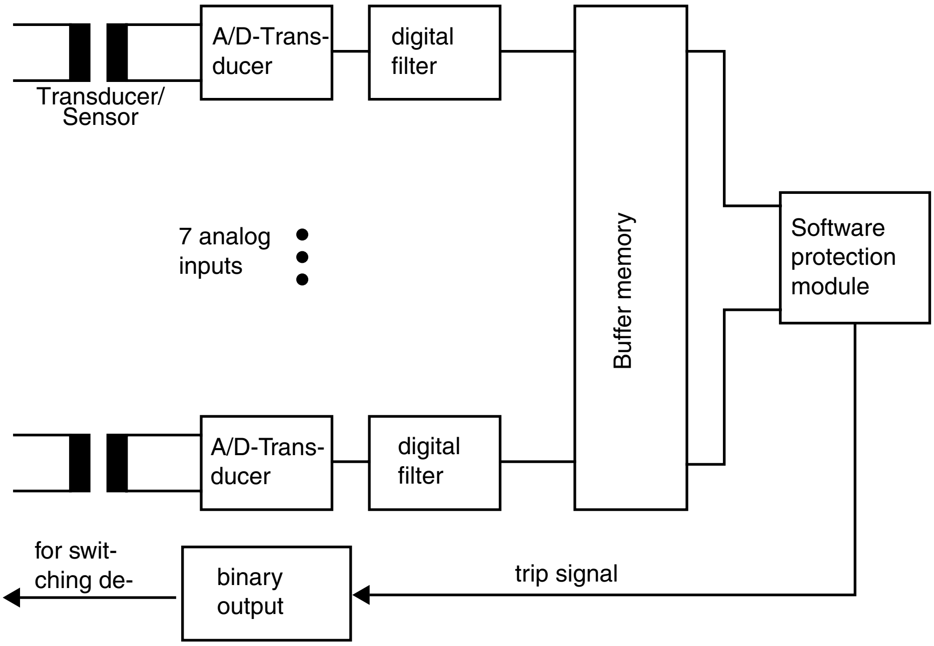


Figure 7: Principal protective function actions in the REF542

The next diagram shows the basic communications structure between the components of the REF542 and the required peripherals. The variety of functions of the bay control and protection unit is only possible with these communications. Continuous data exchange among the three processors ensures mutual monitoring.

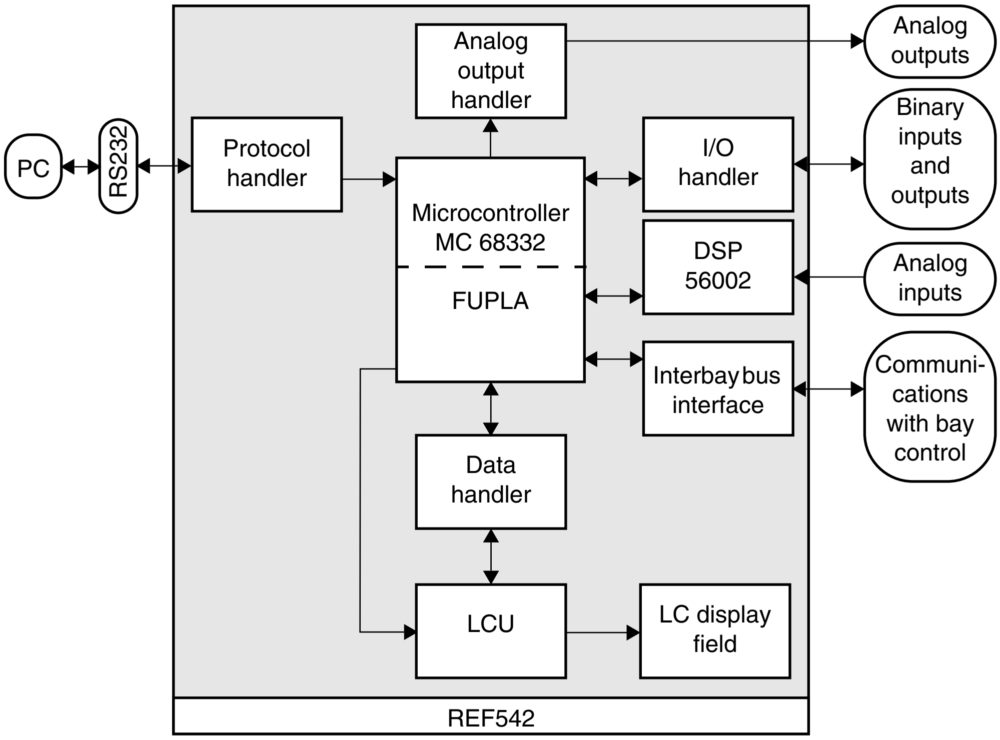


Figure 8: Communication paths between the REF542 and its peripherals

The arrows indicate the direction of communication in every case. The terms and abbreviations are explained below:

- PC: Personal computer for configuring the REF542 and for recording measurement data.
- RS232: REF542 interface to a PC. It is at the operator view (LCU) of the bay control and protection unit.
- Protocol Handler: It administers the data to be exchanged between the REF542 and the PC; for example, when exporting measured values and event data from the REF542 to the PC.
- Analog Output Handler: It ensures that measured or calculated values are output by the analog output board.
- Microcontroller: A processor that coordinates data exchange with the other blocks, among other functions.
- FUPLA: Function chart; in this case a component of the microcontroller for the program controller.
- DSP: Protection and measurement unit (digital signal processor), among other functions responsible for processing the protective functions. The DSP also generates the trip signals for switching devices.
- Interbay bus interface: Intelligent module used to link a higher-order control system to the substation computer by a fiber-optic cable.
- I/O handler: It administers the data and commands for the binary inputs and outputs.
- Data Handler: It administers the data exchanged between the microprocessor and the LCU; for example, the status of the switches or the LED controls.
- LCU (Local Command Unit): Operator view of the REF542 with display screen, keys, LEDs and keyswitches.

Detailed information on the basic functions described above can be found in the following sections:

✎Chapter "3.3 General description of functions" on page 3-5

✎Chapter "3.4 Components: Function and Technical Data" on page 3-12

3.2 Design

The REF542 consists of various components that are described in Chapter "3.4 Components: Function and Technical Data" on page 3-12. General information and an overview of the combination options of the components is given below first.

3.2.1 General information

The REF542 housing is aluminum and painted with a special black coating. The paint protects the housing against electromagnetic interference. There is a short housing and a deep housing. An additional third binary input/output board and also the analog output board can be installed in the deep housing.

To enable installation in a switch panel, the front panel with its control elements is at the front of the housing. The plug connectors for connecting the unit to the bay are on the various boards, which are installed in the housing parallel to the control panel. They are accessible from above and protected by a cover. A signal converter (“Rucksack“) for level conversion is attached to the rear or the side of the housing when current and voltage converters are used.

When sensors are used the converter set is not used. In this case, the sensor connector adapter is attached to the side of the REF542 housing with test taps.

✎Chapter "3.4.6 Recording measured values" on page 3-32

Depending on the equipment option, the REF542 control panel, is fitted with a backlit LC display screen. There are also 9 membrane keys and two keyswitches with eleven LEDs (light-emitting diodes) on the front panel. An RS232-standard interface for connection to a PC is installed on the front panel. Special keyswitches and connector covers can be supplied to raise the protection class.

The unit is of modular design and consists of various boards, each with a specific function.

↳Chapter "3.4 Components: Function and Technical Data" on page 3-12

3.2.2 Combination options for the components/boards

The following table shows what components/boards and housings can be combined. Therefore, it provides information on the unit's expansion options.

Table 1: Combination options of the components/boards

			1st Board		2nd Board		3rd Board			Processor Board		Communications board		Housing	
		Voltage supply	**Transistor relay**	**Conventional relay**	**Transistor relay**	**Conventional relay**	**Transistor relay**	**Conventional relay**	**Analog outputs**	**Processor 1**	**Processor 2**	**SPA Bus**	**MVB**	**Short**	**Deep**
	Voltage supply	—	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
1st Board	**Transistor relay**	✓	—	—	✓	—	✓	—	✓	✓	✓	✓	✓	✓	✓
	Conventional relay	✓	—	—	—	✓	—	✓	✓	✓	✓	✓	✓	✓	✓
2nd Board	**Transistor relay**	✓	✓	—	—	—	✓	—	✓	✓	✓	✓	✓	✓	✓
	Conventional relay	✓	—	✓	—	—	—	✓	✓	✓	✓	✓	✓	✓	✓
3rd Board	**Transistor relay**	✓	✓	—	✓	—	—	—	✓	—	✓	✓	✓	—	✓
	Conventional relay	✓	—	✓	—	✓	—	—	✓	—	✓	✓	✓	—	✓
	Analog outputs	✓	✓	✓	✓	✓	✓	✓	—	—	✓	✓	✓	—	✓
Processor board	**Processor 1**	✓	✓	✓	✓	✓	—	—	—	—	—	✓	—	✓	—
	Processor 2	✓	✓	✓	✓	✓	✓	✓	✓	—	—	✓	✓	✓	✓
Communications board	**SPA bus**	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	—	✓	✓
	MVB	✓	✓	✓	✓	✓	✓	✓	✓	—	✓	—	—	✓	✓
Housing	**Short**	✓	✓	✓	✓	✓	—	—	—	✓	✓	✓	✓	—	—
	Deep	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	—	—

3.3 General description of functions

The REF542 receives a large quantity of information from the switchbay via the binary and the analog inputs. These measured values are acquired and processed in cycles.

The values are acquired by current and voltage transformers. The signal level is converted by signal converters installed in an attachment on the REF542. The signal converter signals are forwarded to the unit by a terminal strip on the converter attachment. If current and voltage sensors are used, the signal converters are not used and the output signals are wired from the sensors to the analog inputs of the REF542 through a sensor connector adapter.

Binary and analog outputs are also available (when the corresponding boards are in use), for example to initiate switching operations. A fiber-optic system enables communication with a higher-order control system.

For the most part, the versatile functions of the REF542 are conducted by a realtime-enabled multiprocessor system. The individual processors conduct the following tasks:

DSP: Digital Signal Processor, Motorola DSP 56002
Protection and measurement unit for:

- Processing the protection algorithms,
- Generating the starting, trip and directional signals,
- Generating the signal for the automatic restart (AR), when configured,
- Processing the blocking signal,
- Input filtering,
- Communication with the microcontroller and
- Self-monitoring.

MC: Microcontroller, Motorola MC 68332
Control and command unit for:

- Communication with the DSP and the peripherals,
- Processing the inputs and outputs,
- Data recording, processing and storage,
- Data exchange with the local control unit (LCU) and
- Self-monitoring.

CP: Communication Processor
Communication unit for the interbay bus for:

- Data exchange with the substation unit of a control system (for example, within the ABB Pyramid® system) via the communications interface. The communications board depends on the protocol in use.

The circuit diagram shows the design and the functional connections of the REF542 and its three main processors.

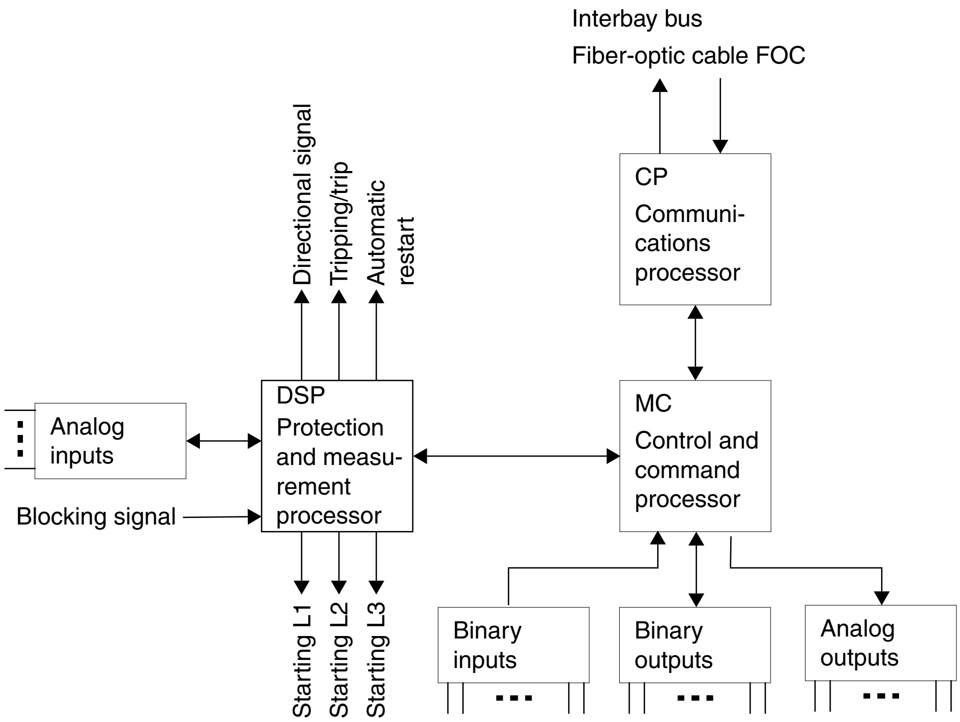


Figure 9: Circuit diagram of the communication paths for the three main processors

A table below shows exactly what protective functions the REF542 has and what types of faults can be detected. The table can also show how much the protection and measurement processor (DSP) is addressed by the various protective functions. The user can also determine the number of parameters used per protective function. This information is important, because an application can only operate properly if the configured protective functions meet the following three criteria:

- Max. DSP load 100%
- Max. 12 protective functions
- Max. 120 protection parameters (note that 26 parameters are always used independently of the protective functions.)

Further information on the restrictions on the use of protective functions can be found in Chapter "5.4.7 General Information on the protective functions" on page 5-87.

Table 2: REF542 protective functions

ANSI Code	Protective function	DSP usage in %	Number of parameters	Protective function	Monitoring function	Phase selective	3-pole AR	1, 2 or 3-pole Faults	Line-earth faults
68	Inrush current blocking	7	8	✓	—	—	—	✓	✓
67	Overcurrent Directional High	12	5	✓	—	—	✓	✓	✓
67	Overcurrent Directional Low	12	5	✓	—	—	—	✓	✓
50	Overcurrent Instantaneous	7	4	✓	—	✓	✓	✓	✓
51	Overcurrent High	3	4	✓	—	✓	✓	✓	✓
51	Overcurrent Low	3	4	✓	—	✓	—	✓	✓
51	IDMT	6	4	✓	—	—	—	✓	✓
50N	Earthfault High	6	4	✓	—	—	✓	✓	✓
50N	Earthfault Low	6	4	✓	—	—	—	✓	✓
67N	Earthfault Directional High	6	6	✓	—	—	✓	✓	✓
67N	Earthfault Directional Low	6	6	✓	—	—	—	✓	✓
51N	Earthfault IDMT	6	4	✓	—	—	—	✓	✓
59	Overvoltage Instantaneous	3	4	✓	—	✓	—	✓	✓
59	Overvoltage High	3	4	✓	—	✓	—	✓	✓
59	Overvoltage Low	3	4	✓	—	✓	—	✓	✓
27	Undervoltage Instantaneous	4	4	✓	—	✓	—	✓	✓
27	Undervoltage High	4	4	✓	—	✓	—	✓	✓
27	Undervoltage Low	4	4	✓	—	✓	—	✓	✓
59N	Residual overvoltage High	3	4	✓	—	—	—	✓	✓
59N	Residual overvoltage Low	3	4	✓	—	—	—	✓	✓
49C	Thermal Overload	7	8	✓	—	—	—	✓	✓
51	Motor Start Protection	3	4	✓	—	—	—	✓	✓
51LR	Blocking Rotor	8	4	✓	—	—	—	✓	✓
66	Number of Starts	0	4	✓	—	—	—	✓	✓
21	Distance Protection	53	57	✓	—	✓	✓	✓	✓
49T	Thermal Supervision [1]	7	4	✓	—	—	—	✓	✓
46	Unbalanced Load	9	5	✓	—	—	—	✓	✓
32	Directional Power	2	5	✓	—	—	—	✓	✓
37	Low Load	4	6	✓	—	—	—	✓	✓
81	Frequency Supervisiom	2	4	—	✓	—	—	✓	✓
25	Synchrocheck	10	5	—	✓	—	—	✓	✓

1) This protective function requires a LON temperature sensor on the process bus

Control functions

Up to eight switchgear units and/or fixed symbols can be displayed on the freely configurable LC display screen by using a single-phase mimic diagram. The three keys below the LC display screen <➘>, <**I**>, <**O**> can be used to select up to five switchgear units and control them in double-pole mode. Manually controlled devices can be displayed as well as the remote controlled devices. The lower keyswitch "local/remote“ blocks the local controller and releases the remote control via the control system. The control functions can be individually defined by using the configuration program and can be adapted for all current stations.

Interlocking

The interlocking is programmed with a user-friendly configuration program. Bay-level interlocking can be easily controlled by the position messages available from the individual switchgear units. Station-level interlocking can also be programmed. The messages required for this are sent to the binary inputs of the REF542 via the wiring. This allows the information to be linked to the bay level.

A control command, regardless of whether it is input at the local controller unit or at a control system, is only run if all interlockings are in place. Otherwise the command is blocked and an error message is displayed.

Measurement functions

Various measured values are displayed above the mimic diagram on the LC display screen. The display is numerically absolute and also in the case of currents and voltages as a bar graph. The currents are displayed relative to the rated value, that is set for the specific bay.

The display of the line voltage is based on the rated system value, and the display of the phase voltage is based on the rated system value /√3.

Chapter "5.3.4.3 The nominal values of the net and the measured value display" on page 5-10

The measured value to be displayed is selected with the two arrow keys. The measured values are arranged in a ring binder menu, which can be leafed through in either direction with the arrow keys.

If all of the REF542 measurement inputs are occupied with the corresponding signals, the following measured and calculated values can be displayed when the unit has all functions activated:

- The three line currents
- The earth current (measured)
- The zero sequence current (calculated)
- The average of current per phase in a configurable time window (1-30 minutes)
- The maximum current value per phase (i.e. the upper, maximum average value recorded),
- The three phase voltages
- The three line voltages
- The residual voltage (measured)
- The zero sequence voltage (calculated)
- The active power
- The reactive power
- The active energy
- The reactive energy
- The cos φ
- The frequency
- The operating hours
- The total of switched phase fault currents
- The number of power circuit-breaker switching cycles.

To enable the option of measuring and calculating the above quantities, the REF542 requires a specific minimum number of current and voltage transformers/sensors that can be assigned to the seven analog inputs/measurement inputs:

- A current transformer/sensor for every phase that is to be measured,
- A voltage transformer/sensor for every phase that is to be measured,
- Once there is more than one voltage transformer/sensor, the line voltages are calculated and
- to calculate the power at least two current transformers/sensors and three voltage transformers/sensors (measurement of the phase voltages) are necessary.

"Table 46: Measured value display on the REF542 LC display screen" on page 8-5 provides a detailed overview of the conditions under which a measured or calculated value is displayed.

The physical sampling rate for the measured values is 2.4 kHz. Because two sampling values are combined by the measurement algorithm, the effective sampling rate is 1.2 kHz. When calculating the rms value (rms value: root mean square = square root of the sum of the quadratic average values) for current and voltage, the signal up to the seventh harmonic for 50 Hz or 60 Hz is used. These values are then also used as the basis for calculating power and energy.

✎Chapter "11.7.1 Measured-value processing" on page 11-30

When calculating power, note that the REF542 expects the conductor-earth voltage as the voltage input quantity. The power can be calculated by the “Aron method“ or three-phase as required.

✎Chapter "11.7.5 Power calculation" on page 11-33

To calculate the frequency, a voltage sensor/transducer is normally used. If there are only current sensors/transducers available, one of them is used.

✎Chapter "11.7.4 Calculation of the frequency" on page 11-33

If the temperature is required as a measured quantity, it is linked to the REF542 via the process bus (LON).

Monitoring

There is a total of eleven LEDs on the LCU, which display the current operating states of the switchbay.

The Operating LED lights as soon as the REF542 is ready for operation.

A three-color protection-status LED provides information on the status of the protective functions (protection not activated, protection activated, protection tripped).

A two-color interlocking status LED monitors the interlocking of the protective functions. It shows red if a prohibited switching operation is attempted.

The large red ALARM LED is strictly for warnings and, for example, is used to display a group alarm. When it is lit, communication with a PC, parameter set switching and parameter setting on the REF542 is not possible. The warning must first be acknowledged. The seven remaining LEDs can have the colors green, orange and red. They are freely configurable.

The warning or alarm messages can be saved until the alarms have been acknowledged. The explanations for the LEDs are displayed on the LC display screen when the <**?**> key is actuated.

Various functions are available for more detailed monitoring of the equipment in the switchbay, such as:

- Switching cycle counter
- Monitoring activation and deactivation circuits of the power circuit-breaker

- Monitoring the gas spaces in SF_6 insulated substations (with corresponding external wiring)
- Monitoring the spring power of the power circuit-breaker (with corresponding external wiring)
- Monitoring the miniature circuit breakers in the switchbay (with corresponding external wiring).

The REF542 monitors itself internally. It has one watchdog relay per binary input/output board. This relay is actuated and breaks the N/C circuit as soon as one of the following faults occurs:

- Processor error: The MC (control and command processor) and the DSP (protection and measurement processor) are in continuous communication with each other. If one of the two processors detects a malfunction in the other, the REF542 is restarted.
- Interruption in auxiliary voltage supply: If this occurs, the REF542 is subject to a defined shut down with an internal voltage reserve. This retains the contents of the REF542 memory. Interruptions in the auxiliary voltage that last for less than 50 ms will have no effect.

The watchdog relay can also provide a second signaling path for reporting a malfunction in the REF542 directly to the message.

In addition, two output channels per binary output board in the REF542 can be monitored for trip circuit defects. A total of four output channels can be checked. The trip circuits on the breaker outputs are continuously monitored for interruptions by a quiescent current.

Trip circuit defects and processor errors are also transmitted to the higher-order control system over the interbay bus. A defective or missing communications board will therefore not influence the local controller functions or the protective functions.

The analog output board can, depending on its configuration, allow a quiescent current of 4 mA to flow to the connected terminal device. This allows the terminal device to generate an error message if the quiescent current fails.

Communications

The optical interface enables the REF542 to communicate directly with a higher-order control system. To ensure interference-resistant data transmission over the interbay bus, transmission throughout the system uses fiber-optic cables. The REF542 supports the SPA bus and the MVB protocol.

There is an RS 232 interface for communication with a PC on the front panel. This enables an application to be sent to the REF542. Before sending an application, the function chart included in it is checked for correctness according to various criteria.

Measured values, configuration data or the data from the optionally configurable interference recorder can be queried while the REF542 is operating via the RS 232 interface.

A defective or missing communications board will not influence the unit's local controller functions or its protective functions.

Data storage

The monitoring values of various sizes are saved internally. This includes: Maximum current values, energy values, switching cycles, switched currents and the fault records. The values are retained even if the auxiliary voltage fails or during maintenance work.

An event list is also maintained internally when the REF542 is connected to a control system. The events are timestamped and saved in a ring list with 50 entries. The trip side, which contains the information on the last protective function trips, is saved in volatile memory.

Configuration

The configuration program is used to configure the REF542. All functions are designed as straight program components, and therefore changes to a function are usually possible without changes on the unit.

The application is saved in non-volatile memory in an EEPROM. It sets most of the capabilities of the REF542.

The configuration software runs under the Microsoft Windows® PC user interface. The functions are linked to one another in a function chart (FUPLA). It is programmed similarly to PLC programming and does not require special knowledge. The REF542 functions can therefore be changed in almost any way desired. This flexibility is particularly significant in with all automation sequences: For example, device and protection interlocking, switching sequences and automated functions can be implemented.

In the function chart various logical functions can be accessed as well as the function blocks of the protective functions and the binary interfaces. AND, OR and XOR logic gates as well as various flip-flop types and timing circuits are also among the other items available.

Operating modes

The REF542 can be used in three different operating modes. The two keyswitches on the control panel (LCU – Local Command Unit) of the unit are used to set the required operating mode.

The two modes "local/operating“ and "remote/operating“ are used in "standard“ REF542 operations. In these modes all configured functions are active, and the unit can be controlled locally ("local/operating“) or from a higher-order control station ("remote/operating“). For example, the operational data (measured and calculated quantities important for tripping the protective functions) can be scanned, maximum values can be displayed, switching operations conducted and alarms acknowledged.

The “local/input“ operating mode enables various settings to be scanned and changed directly at the unit. The protective function parameter sets can be checked and if necessary another parameter set can be selected. In addition, the test mode, in which all interlockings are deactivated and function tests can be run, can be started. Authorization to start the test mode must be configured in the application.

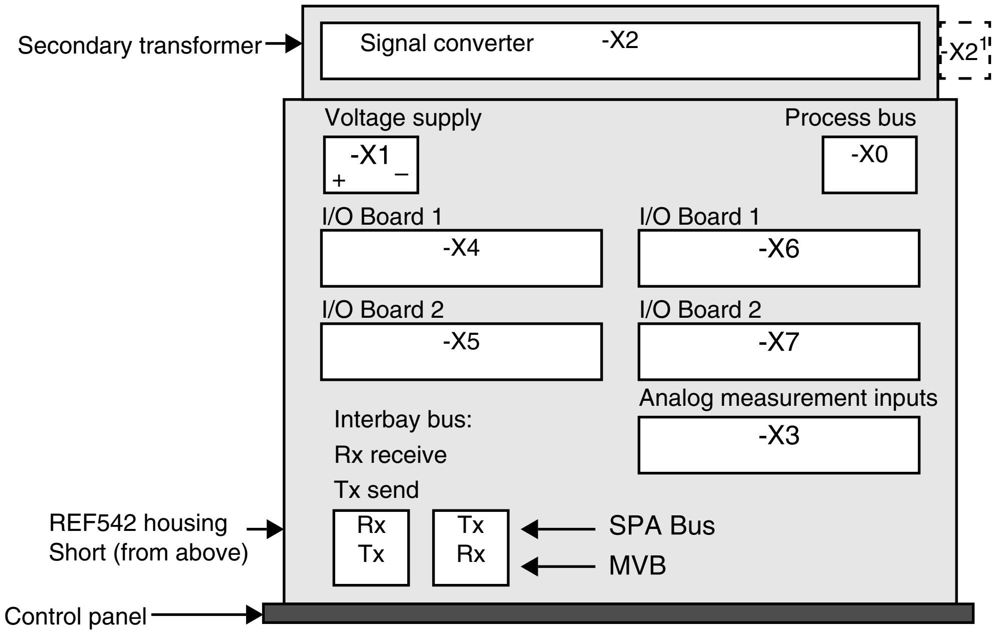
3.4 Components: Function and Technical Data

The various components generally correspond to the individual boards. The fact that every one of these boards can be combined with others gives the REF542 its flexibility and variety of functions.

↳Chapter "3.2.2 Combination options for the components/boards" on page 3-4

The boards have different interfaces, designated X1 to X10, Rx and Tx and accessible from above after removing the housing cover. The interfaces form the connection between the REF542 and the bay or equipment that is being monitored. The boards are plugged into the housing from above. To protect the boards there is an inner cover in the unit that has openings for the interfaces. Every board has the plug contact strip for the backplane (backplane, which is at the bottom of the housing. It connects the various boards together.

The principal configuration of the interfaces of the boards in the deep or short housing is shown in the two diagrams below. They both show a view of the REF542 from above and show the maximum possible number of boards that can be installed. The description and the technical data of the individual interfaces can be found in the following subsections where the individual components are described.



1) Position of the -X2 interface when core-balance current transformers are used in the short REF542 housing from above

Figure 10: Configuration of the interfaces in the short REF542 housing from above

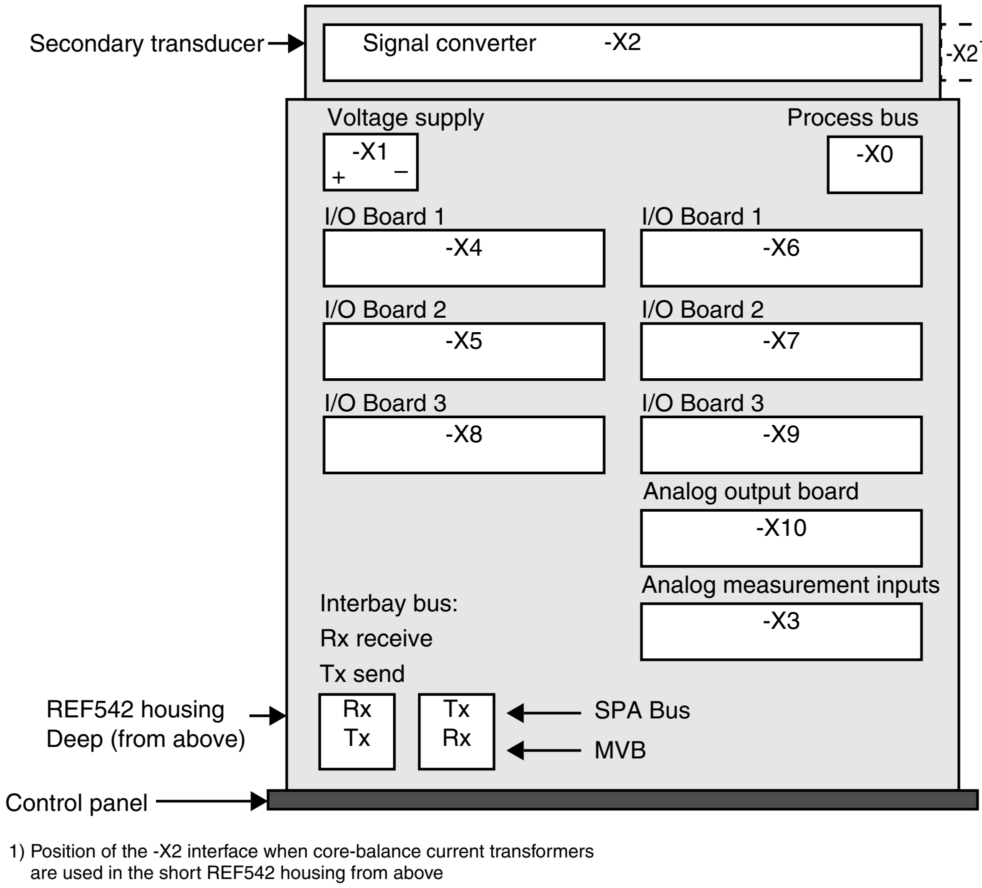


Figure 11: Configuration of the interfaces in the deep REF542 housing from above

3.4.1 CPU Board 1

Note The CPU board 1 can only be used with software versions V1*.**.

The CPU board is the heart of the REF542. It has two of the three processors. The third processor, the communication unit, is on the interbay bus board. The interface that receives the analog input quantities is installed directly on the CPU board. This enables them to be directly processed and evaluated. The following sections contain additional information on recording and processing measured values:

↳Chapter "3.1 Basic Information" on page 3-1

↳Chapter "3.3 General description of functions" on page 3-5

The following diagram shows the schematic design of the CPU1 plug-in board. The sections relevant for this documentation are labeled. The black marks on the EEPROMs in the drawing indicate the orientation of the correspondingly marked corner on the EEPROM itself.

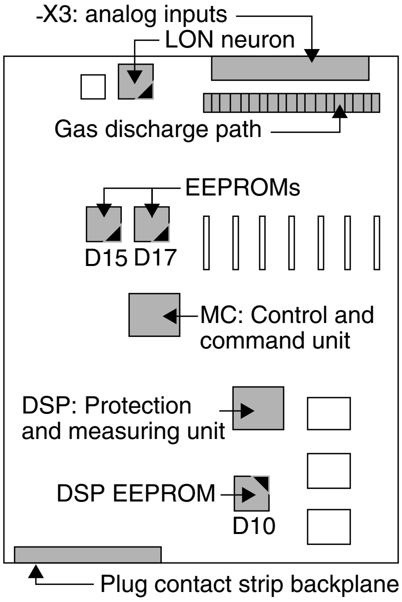


Figure 12: Schematic design of the CPU1 plug-in board

Caution **Observe the precautions necessary when handling components that might be damaged by electrostatic discharges.**

Interface assignment, -X3 analog inputs

The analog input signals are not sent directly from the switchbay to the -X3 interface. If transducers are used, the signals are received at the interface via the signal converter; if sensors are used, the signals are received at the interface via the sensor connection adapter with check tapping.

↳Chapter "3.4.6.4 Sensor terminal adapter" on page 3-35

Table 3: -X3 interface assignment

-X3: analog inputs			
d-terminal	**Signal**	**z-terminal**	**Signal**
2	not assigned	2	not assigned
4	analog signal input 7	4	analog signal input 7
6	not assigned	6	not assigned
8	analog signal input 6	8	analog signal input 6
10	not assigned	10	not assigned
12	analog signal input 5	12	analog signal input 5
14	not assigned	14	not assigned
16	analog signal input 4	16	analog signal input 4
18	not assigned	18	not assigned
20	analog signal input 3	20	analog signal input 3
22	not assigned	22	not assigned
24	analog signal input 2	24	analog signal input 2
26	not assigned	26	not assigned
28	analog signal input 1	28	analog signal input 1
30	not assigned	30	not assigned
32	not assigned	32	not assigned

Plug type

Socket: Harting 09 06 248 3201, DIN 41612
Matching plug: Harting 09 06 000 9474, DIN 41612

Connector cable cross section max. 2.5 mm^2 when transducers are connected to the -X2 signal converter connection
Connector cable cross section max. 0.5 mm^2 when sensors are connected to the sensor connector adapter.

Table 4: Technical data of processor card, CPU 1

Processor Board			
Digital Signal Processor	DSP 56002		
Microcontroller	MC68332		
LON process bus	LON neuron		(optional)
Analog inputs	7		
	Rated frequency: 50 Hz or 60 Hz		Operating range of protective functions: 49.5 Hz … 50.5 Hz or 59.5 Hz … 60.5 Hz
	Rated current:	150 mV 1 A or 5 A	when sensors are used when signal converters are used
	Permissible load of current circuit sustained: $4 \cdot I_n$ during 1 s: $100 \cdot I_n$ dynamic (1 half-period): $250 \cdot I_n$		 (peak value)
	Rated voltage:	$2\ V/\sqrt{3}$ 100 V or 110 V	when sensors are used when signal converters are used
	Consumption per conductor: In the current circuit: In the voltage circuit:	 < 0.1 VA < 0.3 VA < 0.25 A	 at I_n=1 A at I_n=5 A at U_n

3.4.2 CPU board 2

Note The CPU board 2 is used from software version V2*.**.

The CPU board is the heart of the REF542. It has two of the three processors. The third processor, the communication unit, is on the interbay bus board. The interface that receives the analog input quantities is installed directly on the CPU board. This enables them to be directly processed and evaluated. The following sections contain additional information on recording and processing measured values:

↳Chapter "3.1 Basic Information" on page 3-1
↳Chapter "3.3 General description of functions" on page 3-5

The following diagram shows the schematic design of the CPU 2 plug-in board. The sections relevant for this documentation are labeled. The black marks on the EEPROMs in the drawing indicate the orientation of the correspondingly marked corner on the EEPROM itself.

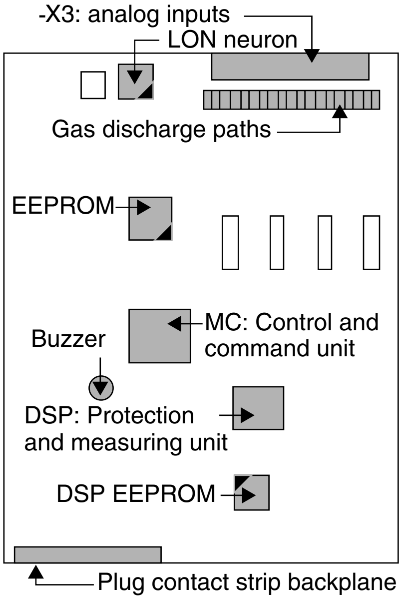


Figure 13: Schematic design of the CPU2 plug-in board

Caution **Observe the precautions necessary when handling components that might be damaged by electrostatic discharges.**

Interface assignment, -X3 analog inputs

The analog input signals are not sent directly from the switchbay to the -X3 interface. If transducers are used, the signals are received at the interface via the signal converter; if sensors are used, the signals are received at the interface via the sensor connection adapter with check tapping.

↳Chapter "3.4.6.4 Sensor terminal adapter" on page 3-35

Table 5: -X3 interface assignment

-X3: analog inputs			
d-terminal	**Signal**	**z-terminal**	**Signal**
2	not assigned	2	not assigned
4	analog signal input 7	4	analog signal input 7
6	not assigned	6	not assigned
8	analog signal input 6	8	analog signal input 6
10	not assigned	10	not assigned
12	analog signal input 5	12	analog signal input 5
14	not assigned	14	not assigned
16	analog signal input 4	16	analog signal input 4
18	not assigned	18	not assigned
20	analog signal input 3	20	analog signal input 3
22	not assigned	22	not assigned
24	analog signal input 2	24	analog signal input 2
26	not assigned	26	not assigned
28	analog signal input 1	28	analog signal input 1
30	not assigned	30	not assigned
32	not assigned	32	not assigned

Plug type

Socket: Harting 09 06 248 3201, DIN 41612
Matching plug: Harting 09 06 000 9474, DIN 41612

Connector cable cross section max. 2.5 mm^2 when transducers are connected to the -X2 signal converter connection
Connector cable cross section max. 0.5 mm^2 when sensors are connected to the sensor connector adapter.

Table 6: Technical data of processor card, CPU 2

Processor Board			
Digital Signal Processor	DSP 56002		
Microcontroller	MC68332		
LON process bus	LON neuron		(optional)
Analog inputs	7		
	Rated frequency: 50 Hz or 60 Hz		Operating range of protective functions: 49.5 Hz … 50.5 Hz or 59.5 Hz … 60.5 Hz
	Rated current:	150 mV 1 A or 5 A	when sensors are used when signal converters are used
	Permissible load of current circuit sustained: $4 \cdot I_n$ during 1 s: $100 \cdot I_n$ dynamic (1 half-period): $250 \cdot I_n$		 (peak value)
	Rated voltage:	$2\ V/\sqrt{3}$ 100 V or 110 V	when sensors are used when signal converters are used
	Consumption per conductor: In the current circuit: In the voltage circuit:	 < 0.1 VA < 0.3 VA < 0.25 A	 at I_n=1 A at I_n=5 A at U_n

3.4.3 Power supply and process bus (LON)

The power supply provides the REF542 with the required operation voltage. It reduces the input DC voltage of 48 … 240V (smoothed) to the voltages required to supply the other boards and components and also the LON sensors. The power supply board of the -X0 process bus connection is also available. The LON is currently used as the process bus for recording temperatures.

↳Chapter "3.4.8 Process bus system" on page 3-41

The following diagram shows the schematic design of the power supply board. The sections relevant for this documentation are labeled.

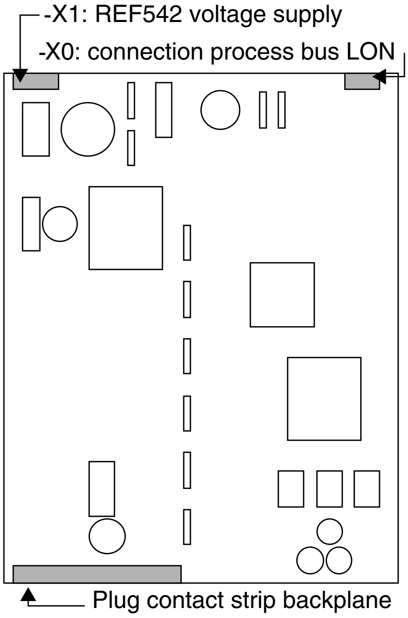


Figure 14: Schematic design of the power supply board

Caution **Observe the precautions necessary when handling components that might be damaged by electrostatic discharges.**

Interface assignment, -X0 process bus (LON)

Table 7: -X0 interface assignment

-X0: process bus (LON)	
Terminal	**Assignment**
1	+ 24V output
2	- 24V output
3	+ LON process bus
4	- LON process bus

↳Chapter "3.4.8 Process bus system" on page 3-41

Interface assignment, -X1 auxiliary voltage supply

Table 8: -X1 interface assignment

-X1: external voltage supply	
Terminal	**Assignment**
1	Plus (48 … 240V/DC, smoothed)
2	not assigned
3	Minus

Plug type

-X0: LON process bus electrical

- PCB plug 90°, 4-pole

-X1: REF542 voltage supply

- Weidmüller BLA, connector cables to 1.5 mm^2

Table 9: Technical data of the power supply and LON process bus board

Power supply and LON process bus board			
Power supply	Voltage range V_{CC}: 48 … 240 V DC		Oscillation amount: max. 10% = $U_t/U_n \cdot 100\%$
	Earth connection on housing		
	Override time: min. 50 ms		
	Power input:	< 40 W < 50 W	Short housing Deep housing
	Surge resistance: 300 V		Surge arrester/varistor
	Switch-on peak current I_P: • 15 A at V_{CC}=48 V • 36 A at V_{CC}=110 V • 73 A at V_{CC}=230 V		> 10 A for 100 µs > 15 A for 100 µs > 20 A for 100 µs

3.4.4 Binary input and output boards

Two types of input and output boards (I/O boards) are available for the REF542. They differ in the type and the number of relays used and are described in next two subsections.

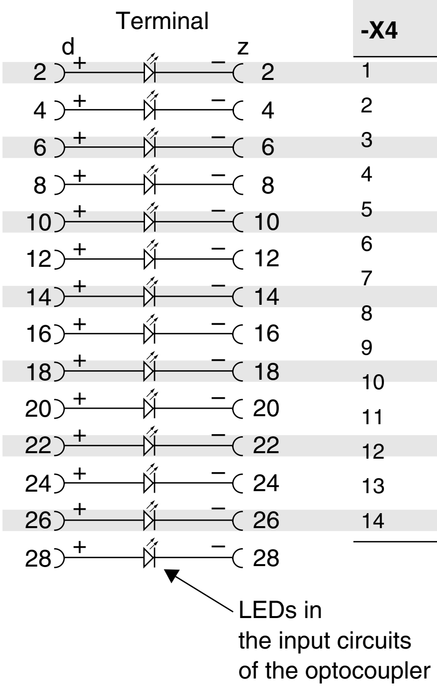
Caution **Input and output boards with conventional and transistor relays cannot be combined in one unit.**

3.4.4.1 Input and output board with transistor relay

This board provides the interfaces “to the outside“. It has the binary inputs, which acquire messages such as switching confirmations, and the binary outputs (channels), through which switching objects such as power circuit-breakers can be controlled. A maximum of three such boards may be installed in the REF542.

Binary inputs on the transistor relay board

The figure below shows the optocoupler input circuits, which are parallel switched to the binary inputs. It also shows the assignment of the input numbers for the terminals of the -X4, -X5 and -X8 interfaces. These interfaces are occupied by the binary inputs of the maximum of three binary input/output boards.

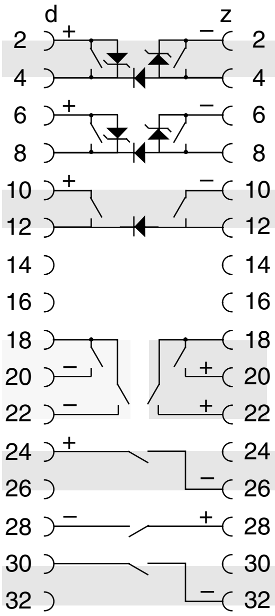


Input numbers		
-X4	**-X5**	**-X8**
1	15	29
2	16	30
3	17	31
4	18	32
5	19	33
6	20	34
7	21	35
8	22	36
9	23	37
10	24	38
11	25	39
12	26	40
13	27	41
14	28	42

Figure 15: Binary inputs on the transistor relay boards

Binary outputs on the transistor relay board

The figure below shows the configuration of the transistor relay on the input terminals of the binary outputs. It also shows the assignment of the output numbers (channel numbers) for the terminals of the -X6, -X7 and -X9 interfaces. These interfaces are occupied by the binary outputs of the maximum of three binary input/output boards.



Output numbers -X6	-X7	-X9	Type of output
1	10	19	Trip circuit monitoring; Power output
2	11	20	Trip circuit monitoring; Power output
7	16	25	Power output
–	–	–	
3, 4	12, 13	21, 22	Motor control unit
5, 6	14, 15	23, 24	Motor control unit
8	17	26	Signal output
9	18	27	Signal output
–	–	–	Watchdog

Figure 16: Configuration of the transistor relays on the binary outputs

Functional principle of the transistor relay and the trip circuit monitoring

The following diagram uses the example of binary output 1 on the first transistor relay board to show the functioning of the transistor relay and the trip circuit monitoring.

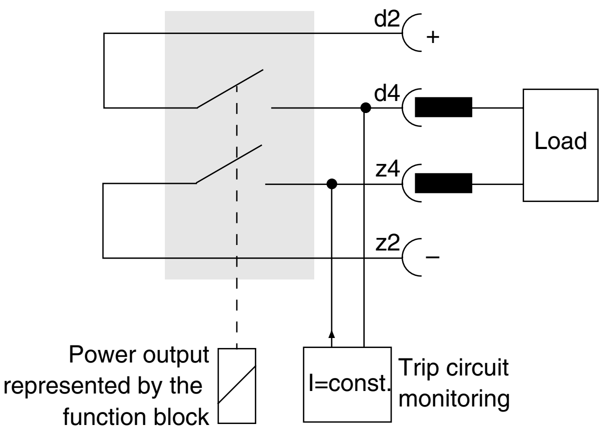


Figure 17: Principle of a power output with trip circuit monitoring using the example of binary output 1

Note

Trip circuit monitoring is only available for the first two I/O boards.

The trip circuits are monitored for binary outputs 1, 2 (1st I/O board) and 10, 11 (2nd I/O board). For this purpose there is a permanent constant DC current of 2 mA in the trip circuit (connections -X4/-X5:d4/z4 and -X4/-X5:d8/z8). If the auxiliary supply voltage fails for at least 100 ms, this is interpreted as a fault in the trip circuit and an error message appears on the LC display screen:

Table 10: Trip circuit monitoring error message

Defective	Error message
Binary output 1 on the 1st I/O board defective.	Coil monitor board 1.1
Binary output 2 on the 1st I/O board defective.	Coil monitor board 1.2
Binary output 1on the 2nd I/O board defective.	Coil monitor board 2.1
Binary output 2 on the 2nd I/O board defective.	Coil monitor board 2.2

If more switching operations have to be suppressed in the event of a failure, the message is required not only on the REF542 display screen but also as a signal that can be processed in the function chart. A special function block has been developed for this. It sends a logical 1 for every monitored circuit if a malfunction occurs.

↳Chapter "5.4.2.17 IO-Supervision" on page 5-64

Transistor relay: Power output to motor control unit

The binary outputs 3, 4 and 5, 6 (1st I/O board), 12, 13 and 14, 15 (2nd I/O board) and 21, 22 and 23, 24 (3rd I/O board) are power outputs that can be specifically used for the motor control unit. To enable optimum usage of these power outputs, two special switching objects are available.

↳Chapter "5.4.2.14 Switching object 2-2: H bridge Card" on page 5-56
↳Chapter "5.4.2.15 Switching object 4-4: H bridge Card" on page 5-59

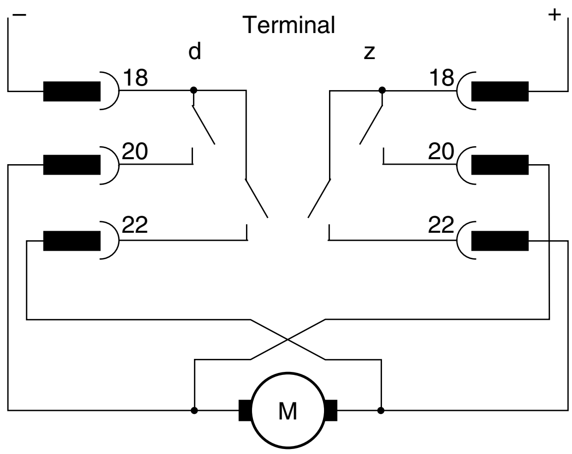


Figure 18: Principle of the power output to the motor control unit using the example of the binary outputs 3, 4, 5 and 6 on the transistor relay board

Plug type

-X4-9: socket: Harting 09 06 248 3201, DIN 41612

Matching plug: Harting 09 06 000 9474, DIN 41612

- Binary inputs: Connector cables to 1.5 mm^2 265 V AC/DC
- Power outputs: Connector cables to 1.5 mm^2 265 V AC/DC
- Signal outputs: Connector cables to 1.5 mm^2 250 V AC/DC

Schematic layout

The schematic layout of the transistor relay input and output board is shown in the diagram below. The sections relevant for this documentation are labeled.

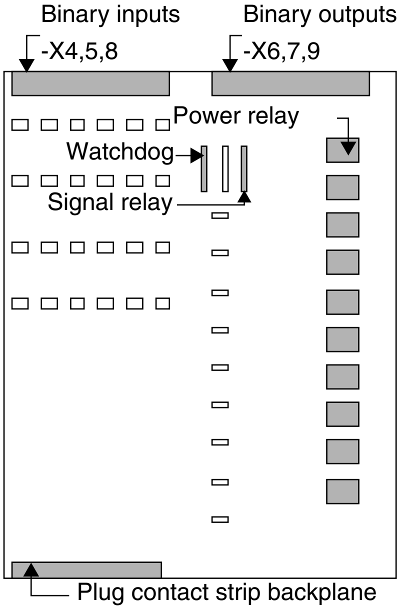


Figure 19: Schematic view of transistor relay and input and output board

Caution **Observe the precautions necessary when handling components that might be damaged by electrostatic discharges.**

Table 11: Technical data of the binary input/output board with transistor relay

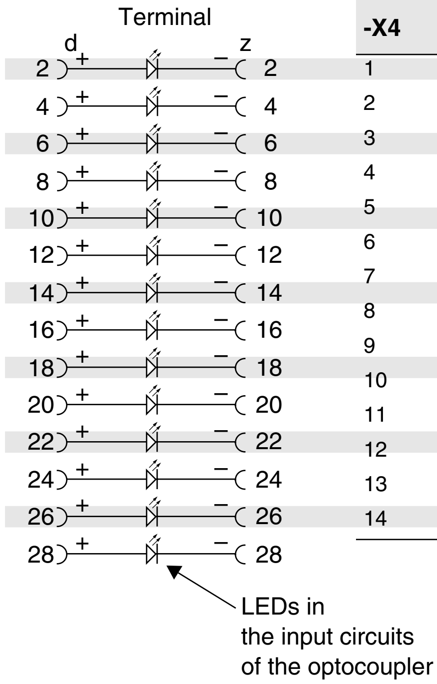
Binary input/output board with transistor relay		
Max. number	2	Short housing
	3	Deep housing
Number of inputs	14 per board	
Input voltage	48 … 265 V DC	
Voltage ON state	> 35 V	
Input current ON state	1.2 mA	
Voltage OFF state	< 25 V	
Input current OFF state	0 mA (0 V)	
Minimum impulse time	15 ms	
Configurable delay	0 … 65 000 ms	additive to min. impulse time
Number of power outputs	2 per board	
Transistor relay type	IRGPC50S	
Operating voltage	48 … 265 V DC	
Impulse current	12 A	Maximum of 10 switching operations with a switching duration < 30 s within 10 min.
Phase fault current	70 A	Switching duration < 10 ms
Number of power outputs	4 per board	
Transistor relay type	IRFP350	
Operating voltage	48 … 265 V DC	
Impulse current	10 A	Maximum of 10 switching operations with a switching duration < 30 s within 10 min.
Phase fault current	16 A	Switching duration < 10 ms
Number of signal outputs	2 per board	
Transistor relay type	AQZ204	
Operating voltage	48 … 265 V DC	
Load current	0.3 A	
Phase fault current	1 A	Switching duration < 100 ms
Number of watchdog relays	1 per board	
Transistor relay type	AQZ204	
Operating voltage	48 … 265 V DC	
Load current	0.3 A0	
Phase fault current	1 A	Switching duration < 100 ms
Total inputs	14 per board	
Total outputs	9 per board (8 freely configurable)	

3.4.4.2 Input and output boards with conventional relays

This board provides the interfaces “to the outside“. It has the binary inputs, which acquire messages such as switching confirmations, and the binary outputs (channels), through which switch objects such as power circuit-breakers can be controlled. A maximum of three such boards may be installed in the REF542.

Binary inputs on the conventional relay board

The diagram below shows the optocoupler input circuits, which are switched parallel to the binary inputs. It also shows the arrangement of the input numbers for the terminals of the -X4, -X5 and -X8 interfaces. These interfaces are occupied by the binary inputs of the maximum of three binary input/output boards.

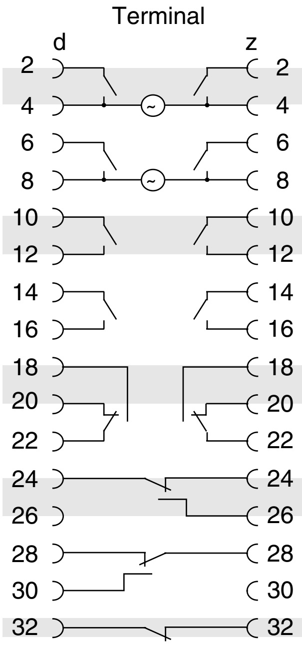


Input numbers		
-X4	**-X5**	**-X8**
1	15	29
2	16	30
3	17	31
4	18	32
5	19	33
6	20	34
7	21	35
8	22	36
9	23	37
10	24	38
11	25	39
12	26	40
13	27	41
14	28	42

Figure 20: The binary inputs on the conventional relay boards

Binary outputs on the conventional relay board

The diagram below shows the configuration of the conventional relays to the input terminals of the binary outputs. It also shows the assignment of the output numbers (channel numbers) to the terminals on the -X6, -X7 and -X9 interfaces. These interfaces are occupied by the binary outputs of the maximum of three binary input/output boards.



Output numbers -X6	-X7	-X9	Type of output
1	9	17	Trip circuit-monitoring; Power output
2	10	18	Trip circuit-monitoring; Power output
3	11	19	Power output
4	12	20	Power output
5	13	21	Motor control unit
6	14	22	Motor control unit
7	15	23	Signal output
8	16	24	Signal output
–	–	–	Watchdog

Figure 21: Breaker configuration implemented with the conventional relays

Functional principle of the conventional relay and the trip circuit monitoring

The following diagram uses the example of binary output 1 on the first conventional relay board to clarify the functioning of the conventional relay and the trip circuit monitoring.

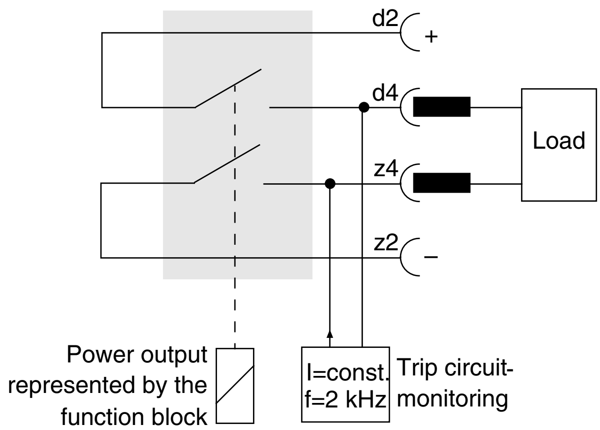


Figure 22: Principle of a power output with trip circuit monitoring using the example of binary output 1

Note: Trip circuit monitoring is only available for the first two binary output boards.

The trip circuits are monitored for binary outputs 1, 2 (1st I/O board) and 9, 10, (2nd I/O board). There is a permanent DC current with a frequency of 2 kHz in the trip circuit (connections -X6/-X7:d4/z4 and -X6/-X7:d8/z8; current flows from d to z). The amount of this current is independent of the applied voltage of the output. If there is no current for at least 100 ms, it is interpreted as a fault and an error message is displayed on the LC display screen:

Table 12: Error message in the trip circuit monitoring

Defective	Error message
Binary output 1 on the 1st I/O board defective.	Coil monitor board 1.1
Binary output 2 on the 1st I/O board defective.	Coil monitor board 1.2
Binary output 1on the 2nd I/O board defective.	Coil monitor board 2.1
Binary output 2 on the 2nd I/O board defective.	Coil monitor board 2.2

If more switching operations have to be suppressed in the event of a failure, the message is required not only on the REF542 display screen but also as a signal that can be processed in the function chart. A special function block has been developed for this. It supplies a logical 1 for every monitored circuit if a malfunction occurs.

↳Chapter "5.4.2.17 IO-Supervision" on page 5-64

Conventional relay: power output to motor control unit

The binary outputs 5, 6 (1st I/O board), 13, 14, (2nd I/O board) and 21, 22 (3rd I/O board) are power outputs that can be specifically used for the motor control unit. To enable optimum usage of these power outputs, two special switching objects are available.

↳Chapter "5.4.2.12 Switching object 4-3: Motorcard" on page 5-49
↳Chapter "5.4.2.13 Switching object 6-5: Magnetmotorcard" on page 5-52

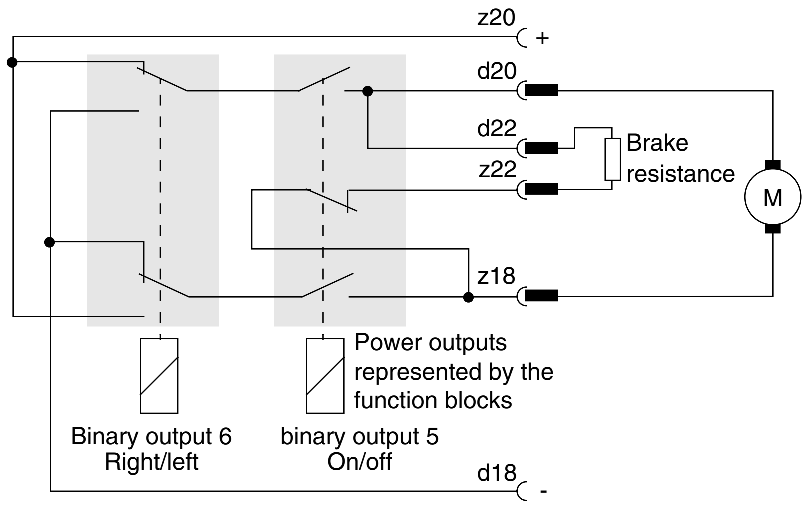


Figure 23: Principle of the power output to the motor control unit using the example of binary outputs 5 and 6 of the conventional relay board

Plug type

-X4-9: socket: Harting 09 06 248 3201, DIN 41612

Matching plug: Harting 09 06 000 9474, DIN 41612

- Binary inputs: Connector cables to 1.5 mm^2 265 V AC/DC
- Power outputs: Connector cables to 1.5 mm^2 265 V AC/DC
- Signal outputs: Connector cables to 1.5 mm^2 250 V AC/DC

Number of switching cycles for conventional power relays

Note that the conventional, mechanical relays are not infinitely durable. The following tables show the maximum switching cycles of the power relays.

Table 13: Maximum switching cycles of the conventional power relays

Number of maximum switching cycles					
Operating voltage	**Switched current**	**Power**	**Load type**	**Switching frequency**	**Switching cycles**
250 V AC	8 A	2000 VA	cos φ = 1	0.2 Hz	30 000
220 V AC	6.62 A	1500 VA	cos φ = 1	0.2 Hz	100 000
220 V AC	5.11 A	1125 VA	cos φ = 0.6	0.2 Hz	100 000
220 V AC	4.43 A	975 VA	cos φ = 0.35	0.2 Hz	100 000
220 V AC	2.27 A	500 VA	cos φ = 1	0.2 Hz	300 000
220 V AC	1.7 A	375 VA	cos φ = 0.6	0.2 Hz	300 000
220 V AC	1.45 A	320 VA	cos φ = 0.35	0.2 Hz	300 000
30 V DC	2 A	60 W	$^{L}/_{R}$ = 0 ms	0.2 Hz	2 000 000
60 V DC	0.05 A	3 W	$^{L}/_{R}$ = 26 ms	0.2 Hz	2 000 000
10 V DC	0.01 A	0.1 W	$^{L}/_{R}$ = 0 ms	0.2 Hz	2 000 000

Schematic layout

The following diagram shows the schematic design of the board. The sections relevant for this documentation are labeled.

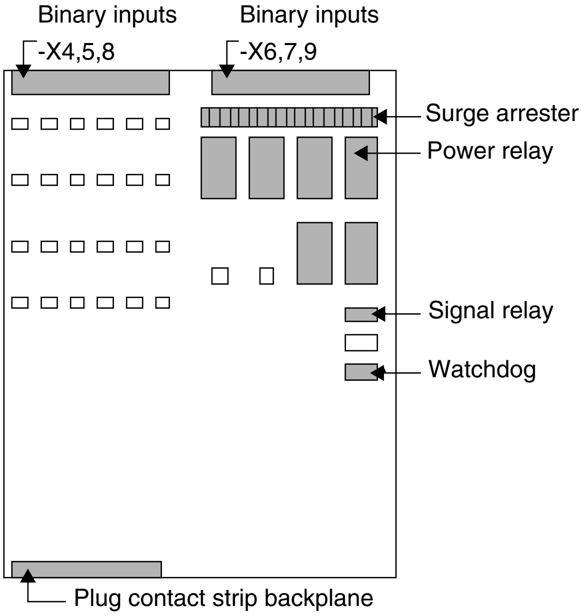


Figure 24: Schematic view of the conventional relay board

Caution **Observe the precautions necessary when handling components that might be damaged by electrostatic discharges.**

Table 14: Technical data of the binary input/output board with conventional relays

Binary input/output board with conventional relays		
Max. number	2	Short housing
	3	Deep housing
Number of inputs	14 per board	
Input voltage	48 … 265 V DC	
Voltage ON state	> 35 V	
Input current ON state	1.2 mA	
Voltage OFF state	< 25 V	
Input current OFF state	0 mA (0 V)	
Minimum impulse time (filter time)	15 ms	Type-specific filter time
Configurable delay	0 … 65 000 ms	additive to min. impulse time
Number of power outputs	5 per board	
Relay type	SF2	
Operating voltage	265 V DC or 250 V AC	
Switch-on peak current	20 A	
Load current	12 A	
Shutdown current	6 A	
Switching power	300 W for max. 100 ms	
Switching cycles	"Table 13: Maximum switching cycles of the conventional power relays" on page 3-28	
Number of signal outputs	2 per board	
Relay type	DS2E	
Operating voltage	220 V DC or 250 V AC	
Max. current	2 A	
Switching cycles	Electrical max. 100 000	
	Mechanical max. 10 000 000	
Number of watchdog relays	1 per board	
Relay type	DS2E	
Operating voltage	220 V DC or 250 V AC	
Max. current	2 A	
Switching cycles	Electrical max. 100 000	
	Mechanical max. 10 000 000	
Total inputs	14 per board	
Total outputs	8 per board (7 freely configurable)	

3.4.5 Analog output board

This board continuously sends four analog signals to its outputs. The signals represent measured or calculated values from the REF542 and may be displayed on analog measuring instruments. The measured or calculated values to be output from the REF542 are converted by digital-analog converters and represented over a range of 0 … 20 mA or 4 … 20 mA. In each case there is an overload range of 20%.

If the range 4 … 20 mA is used, a quiescent current of 4 mA flows through the carrier to the terminal device. This enables the terminal device to generate an error message if there are problems with the carrier or the board. The use of the analog output board must be input in the configuration program when configuring the unit.

↳Chapter "5.3.5 Analog outputs" on page 5-11

The figure below shows the wiring of the -X10 interface. It also shows the numbers of the analog outputs and their terminal assignments.

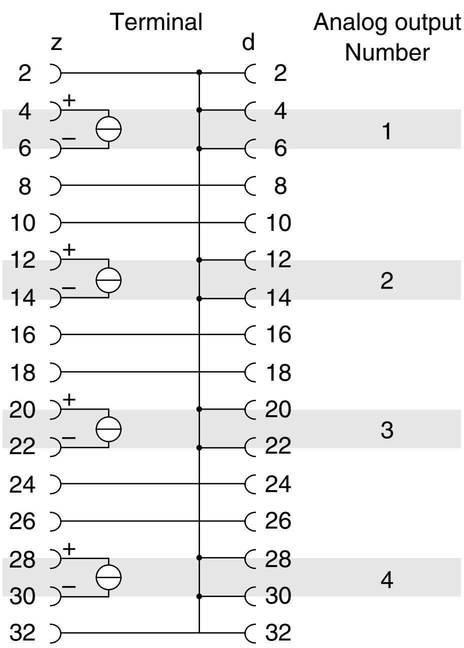


Figure 25: Configuration of the analog output board current sources

Table 15: Technical data of the analog output board

Analog output board (optional)			
	Number of analog outputs	4	
	Output current	0 … 20 mA or 4 … 20 mA	with 20% overload in each case
	Output voltage	< 15 V	
	Permissible burden	500 Ω	

Limitations on the output of Operational measured values

Note — The analog output board can only yield values that are measured or calculated based on the configuration.

The following table shows the conditions under which a measured or calculated value is also output:

Table 16: Limitations on the output of analog signals

Measured or calculated value	Condition
U_{1E}, U_{2E}, U_{3E}: Phase voltages U_{12}, U_{23}, U_{31}: Line voltage	Three voltage transformers/sensors configured
U_{7E}: Measured residual voltage	Voltage transformer or voltage sensor on the 7th analog input
U_0: Calculated zero sequence voltage	Neutral point voltage-protective function configured
I_1, I_2, I_3: Line currents	Three current transformers/sensors configured
I_7: Measured earth current	Voltage transformer/sensor on the 7th analog input
I_0: Calculated zero sequence current	Earth fault-protective function configured
P: Active power Q: Reactive power Phase difference: cos φ	Power calculation activated in the configuration
U37, U67: Calculated line voltages of the second network	Synchrocheck configured.

Schematic layout

The following diagram shows the schematic design of the plug-in board. The sections relevant for this documentation are labeled.

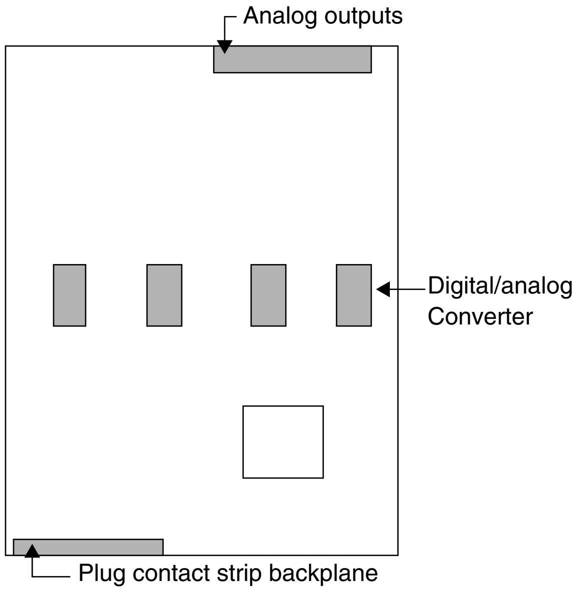


Figure 26: Schematic design of the analog output board

Caution **Observe the precautions necessary when handling components that might be damaged by electrostatic discharges.**

Plug type

Socket: Harting 09 06 248 3201, DIN 41612
Matching plug: Harting 09 06 000 9474, DIN 41612

Connector cable cross section max. 1.5 mm^2, twisted-pair low-current cable

3.4.6 Recording measured values

The REF542 operates with current and voltage transformers and also with sensors.

When instrument transformers are connected, the REF542 requires a signal converter in which several input transformers for adjusting the current and voltage measured quantities are installed. The input transformers are there for electrical decoupling of the electronics from the primary measured quantities, which have disturbance variables. The input transformers transform the standardized phase voltages

$$\frac{100V}{\sqrt{3}} \quad \text{on} \quad \frac{2V}{\sqrt{3}}$$

and the standardized line currents

1 A or 5 A on 150 mV

in accordance with the defined measurements for the analog inputs of the bay control and protection unit.

When measurement sensors are connected, the REF542 receives the measurements directly at the output of the sensors. Only one sensor connection adapter, which can be easily installed, is installed between them.

The following subsections have brief descriptions of the various measurement recorders and the required converters or adapters.

Note: Please note that in the REF542 the measurement and protective functions use the same measurement recorders.

3.4.6.1 Instrument transformer

Current transformer

These are transformers in a special small design. They transform the high currents that are to be measured down to lower currents virtually linearly. They are then connected (secondary converter) to the REF542 via a signal converter. The instrument transformer consists of the primary coil (the primary conductor) and the secondary coil, which is wound around the core.

↳Chapter "11.1 Requirements for the current transformers when implementing distance protection" on page 11-1

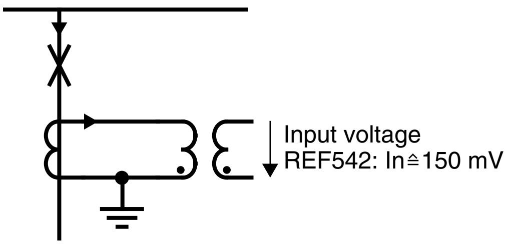


Figure 27: Circuit diagram of a current transformer at a phase

Note: When selecting the rated value of current transformers, note that their signals are used for the REF542 measurements and also for starting and tripping protective functions.

Voltage transformer

The voltage transformers are also special transformers that step down the high primary voltage signal to a lower, more easily measurable secondary quantity virtually linearly. Also in this case a signal converter (secondary converter) must be used for the connection to the REF542.

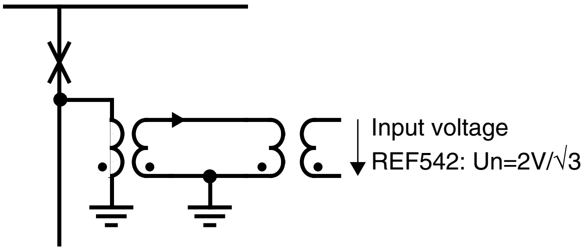


Figure 28: Circuit diagram of a voltage transformer used to measure the conductor-earth voltage

3.4.6.2 Signal converter

The signal converters are installed in a separate housing at the rear of the REF542. They are used exclusively for adjusting the levels between the transducers and the analog inputs. The standardized conductor-earth voltages are transformed from

$$\frac{100V}{\sqrt{3}} \quad \text{on} \quad \frac{2V}{\sqrt{3}}$$

and the standardized line currents from

1 A or 5 A on 150 mV

Closed U-core transformers and core-balance current transformers are different. While in the closed U-core transformers a phase error of approximately 2.7 ° occurs, the core-balance current transformers show no phase error. Otherwise the only difference is in the configuration of the -X2 interface: In the closed U-core transformers it is at the top of the transformer housing and at the left in core-balance current transformers.

-X2 interface assignment (example)

Table 17: Example of an -X2 terminal strip assignment

-X2: signal converter input			
Terminal number	**Signal**		**Nominal value**
1	Current transformer	I_{L1}	1A
2	Neutral point current	I_{L1}'	
3	Current transformer	I_{L1}	5A
4	Current transformer	I_{L2}	1A
5	Neutral point current	I_{L2}'	
6	Current transformer	I_{L2}	5A
7	Current transformer	I_{L3}	1A
8	Neutral point current	I_{L3}'	
9	Current transformer	I_{L3}	5A
10	Voltage transformer	U_{L1E}	100V/√3 or 110V/√3
11	Neutral point voltage	N	
12	Voltage transformer	U_{L2E}	100V/√3 or 110V/√3
13	Neutral point voltage	N	
14	Voltage transformer	U_{L3E}	100V/√3 or 110V/√3
15	Neutral point voltage	N	

Table 17: Example of an -X2 terminal strip assignment

-X2: signal converter input		
Terminal number	**Signal**	**Nominal value**
16	not assigned	
17	not assigned	
18	not assigned	
19	Residual current transformer I_0	1A
20	Neutral point residual current I_0’	
21	Earth	

Plug type

Weidmüller AP DFK6 Gr C, connector cables up to 6 mm^2

3.4.6.3 Combi sensors

The combi sensors measure current and voltage of a phase simultaneously. The required current and voltage sensor is integrated into a cast resin housing. A Rogowski coil is used as a current sensor and a resistive precision voltage divider as a voltage sensor. In addition, the required shielding of the voltage sensor to prevent interference by any signals is also used as a capacitive voltage divider.

The sensors are distinguished by their high precision, their linear response characteristics and their high dynamic range. The Rogowski coil and the voltage sensor map the line current or the line voltage directly to voltage signals that can be processed by the REF542. The Rogowski coil, because of its design as an air-core coil, does not show saturation characteristics as experienced with conventional iron-core transformers. The current-proportional measured quantities are inductively phase-shifted by 90°.

The special, double-shielded signal lines are installed on the sensor terminal adapter of the REF542 in one piece. This eliminates any possible error sources resulting from intermediate terminals.

3.4.6.4 Sensor terminal adapter

The sensor terminal adapter, also referred to as a hedgehog, is used to connect seven sensors. It is installed externally on the side of the REF542 housing and has 7 check taps as well as the sensor connectors. The sensor signals can be measured there. The sensor connection box is linked directly to the -X3 interface for the analog measurement inputs.

The diagram below shows the front view and the circuit diagram of the sensor terminal adapter. The drawings are not to scale and are only intended to give an impression of the design and the function.

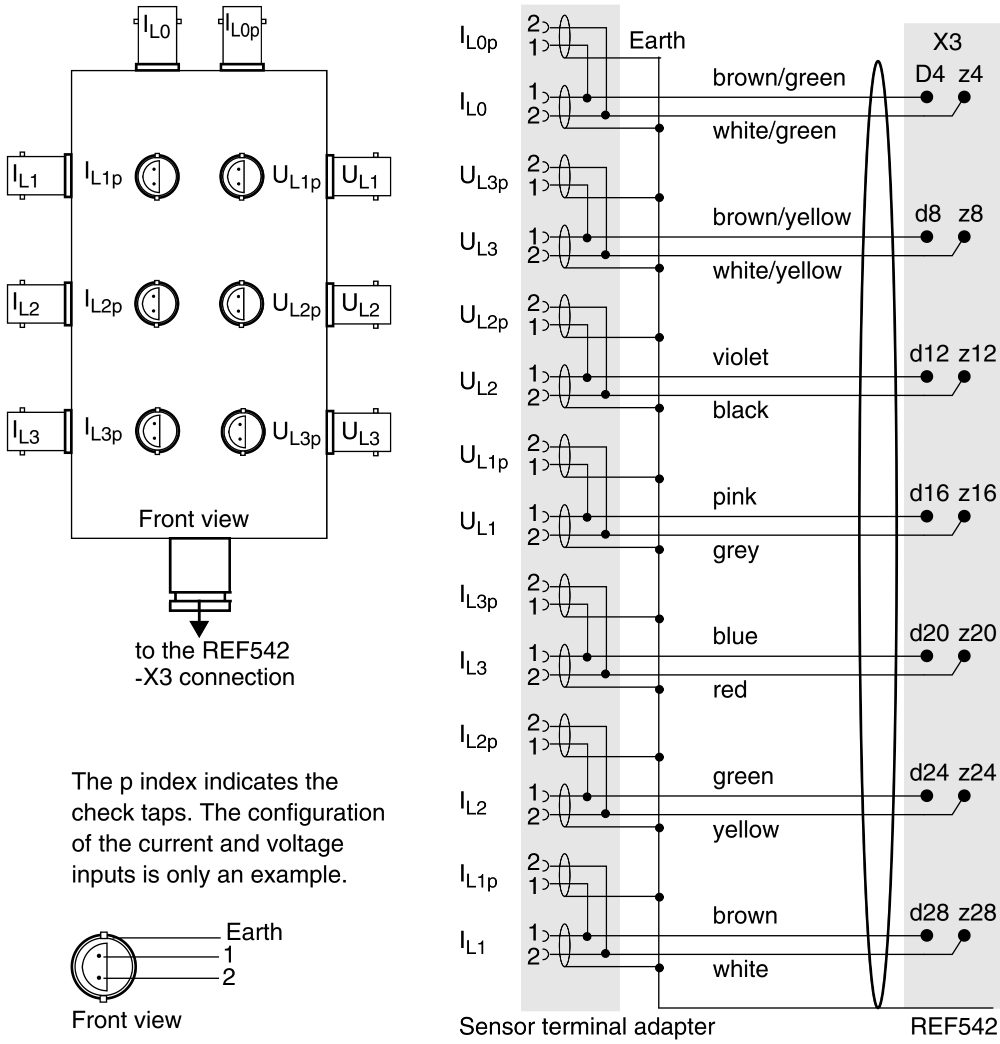


Figure 29: Front view and main circuit diagram of the sensor terminal adapter

Plug type

Socket on sensor terminal adapter: Radiall BR2 R.605550 020

Matching plug: Radiall R.605006 010

Other technical data

Line between sensor terminal adapter and REF542 -X3 interface:

0.5 m cable CY(F168.770) 16 x 0.14 mm^2 with Harting plug 09060009474

3.4.7 Interbay bus system

The optoelectronic interbay bus system (former name: interbay bus system) in the REF542 is used for communication with a higher-order control system or other substations. Therefore, it is particularly suited as a component of the ABB Pyramid® control system. It can be used to send control commands to the REF542 if the "operating/remote" operating mode has been enabled with the keyswitch on the REF542 operator panel. The event data (Events) is sent from the bay control and protection unit with information on current status and monitoring data from various function blocks. Events are transmitted at changes in status. Protective function parameters can also be set and queried over the interbay bus. In addition, the status of specific function blocks can be called up (status information).

The interbay bus system operates with the SPA bus or the MVB, depending on the interbay bus board.

3.4.7.1 SPA bus as interbay bus

The SPA bus is implemented as a system-wide, non-redundant interbay bus system. Incoming and outgoing data are primarily processed by the communication unit (Motorola 68HC11 processor). The SPABUS protocol is an asynchronous, serial communications protocol.

The other substations are connected with fiber-optic or plastic-fiber cables. The fiber-optic cables are used to avoid interference caused by electromagnetic influence. In addition, the SPA bus system is designed to ensure internal substation communications for the protection and control systems and also for the report printer system.

The SPA bus protocol supports one master and several slaves in various bus structures. The bus structure must be input into the device configuration in the configuration program.

↳Chapter "5.3.3 Hardware" on page 5-5

Bus structure of the SPA bus

Inside a substation the slaves, i.e. the various bay control and protection devices, are linked to the master in the ring or star bus.

The advantage of the ring bus is that only one single hardware-I/O module is necessary in the substation. However, one disadvantage is that station-wide communications are disrupted if a line or a slave malfunctions. The diagram below shows the layout of the ring bus:

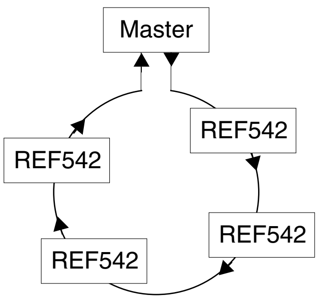


Figure 30: SPABUS in single ring design

Note: For reasons of transmission speed and availability, it is recommended that no more than five REF542s be operated in a ring bus system.

The advantage of the star bus is that every slave is linked directly to the master. If a line or a slave malfunctions, the other system components continue to operate. There is a disadvantage in the greater hardware requirements. The diagram below shows the layout of the star bus:

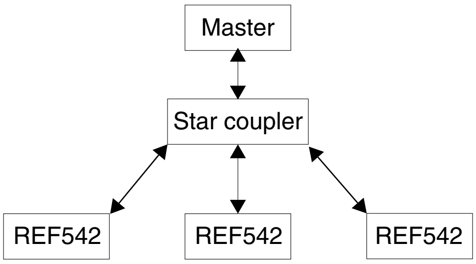


Figure 31: SPABUS in star design

Note — Plastic fiber-optic cables should be used only to lay out a star bus.

Schematic layout

The following diagram shows the schematic design of the SPA bus plug-in board. The sections relevant for this documentation are labeled.

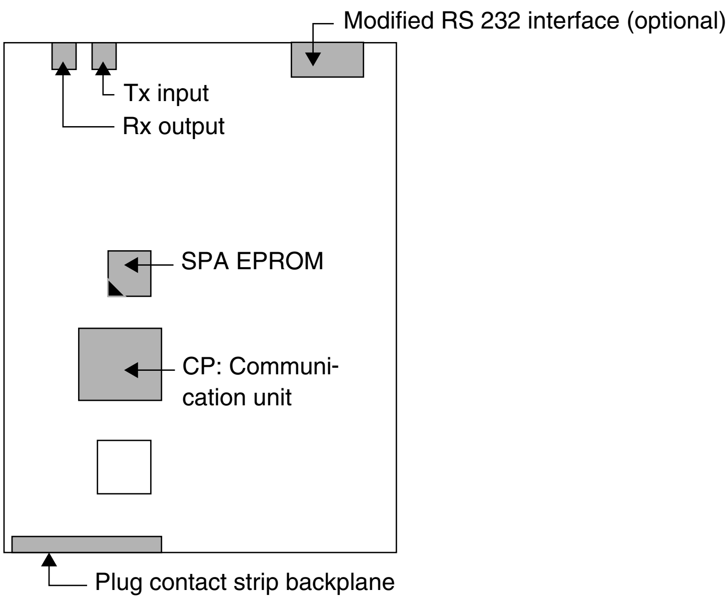


Figure 32: Schematic design of the SPA bus board

Caution — **Observe the precautions necessary when handling components that might be damaged by electrostatic discharges.**

Interface assignment, Tx, Rx, RS 232 (modified)

Tx: Transmission connector for fiber-optic cable
Rx: Receiver connector for fiber-optics cable

RS 232 (modified): Electrical transmitter and receiver connector. This connector is only offered as an option and is used to connect a LON SPA gateway.

The pin assignment of the LON SPA gateway is as follows:

Connection	Label
1	–
2	TXD: Data to SPA bus device
3	RXD: Data from SPA bus device
4	+ 12 V voltage supply
5	Earth (signals and voltage supply)
6	–
7	–
8	–
9	– 12 V voltage supply

The LON SPA gateway power consumption is less than 2 W.

Table 18: Technical data of the SPA bus communications board

Communications board SPA bus (optional)		
Communications processor	MC 68HC11	
Transmission media	Electrical: 9-pole RS 232 cable	(for LON-SPA gateway only)
	Optical: Fiber-optic cable • Inner fiber-optic cable 2-wire (DUPLEX) HBZ 50/125 62.5/125 µm • Inner fiber-optic cable 1-wire (SIMPLEX) HAS 50/125 62.5/125 µm • Outer cable/rodent-resistant fiber-optic 16 strand (DUPLEX) HBN 16G 50/125 62.5/125 µm • Outer cable/rodent-resistant fiber-optic 8 strand (SIMPLEX) HBN 8G 50/125 62.5/125 µm	Guaranteed cable length: 1000 m Typical cable length: 3000 m
	Optical: Plastic fiber-optic • Inner fiber-optic cable 2 strand (DUPLEX) HPZ/PUR • Inner fiber-optic cable 1 strand (SIMPLEX) HPS/PUR	Typical cable length: 30 m Maximum cable length: 40 m **Suitable for star bus only.**
Transmitter and receiver modules	Optical: Glass fiber-optic cable Tx: hp HFBR-1402 Rx: hp HFBR-2402	
	Optical: Plastic fiber-optic cable Tx: hp T-1524 Rx: hp R-2524	
Plug types	Electrical: SUB-D9 plug	
	Optical: Glass fiber-optic cable SMA plug HITRONIC SMA-125 ST plug HITRONIC ST-125	
	Optical: Plastic fiber-optic cable hp plug – grey HFBR 4503 hp plug – blue HFBR 4503	
Data transmission rate	9600 baud ASCII	
Slave answer time	Max. 50 ms	Depends on the complexity of the query
Time synchronization	0.001 … 59.999 s	Signal transmitted by master

3.4.7.2 MVB as interbay bus

The MVB (Multifunction Vehicle Bus) was originally developed for railway technology and its highly synchronous characteristics make it particularly suitable for applications in control systems for substations.

The REF542 function as slaves; they only transmit when queried by the bus master. The bus master scans the data from the slaves in accordance with a configurable list.

The diagram below shows the typical, star-shaped design with the MVB interbay bus. The COM581 in the ABB Pyramid automation control system operates as a gateway to the higher-order control system. One REF542 will support up to three gateways. The gateways are used to adapt the protocols. A special bus master administers the bus. In the ABB Pyramid® automation control system the RER581 is used for this purpose.

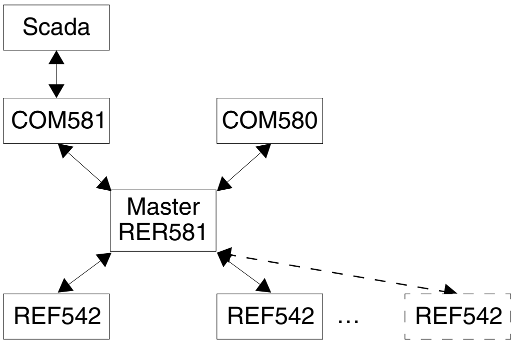


Figure 33: Bus structure of the MVB interbay bus

Sporadic transmission of message data

Message data have event characteristics and are therefore transmitted only as required, not cyclically. Examples are the event messages and the fault record data generated by the REF542.

The bus master allows the slaves to send message data in specified cycles. Message data is addressed to the control system by the REF542 at the available gateway. The other devices on the bus have no access to this data.

Periodic transmission of process data

Process data is items such as position messages from switches, starting and tripping data and measured values. It is transmitted in datasets.

Datasets are bit sequences that have the corresponding application-specific information and are cyclically scanned by the bus administrator. The content and meaning of the dataset must be the same for both sender and receiver.

The length and cycle time of the dataset is configurable. The REF542 provides three datasets:

- Dataset 1: Position messages and starting and tripping data. Transmission every 128 ms.
- Dataset 2 and 3: Analog measured values. Transmission every 512 ms.

If a dataset is sent over the bus, the content is visible for every device. Therefore, the other devices can take information relevant to them from the dataset.

Schematic layout

The diagram below shows the schematic layout of the board. The sections relevant for this documentation are labeled.

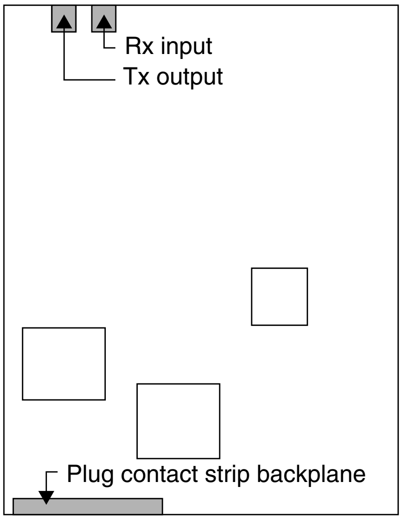


Figure 34: Schematic design of the MVB board

Caution **Observe the precautions necessary when handling components that might be damaged by electrostatic discharges.**

Table 19: Technical data of the SPA bus

Communications board SPA bus (optional)		
Communications processor	MC 68332	
Transmission media	Glass fiber-optic cable 62.5/126 µm	Maximum cable length: 2 000 m
Transmitter and receiver modules	Tx: HFBR-1414 TC Rx: HFBR-2412 TC	
Plug types	SMA plug HITRONIC SMA-125 ST plug HITRONIC ST-125	
Data transmission rate	serial 1.5 Mbit/s	

3.4.8 Process bus system

The LON connector on the power supply board is available for the process bus system. Chapter "3.4.3 Power supply and process bus (LON)" on page 3-18 shows the schematic layout.

The process bus allows a LON sensor that can record temperatures to be connected. Its data can also be processed by the REF542.

The operation of a LON sensor must first be input in the configuration program when configuring the unit. A LON function block can then be added to the function chart. This enables the measurement data to be used in the function chart.

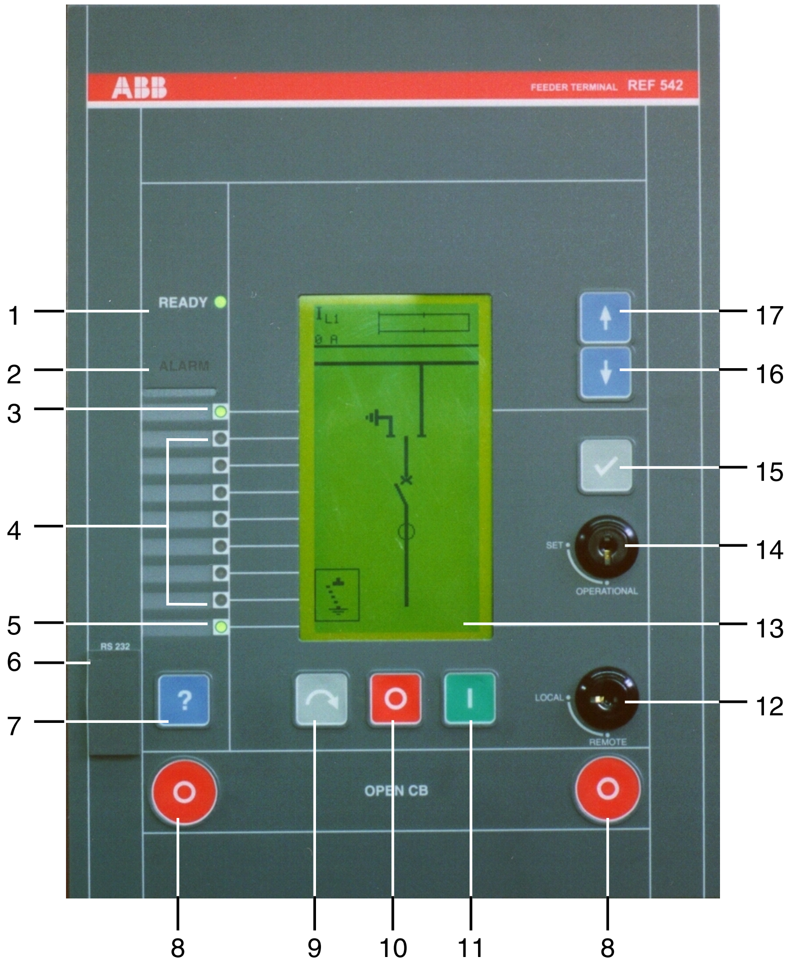
↳Chapter "5.3.3 Hardware" on page 5-5
↳Chapter "5.4.6.5 LON sensor" on page 5-85

Interface assignment

-X0: LON process bus	
Terminal	**Assignment**
1	+ 24V output
2	- 24V output
3	+ LON process bus
4	- LON process bus

3.5 Principles of LCU control

A number of REF542 functions are controlled through the user-oriented operator view, the LCU (Local Command Unit). This consists of the following components:



1: Operating LED,

2: Red alarm LED,

3: Interlocking status LED,

4: 7 three-color LEDs,

5: Protective function status LED,

6: RS232 interface,

7: Key for selecting message texts <**?**>,

8: Danger-Off keys,

9: Key for selecting switchgear <**↘**>,

10: Key for opening the selected switchgear <**O**>,

11: Key for closing the selected switchgear <**O**>,

12: Keyswitch “local/remote“,

13: LC display screen,

14: Keyswitch “operation/input“,

15: Acknowledgment key,

16, 17: Page up/page down keys <**↑**>, <**↓**>

Figure 35: REF542 control panel

LC display screen (13)

The LC display screen (LC is Liquid Crystal and describes the functional principle of the display screen) is subdivided into three sections in standard operation (operating mode: local/operation or remote/operation). The status line (foot of screen) shows messages in plain text. The central, largest section shows the mimic diagram (single-line diagram) of the substation components that are controlled and monitored by the bay control and protection unit. The mimic diagram shows the current switchgear settings. The upper section of the LC display screen also shows a current operational measured value as a numeric value with the module and as a bar graph. For example, a line current maximum value from a configurable time interval can be queried there. This maximum value can also be displayed in the bar graph as a “trailing pointer“.

The LC display screen is also used to show the LED message texts. The language in which the messages appear on the LC display screen may be selected in the configuration program. In addition, the basic texts can be adapted to the specific requirements with an editor.

The LC display screen is backlit. In the event of a high ambient temperature, the backlighting automatically switches off to prevent damage. If the temperature continues to increase, the LC display screen is also switched off. This does not influence the functions of the REF542. Once the temperature is reduced, the LC display screen and the backlighting function normally again.

The mimic diagram and operational measured values are not displayed in the local/input operating mode. Instead, a list of the available pages in this operating mode is shown. The following pages are available and each one enables specific functions:

- List of pages
- Page for defining and selecting the active parameter set
- Pages on which the parameters of the configured protective functions can be seen
- Pages on which the parameters of the configured protective functions can be changed
- Reset page for trailing pointer function, maximum values, energy, switching cycles etc.
- Page for defining and selecting the automatic restart mode (if configured)
- Entry point to test mode (if configured).

Operational status LED (1)

The LED that shows the operational status (READY) is lit when the auxiliary voltage is switched on. It is also wired to the watchdog circuit. If this continuous self-test reports an error, a restart is forced and the LED goes out briefly.

Alarm LED (2)

This LED indicates alarms (ALARM). In the standard configuration it lights when a protective function is tripped or at the occurrence of other, freely definable events. When the event that tripped it is no longer active, the alarm LED may go out or go into a self-holding status (configurable). In this case an alarm must also be acknowledged.

Interlocking status LED (3)

This LED, which shows the interlocking status of the switching objects, shows red for a few seconds in the event of an illegal switching attempt. It is then automatically reset to “green“ (no interlocking violation).

This LED is not lit when the protection and controller functions of the REF542 are not in operation (e. g. when loading a configuration into the unit from a PC).

Configurable LEDs (4)

The configurable LEDs may be programmed with the configuration software. The LED function block in the function chart of the configuration program has two inputs that enable the LEDs to be set to show red, green or orange or not to light. A message text may be input for every LED in the configuration dialog of the LED function block. This is activated on the LC display screen by pressing the <**?**> key.

Protective function status LED (5)

This LED displays the general status of the protective functions:

- Green (protective function not tripped; standard operation),
- Amber/orange (protective function activated but not yet tripped) and
- Red (protective function tripped). The status "protective function tripped" must be acknowledged.

The status line of the LC display screen also shows the name of the protective function that tripped first.

This LED is not lit when the protection and controller functions of the REF542 are not in operation (e. g. when loading a configuration into the unit from a PC).

RS232 interface (6)

This interface is for communication between the bay control and protection unit and a PC (personal computer). For example, the configuration is transferred (in both directions) or measured values or other data are read from the REF542. In addition, data exchange with the fault recorder (if configured in the FUPLA) uses this interface.

Keyswitch (12,14)

The operating mode of the REF542 can be selected with the two keyswitches. Each of the three operating modes provides specific functions. The two modes “local/operation“ and “remote/operation“ are for use in “standard“ REF542 operations. In these modes all configured functions are active, and the unit can be controlled locally or remotely from a higher-order control station. For example, the operational data (measured and calculated quantities that are important for tripping the protective functions) can be scanned, maximum values can be displayed, switching operations conducted and alarms acknowledged.

The “local/input“ operating mode enables various settings to be scanned and changed. The protective function parameter sets can be checked and if necessary another may be selected. In addition, the test mode, in which all interlockings are deactivated, can be activated. The test mode can only be selected if it has been released in the application.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "8.1.6.7 Entry point to test mode" on page 8-23

3.6 Overview of the technical data

The table gives an overview of the most important technical data. Additional information, particularly on the boards and electronic equipment racks, can be found in the relevant sections.

Chapter "3.4 Components: Function and Technical Data" on page 3-12

A list of the various protective functions can be found in "Table 2: REF542 protective functions" on page 3-7.

Table 20: Overview of the most important technical data

Processor Board			
	Digital Signal Processor	DSP 56002	
	Microcontroller	MC68332	
	LON process bus	LON Neuron	(optional)
	Analog inputs	7	
		Rated frequency: 50 Hz or 60 Hz	Operating ranges of protective functions: 49.5 Hz … 50.5 Hz or 59.5 Hz … 60.5 Hz
		Rated current: 150 mV 1 A or 5 A	when sensors are used when signal converters are used
		Permissible load of current circuit sustained: $4 \cdot I_n$ during 1 s: $100 \cdot I_n$ dynamic (1 half-period): $250 \cdot I_n$	 (peak value)
		Rated voltage: $2\ V/\sqrt{3}$ 100 V or 110 V	when sensors are used when signal converters are used
		Consumption per conductor: In the current circuit: < 0.1 VA < 0.3 VA In the voltage circuit: < 0.25 A	 at I_n=1 A at I_n=5 A at U_n
Communications board (optional)			
	Communications processor	SPA bus: MC 68HC11	
		MVB: MC 68332	
	Transmission media	SPA bus: Electrical or optical	(for LON-SPA gateway) (glass or plastic; plastic for star bus only!)
		MVB: optical (glass)	
Analog output board (optional)			
	Number of analog outputs	4	
	Output current	0 … 20 mA or 4 … 20 mA	with 20% overload in each case
	Output voltage	< 15 V	
	Permissible burden	500 Ω	

Table 20: Overview of the most important technical data

Binary input/output board with conventional relays		
Max. number	2	Short housing
	3	Deep housing
Number of inputs	14 per board	
Input voltage	48 … 265 V DC	
Voltage ON state	> 35 V	
Input current ON state	1.2 mA	
Voltage OFF state	< 25 V	
Input current OFF state	0 mA (0 V)	
Minimum impulse time (filter time)	15 ms	Type-specific filter time
Configurable delay	0 … 65 000 ms	Additive to min. impulse time
Number of power outputs	5 per board	
Relay type	SF2	
Operating voltage	265 V DC or 250 V AC	
Switch-on peak current	20 A	
Load current	12 A	
Shutdown current	6 A	
Switching power	300 W for max. 100 ms	
Switching cycles	"Table 13: Maximum switching cycles of the conventional power relays" on page 3-28	
Number of signal outputs	2 per board	
Relay type	DS2E	
Operating voltage	220 V DC or 250 V AC	
Max. current	2 A	
Switching cycles	Electrical max. 100 000	
	Mechanical max. 10 000 000	
Number of watchdog relays	1 per board	
Relay type	DS2E	
Operating voltage	220 V DC or 250 V AC	
Max. current	2 A	
Switching cycles	Electrical max. 100 000	
	Mechanical max. 10 000 000	
Total inputs	14 per board	
Total outputs	8 per board (7 freely configurable)	

Table 20: Overview of the most important technical data

Binary input/output board with transistor relay		
Max. number	2	Short housing
	3	Deep housing
Number of inputs	14 per board	
Input voltage	48 … 265 V DC	
Voltage ON state	> 35 V	
Input current ON state	1.2 mA	
Voltage OFF state	< 25 V	
Input current OFF state	0 mA (0 V)	
Minimum impulse time	15 ms	
Configurable delay	0 … 65 000 ms	Additive to min. impulse time
Number of power outputs	2 per board	
Transistor relay type	IRGPC50S	
Operating voltage	48 … 265 V DC	
Impulse current	12 A	Maximum of 10 switching operations with a switching duration < 30 s within 10 min.
Phase fault current	70 A	Switching duration < 10 ms
Number of power outputs	4 per board	
Transistor relay type	IRFP350	
Operating voltage	48 … 265 V DC	
Impulse current	10 A	Maximum of 10 switching operations with a switching duration < 30 s within 10 min.
Phase fault current	16 A	Switching duration < 10 ms
Number of signal outputs	2 per board	
Transistor relay type	AQZ204	
Operating voltage	48 … 265 V DC	
Load current	0.3 A	
Phase fault current	1 A	Switching duration < 100 ms
Number of watchdog relays	1 per board	
Transistor relay type	AQZ204	
Operating voltage	48 … 265 V DC	
Load current	0.3 A	
Phase fault current	1 A	Switching duration < 100 ms
Total inputs	14 per board	
Total outputs	9 per board (8 freely configurable)	

Table 20: Overview of the most important technical data

General Data			
	LEDs on the control panel of the REF542	1 Ready LED not configurable color: green	Signals that the REF542 is ready for operation
		1 protective function status LED not configurable color: green orange red	No protective function activated One protective function activated One protective function tripped
		1 interlocking status LED not configurable color: green red	No interlocking violation interlocking violation; illegal switching operation
		1 ALARM LED freely configurable color: black (off) or red	
		7 LEDs freely configurable color: black (off), green, orange or red	
	Remote communications	Interface: RS232 (9-pole)	
		Transmission speed: 9600 bit/s Event buffer: 50 events	
		Protocol: SPA or MVB	
	Power supply	Voltage range V_{CC}: 48 … 240 V DC	Oscillation amount: max. 10% = $U_t/U_n \cdot 100\%$
		Earth connection on housing	
		Override time: at least 50 ms	
		Power input: < 40 W < 50 W	Short housing Deep housing
		Surge resistance: 300 V	Surge arrester/varistor
		Switch-on peak current I_P: • 15 A at V_{CC}=48 V • 36 A at V_{CC}=110 V • 73 A at V_{CC}=230 V	> 10 A for 100 µs > 15 A for 100 µs > 20 A for 100 µs
	Temperature Range	Operation: -10 °C … +55 °C Storage: -20 °C … +70 °C Transport: -20 °C … +70 °C	Humidity without condensation < 95%
	Earthquake safety	DIN IEC 60068-3-3 DIN IEC 60068-2-6 DIN IEC 60068-2-59 CEI IEC 61166 CEI IEC 60980	
	Insulation voltage	IEC 60255-5/2 kV, 1 min., 50 Hz	Except for input power supply
	Fast Transient Test	IEC 60801-4/4 kV	
	Electrostatic discharge (ESD)	IEC 60801-2	
	Resistance against electromagnetic fields	IEC 60801-3/30 V/m	
	Environmental Conditions	IEC 60255-4	
	Durability MTBF	MIL 217 E	

Table 20: Overview of the most important technical data

Design			
	Weight	Short housing: 5 kg … 6 kg	Depending on equipment
		Deep housing: 5.5 kg … 7 kg	Depending on equipment
	Installation type	Semiflush, terminal above	Terminals for core-balance current transformer are on the side
	Connections:	DIN 41612	
	Dimensions	240 x 330 x 228 mm (W x H x D)	Short housing
		240 x 330 x 271 mm (W x H x D)	Deep housing
	Panel cutout for semiflush mounting	233 x 322 mm (W x H)	
	Protection class	Housing: IP 30 or IP 54	 When using special keyswitches
		Connection: IP 20 or IP4X	 When using special covers
Configuration Program			
	Personal computer	IBM compatible, min. 80386SX processor, min. 8 MB RAM, 3.5 “ disk drive, mouse 5 MB free hard disk space	
	Operating system	min. DOS 3.3 and Microsoft Windows® 3.1x or Microsoft Windows® NT 3.5x or NT 4.0	
	Control Program	1 diskette 3 1/2 " 1.44 Mbytes	Includes the English, German, Italian and Czech version

4 Configuration Program

In this section you will find the following information:

- How to install the configuration program onto your PC
- How to start the configuration program
- The basic steps in creating or editing a function chart
- The individual menu items of the configuration program
- How to uninstall the configuration program from the computer.

4.1 Safety Information

Testing the application

Warning! **Every application must undergo a function test with the bay for which it was created. The protective functions must be thoroughly checked in this test!**

REF542 function when importing the application

Warning! **So far as possible, avoid loading an application into the REF542 when the bay is operating.**
The bay control and protection unit is out of commission while an application is being loaded from a PC into the REF542.

REF542 function when exporting the application into the PC

Note If the application is exported from the REF542 into a PC while the unit is operating, the REF542 functions are not affected.
However, local control is not possible during this period.

4.2 System Requirements

- IBM compatible personal computer, min. 80386SX processor
- min. 8 MB RAM
- 3.5 “ disk drive
- Mouse
- Min. DOS 3.3 and Microsoft Windows® 3.1x or
  Microsoft Windows® NT 3.5x or NT 4.0
- Hard drive space: 5 MB free

4.3 Installation

The REF542conf configuration program installation is controlled by a menu in the Microsoft Windows® operating system. To start the installation program, please proceed as follows:

- Start your Microsoft Windows® Version.
- Insert the installation disk.
- Display the disk contents in the file manager (Microsoft Windows® 3.1X and NT 3.5X) or in the Explorer (Microsoft Windows® NT 4.0).
- Start the file setup.exe (e.g. double-click the left mouse button when the mouse cursor is over the file) on the diskette. Help can be found in the Microsoft Windows® online help or the manuals.

The installation program, when started, first offers a choice of the language (US. English or German) used to guide the user through the installation process. Please follow the instructions and observe the information provided by the installation program.

Every step in the installation process can be reversed or the entire program can be canceled. If the installation has been canceled, any already installed files should be deleted from the directory where they were installed.

Installing a new version of the program

Note First uninstall the program if you intend to retain the target directory or group names of an older installation.

Several program versions on one computer

Note Windows should be restarted between starting different program versions to avoid problems with previously installed DLLs.

Restart after an installation

Note At the end of the installation you are prompted to decide whether Windows should be restarted. This is recommended if a different version of the configuration program has been run since the last time Windows was started.

4.4 Starting the program

After the installation has been completed as described above, the program can be started in various ways. The method of starting depends on the operating system.

Microsoft Windows® 3.1X and NT 3.5X

- The installation program has assigned the icon for the configuration program to the desired program group.
  The desired group can be displayed in the program manager and the REF542conf program is started in the usual manner.

Microsoft Windows® NT 4.0

- The program groups here are accessed through the `Start` button. After starting Microsoft Windows® NT this button can be found at the lower left side of the screen.
  The program group with the REF542conf program will be found in the opened menu or in one of the following submenus.

Additional information can be found in Microsoft Windows® online help or in the manuals.

4.5 Using the configuration program

The following subsections provide basic information on using the configuration program. The most important activities in creating or editing an application are described.

Another section explains the menu items in the main menu and the character menu in the sequence in which they appear.

Please note that the limitations of the customer version that are described below are not explained any further in the configuration program documentation.

Customer version

The customer version of the configuration program has the following limitations:

- Additional protective functions cannot be added to your application. (Important: if a protective function in the application is deleted, it cannot be added again later.)
- You cannot save your application under another name. (The menu item `Save as...` cannot be selected)
- The device address of the REF542 cannot be changed.

4.5.1 First steps in creating or editing an application

Not all functions of the configuration program are described in the following section. It is intended to introduce only the basic functions. While working with the configuration program you will certainly learn additional functions. All menu items in the configuration program are also described in a separate section.

↳Chapter "4.5.2 Description of the menu items" on page 4-16

The sequence of the following subsection corresponds to the sequence of steps required when creating a new application. When an existing application is opened, all basic settings are of course already specified. The function chart is also complete. However, the procedure for editing an application is the same as for creating it.
Some steps are explained in more detail at other points in the documentation; cross references are given in this case.

4.5.1.1 Working with projects

The set of files that belong to an application in connection with the configuration program is referred to as the project. Projects can be created, opened and saved in the configuration program. After starting the configuration program, a new project with the name `new.edt` is created.

Note — When saving a new project for the first time, always select the menu item `Main Menu/File/Save as F7`. Otherwise the name "new.edt" will be retained.

The table on the next page describes the set of files associated with a project. Not all them will be created in every application. In addition, the table shows when the files are created or updated.

Table 21: Overview of the files belonging to a project

File	Contents	Created	Updated
*.edt	Application comprising: - Drawing - Parameter - LCU configuration - LCU texts All other files can be recreated from this file, with the exception of the fault record files.	When saving.	When saving.
*.bak	Application backup file.	When opening.	When opening.
*.doc	- Device configuration - Rated value of the analog inputs - Configured protective function with setting values	When opening.	When opening.
*.wir	All connections in use are counted and the connection number and the associated text is given. The connections are sorted by the object number to which they are connected and by the number of the connector pin. As well as the object number, the object type to which the connection is connected is also written to this file.	When opening.	When opening.
*.lst	All events generated by the application are listed here.	When opening.	When opening.
*.lcu	The mimic diagram configuration of the current application.	When exporting a mimic diagram.	When exporting the mimic diagram again.
*.ri1	The setting parameter set 1 of the impedance protection. The Omicron test set uses this file for automatic testing.	When saving an application with impedance protection.	When saving an application with impedance protection.
*.ri2	The setting parameter set 2 of the impedance protection. The Omicron test set uses this file for automatic testing.	When saving an application with impedance protection.	When saving an application with impedance protection.
*.cfg	Configuration file for the fault recorder module	When exporting a fault record from the REF542.	
*.dat	Fault record file with the recorded data	When exporting a fault record from the REF542.	

Only files with the names `*.edt` can be directly opened in the configuration program. There is a set of files describing the functioning of the REF542 for every item of equipment or bay that requires monitoring.

4.5.1.2 Selecting the language version

To have the menu bars, dialogs and messages of the configuration program appear in the desired language, select the menu item `Main Menu/Options/Language/[English, German, Italian, Czech]`. Because the English version appears first after installing the program, please select the menu item `Main Menu/Options/Language/[English, German, Italian, Czech]`. The desired language version will be marked in the menu and set immediately. This setting is also retained after closing the program.

4.5.1.3 Setting the PC-REF542 connection

To import the completed application from the PC to the REF542 or to export an application or other data from the REF542, the connection must be established first. They are connected with a 9-pin RS232 cable. One end is plugged into the labeled socket on the REF542 control panel. The other end is plugged into the serial RS232 interface of the PC.

To enable data to be transferred over this connection, the dialog `Main Menu/Transfer/Serial Port` must be started in the configuration program.

↳Chapter "5.3.1 Serial Port" on page 5-2

Note

Ensure that the parameters of the dialog `Serial Interface` ... as set in the configuration program also conform to the parameters for the serial interface, which can be configured in the operating system.

4.5.1.4 Configuring the REF542

- To be able to configure an application at all, the equipment installed in the REF542 must be entered into the configuration program. To do this, start the dialog window `Main Menu/Configure/Global Settings` and `Main Menu/Configure/Hardware`.

  ↳Chapter "5.3.2 Global Settings" on page 5-2

  ↳Chapter "5.3.3 Hardware" on page 5-5
- The analog inputs and outputs should be defined before making the application settings. Start the dialog window `Main Menu/Configure/Terminals/Analog Inputs` and if necessary `Main Menu/Configure/Terminals/Analog Outputs`. If an analog output board is not used, this menu item cannot be selected.

  ↳Chapter "5.3.4 Analog inputs" on page 5-6

  ↳Chapter "5.3.5 Analog outputs" on page 5-11
- After defining the analog inputs, the dialog `Main Menu/Configure/Calculated Values` may also be selected.

  ↳Chapter "5.3.6 Calculated values" on page 5-12
- It is best not to define the settings for the display unit and the display language until the function chart has been created.

  ↳Chapter "5.3.7 Display" on page 5-13

  ↳Chapter "5.3.8 Display language" on page 5-18

4.5.1.5 Creating a function chart (FUPLA)

To create the function chart, start the function chart editor with the menu item `Main Menu/Configure/Drawing`.

Note

Before the function chart editor can be started, make the settings for a new application in the configuration dialogs `Main Menu/Configure/Global Settings` and `Main Menu/Configure/Hardware`.

The first page of the application will appear. To make an application more manageable, it can be distributed over several pages. One page is larger than the PC screen. All areas of the current page can be viewed by using the scroll bars to the right and at the bottom of the drawing editor window. The arrow keys (cursor keys) on the keyboard can also be used for this.

The current working mode is shown in the left upper corner of the screen:

- DrawMode: draw mode. Function blocks can be added, moved, configured and deleted here. Connections can also be configured or deleted.
- WireMode: Connection mode. Connections can be added and changed in the function chart. Connections and function blocks can also be configured or deleted here. If a function block is added in connection mode, the view switches automatically to draw mode.

4.5.1.6 Add or move function blocks

Function blocks can be added in either working mode. If you are in connection mode, draw mode is automatically selected. Moving is possible only in draw mode.

Add function block

Select `Drawing Menu/Insert`. A submenu with various function groups appears. Selecting a function group brings up another submenu listing the individual function blocks. The selected function block is placed on the top left of the page.

Example: Select `Drawing Menu/Insert/Control Panel/Indication LED` to select the indication LED function block.

Move function block

To move hold the left mouse button down when the cursor is on the function block and drag it with the mouse.

4.5.1.6.1 Restrictions

Note that not all function blocks can be combined with one another.

"Table 40: Use of the protective functions depending on the configuration of the analog measuring inputs" on page 5-89

There are also additional restrictions for function blocks and connections, which are listed in the table below.

Table 22: Restrictions in the FUPLA

Function block	Restriction
Protective functions	• Max. 12 protective functions *and* • Max. 120 protective parameters *and* • 100% maximum DSP load.
Fault recorder	• Max. 1 fault recorder • Min. 1 configured protective function
Store object	Max. 1
Energy counter	Max. 15
Switching object	Max. 62
Analog Threshold object	Max. 10 threshold objects per analog input
Direct write-read command	Max. 100
Connections	Max. 512, while 502 numbers can be assigned
Indication LEDs	Max. 7
LON sensors	Max. 15

Determining the cycle time

Note Once a new application has been created and loaded into the REF542, its cycle time must be checked. Set the “keyswitch local/remote” on the REF542 control panel to “local“ and the “keyswitch input/operation" to “input“. Press the <?> key and read off the cycle time on the LC display screen.

Warning! The cycle time of an application must be less than 30 ms to ensure proper functioning of the REF542.

4.5.1.7 Add or move connection

To link the function blocks with one another, switch to connection mode:

- Select `Drawing Menu/Edit/Mode/Wire Mode F3`
  OR
- Press the `F3` function key on the PC keyboard.

Now position the mouse cursor over a connection point on a function block or at the beginning or end point of a connection. The mouse cursor will change to the shape of a soldering iron.

A total of 512 connections can be added. There are 502 numbers available for connections (11 … 512). Connection numbers 0 … 10 are for internal use.

Add connection

When the soldering iron appears, hold the right mouse button down and drag the mouse to make a connection. The connection will end when the mouse button is released.

The terminals of two function blocks can be connected in this way. The connection can also end in the FUPLA without connecting to a terminal. The connection number is automatically 1 or 2 in this case to indicate that it does not connect two function blocks. Now use the configuration dialog to assign a previously used connection number to the connection. Connections with the same connection number are considered to be connected even if they do not contact each other.

Connections run at right angles or in a straight line (therefore, also diagonally), depending on their setting. The relevant setting is made with the menu item `Drawing Menu/View/Wires/Right-angled` or `Drawing Menu/View/Wires/Straight`.

Move connections

When the soldering iron appears, hold the left mouse button down and drag the mouse to move a connection point. When the mouse button is released, the connection point will remain at this position.

Note When a connection point is dragged or moved from one function block terminal to another function block terminal, ensure that the connection is properly positioned at the function block.

Check connections after a move

There are two options for carrying out the above check:

- Move the mouse pointer over the function block. Double-click the left mouse button to start the configuration dialog for the function block. The terminal information area shows the number of the connection that is properly terminated. The numbers 1 and 2 indicate that there is still no connection. OR
- Move the function block in draw mode. If the connections are moved with it, the connection is correct.

4.5.1.8 Starting configuration dialogs

A dialog window can be opened for all function blocks and connections. To start it move the mouse cursor over the function block or the connection in draw mode or connection mode. The configuration dialog appears after double-clicking the left mouse button.

Configuration dialog function block

This enables the function block to be configured and/or provides information on the terminated connections.

↳Chapter "5.4 Function and configuration of the function blocks" on page 5-20

Configuration dialogue connection

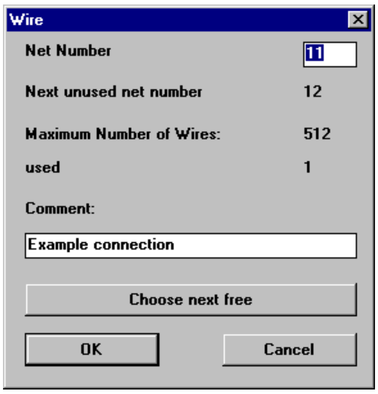


Figure 36: Configuration dialogue for a connection

Entry field `Net number`: Enter the connection number here. The currently assigned connection number will appear, a 1 or a 2. The numbers 1 or 2 only appear when the connection ends with a terminal point in the FUPLA.
To find the currently assigned connection number, the configuration program searches the connection numbers from 11 upwards for a free connection.

The connection number is also shown in the function chart beside the connection.
Setting range: 11 … 512 (Steps: 1)
Default: Currently assigned connection, 1 or 2

Information field `Next unused net number`: The next free connection is assigned here. The configuration program searches the connection numbers from 11 upwards for a free connection.

Information field `Maximum Number of Wires`: This shows the maximum possible number of connections in the current function chart. A total of 512 connections can be used. There are 502 connection numbers available.

Information field `used`: This shows how many connections are already set up in the function chart.

Input field `Comment`: Enter a comment, a name, for the connection here. The name will also appear in the function chart beside the connection. This name will be assigned to

all connections with the same connection number.
Setting range: 0 … 21 characters of the standard character set
Default: Empty

Button `Choose next free`: Click on this button to assign the next free connection number to the connection. The dialog window is then closed, and the connection has the corresponding number.

`OK`: All settings are saved in the configuration program. The dialog window is closed.

`Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

4.5.1.9 Deleting objects in the function chart

Various options are available here:

- Delete a function block: Move the mouse pointer over the function block that is to be deleted. Double-click the right mouse button.
  A confirmation query appears. Click the `OK` button to delete the function block or `Cancel` to retain the function block.
- Delete a connection: Move the mouse pointer over the connection which is to be deleted. Double-click the right mouse button.
  A confirmation query appears. Click the `OK` button to delete the connection or `Cancel` to retain the connection.
- Delete the current page: Select the menu `Draw Mode/Edit/Delete Page`. A confirmation query appears. Click the `OK` button to delete the page or `Cancel` to retain the page.
- Delete all connections in the application: Select the menu `Draw Mode/Edit/Delete All/Wires`. A confirmation query appears. Click the `OK` button to delete the connections or `Cancel` to retain the connections.
- Deleting all pages in the application: Select the menu `Draw Mode/Edit/Delete All/Pages`. A confirmation query appears. Click the `OK` button to delete the pages or `Cancel` to retain the pages.

4.5.1.10 Check function chart

The function chart can be checked both in draw mode and connection mode:

- Press the F9 function key on the keyboard or
- Select the menu item `Drawing Menu/Utilities/Check Drawing F9` or
- Select the menu item `Main Menu/Utilities/Check Drawing F9`

The check routine of the configuration program runs the following tests:

- Binary inputs and outputs: Availability of the numbers of the binary inputs and outputs used in the application. The availability depends on the number and type of binary input and output boards in use.
- Device configuration: Availability of a device configuration. Has the configuration dialog in the menu item `Main Menu/Configure/Hardware` been processed?
- AR and power circuit-breaker: If the automatic restart has been configured, there must be a power circuit-breaker in the application.
- Function blocks: All function blocks must be linked to at least one connection.
- DSP load: The DSP load (load on the protection and measuring unit) can be a maximum of 100%, a maximum of 120 protective parameters can be used and a maximum of 12 protective functions can be used.
- Connections: The number of connections must not exceed 512.
- Double connections: Connections with the same number may only be connected to one function block output.

- Calculation of power: The configuration of the analog inputs must match the type of power calculation.
- Switching objects: A maximum of 62 switching objects may be configured. Every switching object must have its own interbay bus address and binary output represented by the switching object must be physically present.
- Direct write-read command: A maximum of 100 such function blocks are permitted.

4.5.1.11 Setting the LC display screen and display language

When the application has been set up, the mimic diagram for the LC display screen may be configured and the language in which the messages appear on the LC display screen selected. Select the menu items `Main Menu/Configure/Display` and `Main Menu/Configure/Display Language`.

↳Chapter "5.3.7 Display" on page 5-13

↳Chapter "5.3.8 Display language" on page 5-18

4.5.1.12 Sending the application to the REF542

Sending an application to the REF542 is independent of the setting of the two keyswitches on the operator view of the REF542.

Warning! **So far as possible, avoid loading an application into the REF542 when the bay is operating.
The bay control and protection unit is out of commission while an application is being loaded from a PC into the REF542.**

Note If the PC has several serial interfaces, ensure that the one set in the configuration program is used.

- Connect the RS232 interface of the REF542 to the PC serial interface with a 9-pin RS232 cable.
- Open the application in the configuration program that is to be transferred. Select the menu item `Main Menu/Transfer/Send to REF542`.

Note If there is an alarm active, the application cannot be successfully exported from the PC to the REF542.

- The test routine of the configuration program is now automatically started again. If there is any error, the application cannot be exported.

While the application is being transferred, status messages are shown in the configuration program. They indicate which data is being transferred at any given point.

Messages on the data received are also output to the LC display screen on the REF542 in the status line.
During transmission the Ready LED and the protective function status LED on the operator view of the REF542 are out. This signals that the unit is not operating.

When the transmission is finished, a message indicating that it is complete appears in the configuration program. The REF542 restarts with the new application.
The mimic diagram then appears on the LC display screen, the Ready LED and the protective function status LED show green.

- Remove the RS232 cable.

Determining the cycle time

Note Once a new application has been created and loaded into the REF542, its cycle time must be checked. Set the “keyswitch local/remote” on the REF542 control panel to “local“ and the keyswitch "input/operation" to “input“. Press the <?> key and read off the cycle time on the LC display screen.

Warning! **The cycle time of an application must be less than 30 ms to ensure proper functioning of the REF542.**

4.5.1.13 Receiving an application from the REF542

Receiving an application from the REF542 is independent of the setting of the two keyswitches on the operator view of the REF542.

Warning! **The functions of the REF542 are not affected while an application is being exported from the REF542 to the PC.**
However, local control is not possible during this period.

Note If the PC has several serial interfaces, ensure that the one set in the configuration program is used.

- Connect the RS232 interface of the REF542 to the PC serial interface with a 9-pin RS232 cable.
- Start the configuration program.
- Select the menu item `Main Menu/Transfer/Load from REF542`.

While the application is being transferred, status messages are shown in the configuration program. They indicate which data is being transferred at any given point. Messages on the data sent are also output to the LC display screen on the REF542 in the status line.
When the transmission is finished, a message appears in the configuration program. The application can now be viewed and edited.

- Remove the RS232 cable.

4.5.1.14 Exporting the fault recorder

If a fault recorder is configured in the application, its data can be exported from the REF542. The configuration program converts the raw data to the COMTRADE format. The fault events can then be displayed using the WINEVE or CMC X.X programs. WINEVE is an evaluation program from ABB and CMC X.X is a testing program supplied by Omicron.

The fault recorder data can also be forwarded to the higher-order control system over the interbay bus.

- Connect the RS232 interface of the REF542 to the PC serial interface with a 9-pin RS232 cable.
- Start the configuration program.
- Select the menu item `Main Menu/Transfer/Read Faultrecorder`
  If there are no fault records in the REF542, a message indicating that will appear in the configuration program.

Otherwise the following dialog window appears:

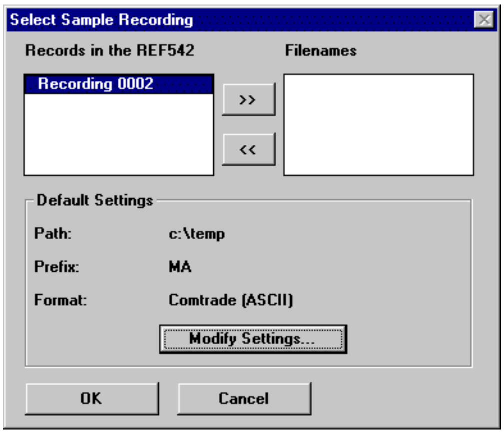


Figure 37: Example of a dialog window for exporting fault records

The fault records stored in the REF542 are shown in the left list window. The fault record with the highest number is the latest.
The right list window shows the default file names of the fault records that are to be loaded.

- Check the settings for saving the fault records on the PC in the `Default Settings` information field.
  The `Path` shows the memory location for the fault records.
  The `Prefix` is the character combination that is placed in front of the four-digit fault record number in the file name.
  The `Format` shows the format to which the fault record data from the REF542 will be converted.
  Please read the information in the following subsection to change the defaults.
- Mark a fault record with the mouse and click the `>>` button. The file name under which the fault record will be saved on the PC will appear in the right list window. The characters `>>>` will appear in place of the moved fault record in the left list window.
  Repeat this operation for additional fault records if they are also to be saved.
  If the Shift key on the keyboard is held down while marking the fault records, several fault records can be marked simultaneously and then moved all at once to the right list window with the `>>` button.
  The `<<` button removes a marked fault record from the list of fault records to be loaded.
- Click the `OK` button to export the marked fault records with the displayed defaults from the REF542. The dialog window is closed and the user is returned to the main menu of the configuration program.
  The `Cancel` button stops the export of fault records to the PC. Changes to the defaults are not saved. The dialog window is closed and the user is returned to the main menu of the configuration program.

Status messages are shown in the configuration program during export of the data from the fault recorder.

Changing the default

- Click the `Modify Settings` button to start the configuration dialog for changing the fault records. The following dialog window appears:

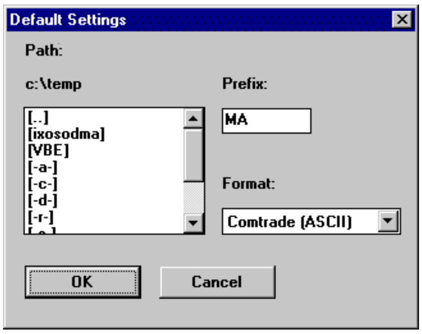


Figure 38: Example of a dialog window for setting the fault record defaults

- The list window, which indicates the current path, enables the memory location for the fault records to be selected. To make a selection, double-click on the memory location with the right mouse button. Then you can move through the directory trees of the memory media step by step.
- The input field `Prefix` allows the input of a maximum of 4 characters, which are placed before the four-digit fault record number in the file name.
  E.g.: Fault record 0034 will become file XXXX0034.dat when saved
- Select the format in which the fault record should be saved in the file `Format` selection list. In this version of the configuration program the fault records can only be saved in the COMTRADE [ASCII] format. This format is read by programs such as WINEVE or CMC X.X, which process the fault record data and can display them graphically.
  WINEVE is an evaluation program from ABB and CMC X.X is a testing program supplied by Omicron.

4.5.1.15 Exporting the input or output status

The current values of the binary inputs or outputs on the REF542 can be displayed. They can then also be printed and saved. Because the procedure and the structure of the dialog window are identical, the two processes are described in parallel.

It is also possible to export the status of the binary inputs and outputs regularly and automatically. Further information can be found in
Chapter "4.5.1.16 Exporting the operational measured values" on page 4-14.

- Connect the RS232 interface of the REF542 to the PC serial interface with a 9-pin RS232 cable.
- Start the configuration program.
- Select the menu item `Main Menu/Transfer/Input Status` or `Main Menu/Transfer/Output Status`.
  One of the following dialog windows will appear: However, no data are shown in the list field yet.

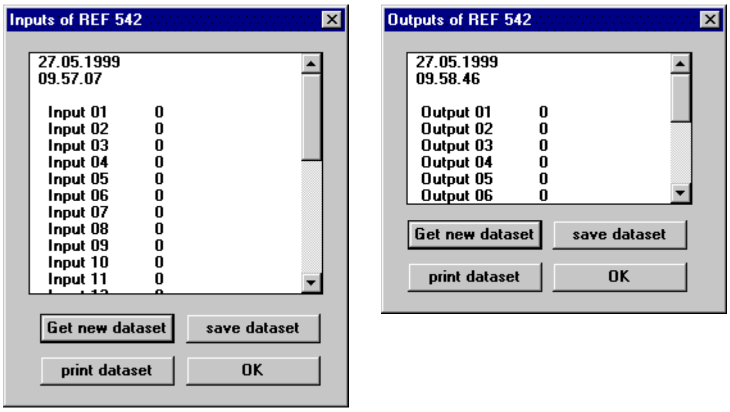


Figure 39: Examples of the dialog windows for displaying the status of the analog inputs or outputs

- Click the `Get new dataset` button. If the connection to the REF542 is correct, the current data of the first two binary input and output boards will be displayed in the corresponding list field after transmission:
  The export date and time are followed by a list of the available binary inputs/outputs. Then the status of the specific input/output is given.
  1: A logical 1 is contacted/can be tapped.
  0: A logical 0 is contacted/can be tapped.
  --: The input/output has not been defined in the function chart.
  xxx: A connection to the REF542 could not be established.

If it is not possible to connect to the REF542, an error message, which must be acknowledged, will appear first.

Note — The date and time are set by the exporting PC. Please ensure that the system time is set correctly.

- If the `Get new dataset` button is clicked again, another list with the new data will be appended to the previous list.
- Select the `save dataset` button to start a standard operating system dialog. This enables the data to be saved in any directory under a name that can be freely selected. The data are saved as ASCII text with line breaks.

Note — There is a danger that the application will be overwritten.
Therefore, do not select the name of the current application.

- Select the `print dataset` button to start a standard operating system dialog. This enables the data to be output to a printer.
- Select `OK` button to close the dialog window and to return to the main menu of the configuration program.
  The `Cancel` button closes the dialog window and returns the user to the main menu of the configuration program.

4.5.1.16 Exporting the operational measured values

Part of the operational measured values and the calculated values can be exported from the REF542. They can then also be printed and saved. Only the values that can also be found in the screenshot below are displayed. For example, the external phase-to-neutral voltages are not shown.
In addition, a configuration dialog that will display the operational measured values

and, if selected, the status of the binary inputs and outputs regularly and will automatically export them can be started.

- Connect the RS232 interface of the REF542 to the PC serial interface with a 9-pin RS232 cable.
- Start the configuration program.
- Select the menu item `Main Menu/Transfer/Measurement...`.
  The dialog window shown below appears. Part of the information window is still empty at this point and no data are shown.

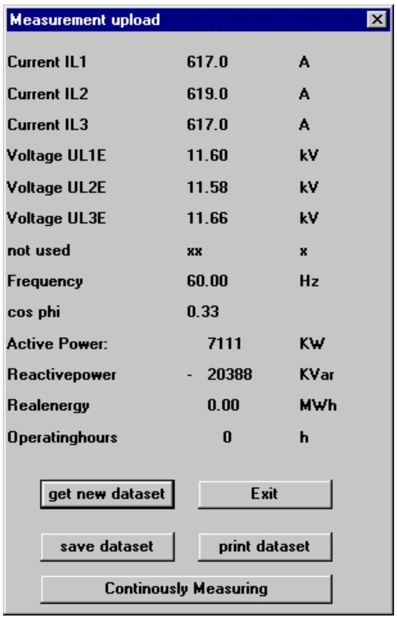


Figure 40: Examples of the dialog window for displaying the operational measured values

- Click the `get new dataset` button. If the connection to the REF542 is correct, the corresponding data will be displayed in the corresponding list field after transmission: This is the data current at the time of transmission.
  If it is not possible to connect to the REF542, two error messages appear. After acknowledging them, the dialog window appears again with the empty information window.
- If the `get new dataset` button is clicked again, the content of the information window is updated.
- Select the `save dataset` button to start a standard operating system dialog. This enables the data to be saved in any directory under a name that can be freely selected. The data are saved as ASCII text with line breaks.

Note There is a danger that the application will be overwritten.
Therefore, do not select the name of the current application.

- Select the `print dataset` button to start a standard operating system dialog. This enables the data to be output to a printer.
- Select `Exit` button to close the dialog window and to return to the main menu of the configuration program.

- Select the `Continuously Measuring` button to start the following dialog. It enables the operational measured values and the status of the binary inputs and outputs to be exported from the REF542 regularly and automatically.

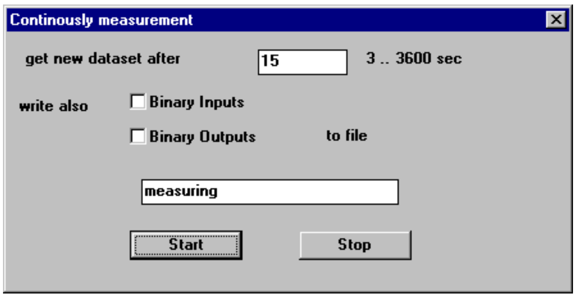


Figure 41: Configuration dialog for the continuous measured value scan

  – Enter the period between measurements in seconds into the input field `get new dataset after`.
    Setting range: 3 … 3600 seconds (One step: 1 second)
    Default: 15 seconds

  – Mark the `Binary Inputs` and/or `Binary Outputs` checkboxes to include their status in the continuous measured value acquisition process.

    The input field above the two buttons (measuring) has no function.

  – Click the `Start` button to begin continuous acquisition of the operational measured values (and the status of the binary inputs and outputs, if configured). The dialog window is closed.
    Click the `Stop` button to close the dialog window and not start continuous acquisition of measured values.

  – A standard operating system dialog window for file backup appears. The various settings required to back up the data from the continuous measured value acquisition are made here.
    The data are saved as ASCII text with line breaks with the corresponding time information; some data is separated by tabs. New data are always appended to previous data.

  – The dialog window with the operational measured values appears. This always shows the last set of measured values transferred from the REF542. The `OK` button has now become the `Stop` button.

  – Click the `Stop` button to stop continuous measured value recording. The `Stop` button then becomes the `Exit` button.
    Press the `Exit` button to close the dialog window and return to the main menu of the configuration program.

4.5.2 Description of the menu items

The following subsections provide a description of all menu items of the configuration program. They are subdivided into main and drawing menu.

The main menu is displayed after starting the configuration program. The drawing menu is displayed when the menu item `Main Menu/Configure/Drawing` has been selected in the main menu.

4.5.2.1 Main Menu/File

New

A new project under the name new.edt is created. Save it immediately under a different name, because this name is always reserved for new projects.

Open… F2

A standard operating system dialog window for opening a file opens. The default file ending for the file format is `edt`. If necessary, move through the disk and directory structure to open a configuration file.

The dialog for opening the file will also appear when the F2 key on the PC keyboard is pressed.

After the project has been opened, a drawing check is run. Any error messages must first be acknowledged before the project can be edited.

Save F6

The open application file is saved. If a new application file has been created, the file `new.edt` will be saved in the default work directory of the configuration program. In the case of a new file, use the menu item `Save as` … when it is saved for the first time.

An application can also be saved by pressing the F6 function key on the PC keyboard.

Note Before saving, the configuration program runs a check of the application. Any messages that appear must be acknowledged before saving.

Save as… F7

A standard operating system dialog window for saving a file appears. The file can be given any desired name and location. The default file ending for the file format is `edt`.

The dialog can also be started by pressing the F6 function key on the PC keyboard.

Note Before saving the configuration program runs a check of the application. Any messages that appear must be acknowledged before saving.

Print

Another submenu is opened here where the information that is to be printed can be selected. A dialog window appears. Its appearance depends on the operating system and the installed printer. Additional inputs regarding the print process can be made here.

- Drawing
  The function chart is printed out, on several pages if necessary.
- Parameters
  A file is printed with a list of all the parameters input in the application sorted by their origin. For example, this includes the device settings and also the parameter sets for the protective functions.
- Eventlist
  A file that lists all possible events that could be generated by the application is printed out. They are sorted by the function block that generated them.
- Connections
  The connection numbers and the associated comments are printed out in list form.
- Print All
  When this menu item is selected, all previously described printable information is printed out in sequence.

4.5.2.2 Main menu/Transfer

Serial Port

Starts the configuration dialog for the connection from the PC to the REF542 via the serial port.

↳Chapter "5.3.1 Serial Port" on page 5-2

Send to REF542

Sends the data from the open application to the REF542.

↳Chapter "4.5.1.12 Sending the application to the REF542" on page 4-10

Load from REF542

Exports the application currently in the REF542 from the unit.

↳Chapter "4.5.1.13 Receiving an application from the REF542" on page 4-11

Read Faultrecorder…

Exports the fault record data saved in the REF542 when the `New Data` button is pressed in the dialog window.

The data can be saved. If the MVB is being used as the interbay bus, the data will include the current time and date.

↳Chapter "4.5.1.14 Exporting the fault recorder" on page 4-11

Input Status…

Exports the current status of the binary inputs of the first two input/output boards of the REF542 when the `New Data` button is pressed in the dialog window. The data are marked with the current PC system date and time and can be saved and printed.

↳Chapter "4.5.1.15 Exporting the input or output status" on page 4-13

Output Status…

Exports the current status of the binary outputs of the first two input/output boards of the REF542 when the `New Data` button is pressed in the dialog window. The data is marked with the current PC system date and time and can be saved and printed.

↳Chapter "4.5.1.15 Exporting the input or output status" on page 4-13

Measurement…

Exports the current status of the operational measured values from the REF542. These are certain values that can also be displayed in the LC display screen above the mimic diagram.
The continuous measured value transmission to the PC can be configured in the operational measured values dialog window. The operational measured values and, if desired, the values from the binary inputs and outputs, will then be regularly transmitted from the REF542 to the PC.

The data is marked with the current PC system date and time and can be saved and printed.

↳Chapter "4.5.1.16 Exporting the operational measured values" on page 4-14

Version

Reads the current versions of the REF542 microcontrollers (MC) and the configuration program. The information is displayed in a dialogue window. If a connection to the REF542 cannot be established, an error message is shown.

4.5.2.3 Main menu/Configure

Global Settings…

Starts a configuration dialog in which the basic settings are made. Functions such as fault monitoring, coil monitoring and default values such as the general filter time and the device address are defined here. In addition, the system messages (events), which can be sent from the system itself to a higher-order control system, can be configured in two other dialogs.

Chapter "5.3.2 Global Settings" on page 5-2

Note This configuration dialog must be edited before an application can be created.

Hardware...

Starts a configuration dialog in which settings that describe the delivery variations of the REF542 can be made.

Chapter "5.3.3 Hardware" on page 5-5

Note This configuration dialog must be edited before an application can be created.

Terminals

This menu item enables the selection of two submenu items. With them the analog inputs and outputs can be configured. Correct configuration of the analog inputs in particular is extremely important if the REF542 is to function properly.

Analog Inputs...

Starts a configuration dialog in which settings can be made to adapt the analog inputs of the REF542 to the sensors or transducers used. Information important for starting and tripping protective functions is sent to the bay control and protection unit via these inputs. Measured values are also recorded with these sensors or transducers.

Chapter "5.3.4 Analog inputs" on page 5-6

Note The same measurement recorders are used for the protection and the measurement functions.

Analog Outputs...

Starts a configuration dialog in which settings that influence the REF542 analog outputs can be made. The operational measured values that must be output are selected and the dynamic range of the output signal can be influenced.

Chapter "5.3.5 Analog outputs" on page 5-11

Calculated Values…

Starts a configuration dialog in which settings for the calculated quantities are made. This includes items such as the selection of the metering system and the type of power calculation.

Chapter "5.3.6 Calculated values" on page 5-12

Drawing

Starts the function chart editor. Function blocks can be added, connected and configured here to set the desired functions for the bay control and protection unit.

The menu bar with the drawing menu appears. The menu items of the drawing menu are described in Chapter "4.5.2.7 Drawing menu/File" on page 4-21.

Display…

Starts the editor for the LC display screen. The mimic diagram can be set up here. Its elements are connected to the corresponding function blocks.

↳Chapter "5.3.7 Display" on page 5-13

Display Language…

Starts the dialog that sets the language version for the texts displayed on the LC display screen. At the same time the correct message texts for the application are selected.

↳Chapter "5.3.8 Display language" on page 5-18

4.5.2.4 Main menu/Utilities

Check Drawing F9

Starts the program routine that checks the drawing according to specific criteria. If necessary, relevant error messages appear after the check.

↳Chapter "4.5.1.10 Check function chart" on page 4-9

4.5.2.5 Main menu/Options

Language

Only one more submenu needs be selected to select the language version of the configuration program. All menu items, dialogs and messages will then appear in the selected language. This setting is retained every time the program is started in future.

↳Chapter "4.5.1.2 Selecting the language version" on page 4-4

4.5.2.6 Main menu/Help

Function Keys F1

Opens an information window that shows the assignment of the function keys on the PC keyboard. The appropriate function key is also shown with the corresponding menu items.

The following table shows the assignment of the function keys in the main menu and in the drawing menu.

Table 23: Assignment of the function keys

Key	Main menu	Drawing menu
F1	Help on function keys	Information dialog function keys
F2	Open existing file	–
F3	–	Wire mode: Connect FUPLA symbols
F4	–	Draw mode: Move FUPLA symbols
F5	–	Refresh drawing (screen refresh)
F6	Save	Save
F7	Save as…	–
F8	–	Repeat last add action (only for logic symbols)
F9	Check Drawing	Check drawing
F10	–	Sequences ON/OFF

About…

Opens an information window with copyright and version information of the configuration program.

4.5.2.7 Drawing menu/File

Save F6

The open application file is saved. If a new application file has been created, the file `new.edt` will be saved in the default work directory of the configuration program. In the case of a new file, use the menu item `Save as` ... when it is saved for the first time.

A project can also be saved by pressing the F6 function key on the PC keyboard.

Note

Before saving, the configuration program runs a check of the application. Any messages that appear must be acknowledged before saving.

Exit Edit

The editor used to create and edit the function chart is closed. The function chart display disappears and the `main menu` menu bar appears again.

4.5.2.8 Drawing menu/Edit

Mode

The function chart editor working mode can be selected in this submenu.

- Design Mode (Draw Mode): Function blocks can be added, moved, configured and deleted here. Connections can be configured or deleted.
- Wire mode (Connection Mode): Connections can be added and changed in the function chart. Connections and function blocks can also be configured or deleted here.
  If a function block is added in connection mode, the view switches automatically to draw mode.

Insert Page…

Starts a dialog with which a page can be added. The number of the page is entered in the input field before an empty page is added. An information window shows the last page that has been used in the application.
The `Accept` and `Cancel` buttons are used to add the page or to cancel the procedure. The dialog window is closed and the user is returned to the drawing menu.

The configuration program provides a maximum of 99 pages for one application.

Delete Page…

Starts a dialog with which the current page can be deleted. The `Accept` and `Cancel` buttons are used to delete the page or to cancel the procedure. The dialog window is closed and the user is returned to the drawing menu.

Delete All

This menu item has two submenu items. They provide the option of deleting all connections or all pages.

After making the selection, a confirmation window appears. Click the `OK` button to confirm the deletion or `Cancel` to delete nothing. The dialog window is closed and the user is returned to the drawing menu.

Search Wire…

Opens a dialog window where all connections with the same number can be found. The connection number is entered into the appropriate input field.

The `OK` button closes the dialog window and the connections with the number input are marked red on all pages of the function chart.

The `Cancel` button closes the dialog window and returns the user to the drawing menu.

Search Object…

This menu item has two submenu items. They enable a function block (referred to as an object here) to be searched either by its interbay bus address or its object number.

A dialog window appears after making the selection. The interbay bus address or the object number can be entered into the input field.

The `OK` button closes the dialog window and the object with the interbay bus address or the object number that was entered is displayed in the function chart.

The `Cancel` button closes the dialog window and returns the user to the drawing menu.

4.5.2.9 Drawing menu/view

Sequences F10

This menu item shows and hides all labels on the function blocks and connections. The F10 function key on the PC keyboard does the same thing.

Wires

This menu item has two submenu items. This enables the user to select whether connections can run only at right angles (perpendicular and horizontal) or in straight lines (perpendicular, horizontal and diagonal).

This setting may be changed at any time and affects all connections.

Next page PgDn

Shows the next page in the function chart. The PgDn (Page Down) key or Screen↓ on the PC keyboard does the same thing.

Previous page PgUp

Shows the previous page in the function chart. The PgUp (Page Up) key or Screen↑ on the PC keyboard does the same thing.

Go to page...

Starts a dialog with which any page of the function chart can be displayed. The number of the page wanted is entered into the input field. An information window shows the last page that has been used in the application.
The `OK` and `Cancel` buttons show the page or cancel the procedure. The dialog window is closed and the user is returned to the drawing menu.

The configuration program provides a maximum of 99 pages for one application.

Zoom…

Opens a dialog window with which the page view can be enlarged. The percentage factor is entered into the appropriate input field. It is always based on the default size of 100%.

Redraw F5

Refreshes the display on the screen. The size and the markings of searched objects remain as before.

Reset

Removes the markings on searched objects and resets the size to the default factor of 100%. Page 1 of the application also appears.

4.5.2.10 Drawing menu/Insert

A menu with all possible function blocks arranged by function groups appears. The various submenus are used to select the corresponding function blocks. The selected one is then added to the function chart.

The description of every function block can be found in Chapter "5.4.1 Control panel" on page 5-21 to Chapter "5.4.14 Other components" on page 5-206. The sequence of descriptions there corresponds to the menu structure of the `Insert` menu described here. Therefore, a list of the function groups with their function blocks is not given here.

4.5.2.11 Drawing menu/Utilities

Check drawing F9

Starts the program routine for checking the drawing according to specific points. If necessary, relevant error messages appear after the check.

↳Chapter "4.5.1.10 Check function chart" on page 4-9

Switching objects…

An information dialog appears. It lists the interbay bus addresses available for the switching objects. Additional information is also shown adjacent:

- ----------: The interbay bus address is not used by a switching object.
- "EXAMPLE TEXT":Text from the `Comment` input field in the configuration dialog of the switching object.
- "empty": The interbay bus address is used by a switching object. However, no comment text has been entered.

Note — When the mouse cursor is placed over a line with the data of a switching object and the left mouse button is double-clicked, the dialog is closed and the switching object is marked in the function chart.

↳Chapter "5.4.2 Binary IO (switching objects)" on page 5-26

Protection functions…

The dialog window shown below appears. It lists the protective functions in the application.

Figure 42: Dialog drawing menu/Utilities/protection functions…

A protective function can be marked with the option fields. If the `Search` button is clicked, the dialog window is closed and the protective function (of the function block) is marked in the FUPLA.

The `DSP load` information field shows the percentage load on the protection and measurement unit (DSP: digital signal processor) resulting from the configured protective functions. A maximum of 100% is permitted. No more than 120 protective parameters and 12 protective functions may be used simultaneously.

The `Close` button ends the dialog.

Wires…

An information dialog with the numbers of the connections in use opens. The number of connections with this number is shown adjacent in parentheses. At the end the text that was entered into the comment field of the configuration dialog of the connection follows.

Note — When the mouse cursor is placed over a line with the data of a connection and the left mouse button is double-clicked, the dialog is closed and all relevant connections are marked in the function chart.

4.5.2.12 Drawing menu/options

Block Moving of Objects

This menu item can be marked by selecting it. A <✓> then appears beside the menu item. The function blocks in drawing mode are moved only when the Shift key is held down.

↳Chapter "4.5.1.6 Add or move function blocks" on page 4-6

4.5.2.13 Drawing menu/Help

Function keys F1

Opens an information window that shows the assignment of the function keys on the PC keyboard. The function keys are also shown with the corresponding menu items.

The following table shows the assignment of the function keys in the main menu and the drawing menu.

Table 24: Assignment of the function keys

Key	Main menu	Drawing menu
F1	Help on function keys	Information dialog function keys
F2	Open existing file	–
F3	–	Wire mode: Connect FUPLA symbols
F4	–	Draw mode: Move FUPLA symbols
F5	–	Refresh drawing (screen refresh)
F6	Save	Save
F7	Save as…	–
F8	–	Repeat last add action (only for logic symbols)
F9	Check Drawing	Check drawing
F10	–	Sequences ON/OFF

‚About…

Opens an information window with copyright and version information of the configuration program.

4.6 Uninstall

Windows 3.1x and Windows NT 3.5x

Open the uninstall program `uninstall_REF542conf`. It is in the same location (the same program group) as the configuration program. It is also important for the file `install.log` to be in the same directory. It was created when the program was installed. The program then guides the user through the uninstall process, which can be user-defined or automatic.

All references to an uninstalled file are automatically deleted in Windows 3.1x and Windows NT 3.5x (old user interface). Program groups that are left empty during this process are also deleted.

In Windows NT 3.5x personal program groups are not affected if there are general program groups with the same name.

Windows NT 4.0

In Windows NT 4.0 start the uninstall process with `Start/Configure/System Settings/Software`.

Note With the user-defined uninstall process note that a directory is always deleted, even if it is not empty. This may accidentally delete files.

5 REF542 Setup

In this chapter you will find the following information:

- On the options for adding required functions to your bay control and protection unit.
- On the settings that can be made in the configuration program to adapt the REF542 to the application.
- On connecting the function chart to the bay in which the unit is operating.
- On implementing the protective functions by using the associated function blocks.
- On all other function blocks that can be added to the function chart.

If the unit has been delivered with a custom application, this section will assist in understanding the function blocks with respect to their function and configuration.

5.1 Basic information

The variety of functions offered by the REF542 results mainly from the PLC-like programming option provided by the REF542 configuration program. Various function blocks are linked to one another in one function chart (FUPLA).

The objects that can be added to the function chart are referred to as function blocks. They are used to address binary and analog inputs and outputs and to define switching operations, interlocking and protective functions.
Each function block has inputs and/or outputs that can be used within the function chart. Double-click the left mouse button (Microsoft Windows® in the default setting) to open the configuration dialog of the function block on which the mouse cursor is resting.

Normally a configuration or application has been created to be precisely customized for the purpose and location of the REF542 bay control and protection unit. This configuration has been loaded into the REF542 and saved there. It specifies what protective functions are tripped under what conditions, when and what interlockings are activated and what initial variables are set for the analog and binary outputs of the REF542. The application implemented with the function chart provides exactly the protection, measurement, supervision and control functions that are required.

5.2 Connecting inputs and outputs

The REF542 receives a great variety of information on the equipment being monitored through its analog and binary inputs. These input quantities are digitally processed in the function chart. The REF542 outputs are addressed from the function chart, for example to trip the switching objects in the bay.

To enable the REF542 inputs and outputs to be used in the function chart, they are represented by function blocks, the switching objects. This enables several inputs and outputs to be combined.

↳Chapter "5.4.2 Binary IO (switching objects)" on page 5-26

5.3 General settings

Before a function chart can be created and exported to the REF542, some settings must be made in the PC and the bay control and protection unit for which the application is to be programmed.

5.3.1 Serial Port

To enable the Serial Port (RS232) of the computer to be used to transmit the configuration/application, the applicable dialog window must be edited. After starting the configuration program, open the menu `Main Menu/Transfer/Serial Port` . The dialog window has five option fields where settings for the computer Serial Port can be made.

Configuration dialog

Option field `ComPort`: Here enter the active interface on the computer to enable communication from the PC to the REF542 over an RS232 cable.
Setting range: [COM1, COM2]
Default: COM 1

Note The following options are set.

- Option field `BaudRate`:
  Default: 9600
- Option field `Parity`:
  Default: None
- Option field `Data BITS`:
  Default: 8
- Option field `Stop BITS`:
  Default: 1

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.3.2 Global Settings

The "Global Settings" dialog window is opened with the menu `Main Menu/Configure/Global Settings` . The desired general configuration inputs are made here. With the exception of those for trip circuit supervision, the inputs are independent of the REF542 model supplied.

Note It is absolutely essential to edit the configuration dialogs `Main Menu/Configure/Global Settings` and `Main Menu/Configure/Hardware` before the drawing editor is opened.

Configuration

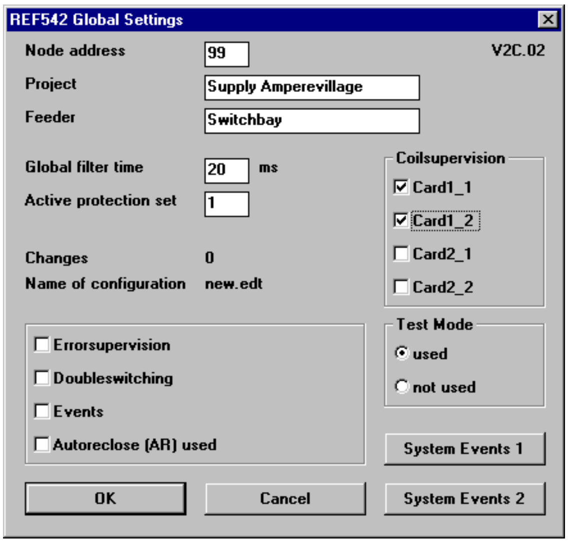


Figure 43: Configuration dialog for the REF542 Global Settings

Input field `Node address`: The Node address sets the addressing of the bay control and protection unit over the interbay bus. Every device installed on an interbay bus is assigned a unique device address.
Setting range: 1 ... 255
Default: 99

Input field `Project`: Enter a name for the project here. The name entered is only for a more precise description and has nothing to do with the name under which the application can be saved. One project can include several bays.
Setting range: 0 … 21 characters (standard character set)

Input field `Feeder`: Enter a name for the feeder for which the application will be created as part of the above project. The name entered is only for more precise description and has nothing to do with the name under which the application can be saved.
Setting range: 0 … 21 characters (standard character set)

Input field `Global filter time`: Time in ms required for an input signal to address the binary input to be detected as such. The general filter time is valid for all binary inputs and is added to a non-adjustable filter time that is set by the design of the unit (15 ms). The last is referred to as the hardware filter time.
Setting range: 0 … 999 ms (Increment: 1 ms)
Default: 20

Input field `active protection set`: Parameter set of the protective parameter that is intended to be active when the REF542 is started. The active parameter set can be changed later with the local control on the REF542 operator view.
Setting range: 1 … 2 (Increment: 1)
Default: 1

Information field `changes`: A variable that shows the number of changes to the configuration for the service in encrypted form appears here.

Information field `Name of configuration`: This shows the name under which the application file/configuration file is saved.

↪Chapter "4.5.1.1 Working with projects" on page 4-3

Input range `coil supervision`: There are four checkboxes here that enable trip circuit supervision (=coil supervision) to be activated for two trip circuits each for a maximum of two binary input and output boards.

- Checkbox board 1_1: Activates or deactivates trip circuit supervision for binary output 1 on the 1st input and output board.
- Checkbox board 1_2: Activates or deactivates trip circuit supervision for binary output 2 on the 1st input and output board.
- Checkbox board 2_1: Activates or deactivates trip circuit supervision for binary output 1 on the 2nd input and output board.
- Checkbox board 2_2: Activates or deactivates trip circuit supervision for binary output 2 on the 2nd input and output board.

↳Chapter "3.4.4.1 Input and output board with transistor relay" on page 3-20

↳Chapter "3.4.4.2 Input and output boards with conventional relays" on page 3-25

↳Information on the corresponding function block is in Chapter "5.4.2.17 IO-Supervision" on page 5-64

Checkbox `Errorsupervision`: Activate fault supervision here by checking the box. It monitors the switching of the controlled binary outputs. If the relays have not reacted to the switching command, an error message will appear on the REF542 LC display screen.

Checkbox `Doubleswitching`: This provides the option of activating double actuation. Then, after selecting a switching object once on the operator view of the REF542, the option of sending two switching commands to this switching object is available. In general, three seconds are available for sending a switching command after selecting a switching device. If double actuation is activated, another 10 seconds is available to send another switching command after the first switching command.

Checkbox `events`: Mark this checkbox to allow event data to be generally sent to a higher-order control system. See also the `system messages 1` and `2` buttons.

Checkbox `autoreclosure (AR) used`: Mark this checkbox to enable the autoreclosure function in general.

↳Chapter "5.5.1 Autoreclosure" on page 5-209

Option field `test mode`: Select whether entry to the test mode is generally allowed via the local input operating mode.

↳Chapter "8.1.6.7 Entry point to test mode" on page 8-23

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `system events 1`: Clicking on this button starts a dialog window in which various device-based events can be enabled. If they occur they are then sent to the higher-order control system.

See also button `system events 2` and checkbox `events`. Events may also be enabled in the configuration dialogs of some function blocks and they are then based on these.

Button `system events 2`: Clicking on this button starts another dialog window in which various device-based events can be enabled. If these events occur they are then sent to the higher-order control system.

See also button `system events 1` and checkbox `events`. Events may also be enabled in the configuration dialogs of some function blocks and they are then based on these.

5.3.3 Hardware

The hardware configuration dialog window is opened with the menu `Main Menu/Configure/Hardware`. General inputs on the REF542 model for which the configuration/application is to be created may be made there.

Note

It is absolutely essential first to edit the configuration dialogs `Main Menu/Configure/Global Settings` and `Main Menu/Configure/Hardware` to get to the drawing editor.

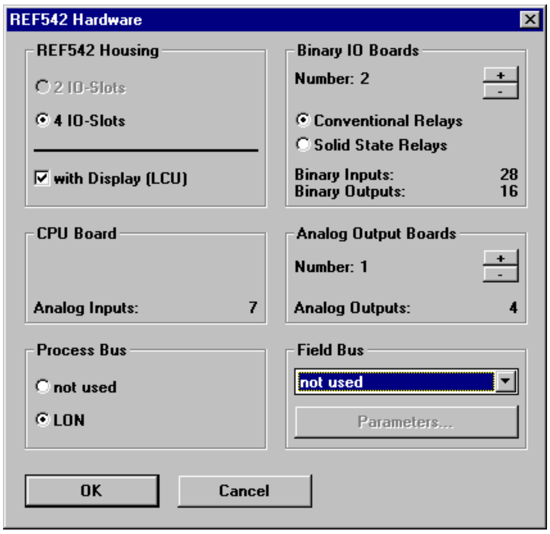


Figure 44: Dialog window for the REF542 hardware configuration

Input range `REF542 housing`: Various inputs regarding the type of housing in use can be made here:

- Options `IO-slots`: Specifies whether a short housing (2 input/output slots) or a deep housing (4 input/output slots) is in use.
- Checkbox `with display(LCU)`: Mark this checkbox when the REF542 has a LC display screen on the operator view (LCU – Local Command Unit).

Input range `binary IO boards`:

- <+> and <-> buttons: Increase or reduce the number of active binary input and output boards. The desired number is shown in the information field on the left.
- Options `relay`: Enter the type of relay that is used on the active binary input and output boards. Either conventional (mechanical) relays or Solid State (transistor) relays. Different boards cannot be combined.
- Information field `binary inputs`, `binary outputs`: This shows how many binary inputs and outputs are available depending on the number and type of boards in use.

Information field `CPU board`: Shows the number of analog inputs.

↳Additional configuration options: Chapter "5.3.4 Analog inputs" on page 5-6

Input range `analog output boards`: Configure the number of analog output boards in use here. These boards can only be used in the deep housing.

The <+> and <-> buttons are used for settings. The information field shows the number of possible analog outputs.

↳Additional configuration option: Chapter "5.3.5 Analog outputs" on page 5-11

Option field `process bus`: Mark whether the process bus is to be used or not.

Input range `field bus`:

- Use the button that opens the list field <🡻> to open the interbay bus variation selection list. Depending on the type of interbay bus the `parameters` button is then activated.
- Button `parameters`: When the MVB (Multi Vehicle Bus) is selected, the number of communications computers (number of higher-order control system gateways) can be entered with the familiar control components in the dialog window.

  ↳Chapter "3.4.7.2 MVB as interbay bus" on page 3-39

  When the SPA bus is selected, use the control components to enter whether the interbay bus configuration (topology) is star or ring-type.

  ↳Chapter "3.4.7.1 SPA bus as interbay bus" on page 3-36

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.3.4 Analog inputs

The menu `Main Menu/Configure/Terminals/Analog Inputs` opens the dialog window shown below. The analog measurement inputs of the REF542 can be configured and set for the transducers in use. The settings are particularly important for the safe and proper functioning of the unit.

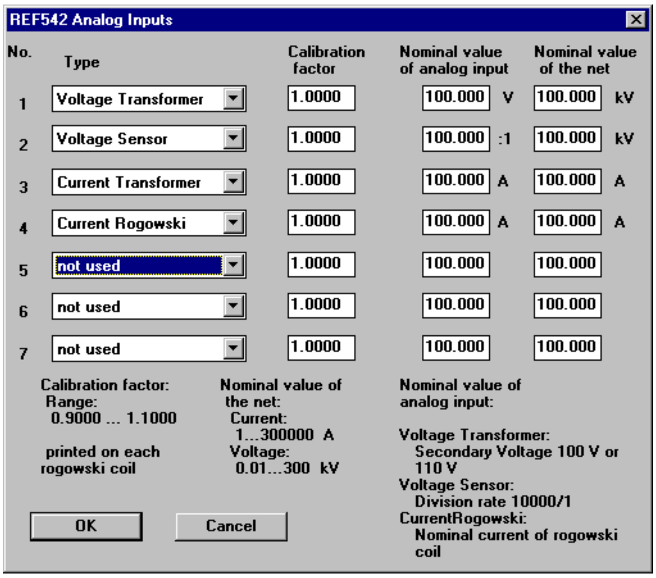


Figure 45: Example of the configuration dialog for setting the analog inputs

The dialog window is initially identical for all analog inputs (no. 1 … 7). For this reason only one input and its configuration is described. Information on the setting ranges or representative settings can be found below in the window in the information field.

Selection list `type`: First, open the selection list of possible types be clicking the <🡻> button for list selection. The type of the measurement recorder in use can be selected there. Sensors (voltage sensors and Rogowski coils) and transducers (current and voltage transformers) are available.

Input field `calibration factor`: This setting value only needs to be input when using the Rogowski coil. It is used to monitor manufacturing tolerances in making the coil. The calibration factor is printed on the Rogowski coil housing.

Caution **Enter a calibration factor for the Rogowski coil only. With all other measurement recorders a calibration factor unequal to 1.0000 will result in incorrect measured values.**

Input field `nominal value of analog input`: The nominal value at the analog input is entered here, depending on the measurement recorder in use.
Setting ranges:

↳Chapter "5.3.4.1 Setting the rated network values" on page 5-7

↳Chapter "5.3.4.2 The nominal values of the net and the protection settings" on page 5-9

↳Chapter "5.3.4.3 The nominal values of the net and the measured value display" on page 5-10

Input field `nominal value of the net`: The nominal value of the net is entered here, depending on the measurement recorder in use. The nominal values are always based on the network that is to be monitored. The nominal value is used for correct control of the bar graph on the REF542 LC display screen.

↳Chapter "5.3.4.1 Setting the rated network values" on page 5-7

↳Chapter "5.3.4.2 The nominal values of the net and the protection settings" on page 5-9

↳Chapter "5.3.4.3 The nominal values of the net and the measured value display" on page 5-10

Information fields below in window: The applicable setting ranges are shown here again as an aid.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.3.4.1 Setting the rated network values

Setting the rated network values is known to cause problems and is therefore precisely explained again in the following section for the usable measurement recorders.

Current transformer

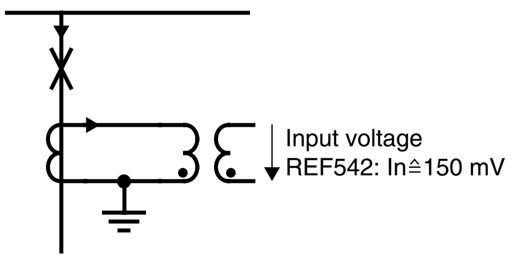


Figure 46: Nominal values for the current transformer

- Calibration factor: For proper functioning it must equal 1.0000.
- Nominal value of analog input: The primary rated current of the current transformer is entered here.
  This is understood as the primary current that has to flow to generate a secondary signal 1 A or 5 A (depending on the type of transducer).
- Nominal value of the net: The load current that should actually be expected is entered here. At this value the bar in the bar graph on the LC display screen will be in the middle and indicates the rated load of the network.

↳Chapter "5.3.4.3 The nominal values of the net and the measured value display" on page 5-10

Voltage transformer

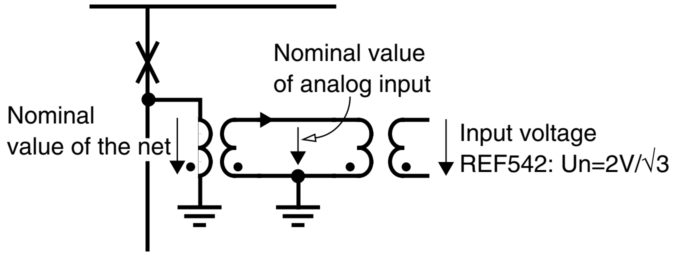


Figure 47: Rated network values for the voltage transformer

Note The REF 542 only measures conductor-earth voltages. The external phase-to-neutral voltages are calculated and then displayed.
The voltage inputs are based on the phase-to-phase voltages (external phase-to-neutral voltages).

- Calibration factor: For proper functioning it must equal 1.0000.
- Nominal value of analog input: The secondary voltage of the primary voltage transformers is entered here. Generally 100 V or 110 V.
- Nominal value of the net: The primary voltage of the network (external phase-to-neutral voltage!) is entered here. The secondary voltage of 100 V or 110 V is generated at this value.

↳Chapter "5.3.4.3 The nominal values of the net and the measured value display" on page 5-10

↳Chapter "5.3.4.2 The nominal values of the net and the protection settings" on page 5-9

Rogowski coil

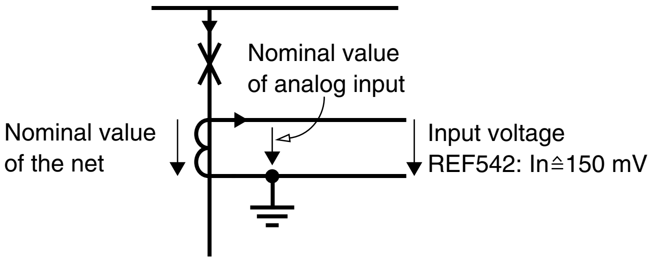


Figure 48: Rated network values for the Rogowski coil

- Calibration factor: Entering the calibration factor eliminates the coil manufacturing tolerance. It is printed every Rogowski coil.
- Nominal value of analog input: The rated current of the Rogowski coil is entered here.
  This is understood as the primary current that has to flow to generate a secondary signal of 150 mV.
- Nominal value of the net: The rated network current that should actually be expected is entered here. At this value the bar in the bar graph on the LC display screen will be in the middle and indicates the rated load of the network.

↳Chapter "5.3.4.3 The nominal values of the net and the measured value display" on page 5-10

Voltage sensor

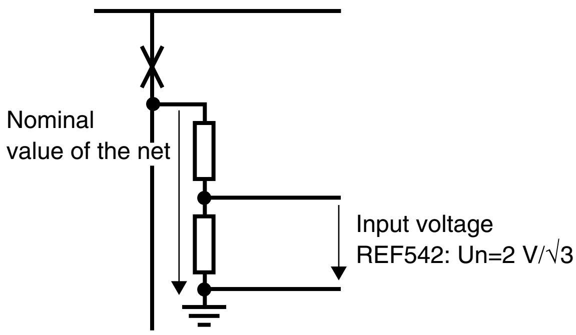


Figure 49: Rated network values for the voltage sensor

Note

The REF 542 only measures the phas voltages. The line voltages are calculated and then displayed. The voltage inputs are based on the line voltages.

Chapter "5.3.4.2 The nominal values of the net and the protection settings" on page 5-9

- Calibration factor: For proper functioning it must equal 1.0000.
- Nominal value af analog input: The voltage sensor divisor ratio based on its secondary output voltage of 2 V is entered here.
  Voltage sensors with a rated voltage of 20 kV are currently in use. As an example, 10 kV primary voltage is mapped to a secondary voltage of 1 V.
- Nominal value of the net: The actual primary voltage of the network (external phase-to-neutral voltage!) is entered here.

Chapter "5.3.4.3 The nominal values of the net and the measured value display" on page 5-10

5.3.4.2 The nominal values of the net and the protection settings

Voltage protective functions

Caution

All voltage protective functions are always based on Un=2 V/√3, thus the voltage applied at the analog input at the rated load. Proper configuration of the analog inputs is therefore particularly important.

If a protective function is started at X·Un, the protective function will actually be started if a voltage of X·2 V ⁄ √3 is applied to the analog input.

Example: Overvoltage protective function U>

Starting value: 1.2 U_n

The overvoltage protective function would start if a voltage of 1.2·2 V / √3 = 1.38 V is applied to the analog input.

Current protective functions

Caution

All current protective functions are always based on 150 mV, thus the voltage applied at the analog input at the rated load in the monitored conductor. Proper configuration of the analog inputs is therefore particularly important.

If a protective function is started at X·In, the protective function will actually be started if a current is applied that initiates a voltage of X·150 mV at the analog input.

Example: Overcurrent protective function I>>>

Starting value: $25 \cdot I_n$

The overcurrent protective function would start if a current is applied that would initiate a voltage of 25·150 mV = 3.75 V at the analog input.

5.3.4.3 The nominal values of the net and the measured value display

The following table shows some actual examples of the connections between the inputs in the configuration dialog for the analog inputs and the display on the LC display screen on the REF542 control panel.

Table 25: Configuration examples of the measurement recorder

Settings in the configuration dialog				**Simulated input quantity**	**Display on the REF542**	
Measurement recorder type	**Calibration factor**	**Nominal value of analog input**	**Nominal value of the net**		**Value**	**Bar**
Current transformer	1.0000	300 A	300 A	150 mV	300 A	1/2
Current transformer	1.0000	300 A	150 A	150 mV	300 A	full
Current transformer	1.0000	300 A	150 A	75 mV	150 A	1/2
Current transformer	1.0000	150 A	300 A	150 mV	150 A	1/4
Current transformer	1.0000	150 A	300 A	75 mV	75 A	1/8
Voltage sensor	1.0000	10 000:1	10 kV	$2\text{ V}/\sqrt{3}$	$U_{LE}=20/\sqrt{3}$ kV $U_{LL}=20$ kV	full
Voltage sensor	1.0000	10 000:1	10 kV	$1\text{ V}/\sqrt{3}$	$U_{LE}=10/\sqrt{3}$ kV $U_{LL}=10$ kV	1/2
Voltage sensor	1.0000	10 000:1	20 kV	$2\text{ V}/\sqrt{3}$	$U_{LE}=20/\sqrt{3}$ kV $U_{LL}=20$ kV	1/2
Voltage sensor	1.0000	10 000:1	20 kV	$1\text{ V}/\sqrt{3}$	$U_{LE}=10/\sqrt{3}$ kV $U_{LL}=10$ kV	1/4
Rogowski coil	1.0000	300 A	300 A	150 mV	300 A	1/2
Rogowski coil	1.0000	300 A	150 A	150 mV	300 A	full
Rogowski coil	1.0000	300 A	150 A	75 mV	150 A	1/2
Rogowski coil	1.0000	150 A	300 A	150 mV	150 A	1/4
Rogowski coil	1.0000	150 A	300 A	75 mV	75 A	1/8
Voltage transformer	1.0000	100 V	10 kV	$2\text{ V}/\sqrt{3}$	$U_{LE}=10/\sqrt{3}$ kV $U_{LL}=10$ kV	1/2
Voltage transformer	1.0000	100 V	10 kV	$1\text{ V}/\sqrt{3}$	$U_{LE}=5/\sqrt{3}$ kV $U_{LL}=5$ kV	1/4
Voltage transformer	1.0000	100 V	20 kV	$2\text{ V}/\sqrt{3}$	$U_{LE}=20/\sqrt{3}$ kV $U_{LL}=20$ kV	1/2
Voltage transformer	1.0000	100 V	20 kV	$1\text{ V}/\sqrt{3}$	$U_{LE}=10/\sqrt{3}$ kV $U_{LL}=10$ kV	1/4
In the following configuration note that the primary transformer generates a secondary voltage of 110 V. Because only signal converters with a rated voltage of 100 V are used in the REF542, the measurement results must be adapted by the program. This is done by changing the nominal value of analog input from 100 V to 110 V. If such a special solution is used, please note the thermal durability of the signal converter and test the desired configuration beforehand.						
Voltage transformer	1.0000	110 V	20 kV	$2.2\text{ V}/\sqrt{3}$	$U_{LE}=20/\sqrt{3}$ kV $U_{LL}=20$ kV	<1/2
Voltage transformer	1.0000	110 V	20 kV	$1.1\text{ V}/\sqrt{3}$	$U_{LE}=10/\sqrt{3}$ kV $U_{LL}=10$ kV	<1/4

5.3.5 Analog outputs

The menu `Main Menu/Configure/Terminals/Analog Outputs` opens the dialog window shown below. The analog outputs on the REF542 analog output board can be configured there.

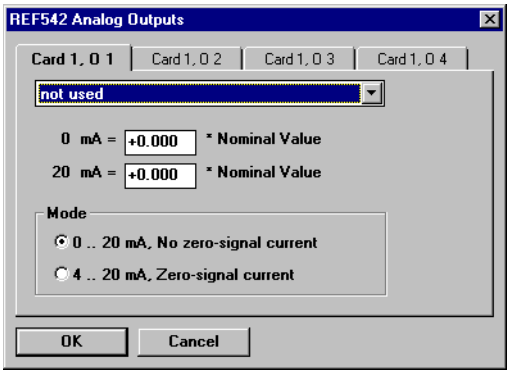


Figure 50: Configuration dialog for the analog outputs

Because all analog outputs are configured the same way, only one output is described here. All setting options for an analog output can be found on one index card:

- `Selection list`: A click of the mouse on the button opens the selection list ↓ and a REF542 measured or calculated value can be selected. It can then be tapped at the corresponding analog output.

Note

The selection list always shows all possible measured and calculated values. In fact only the following values can be output:
– Measured values applied to the analog inputs and
– calculated values required by a configured protective function.

- Input field `0 mA= / 4 mA=`: Specify what multiple of the rated value of a measured or calculated value is mapped to the initial value of the analog output board. The initial value of the output range of the analog output changes here depending on the mode marked.
  If 0 mA or 4 mA can be tapped at the analog output, the actual measured or calculated value will be [-4.000 … +4.000] multiplied by its rated value.
  Default: +0.0000 (Increment: 0.0001)
  Setting range: -4.0000 … +4.0000
- Input field `20 mA=`: Specify what multiple of the rated value of a measured or calculated value is mapped to the final value of the analog output board.
  If 20 mA can be tapped at the analog output, the actual measured or calculated value will be [-4.000 … +4.000] multiplied by its rated value.
  Default: +0.0000 (Increment: 0.0001)
  Setting range: -4.0000 … +4.0000
- Option field `mode`: Mark the output mode here. This sets the output range to which the input range set above will be mapped.
  The option `with quiescent current` allows a continuous quiescent current to flow through the line from the analog output board to the display device. This enables an error message to be generated by the display device if no signal is received over the line. However, this will limit the output range.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.3.6 Calculated values

The menu `Main Menu/Configure/Calculated Values` opens the dialog window shown below. Various settings that influence the calculation methods of certain calculated values in the REF542 are made here.

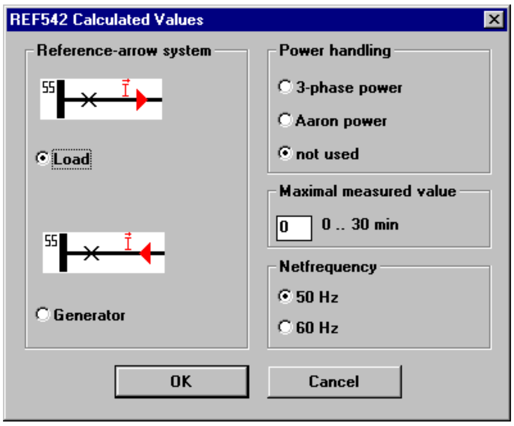


Figure 51: Configuration dialog for calculating some internal quantities

Option field `Reference-arrow system`: Activate the consumer or or generator metering system here. The two diagrams in the option field show the positively metered current direction.

The setting influences the sign of the values determined in the power calculation!

Note: The choice of the metering system influences the sign in the power calculation.
The choice of the metering system does not affect the directional protective functions.

Option field `power handling`: The type of power calculation is configured here. The three options are three-phase power calculation, power calculation by the Aron method and deactivation of the power calculation.

↳Chapter "11.7.5 Power calculation" on page 11-33

Note: Please remember that the choice of power calculation always requires specific wiring of the analog inputs with sensors or transducers.

Input field `Maximal mesured value`: This input window enables the length of a time window in minutes to be input. The average value of the line currents is mapped in this time window. The average value has a trailing pointer function. The maximum value is indicated in the bar graph on the LC display screen with a perpendicular line.
The setting value 0 deactivates this function.
Setting range: 0 … 30 min. (increment: 1 min.)
Default: 0

Option field `netfrequency`: Select the network frequency of the monitored network here.

Caution **If the network frequency of 60 Hz is selected, the protective function distance protection will not be available.**

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.3.7 Display

The menu `Main Menu/Configure/Display` ... opens the dialog window shown below. This editor is used to configure the mimic diagram displayed on the LC display screen in standard operation. The editor is also used to configure the connection between the mimic diagram and the switching device.

5.3.7.1 User controls for the editor for the LC display screen

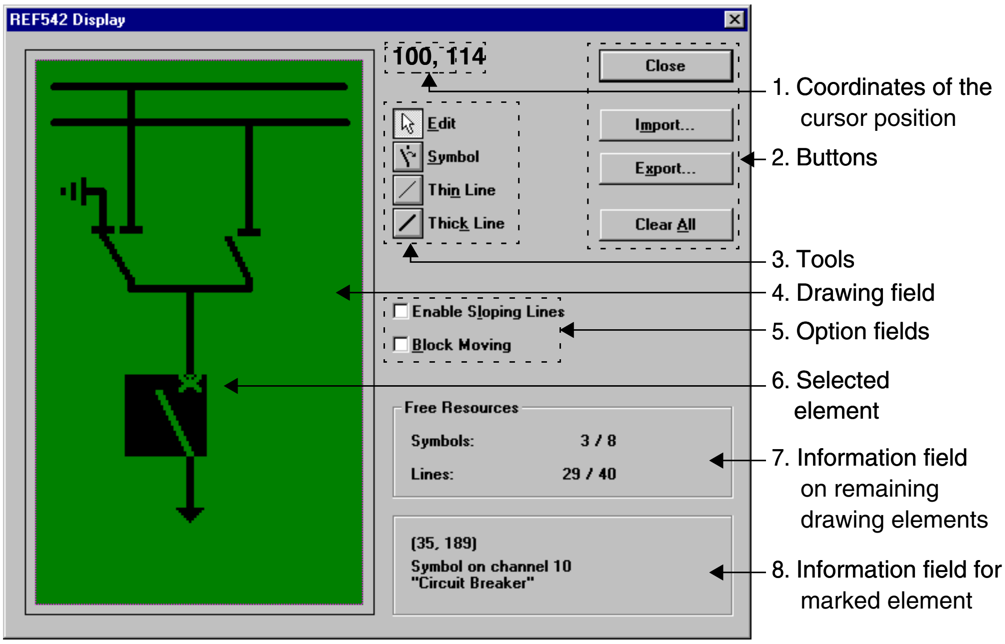


Figure 52: Editor for configuring the mimic diagram

The elements labeled in the above screenshot are described in the following paragraphs:

4. Drawing field:

- This area represents the area of the REF542 LC display screen usable for the mimic diagram. It has an area of 127x212 pixels. A mimic diagram configured here always fits between the measured value display and the status line on the LC display screen.

1. Coordinates of the cursor position:

- When mouse cursor is in the drawing field (4.), the location coordinates will be shown in the form x, y. Here the left upper corner corresponds to the coordinates 0, 35 and right lower corner to the coordinates 127, 247.
  This ensures compatibility to mimic diagrams configured with older software versions.

2. Buttons:

- Button `close`: This closes the editor. The mimic diagram is automatically saved with the configuration. When the editor is closed the user is prompted to save the mimic diagram.

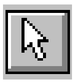
- Buttons `import` and `export`: They offer the option of reusing a previously configured mimic diagram.
  To do this the mimic diagram must first be exported. After clicking on the appropriate button, a standard Microsoft Windows® dialog for saving the file to be exported appears. The file name has the ending *.lcu.
  If the user wishes to reuse or change a previously configured mimic diagram, click the `import` button. A standard Microsoft Windows® dialog in which the file to be imported can be selected appears. The file name must have the ending *.lcu.

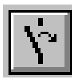
Note: Mimic diagrams that were not prepared with the editor described above cannot be imported.

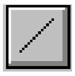
- Button `clear all`: All elements on the drawing field (4.) will be deleted. If the configuration has been previously saved, the drawing as it stands at this point will be saved with it.

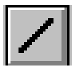
3. Tools:

The four buttons set the mode in which work on the drawing field (4.) is conducted. The appearance of the mouse cursor also depends on the mode.


Button `edit`: Elements can be selected, moved and deleted in this mode. The editing mode is always activated again after using other modes.


Button `symbol`: Any icon can be added and configured on the drawing field (4.) in this mode.


Button `thin line`: Use this mode to draw thin lines in the drawing field (4.).


Button `thick line`: Use this mode to draw thick lines in the drawing field (4.).

The exact usage of the buttons will be explained in more detail after the editor controls have been explained.

5. Option fields:

- Option field `Enable Sloping Lines`: When this field is marked, diagonal lines can be drawn on the drawing field (4.) as well as perpendicular and horizontal lines.

- Option field `Block moving`: Marking this field prevents unwanted movement of elements on the drawing field (4.). To move an element, hold down the shift key. This key must also be used for extending, shortening or changing the direction of lines.

6. Selected element:

- A selected element is shown inverted. All operations can only be conducted on the selected element. For this reason only one can be selected at any time.

7. Information field `free Resources`:

- This shows information on the number of icons and lines (the possible elements) that can still be drawn. A maximum of 8 icons and 40 lines can be drawn.

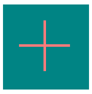
8. Information field marked element:

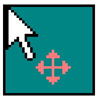
This shows information on the element that is to be selected:

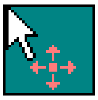
- Lines: Coordinates of the start and finish points, the line thickness (thin, thick) and the line length in pixels.
- Switching objects: Coordinates of the lower left corner, Field bus address and comment for the function block that is represented.
- Other icons: Coordinates of the left lower corner.

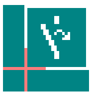
Mouse cursor appearance

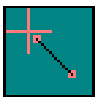
The mouse cursor can also appear differently depending on the specific mode in the drawing field (4.):


Standard appearance: Shown when the mouse cursor is not on any element.


Movement mouse cursor: Shown when the mouse cursor is on an element. Click the mouse button to select the element.


Drag mouse cursor: Shown when the mouse cursor is on the end of a selected line. The line can then be shortened or lengthened by dragging with the left mouse button held down.


Icon mouse cursor: This is used in icon mode. Click the mouse to open the configuration dialog for a new icon.


Line mouse cursor: This is used in line mode. Hold the left mouse button down and drag to draw perpendicular, horizontal or diagonal (if enabled) lines.

5.3.7.2 Working with the editor for the LC display screen

Select an element/deactivate selection

- Click the left mouse button when the mouse cursor is on an icon or a line.

The selected icon is shown inverted; the sizing handles at the ends of the line are emphasized.

- Click the left mouse button when the mouse cursor is not on an element in the drawing field.

Select sizing handle

- Select a line. The sizing handles will show.
- Move the mouse cursor to the sizing handle and hold the left mouse button down. Drag the sizing handle with the mouse.
  OR:

- Mark one or the other sizing handle by using the key combination `Ctrl+space` several times. Then the `cursor keys` on the keyboard can be used to make very precise movements of the sizing handle.

Move element

- Select the element and drag the mouse with the element while holding the left mouse button down.
  OR:
  After selecting the element move it with the `cursor keys` on the keyboard.

Insert icon

- Click the `symbol` button.
- Move the mouse cursor to the position desired for the icon in the drawing field.
- Click the left mouse button to open the icon configuration dialog.

↳Chapter "5.3.7.3 Configuration dialog for icons" on page 5-17

Configure existing icon

- Move the mouse cursor over the icon and double-click the left mouse button. The configuration dialog then opens.

↳Chapter "5.3.7.3 Configuration dialog for icons" on page 5-17

Insert line

- Click the `thin line` or `thick line` button.
- Move the mouse cursor in the drawing field to the position desired for the beginning of the line.
- Click the left mouse button and hold it down to set the beginning point of the line. Drag the mouse with the button held down to the end point of the line. Release the mouse button.

Configure existing line

- Move the mouse cursor over the line and double-click the left mouse button. The configuration dialog then opens.

↳Chapter "5.3.7.4 Configuration dialogue for lines" on page 5-18

Delete element

- Select the element that is to be deleted.
- Click the `Del key` on the keyboard. The user is then prompted to confirm or cancel the deletion.

Change line size

- Select sizing handle
- Drag the mouse with the sizing handle while holding the left mouse button down.
  OR:
  After selecting the sizing handle move it with the `cursor keys` on the keyboard.

Change the appearance of a switching object

- Click on the switching object icon while holding the `Ctrl key` down. Every switching object has four different appearances, which represent its switching status.
  OR:
  Select the switching object and change its appearance with the key combination `Ctrl+space`.

Select elements one after the other

- Select an element
- Use the keys `Ctrl+right cursor` or `Ctrl+up cursor` to select the next or the previous element according to an internal sorting process.
- Use the keys `Ctrl+left cursor` or `Ctrl+down cursor` to select the next or the previous element in the opposite direction to the internal sorting process.

Copy drawing field to the clipboard

- Use the `Ins key` on the keyboard to copy the entire drawing field to the clipboard as a two-color bitmap graphic.

Open context-dependent popup menus

In addition to the options for conducting various operations described above, the editor for the LC display screen also has contect-dependent popup menus.
They are opened by clicking the right mouse button and the contents depend on where the mouse cursor is on the drawing field at that time (popup menus can only be opened there). A menu beside the mouse cursor opens in which various editing options can be selected. This offers faster access to the various functions. All functions offered there can also be accessed as described above.

5.3.7.3 Configuration dialog for icons

The configuration dialog for icons appears when a new icon is added or if it is opened as described in the previous subsection.

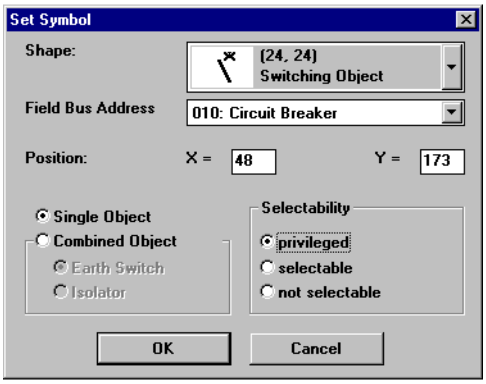


Figure 53: Configuration dialog for icons in the editor for the LC display

List field `Shape`: Click the button to open the list field that displays the selection menu for optional appearances of the icons. A description and the dimensions of the image (height, width) are adjacent to the image. In the case of the switching objects, please note that only one of four possible images is ever shown.

List field `Field bus address`: Set the connection between the element on the LC display and the function chart. The selected icon represents the switching object with the corresponding Field bus address on the LC display.
After clicking the button that opens the list field ↓, the selection of possible Field bus addresses that have been used in the function chart for switching objects appears. The comment that can be entered in the configuration dialog of that switching object is adjacent.

The list field `Field bus address` is opened automatically when an icon in the above list field `image` has been selected.

Input fields `position`: The `x` and `y` coordinates appear at the lower left corner of the icon. Other coordinates can be entered here to move the icon.

Option fields `Single object/combined object`: Here select whether the desired switching object will be represented by one or two icons. The second icon can be selected with the option fields `earth switch/isolator`. Only these two options are available for the second icon.

Example: A 3-position switch (with some exceptions) can be shown with an object combined of a earthing switch and a Isolator.

Option range `selectability`: Here select how the switching object can be selected locally directly at the REF542.

- privileged: It is the first switching object that will be selected.
- selectable: It can be selected.
  The sequence in which the switching objects will be selected is set internally. Only the switching object that will be selected first can be set (see above).
- not selectable: This switching object cannot be selected locally on the REF542. (It can only be addressed from the higher-order control system.)

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.3.7.4 Configuration dialogue for lines

The configuration dialog for lines is opened as described in the subsection above.

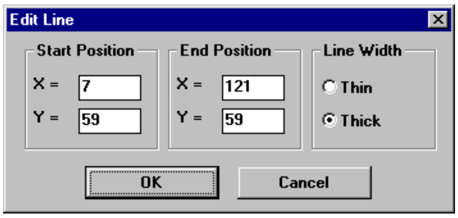


Figure 54: Configuration dialog for lines in the editor for the LC display

Input range `start position`: Enter the x and y coordinates of the starting point of the line into the two input fields. The current values appear there when the dialog window is opened.

Input range `end position`: Enter the x and y coordinates of the end point of the line into the two input fields. The current values appear there when the dialog window is opened.

Option field `line thickness`: Here mark whether the selected line should be drawn thick or thin. The current values appear there when the dialog window is opened.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.3.8 Display language

The menu `Main Menu/Configure/Display Language` ... opens the dialog window shown below. Select the language file from which the texts that appear on the LC display screen will be read.

Figure 55: Configuration dialog for selecting the language of the texts on the LC display screen

List field `display language`: Click with the mouse on the button <↓> to open a selection list with various files. The file is selected depending on the desired language and the configuration used. A set of six files is provided for every language.
The files are in the following form: S_LB_AP.stc:

- L stands for the language used,
- LB for the type of power calculation and
- AP for the application used.

The following table shows an overview of the options available.

L: Language	LB: Power calculation	AP: Application
E: English G: German I: Italian C: Czech S: Spanish P: Portuguese M: Mexican	AA: Power calculation according to Aron 3P: Three-phase power calculation	CA: Dependent thermal protection (thermal replica) for lines MO: Dependent thermal protection (thermal replica) for motors TR: Dependent thermal protection (thermal replica) for transformers

Note A language file must be specifically selected if the protective function "dependent thermal protection“ (thermal replica) and/or a form of the power calculation is used in the application.

Please follow the points below when selecting the desired language file.

- First decide what language is required on the LC display.
- What equipment is protected by the protective function “dependent thermal protection“ (thermal replica)? Line, motor or transformer?

Note If the protective function “dependent thermal protection“ is not used, only the selection according to the type of power calculation is still important.

- What method is used to calculate the power in the application?
  Three-phase or Aron?

Note If power calculation is not used, only the selection of the equipment protected with the protective function “dependent thermal protection“ (thermal replica) is important. If this protective function is also not used, only the selection of the desired language is decisive.

Example: G_3p_CA.stc
Use this file if the following criteria must be met:

- Display language:German AND
- Calculation of the power: 3-phase OR no power calculation,
- Protection: dependent thermal protection for lines OR no dependent thermal protection used.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4 Function and configuration of the function blocks

This section describes all function blocks that can be added to the function chart or that are already present in the function chart. The structure is adapted to the menu structure of the `Add` menu in the function chart editor. Every description has a similar structure.

Description of the function blocks

A diagram of a function block is followed by an explanation of its function, its connections and, if applicable, a typical application. This is followed by a screenshot of the configuration dialog associated with the function block if it is not an information dialog, which only has the `OK` or `cancel` buttons.

Finally, the various elements of the configuration dialog are explained. If input parameters are involved, the input range and its optional increment and the default are also given. To ensure that every function block has a complete description, even elements that occur repeatedly are always described.

Description of the switching objects

Only the sections where the switching objects are described have a different procedure. They are preceded by an additional section that describes a selected switching object in detail. This includes information on the appearance of a switching object in the function chart and its configuration dialog. All descriptions are somewhat shorter in the sections on every single switching object.

Object number

The number on the left above every function block is the sequential number (object number), which is assigned by the configuration program. It may be assigned several times in the images of the function blocks. Every object number is only assigned once in a correct application.

5.4.1 Control panel

The subsections contain the descriptions of the function blocks that are available via the menu `Drawing Menu/Insert/Control Panel`.

5.4.1.1 Indication LED

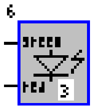


Figure 56: Function block indication LED

Function

This function block represents the configurable indication LEDs adjacent to the LC display screen on the local command unit (LCU). This function block can be used to address the LEDs (light-emitting diodes) from the function chart and appropriate message texts can be added. The LEDs can be in one of four states depending on the wiring of the two inputs: Off, green, red, orange (amber).

The configuration and numbering of the configurable LEDs (no. 3-9) can be found in the following figure:

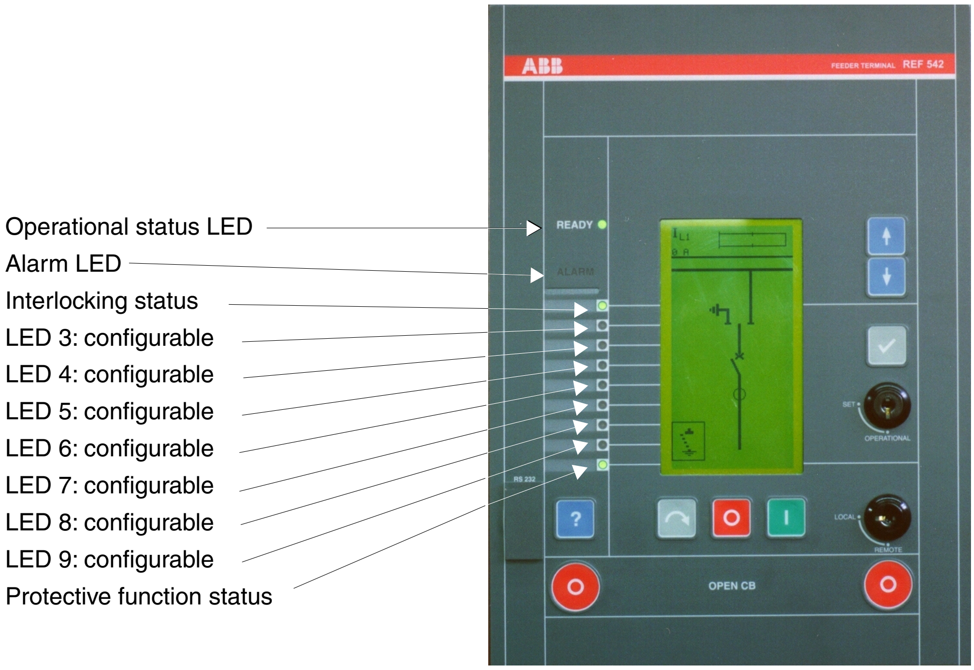


Figure 57: Control panel of the LCU with the LEDs

Typical application

Use of the signaling LED to receive the status message for temperature supervision of a motor. A green LED stands for "OK“, an orange LED stands for "critical status“ (with the starting signal of a protective function) and a red LED stands for "fault: motor too hot“ (with the trip signal of a protective function).

Connections:

Depending on the wiring of the two inputs, the LED has one of the four following states: OFF, green, red or orange. The following tables show the corresponding combinations.

Table 26: Connections on the function block signaling LED

Color	Connection Green input	 Red input
Off	0	0
Green	1	0
Red	0	1
Amber	1	1

Configuration

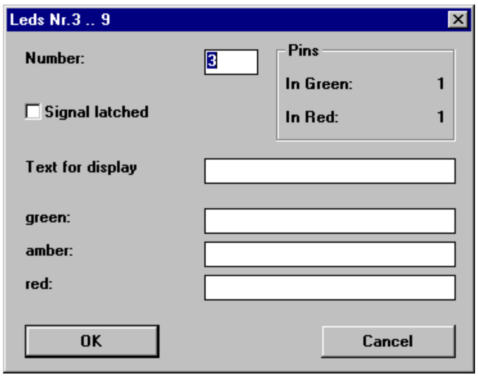


Figure 58: Configuration dialog function block signaling LED

Input field `number`: Input of the number of the LED that is to be configured. The number is also input in the function block. The LED numbers can be found in Figure:57.
Setting range: 3 … 9 (increment: 1)
Default: [number of the next LED that is not configured]

Checkbox `Signal latched`: This checkbox must be marked if an acknowledgement is required after the LED status (off, red, green or orange) has changed. If the reason for the LED change of state is still in effect, the acknowledgement will have no effect.
Setting range: Marked/unmarked
Default: Unmarked

Input field `text for display`: Text that is shown in the REF542 LC display screen after the scan of the LED message texts when the LED is out. In the function chart the text is displayed above the function block.
Setting range: 0 … 21 characters (standard character set)
Default: [Empty]

Input field `Green`: In the function chart the text is displayed above the function block. It is provided only to enable the function of the LED in the function chart to be understood better and is not displayed on the LC display screen.
Setting range: 0 … 21 characters (standard character set)
Default: [Empty]

Input field `Amber`: In the function chart the text is displayed above the function block. It is provided only to enable the function of the LED in the function chart to be understood better and is not displayed on the LC display screen.
Setting range: 0 … 21 characters (standard character set)
Default: [Empty]

Input field `Red`: In the function chart the text is displayed above the function block. It is provided only to enable the function of the LED in the function chart to be understood better and is not displayed on the LC display screen.
Setting range: 0 … 21 characters (standard character set)
Default: [Empty]

Information field `Pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.1.2 Alarm LED

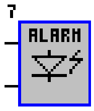


Figure 59: Function block alarm LED

Function

This function block represents the alarm LED on the LCU control panel. This enables it to be controlled from the function chart.

Connections:

The function block connections are not labeled on the function block. They are described as the upper and lower connection.

There are two options for switching the alarm LED on and off:

- The LED is switched on if the upper connection is at logical 1 and
- the LED is switched off if the upper connection is at logical 0.

OR

- the LED is switched on if the lower connection receives a logical 1 signal and
- the LED is switched off if there is no longer a logical 1 signal at the lower connection AND if the "alarm" is acknowledged at the REF 542 control panel.

Typical application

This LED or the "ALARM“ text is on if a power circuit-breaker OFF command has been generated by a protective function being addressed and the power circuit-breaker was tripped.

Configuration

Only the function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.1.3 Alarm Reset

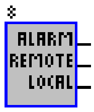


Figure 60: Function block alarm reset

Function

This function block provides return confirmations on the alarm and where the alarm was acknowledged from in the function chart.

Connections:

`ALARM` output: Logical 1 if the alarm is still active and the ALARM LED is on (even after an attempted acknowledgement of the alarm)

`REMOTE` output: Logical 1 impulse if acknowledged from the higher-order control system.

`LOCAL` output: Logical 1 impulse if acknowledged "locally“.

Typical application

The signals received can be used to reset flip-flops if an alarm (e.g. power circuit-breaker off) is acknowledged at the REF542 control panel.

Configuration

Only the function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.1.4 LR-Key

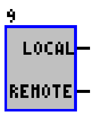


Figure 61: Function block LR-Key

Function

This function block provides information on the position of the “local/remote“ keyswitch on the REF542 control panel at both of its outputs.

Connections:

Table 27: Connections at the function block local-remote switchover

	Function: Keyswitch setting	
Connection	**Local**	**Remote**
Local/at local output	1	0
Remote/from remote output	0	1

Typical application

A return confirmation of the keyswitch setting that can also be forwarded to a higher-order control system is possible with this function block. This enables switching authorizations to be assigned, e.g. no switching operations permitted at the LCU.

Configuration

Only the function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.1.5 Emergency Buttons

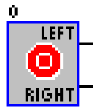


Figure 62: Function block Emergency Buttons

Function

This function module represents the two danger-OFF switches on the LCU (local command unit). If a switch is actuated, a logical 1 can be tapped at the corresponding function block output.

Connections:

`LEFT` output: Logical 1 can be tapped if the left "danger off" key on the REF542 control panel is actuated.

`RIGHT` output: Logical 1 can be tapped if the right "danger off" key on the REF542 control panel is actuated.

Typical application

Actuation of the trip solenoids of the power circuit-breaker with the two danger-OFF switches. With an additional AND interconnection, it can be configured so the two switches have to be actuated simultaneously to trip the power circuit-breaker.

Configuration

Only the function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.1.6 Beeper

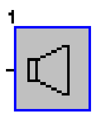


Figure 63: Function block beeper

Function

The function block beeper represents the buzzer, which is installed on the motherboard in the REF542. The LCU sounds a warning tone as long as there is a logical 1 at the function block input (left connection).

Configuration

Only the function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.2 Binary IO (switching objects)

The subsections contain the descriptions of the function blocks that are available via the menu `Drawing Menu/Insert/Binary IO`.

The function blocks described here are switching objects. A switching object represents one or more combined binary inputs and outputs in the function chart. A switching object enables signals at the binary inputs to be used in the function chart: For example, the message from a sensor that monitors the spring of a power circuit-breaker or the position messages of a switching device.

A switching object also enables signals to be sent to the binary outputs from the function chart. For example, a switching command can be sent to a switching device in this way. Both power and signal outputs can be addressed in the case of the outputs.

5.4.2.1 System of function blocks and configuration dialogs of the switching objects

All the switching objects described in the following subsections have identically structured FUPLA displays and configuration dialogs. To clarify the principle, a switching object 2-1 is described below. However, all elements of the FUPLA display and of the configuration dialog are explained with the individual switching objects. The explanation there is somewhat shorter.

The switching object labeling already shows the principal structure. The switching object 2-1 represents the logical combination of two binary outputs and one binary input.

Limit stop

If inputs and outputs are combined in one switching object and internally interconnected, the function block will include a limit stop, which functions as follows: When the desired position of a switch is reached and the return confirmation is received via a binary input, the switching impulse (can be tapped at P) is canceled, even if the configured impulse length has not yet been reached.

The combined inputs can also be addressed under an Field bus address..

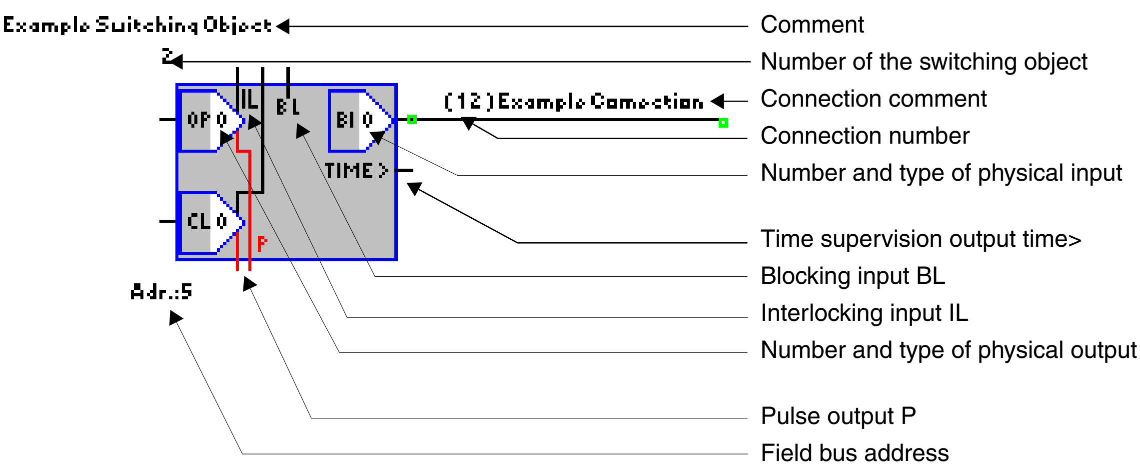


Figure 64: Example of the display of a switching object in the function chart

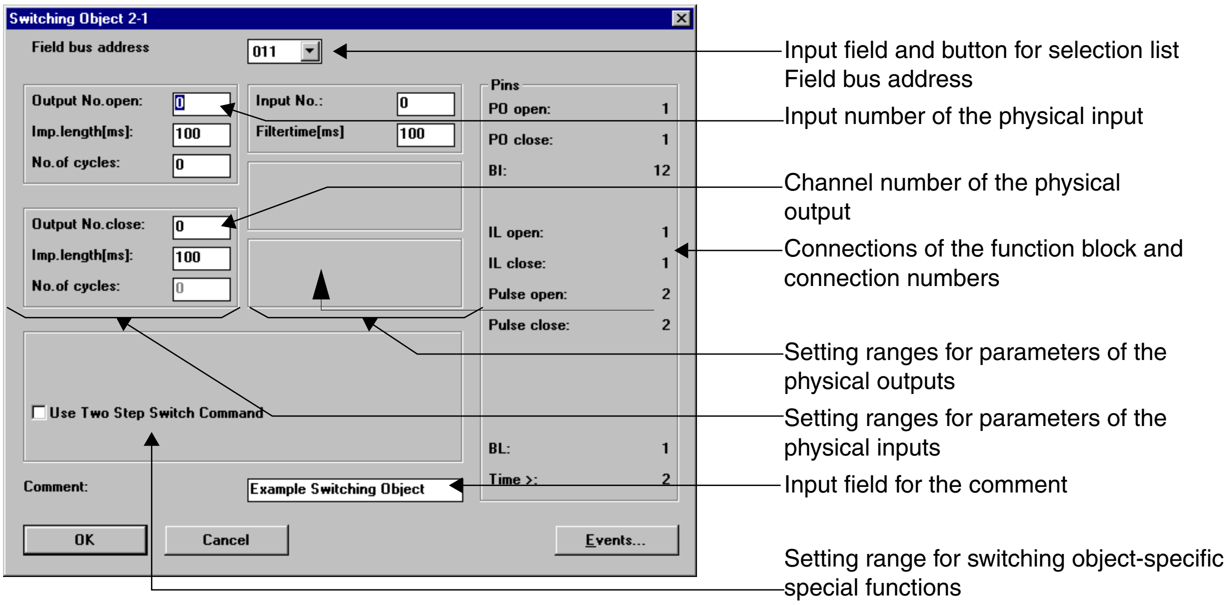


Figure 65: Example of the switching object configuration dialog

`Comment`
Configuration dialog/FUPLA icon:
Remarks regarding the switching object may be input here. It is shown on the upper left of the switching object in the function chart.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

`Number of the switching object`
Configuration dialog/FUPLA icon:
The sequential number appears to the upper left of the function block in the function chart. It is automatically assigned by the configuration program and updated when function blocks are deleted or new ones are added. It is used to localize the relevant function block in the event of error messages from the configuration program. It is also required in the internal processing of the function blocks in the REF542.

`Connection comment/connection number`
Configuration dialog/FUPLA icon:
Every connection drawn in the FUPLA is assigned a connection number. A comment should also be attached to the connection. Comment and number are displayed with every connection in the function chart and the connection number is also displayed in the configuration dialogs of the connected function blocks.

`Number and type of the physical input`
Configuration dialog/FUPLA icon:
Physical binary inputs are always placed in the right half of the FUPLA display of a switching object. Their connections are also on the right. The signal that is applied to the physical input can be tapped at the relevant connection.
The type (BI - binary input etc.) and the input number of the physical input are also shown in the FUPLA display. The explanation is adjacent to the relevant switching object.
In the configuration dialogue:

Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

✎Chapter "3.4.4 Binary input and output boards" on page 3-20

`Input Filtertime [ms]`
Configuration dialog:
Enter a period in ms during which an input signal at the binary input must be applied to be detected as such. The function block-dependent filter time entered here is added to the general filter time, which is specified in the configuration dialog `REF542 Global Settings`, and to the hardware filter time, which is set by the design of the binary input/output board.

Note

Hardware filter time
\+ general filter time
\+ function block-dependent filter time
total filter time

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "3.6 Overview of the technical data" on page 3-45

`Number and type of physical output`
Configuration dialog/FUPLA icon:
Physical binary outputs are always placed in the left half of the FUPLA display of a switching object. Their connections are also on the left. A logical signal to the appropriate connection starts, if authorized, an output relay switching operation. To enable this a logical 1 must be at the IL input and a logical 0 at the BL input. Otherwise, the interlokking status LED will show red or the switching operation will be suppressed.
The type (OP - Open or CL - close etc.) and the channel number of the physical input are also displayed in the FUPLA. The channel number is input in the configuration dialog.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0
Note the different relay types.
↳Chapter "3.4.4 Binary input and output boards" on page 3-20

`Setting range for parameter of the physical inputs`
Configuration dialog:
Various input fields appear here, depending on the type of physical binary input. Parameters that are important for configuring the input are entered into them.
Additional details can be found in the description of the switching object and in the following description of specific elements of the function chart display and the configuration dialog.

`Setting range for parameters of the physical outputs`
Configuration dialog:
Various input fields appear here, depending on the type of physical binary output.
Parameters that are important for configuring the output are entered into them.
Additional details can be found in the description of the switching object and in the following description of specific elements of the function chart display and the configuration dialog.

`Pulse output P` FUPLA icon and
`input field imp.length` configuration dialog:
The connection `pulse output` is available only with switching objects that represent at least one physical input and output.
Because most switchgear can only switch with short impulses, a closing time of 0 to 65000 ms can be input in the configuration dialog under `impulse length`, which has exactly the same effect on the actual output. This "extended“ switching signal can also be tapped as logical 1 at the `pulse output P` connection.
This logical 1 is canceled in the case of switching objects with a limit stop if a return confirmation regarding the successful switching operation has been transmitted over a binary input of the switching object.

Switching objects have a limit stop if they represent at least one physical input and output.

`Input field number of cycles`
Configuration dialog:
Enter the value of the mechanical switching cycle counter at the power circuit-breaker here. The value input is the starting value of the electronic switching cycle counter in the REF542.
When the configuration is exported to the PC from the REF542, the current value of the switching cycles is input at this position.

Note

In this program version the input field is only used by the switching object 2-2 when used as a power circuit-breaker. It has no function with all other switching objects.

`Time monitor output Time>`
FUPLA icon:
The connection time monitor output is available only with switching objects that represent at least one physical input and output. A logical 1 can be tapped at the connection if the impulse time (at the pulse output P) has expired and a return confirmation regarding the successful switching operation has not yet been received over the binary input.

`Blocking input BL`
FUPLA icon:
The connection blocking input (blocking) is available only with switching objects that represent at least one physical output. If a logical 1 is applied to this connection, a switching operation can be blocked. A logical 1 at the BL connection will place the function block out of service.
If the interlocking input IL is set to logical 1, a switching operation would be allowed. However, this can be blocked by a logical 1 signal at the connection BL. If a signal for the switching operation is given to the connection of the physical output, no switching takes place and an "interlocking violation" error message (interlocking status LED) is also generated.

`Interlocking input, IL`
FUPLA icon:
The interlocking input (interlocking) connection is available only with switching objects that represent at least one physical output. To enable a switching operation, there must be a logical 1 at the connection IL. If a switching operation is started and the interlocking input IL is at logical 0, an error message "interlocking violation“ will be generated and displayed at the REF542 control panel using the LED provided for that purpose (interlocking status LED).

`Input field bus address`
FUPLA icon/configuration dialog:
The Field bus address is shown at the bottom left of the FUPLA beside the switching object: "Adr.: XX“. It is automatically assigned in the configuration dialog so every Field bus address is only used once. Addresses that are freed (when a function block is deleted) are assigned again by the configuration program. As an alternative the Field bus address can also be assigned in the configuration dialog with the interbay bus selection list. The selection list is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: The next free Field bus address automatically

`Information field Pins`
Configuration dialog:
List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

`Setting range for switching object-specific special functions`
Configuration dialog:
Checkboxes for activating or deactivating functions appear here. Further information may be found in the switching object description.

`Button Events`
Configuration dialog:
The events button cannot be selected if the transmission of events is generally suppressed in the REF542 Global Settings.
A dialog window opens when this button is clicked. Here the events are released that are then sent to the higher-order control system. The default is for all events to be released for sending.
An event that has been sent is a message to the higher-order control system regarding a change in status. Depending on the function block type, different events can be generated and released. The input can be accepted or canceled in the dialog field with the two buttons.
An overview of the possible events is given in the appendix.
↳Chapter "11.2 Event list of switching objects" on page 11-4

`Button OK`
Configuration dialog:
All settings are incorporated into the configuration program. The dialog window is closed.

`Button cancel`
Configuration dialog:
No setting is changed in the configuration program. The dialog window is closed.

5.4.2.2 Switching object 0-1

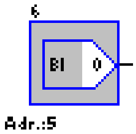


Figure 66: Function block switching object 0-1

Function

The signal of a physical binary input is made available in the function block.

Connections:

`BI` output: Connection at which the binary input signal of the represented physical input can be tapped.

Table 28: Connection labels switching object 0-1

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
BI	input	BI

Typical application

Connection of a gas pressure monitor that sends a logical 1 or 0 to the relevant binary input.

Configuration

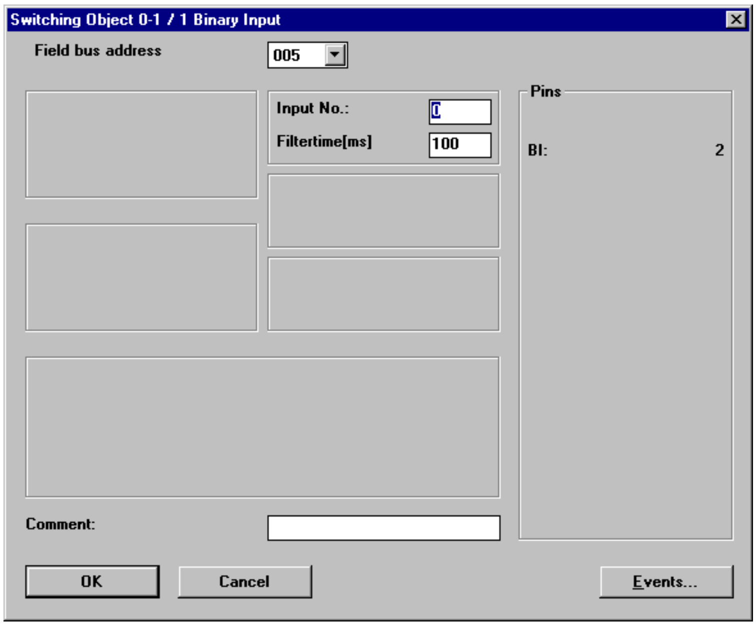


Figure 67: Configuration dialog switching object 0-1

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26.

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once. As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Input field `Input No. [Name]` (once per represented input): Enter the number of the physical input that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

Input field `Filtertime[ms] (once` per represented input): Enter the time during which a signal must be applied at the physical binary input to be detected as a logical signal. The input filter time is added to the hardware and to the general filter time.

Input field `comment`: Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.3 Switching object 0-2

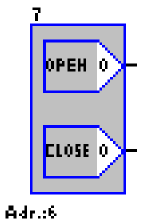


Figure 68: Function block switching object 0-2

Function

The signal of two physical binary inputs is made available in the function block. The two connections are addressed over one Field bus address.

Connections:

OPEN, CLOSE outputs: Connections at which the binary input signals of the various represented physical inputs can be tapped.

Table 29: Connection labels switching object 0-2

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
OPEN	Input No.	BI open
CLOSE	Input No. close	BI closed

Typical application

Position confirmation signal from a manually operated switching device, e.g. a earth switch with two defined positions.

Configuration

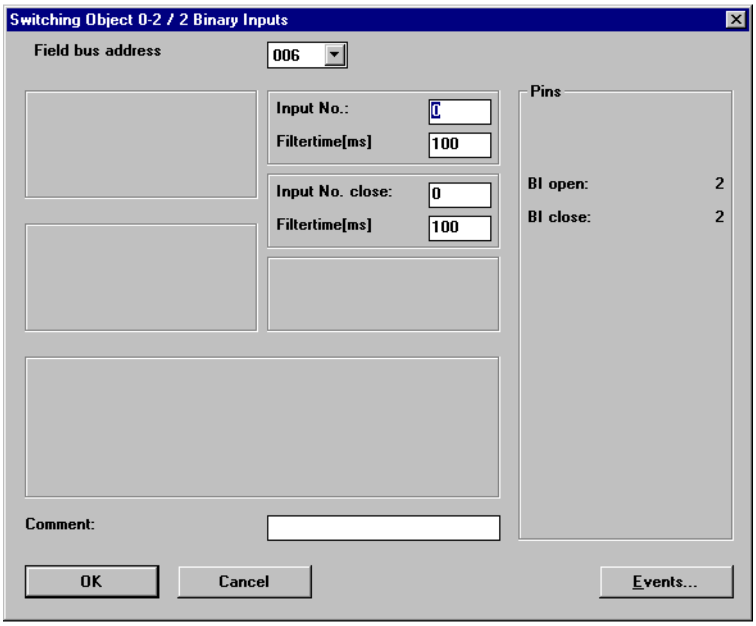


Figure 69: Configuration dialog switching object 0-2

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once. As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Input field `Input No. [Name]` (once per represented input): Enter the number of the physical input that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

Input field `Filtertime[ms] (once` per represented input): Enter the time during which a signal must be applied at the physical binary input to be detected as a logical signal. The input filter time is added to the hardware and to the general filter time.

Input field `comment`: Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.4 Switching object 0-3

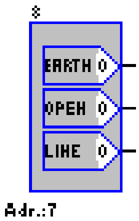


Figure 70: Function block switching object 0-3

Function

The signal of three physical binary inputs is made available in the function block. All connections are addressed over one Field bus address.

Connections:

EARTH, OPEN, LINE outputs: Connections at which the binary input signals of the various represented physical inputs can be tapped.

Table 30: Connection labels switching object 0-3

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
EARTH	Input No. earth	BI earth
OPEN	Input No. open	BI open
LINE	Input No. line	BI line

Typical application

Position confirmation signal from a manually operated switching device, e.g. a 3-position Isolator.

Configuration

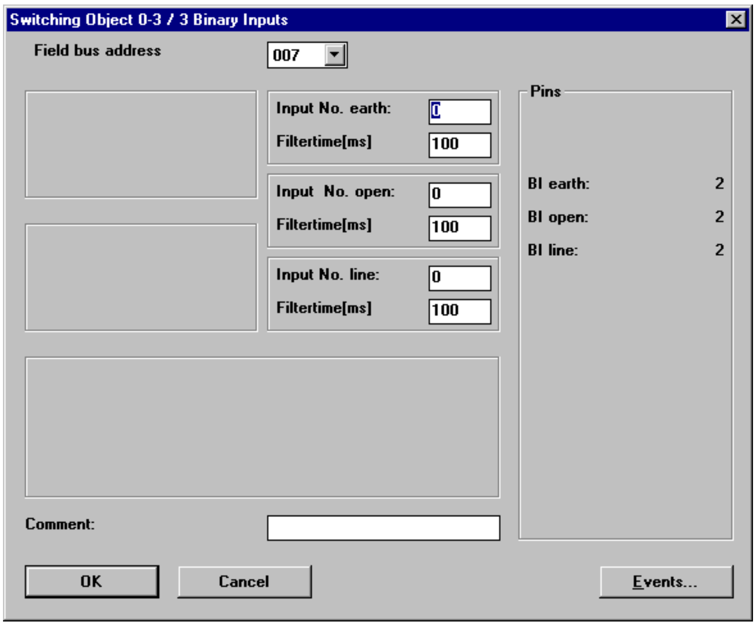


Figure 71: Configuration dialog switching object 0-3

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once. As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Input field `Input No. [Name]` (once per represented input): Enter the number of the physical input that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

Input field `Filtertime[ms] (once` per represented input): Enter the time during which a signal must be applied at the physical binary input to be detected as a logical signal. The input filter time is added to the hardware and to the general filter time.

Input field `comment`: Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.5 Switching object 1-0

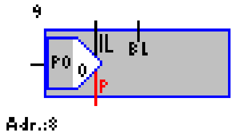


Figure 72: Function block switching object 1-0

Function

Actuates a physical binary output from the function chart.

Connections:

`IL` input: Interlocking input; a switching operation can only be conducted if there is a logical 1 here.

`BL` input: Blocking input; if there is a logical 1 signal here, the switching operations of the represented output will be blocked.

`PO` input: Signaling input for a physical output, a logical 1 initiates, if enabled, an output relay switching operation.

`P` output: Pulse output; a logical 1 can be tapped for the duration of the output relay switching operation.

Table 31: Connection labels switching object 1-0

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
PO	Output NoI	PO active
IL	–	IL
P	–	Pulse
BL	–	BL

More information on specific outputs can also be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26.

Typical application

Use as output for a general starting.

Configuration

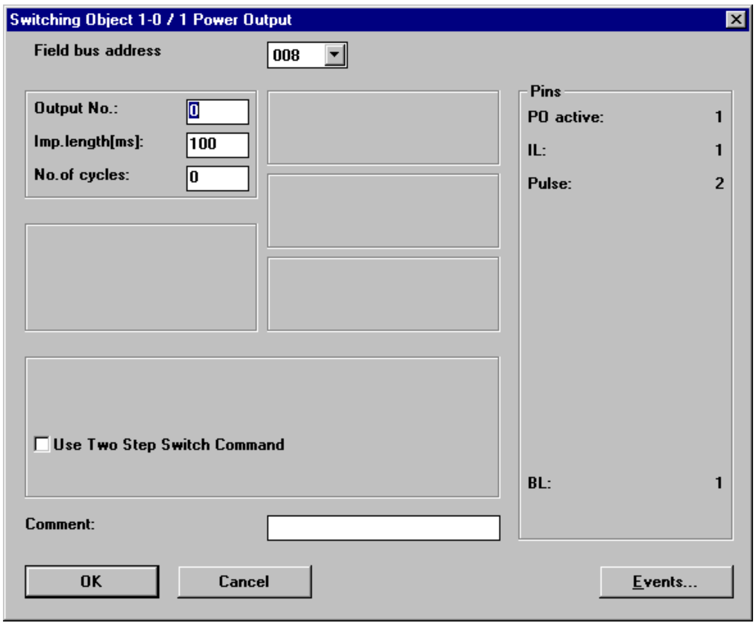


Figure 73: Configuration dialog switching object 1-0

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once. As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Input field `Output No. [Name]` (once per represented output): Enter the number of the physical output that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input field `imp.length [ms] (once` per represented output): Enter the maximum duration of the output relay switching operation. In function blocks with limit stops the switching operation will be ended before if necessary.

Input field `No. of cycles` (once per represented output): Not used.

Input field `comment`: Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Checkbox `use two step switch command`: If two-stage switching is activated, a switching object must be selected with a command from the higher-order control system and switched with a 2nd command.
This option does not refer to local switching.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.6 Switching object 1-1

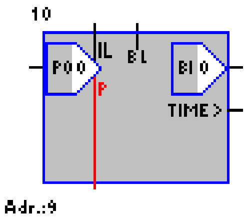


Figure 74: Function block switching object 1-1

Function

Actuates a physical binary output from the function chart. The return confirmation is received via the physical binary input, which can be tapped in the function chart.

Connections:

`IL` input: Interlocking input; a switching operation can only be conducted if there is a logical 1 here.

`BL` input: Blocking input; if there is a logical 1 signal here, the switching operations of the represented output will be blocked.

`PO` input: Signaling input for a physical output. A logical signal to this function block input starts, if enabled, a corresponding switching operation of the represented output relay.

`P` output: Pulse output; a logical 1 can be tapped for the duration of the output relay switching operation.

`BI` output: Signal output at which the binary input signal of the represented physical input can be tapped.

`Time >` output: Time monitor output; if a logical 1 can be tapped here, the set impulse time is expired and a return confirmation regarding the correct switching operation is no longer received over the represented binary input.

Table 32: Connection labels switching object 1-1

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
IL	–	IL
BL	–	BL
PO	Output No.	PO active
TIME>	–	Time >
BI	Input No.	BI
P	–	Pulse

More information on specific connections can also be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26

Typical application

Using the physical output to actuate a tension motor for the spring of a power circuit-breaker. The return confirmation over the physical input then provides information on the spring status.

Configuration

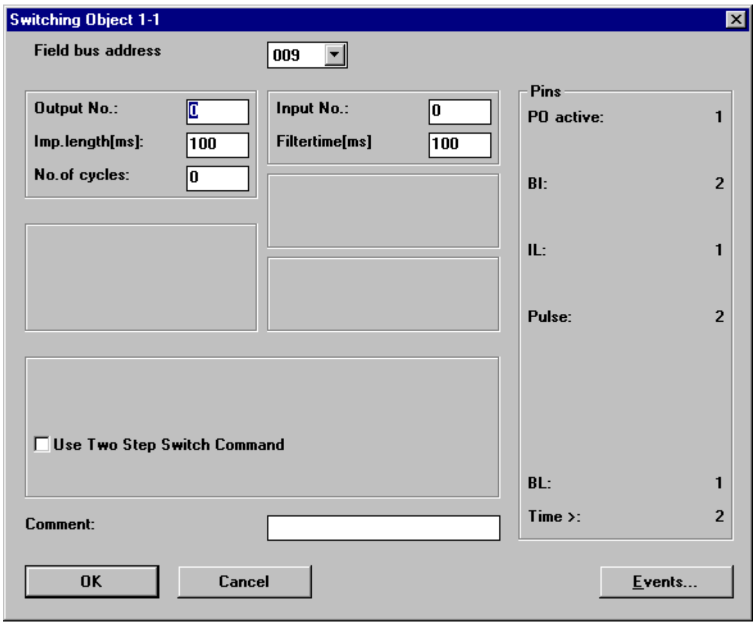


Figure 75: Configuration dialog switching object 1-1

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once. As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Input field `Output No. [Name]` (once per represented output): Enter the number of the physical output that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input field `imp.length [ms] (once` per represented output): Enter the maximum duration of the output relay switching operation. In function blocks with limit stops the switching operation will be ended before if necessary.

Input field `No. of cycles` (once per represented output): Not used.

Input field `Input No. [Name]` (once per represented input): Enter the number of the physical input that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

Input field `Filtertime [ms] (once` per represented input): Enter the time during which a signal must be applied at the physical binary input to be detected as a logical signal. The input filter time is added to the hardware and to the general filter time.

Input field `comment`: Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Checkbox `use two step switch command`: If two-stage switching is activated, a switching object must be selected with a command from the higher-order control system and switched with a 2nd command.
This option does not refer to local switching.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.7 Switching object 1-2

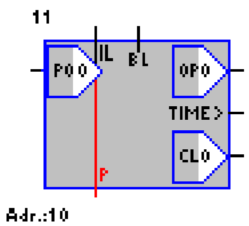


Figure 76: Function block switching object 1-2

Function

Actuates a physical binary output from the function chart. The return confirmation is received via two physical binary inputs, which can be tapped in the function chart.

Connections:

`IL` input: Interlocking input; a switching operation can only be conducted if there is a logical 1 here.

`BL` input: Blocking input; if there is a logical 1 signal here, the switching operations of the represented output will be blocked.

`PO` input: Signaling input for a physical output. A logical signal to this function block input starts, if enabled, a corresponding switching operation of the represented output relay.

`Time >` output: Time monitor output; if a logical 1 can be tapped here, the set impulse time is expired and a return confirmation regarding the correct switching operation is no longer received over the represented binary input.

`OP, CL` outputs: Signal outputs at which the binary input signal of the represented physical input can be tapped.

`P` output: Pulse output; a logical 1 can be tapped for the duration of the output relay switching operation.

Table 33: Connection labels switching object 1-2

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
IL	–	IL
BL	–	BL
PO	Output No.	PO active
Time>	–	Time >
OP	Input No. open	BI open
CL	Input No. closed	BI closed
P	–	Pulse

More information on specific connections can also be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26

Configuration

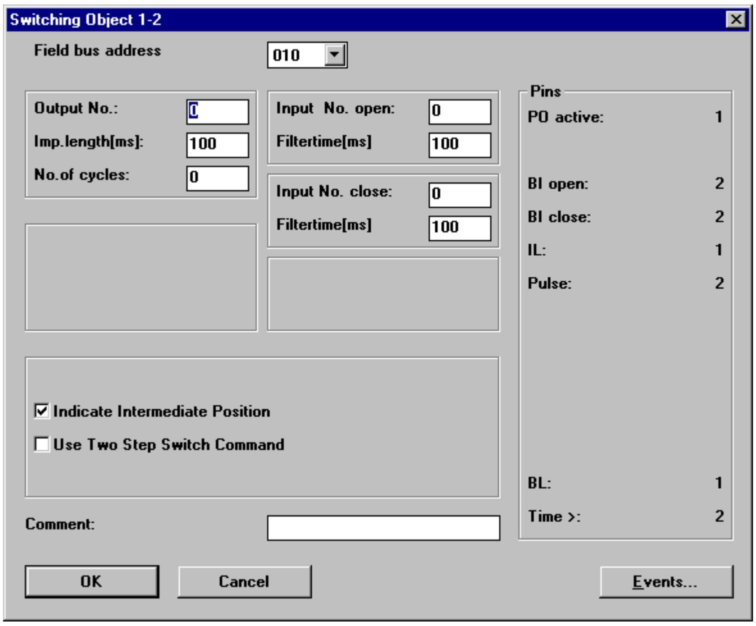


Figure 77: Configuration dialog switching object 1-2

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once. As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Input field Output No. [Name] (once per represented output): Enter the number of the physical output that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input field imp.length [ms] (once per represented output): Enter the maximum duration of the output relay switching operation. In function blocks with limit stops the switching operation will be ended before if necessary.

Input field No. of cycles (once per represented output): Not used.

Input field Input No. [Name] (once per represented input): Enter the number of the physical input that is to be represented.
The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

Input field Filtertime [ms] (once per represented input): Enter the time during which a signal must be applied at the physical binary input to be detected as a logical signal. The input filter time is added to the hardware and to the general filter time.

Input field comment: Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field pins: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Checkbox indicate intermediate position: If this checkbox is marked, an intermediate setting will be displayed on the LC display screen during the switching operation. This enables a visual return confirmation of the switching operation on the LC display screen.
Otherwise only the initial and final positions are displayed during a switching operation.

Checkbox use two step switch command: If two-stage switching is activated, a switching object must be selected with a command from the higher-order control system and switched with a 2nd command.
This option does not refer to local switching.

Button OK: All settings are saved in the configuration program. The dialog window is closed.

Button Cancel: Settings are not saved in the configuration program. The dialog window is closed.

Button events: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.8 Switching object 2-1

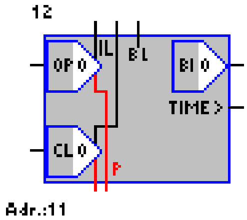


Figure 78: Function block switching object 2-1

Function

Actuates two physical binary outputs from the function chart. The return confirmation is received via the physical binary input, which can be tapped in the function chart.

Connections:

`IL` input: Interlocking input; a switching operation can only be conducted if there is a logical 1 here.

`BL` input: Blocking input; if there is a logical 1 signal here, the switching operations of the represented output will be blocked.

`OP, CL` inputs: Signaling inputs for one physical output each. A logical signal to this function block input starts, if enabled, a corresponding switching operation of the represented output relay.

`Time >` output: Time monitor output; if a logical 1 can be tapped here, the set impulse time is expired and a return confirmation regarding the correct switching operation is no longer received over the represented binary input.

`BI` output: Signal output at which the binary input signal of the represented physical input can be tapped.

`P` outputs: Pulse output, one for each represented output; a logical 1 can be tapped for the duration of the switching operation of the output relay

Table 34: Connection label switching object 2-1

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
IL	–	IL open
IL	–	IL closed
BL	–	BL
OP	Output No. open	PO open
CL	Output No. closed	PO closed
Time>	–	Time >
BI	Input No.	BI
P	–	Pulse open
P	–	Pulse close

More information on specific outputs can also be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26

Configuration

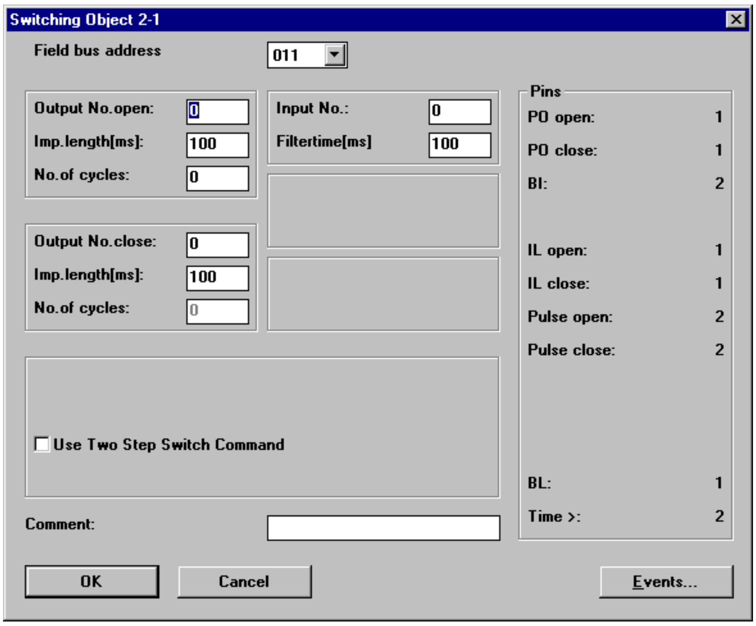


Figure 79: Configuration dialog switching object 2-1

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once. As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Setting range for physical outputs Every input field exists once per represented output:

Input field `Output No. [Name]` (once per represented output): Enter the number of the physical output that should be represented here. The assigned number, underlined in white, is also shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input field `imp.length [ms]` (once per represented output): Enter the maximum duration of the output relay switching operation. In function blocks with limit stops the switching operation will be ended before if necessary.

Input field `No. of cycles` (once per represented output): Not used.

Input field `Input No. [Name]` (once per represented input): Enter the number of the physical input that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

Input field `Filtertime[ms]` (once per represented input): Enter the time during which a signal must be applied at the physical binary input to be detected as a logical signal. The input filter time is added to the hardware and to the general filter time.

Input field `comment [ms]` (once per represented input): Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Checkbox `use two step switch command`: If two-stage switching is activated, a switching object must be selected with a command from the higher-order control system and switched with a 2nd command.
This option does not refer to local switching.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.9 Switching object 2-2

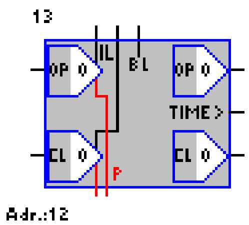


Figure 80: Function block switching object 2-2

Function

Actuates two physical binary outputs from the function chart. The return confirmation is received via two physical binary inputs, which can be tapped in the function chart. This switching object can also actuate a power circuit-breaker. The power circuit-breaker checkbox is marked for this purpose.

↳Chapter "5.4.2.10 Switching object 2-2 as power circuit-breaker" on page 5-48

Connections:

`IL` inputs: Interlocking inputs, one per represented output; a switching operation can be conducted if there is a logical 1 here.

`BL` input: Blocking input; if there is a logical 1 signal here, the switching operations of the represented output will be blocked.

`OP, CL` inputs (left): Signaling inputs for one physical output each. A logical signal to this function block input starts, if enabled, a corresponding switching operation of the represented output relay.

`Time >` output: Time monitor output; if a logical 1 can be tapped here, the set impulse time is expired and a return confirmation regarding the correct switching operation is no longer received over the represented binary input.

`OP, CL` outputs (right): Signal outputs at which the binary input signal of the represented physical input can be tapped.

`P` outputs: Pulse outputs, one per represented output; a logical 1 can be tapped for the duration of the switching operation of the output relay

Table 35: Connection labels switching object 2-2

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
IL	–	IL open
IL	–	IL closed
BL	–	BL
OP (left)	Output open	PO open
CL (left):	Output closed	PO closed
Time>	–	Time >
OP (right)	Input open	BI open
CL (right)	Input closed	BI closed
P	–	Pulse open
P	–	Pulse closed

More information on specific outputs can also be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26.

Typical application

Use of the binary outputs to actuate a motor-driven Isolator. The position confirmation signal is received via the two binary inputs.

Configuration

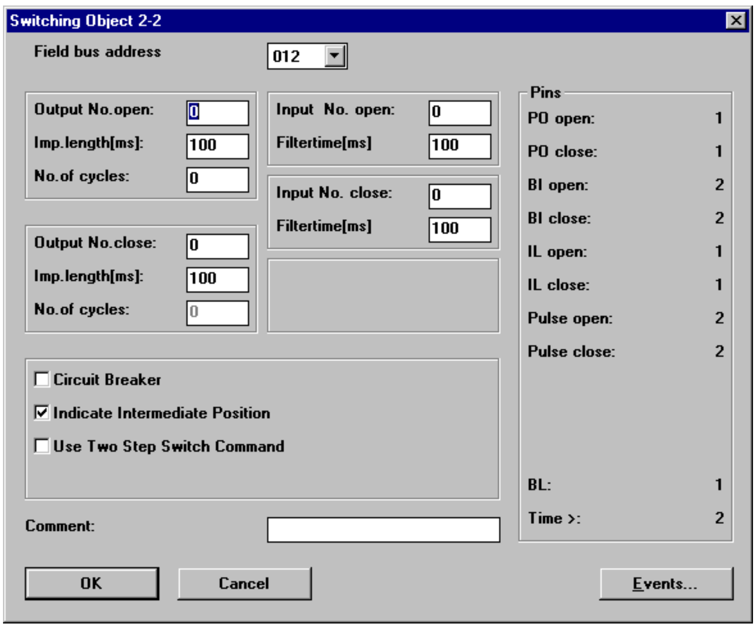


Figure 81: Configuration dialog switching object 2-2

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once.

As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Input field `Output No. [Name]` (once per represented output): Enter the number of the physical output that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input field `imp.length [ms] (once` per represented output): Enter the maximum duration of the output relay switching operation. In function blocks with limit stops the switching operation will be ended before if necessary.

Input field `No. of cycles` (once per represented output): Not used.

Input field `Input No. [Name]` (once per represented input): Enter the number of the physical input that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

Input field `Filtertime[ms] (once` per represented output): Enter the time during which a signal must be applied at the physical binary input to be detected as a logical signal. The input filter time is added to the hardware and to the general filter time.

Input field `comment`: Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Checkbox `circuit breaker`: Mark this checkbox to use this switching object to actuate the circuit breaker.

↳Chapter "5.4.2.10 Switching object 2-2 as power circuit-breaker" on page 5-48

Checkbox `display intermediate setting`: If this checkbox is marked, an intermediate setting will be displayed on the LC display screen during the switching operation. This enables a visual return confirmation of the switching operation on the LC display screen.
Otherwise only the initial and final positions are displayed during a switching operation.

Checkbox `use two step switch command`: If two-stage switching is activated, a switching object must be selected with a command from the higher-order control system and switched with a 2nd command.
This option does not refer to local switching.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.10 Switching object 2-2 as power circuit-breaker

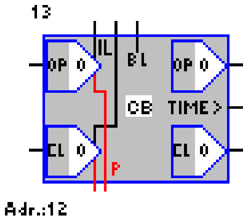


Figure 82: Function block switching object 2-2 as power circuit-breaker

Function

This switching object is used to actuate a power circuit-breaker. The power circuit-breaker checkbox is marked in the 2-2 switching object configuration dialog.

Configuration is identical to that of the 2-2 switching object. The relevant information can be found there.

Chapter "5.4.2.9 Switching object 2-2" on page 5-45

Notes

This switching object is generated by inserting a 2-2 switching object into the function chart. Then the checkbox `circuit-breaker` must be checked in the configuration dialog.

The label `CB` (power circuit-breaker) appears in the middle of the FUPLA display. There are the following differences compared to the 2-2 switching object:

- The REF542 counts the switching cycles of the power circuit-breaker internally (the value that was entered in the configuration dialog under `no. of impulses` as the initial value)
- The switched current is recorded, totaled and can be retrieved from the REF542 operator view
- The 2-2 switching object power circuit-breaker is included in the autoreclosure (AWE) (exception: distance protection).

5.4.2.11 Switching object 2-2 with no power output

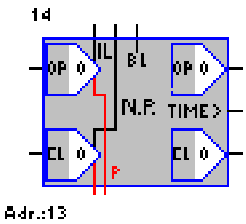


Figure 83: Function block switching object 2-2 with no power output

Function

The switching object 2-2 with no power output does not represent physical binary outputs. The functioning of all other inputs and outputs is identical to switching object 2-2.

Chapter "5.4.2.9 Switching object 2-2" on page 5-45

Typical application

If this switching object is also configured for the LC display screen, it will generate the corresponding events according to selection and switching command. For example, a station-level interlocking can be implemented if there is a higher-order control system.

This switching object also enables switching authorizations to be assigned if the REF542 can be operated from several locations.

Finally, this function block can be used to start automatic switching sequences, such as earthing sequences.

5.4.2.12 Switching object 4-3: Motorcard

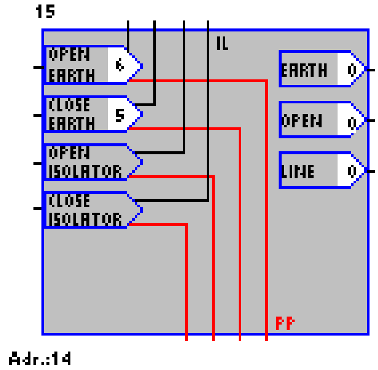


Figure 84: Function block switching object 4-3 motor

Note

This switching object can only be used with the input/output board with conventional relays. One switching object 4-3 motor board or 6-5 magnet motor board per board can be used in the application.

Function

Used to actuate two binary physical outputs, which are specially designed for the motor control unit. The required return confirmations are received via the three physical binary inputs.

Notes

Because these functions are only available at specific binary outputs on the binary input/output boards, the output numbers have fixed assignments.

↳Chapter "3.4.4.2 Input and output boards with conventional relays" on page 3-25
↳Chapter "Conventional relay: power output to motor control unit" on page 3-27

Connections:

`IL` inputs: Interlocking inputs, one per represented output; a switching operation can be conducted if there is a logical 1 here.

`OPEN EARTH/ISOLATOR, CLOSE EARTH/ISOLATOR` inputs (left): Signaling inputs for one physical output each. A logical signal to this function block input starts, if enabled, a corresponding switching operation of the represented output relay.

`EARTH, OPEN, LINE` outputs (right): Signal outputs at which the binary input signal of the represented physical input can be tapped.

`PP` outputs: Pulse outputs, one per represented output; a logical 1 can be tapped for the duration of the switching operation of the output relay

Table 36: Connection labels switching object 1-2

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
IL	–	I. earth open
IL	–	IL earth close
IL	–	IL isol. open
IL	–	IL isol. close
OPEN EARTH	open earth	open Earth
CLOSE EARTH	close earth	close Earth
OPEN ISOLATOR	open isolator	open Isolator
CLOSE ISOLATOR	close isolator	close Isolator
EARTH	Input No. earth	Earth
OPEN	Input No. open	Open
LINE	Input No. line	Linae
P	–	PP isol. close
P	–	PP isol. open
P	–	PP earth close
P	–	PP earth open

More information on specific outputs can also be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26.

Typical application

This enables a 3-position switch to be actuated with a motor drive. Additional auxiliary relays for activating and deactivating the motor are not required. Information on the switch status is received via the three free configurable binary inputs. The switching object itself assumes the subsequent control sequences:

- Checking the interlock conditions,
- Switch on pole reversal relay, depending on selection,
- Switch on motor relay
- Switch off motor relay after reaching the end position and
- Brake motor by short circuiting the motor windings.

This functions with special circuitry of two relays on the binary input/output board with conventional relays.

↳Chapter "Conventional relay: power output to motor control unit" on page 3-27

A 3-position Isolator is represented by two separate objects (Isolator and earth switch) on the REF542 LC display screen, which are then configured as a combined object.

↳Chapter "5.3.7 Display" on page 5-13

Configuration

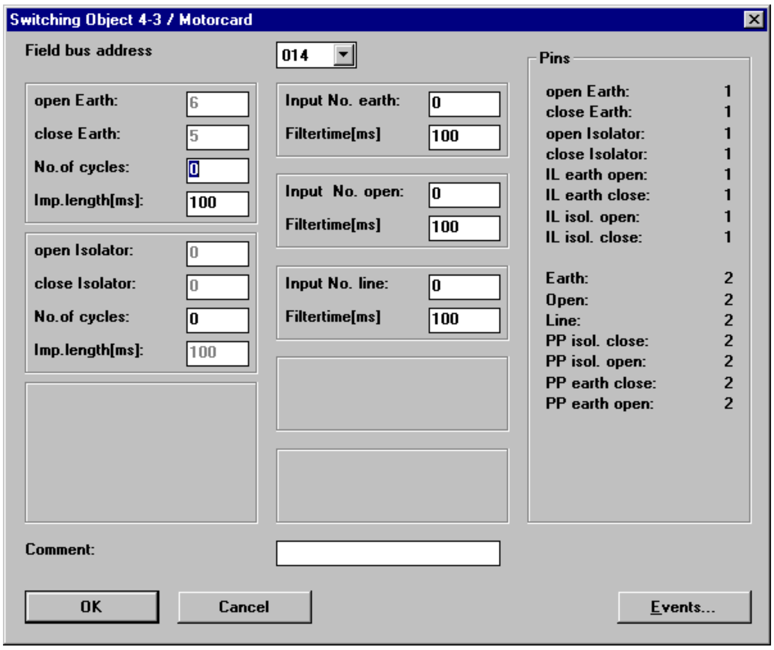


Figure 85: Configuration dialog function block switching object 4-3 motor

Note

The impulse length that can be input is based on the switching operation from an end setting to the intermediate setting.
Please note that the output numbers of the physical outputs cannot be set, because this function is only enabled with two specially switched relays on the binary input/output board with conventional relays.

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26.

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once.
As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Input field `open/close earth, open/close isolator` (once per represented output): The number of the represented physical output is a fixed assignment.
It will also be shown in the function block underlined in white adjacent to the connection.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input field `imp.length [ms]` (once per represented output): Enter the maximum duration of the output relay switching operation. In function blocks with limit stops the switching operation will be ended before if necessary. The impulse length is based on a switching operation from an end setting to the intermediate setting and therefore is only assigned once.

Input field `No. of cycles` (once per represented output): Not used.

Input field `Input No. [Name]` (once per represented input): Enter the number of the physical input that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

Input field `Filtertime[ms]` (once per represented input): Enter the time during which a signal must be applied at the physical binary input to be detected as a logical signal. The input filter time is added to the hardware and to the general filter time.

Input field `comment`: Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.13 Switching object 6-5: Magnetmotorcard

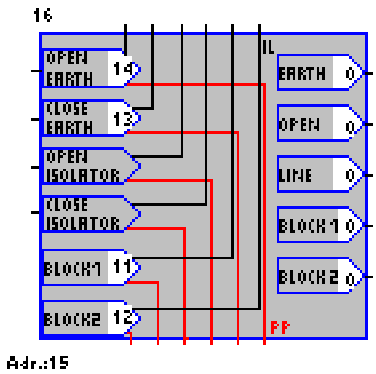


Figure 86: Function block switching object 6-5 magnet motor

Note

This switching object can only be used with the input/output board with conventional relays. One switching object 4-3 motor board or 6-5 magnet motor board per board can be used in the application.

Function

Used to actuate four binary physical outputs, which are specially designed for the motor control unit. The required return confirmations are received via the five physical binary inputs. The function block itself assumes the subsequent sequential control:

Notes

Because these functions are only available at specific binary outputs on the binary input/output boards, the output numbers have fixed assignments.

↳Chapter "3.4.4.2 Input and output boards with conventional relays" on page 3-25

↳Chapter " Conventional relay: power output to motor control unit" on page 3-27

Connections:

`IL` inputs: Interlocking inputs, one per represented output; a switching operation can be conducted if there is a logical 1 here.

`OPEN EARTH/ISOLATOR, CLOSE EARTH/ISOLATOR BLOCK 1/2` inputs (left): Signaling inputs for one physical output each. A logical signal to this function block input starts, if enabled, a corresponding switching operation of the represented output relay. The `BLOCK 1/2` inputs cannot be influenced, their function is implemented over the relay circuitry.

`EARTH, OPEN, LINE, BLOCK 1/2` outputs (right): Signal outputs at which the binary input signal of the represented physical input can be tapped.

`PP` outputs: Pulse outputs, one per represented output; a logical 1 can be tapped for the duration of the switching operation of the output relay

Table 37: Connection label switching object 6-5 magnet motor

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
IL	–	IL earth open
IL	–	IL earth close
IL	–	IL isol. open
IL	–	IL isol. close
IL	–	IL BL1
IL	–	IL BL2
OPEN EARTH	open Earth	open Earth
CLOSE EARTH	close Earth	close Earth
OPEN ISOLATOR	open Isolator	open Isolator
CLOSE ISOLATOR	close Isolator	close Isolator
BLOCK 1 (left)	Output BL 1	–
BLOCK 2 (left)	Output BL 2	–
EARTH	Input No. earth	Earth
OPEN	Input No. open	Open
LINE	Input No. line	Line
BLOCK 1 (right)	Input BL 1	Block 1
BLOCK 2 (right)	Input BL 2	Block 2
PP	–	PP isol. open
PP	–	PP isol. close
PP	–	PP earth close
PP	–	PP earth open
PP	–	PP BL1
PP	–	PP BL2

More information on specific outputs can also be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26.

Typical application

This enables a 3-position switch to be actuated with a motor drive. Additional auxiliary relays for activating and deactivating the motor are not required. Information on the switch status is received via the three free configurable binary inputs. In contrast to the switching object 4-3 motor, installed interlock magnets can be activated and deactivated at the 3-position Isolator. The return confirmation on the position of the interlock magnets via two binary inputs. In this way the motor can be prevented from running over a non-activated interlock magnet. The sequential control itself assumes the subsequent control sequences:

- Checking the interlock conditions,
- Unlock interlock magnets,
- Switch on pole reversal relay, depending on selection,
- Switch on motor relay
- Switch off motor relay after reaching the end position and
- Brake motor by short circuiting the motor windings.

This functions with special circuitry of two relays on the binary input/output board with conventional relays.

↳Chapter "Conventional relay: power output to motor control unit" on page 3-27

A 3-position Isolator is represented by two separate objects (Isolator and earth switch) on the REF542 LC display screen, which are then configured as a combined object.

↳Chapter "5.3.7 Display" on page 5-13

Configuration

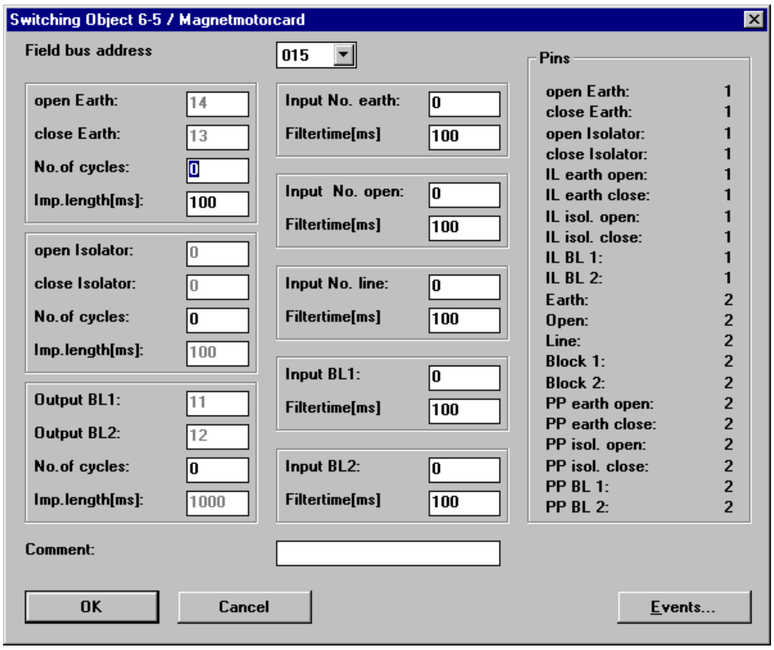


Figure 87: Configuration dialog function block switching object 6-5 magnet motor

Note

The impulse length that can be input is based on the switching operation from an end setting to the intermediate setting.
Please note that the output numbers of the physical outputs cannot be set, because this function is only enabled with two specially switched relays on the binary input/output board with conventional relays.

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once. As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Input field `open/close earth, open/close isolator, output BL1/BL2` (once per represented output): The number of the represented physical output is a fixed assignment. It will also be shown in the function block underlined in white adjacent to the connection.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input field `imp.length [ms]` (once per represented input): Enter the maximum duration of the output relay switching operation. In function blocks with limit stops the switching operation will be ended before if necessary. The impulse length is based on a switching operation from an end setting to the intermediate setting and therefore is only assigned once.

Input field `No. of cycles` (once per represented output): Not used.

Input field `Input No. [Name]` (once per represented output): Enter the number of the physical input that should be represented here. The assigned number, underlined in white, is also shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

Input field `Filtertime[ms]` (once per represented output): Enter the time during which a signal must be applied at the physical binary input to be detected as a logical signal. The input filter time is added to the hardware and to the general filter time.

Input field `comment`: Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.14 Switching object 2-2: H bridge Card

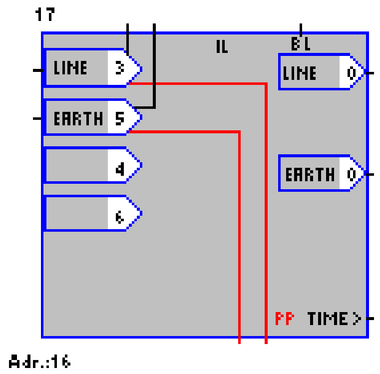


Figure 88: Function block switching object 2-2 H bridge

Note: This switching object can only be used with the input/output board with transistor relays. One switching object 2-2 H bridge or 4-4 H bridge can be used in the application per board.

Function

Used to actuate four binary physical outputs, which are specially designed for the motor control unit. The required return confirmations are received via the three physical binary inputs.
Only two of the four physical outputs inn use can be actuated. The two others are used to implement the desired functions and are actuated internally.

Notes

Because these functions are only available at specific binary outputs on the binary input/output boards, the output numbers have fixed assignments.

↳Chapter "3.4.4.1 Input and output board with transistor relay" on page 3-20

↳Chapter "Transistor relay: Power output to motor control unit" on page 3-22

Connections:

`IL` inputs: Interlocking inputs, one per represented output; a switching operation can be conducted if there is a logical 1 here.

`BL` input: Blocking input; if there is a logical 1 signal here, the switching operations of the represented output will be blocked.

`LINE, EARTH` inputs (left): Signaling inputs for one physical output each. A logical signal to this function block input starts, if enabled, a corresponding switching operation of the represented output relay. The unlabeled inputs cannot be influenced, their function is implemented over the relay circuitry.

`Time >` output: Time monitor output; if a logical 1 can be tapped here, the set impulse time is expired and a return confirmation regarding the correct switching operation is no longer received over the represented binary input.

`LINE, EARTH` outputs (right): Signal outputs at which the binary input signal of the represented physical input can be tapped.

`PP` outputs: Pulse outputs, one per represented output; a logical 1 can be tapped for the duration of the switching operation of the output relay

Table 38: Connection labels switching object 1-2

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
IL (left)	–	IL line
IL (right)	–	IL earth
LINE (left)	Line	Line
EARTH (left)	Earth	Earth
BL	–	BL
LINE (right)	Input No. line	BI line
EARTH (right)	Input No. earth	BI earth
P (left)	–	PP earth
P (right)	–	PP line
TIME>	–	Time >

More information on specific outputs can also be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26.

Typical application

This switching object can be used to control a motor-driven transfer circuit-breaker without an intermediate setting. This functions with special circuitry of two relays on the binary input/output board with conventional relays.

↳Chapter "Transistor relay: Power output to motor control unit" on page 3-22

Configuration

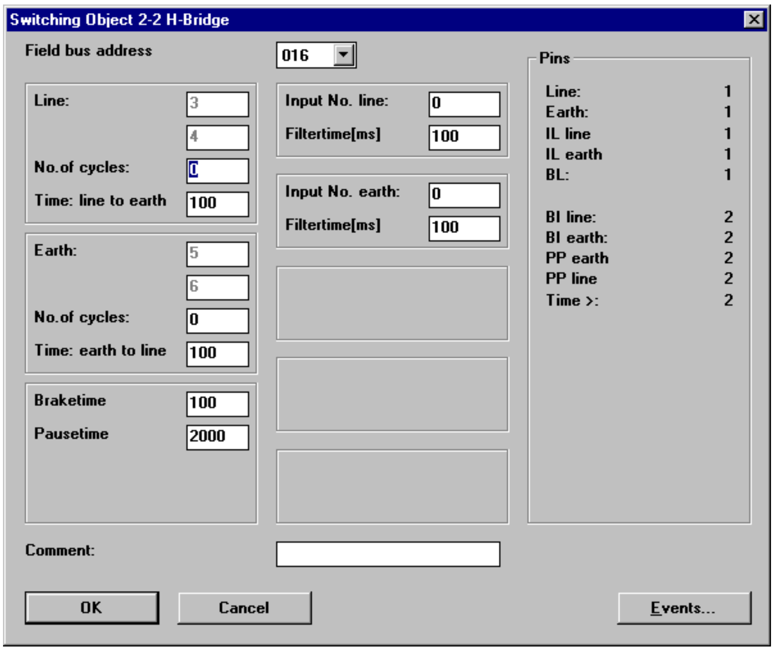


Figure 89: Configuration dialog function block switching object 2-2 H bridge

Note

Please note that the output numbers of the physical outputs cannot be set, because this function is only enabled with four specially switched relays on the binary input/output board with transistor relays.

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26.

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once. As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Input fields `line, earth`: The number of the represented physical output is a fixed assignment. It will also be shown in the function block underlined in white adjacent to the connection.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input fields `time line to earth/earth to line`: Enter the maximum duration of the output relay switching operation. In function blocks with limit stops the switching operation will be ended before if necessary.

Input field `No. of cycles` (available twice): Not used.

Input field `braking time`: Enter a time in ms here for which the motor windings will be short-circuited to brake the motor after reaching the end position.
Setting range: 0 … 65 000 ms (increment: 1 ms)
Default: 100

Input field `dead time`: Enter a time in ms here during which no switching command may be sent to prevent overloading the transistors on the input/output board and the motor.
Setting range: 2 000 … 65 000 ms (increment: 1 ms)
Default: 2 000

Input field `Input No. [Name]` (once per represented input): Enter the number of the physical input that is to be represented.
The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

Input field `Filtertime[ms]` (once per represented input): Enter the time during which a signal must be applied at the physical binary input to be detected as a logical signal. The input filter time is added to the hardware and to the general filter time.

Input field `comment`: Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.15 Switching object 4-4: H bridge Card

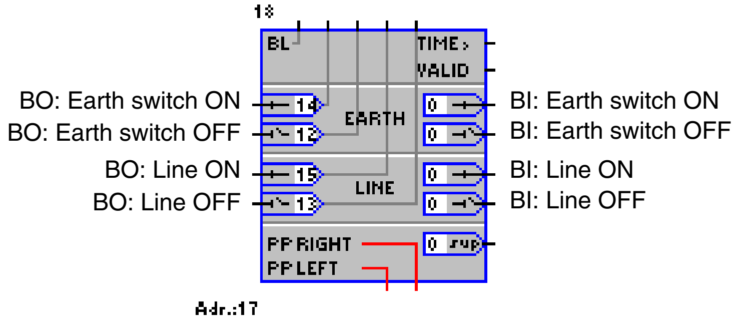


Figure 90: Function block switching object 4-4 H bridge

Note

This switching object can only be used with the input/output board with transistor relays. One switching object 2-2 H bridge or 4-4 H bridge can be used in the application per board.

Function

Used to actuate four binary physical outputs, which are specially designed for the motor control unit. The required return confirmations are received via the five physical binary inputs. The function block itself assumes the subsequent sequential control:
The VALID signaling output signals a valid position of the 3-position switch: Earth switch closed, intermediate setting (earth switch and Line open), line opened. The valid position is reached when the pulse outputs are logical 0 and the binary inputs signal one of the three above positions.
The binary input SUP/earth switch supervision enables sensors that also supervise the all-pole correct earthing to be connected. If this binary input is not used, the connection pin on the function block must be set to logical 1 or connected with the earth switch OFF connection pin.

Notes

The binary inputs/outputs are only labeled with icons in this function block. For this reason the labeling has been inserted in the diagram.

Because these functions are only available at specific binary outputs on the binary input/output boards, the output numbers have fixed assignments.

↳Chapter "3.4.4.1 Input and output board with transistor relay" on page 3-20

↳Chapter "Transistor relay: Power output to motor control unit" on page 3-22

Connections:

`IL` inputs: Interlocking inputs, one per represented output; a switching operation can be conducted if there is a logical 1 here.

`BL` input: Blocking input; if there is a logical 1 signal here, the switching operations of the represented output will be blocked.

`BO: Earth switch ON/OFF, BO: Line ON/OFF` inputs (left): Signaling inputs for one physical output each. A logical signal to this function block input starts, if enabled, a corresponding switching operation of the represented output relay. The unlabeled inputs cannot be influenced, their function is implemented over the relay circuitry.

`TIME>` output: Time monitor output; if a logical 1 can be tapped here, the set impulse time is expired and a return confirmation regarding the correct switching operation is no longer received over the represented binary input.

`BI: Earth switch ON/OFF, BI: Line ON/OFF` outputs (right): Signal outputs at which the binary input signal of the represented physical input can be tapped.

`PP RIGHT/PP LEFT` outputs: Pulse outputs, one per represented output; a logical 1 can be tapped for the duration of the switching operation of the output relay PP RIGHT is the pulse output for the busbar–intermediate setting–earth movement direction and PP LEFT is the pulse output for the earth–intermediate setting–busbar movement direction.

`VALID` output: Signaling output; if a logical 1 can be tapped here, the 3-position switch has reached a valid position.

`SUP`: Signaling output for a physical input. Used for additional supervision of the position earth switch all-pole closed.

Table 39: Connection labels switching object 1-2

FUPLA display	Parameter setting range of the configuration dialog	Connection label in the configuration dialog
BL	–	Block
IL	–	IL close Earth
IL	–	IL open Earth
IL	–	IL close Line
IL	–	IL open Line
BO: Earth switch ON	Earth close	Close Earth
BO: Earth switch OFF	Earth open	Open Earth
BO: Line ON	Line close	Close Line
BO: Line OFF	Line open	Open Line
PP right	–	PP right
PP left	–	PP left
Time >	–	Time >
valid	–	valid
BI: Earth switch ON	Earth closed	BI Earth closed
BI: Earth switch OFF	Earth opened	BI Earth opened
BI: Line ON	Line closed	BI Line opened
BI: Line OFF	Line opened	BI Line closed
SUP	Earth switch supervision	Earth supervision

More information on specific outputs can also be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26.

Typical application

This enables a 3-position switch to be actuated with a motor drive. Additional auxiliary relays for activating and deactivating the motor are not required. Information on the switch status is received via the three free configurable binary inputs. The switching object itself assumes the subsequent control sequences:

- Checking the interlock conditions,
- Switch on pole reversal relay, depending on selection,
- Switch on motor relay
- Switch off motor relay after reaching the end position and
- Brake motor by short circuiting the motor windings.
- Activate timing circuit for dead time.

This functions with special circuitry of two relays on the binary input/output board with conventional relays.

↳Chapter "Transistor relay: Power output to motor control unit" on page 3-22

A 3-position Isolator is represented by two separate objects (Isolator and earth switch) on the REF542 LC display screen, which are then configured as a combined object.

↳Chapter "5.3.7 Display" on page 5-13

Configuration

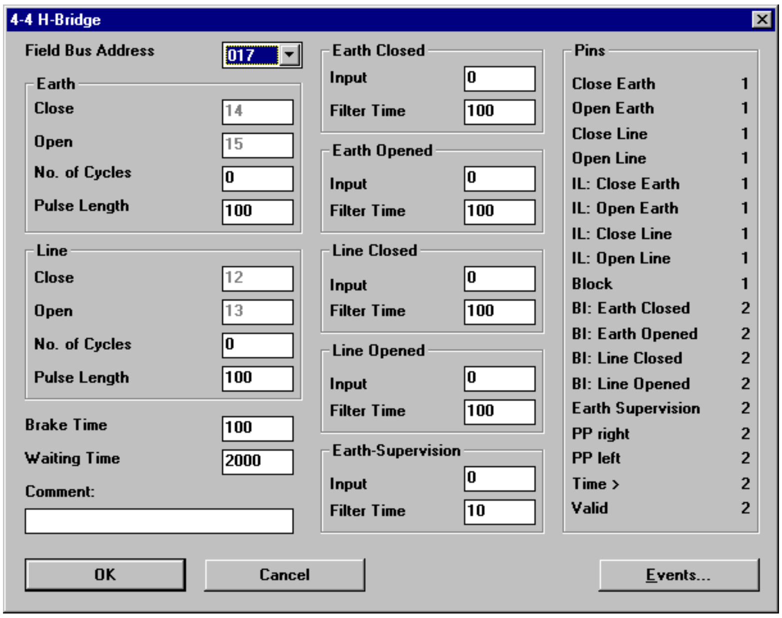


Figure 91: Configuration dialog function block switching object 4-4 H bridge

Note

Please note that the output numbers of the physical outputs cannot be set, because this function is only enabled with four specially switched relays on the binary input/output board with transistor relays.

More detailed information on the layout of the FUPLA display and the configuration dialogs for the switching objects can be found in Chapter "5.4.2.1 System of function blocks and configuration dialogs of the switching objects" on page 5-26.

List field `Field bus address`: It is automatically assigned so every Field bus address is only used once. As an alternative the Field bus address can also be selected from the list field, which is displayed by clicking the ↓ button.
Setting range: 5 … 49 and 111 … 127 (increment: 1)
Default: Next free Field bus address

Input fields `earth close/open, line close/open`: The number of the represented physical output is a fixed assignment.
It will also be shown in the function block underlined in white adjacent to the connection.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input fields `pulse length`(once per represented output pair): Enter the maximum duration of the output relay switching operation. In function blocks with limit stops the switching operation will be ended before if necessary.

Input fields `No. of cycles`(once per represented output pair): Not used.

Input field `brake time`: Enter a time in ms here for which the motor windings will be short-circuited to brake the motor after reaching the end position.
Setting range: 0 … 65 000 ms (increment: 1 ms)
Default: 100

Input field `waiting time`: Enter a time in ms here during which no switching command may be sent, to prevent overloading the transistors on the input/output board and the motor.
Setting range: 2 000 … 65 000 ms (increment: 1 ms)
Default: 2 000

Input field `Earth/Line closed/opened input` (once per represented input): Enter the number of the physical input that is to be represented. The assigned number, underlined in white, will also be shown in the function block adjacent to the connection.
Setting range: 0 … [number of binary inputs] (increment: 1)
Default: 0

Input field `Filter Time[ms]` (once per represented input): Enter the time during which a signal must be applied at the physical binary input to be detected as a logical signal. The input filter time is added to the hardware and to the general filter time.

Note Enter a 0 as number of the represented input so as not to use the earth switch supervision (SUP) binary input.

Input field `comment`: Enter remarks on the switching object here (e.g. purpose). The text will also appear in the FUPLA on the left above the switching object.
Setting range: 0 … 21 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 Global Settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.2 Event list of switching objects" on page 11-4

5.4.2.16 Module for truck (witdrawable unit)

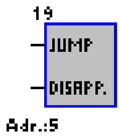


Figure 92: Function block module for truck

Function

This function block is used to move or hide switch icons on the LC display screen. Fixed icons (transducers, motors, generators etc.) cannot be hidden or moved, because they do not have a unique Field bus address.

The interconnections of the switch icons on the LC display screen with the switching objects in the function chart are shown with the Field bus address. In the same way, the function block module for thrust is linked to the switching icon that is to be moved or hidden with the Field bus address.

Connections:

Input `jump` (move): If this input is set to logical 1, an icon on the LC display screen is moved 11 pixels to the left.
If the input is set to logical 0 again, the icon on the LC display screen will resume its initial position.

Input `disapp.`: If the input is set to logical 1 again, the icon on the LC display screen will be hidden.
If the input is set to logical 0 again, the icon on the LC display screen will become visible again.

Typical application

If the power circuit-breaker is on a trolley (thrust), it must also be possible to show its end positions on the LC display screen. The power circuit breaker icon must be correctly displayed depending on the actual position of the thrust (operating or test position).

In addition, if the power circuit-breaker is no longer connected with the other secondary technology, this status must be shown on the LC display screen. For example, this occurs when the icon is hidden.

Configuration

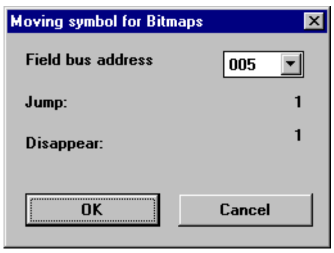


Figure 93: Configuration dialog function block module for thrust

List field `Field bus address`: After clicking the button that opens the list field ↓, a selection list of the Field bus addresses used in the function chart appears. Select the Field bus address of the switching object whose icon is to be moved on the LC display screen.

Information fields `jumpt/disappear`: The connections of the function block with the connection number connected to it are shown here. Inputs are not possible.
If there are no connections on the function block yet, connection number 1 will appear. It indicates an input.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.2.17 IO-Supervision

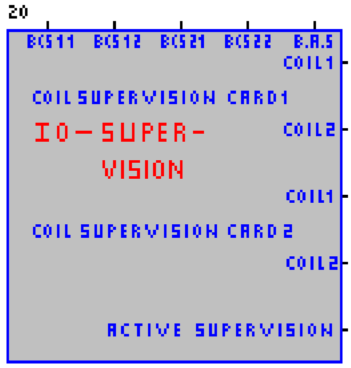


Figure 94: Function block trip circuit supervision

Function

This function block provides the messages from the trip circuit supervision to the function chart. The REF542 Global Settings referring to trip circuit supervision and the FUPLA are linked in this way. The single messages can be blocked independently of one another. In addition, the entire function block can be blocked; a signal regarding that can be tapped at one of its outputs. The error messages from the trip circuit supervision cannot be suppressed on the LC display screen.

Up to two output channels can be monitored for the first two binary input/output boards (cards). The trip circuit supervision must be activated in the Global Settings of the REF542 configuration program for every channel.

↳Chapter "5.3.2 Global Settings" on page 5-2

Connections:

Because the labeling of the inputs and outputs is partly abbreviated in the function block and in the configuration dialog, the list below expands the abbreviation if necessary.

`BCS11/BI.Ca.1 Co.1` input:
Blocking Coil Supervision 11/blocking board 1 coil 1: If a logical 1 is set on this channel, the output signal will be blocked thereby generating the supervision function of this coil.

`BCS12/BI.Ca.1 Co.2` input:
Blocking Coil Supervision 12/blocking board 1 coil 2: If a logical 1 is set on this channel, the output signal will be blocked thereby generating the supervision function of this coil.

`BCS21/BI.Ca.2 Co.1` input:
Blocking Coil Supervision 21/blocking board 2 coil 1: If a logical 1 is set on this channel, the output signal will be blocked thereby generating the supervision function of this coil.

`BCS22/BI.Ca.2.Co.2` input:
Blocking Coil Supervision 22/blocking board 2 coil 2: If a logical 1 is set on this channel, the output signal will be blocked thereby generating the supervision function of this coil.

`B.A.S./BI. active superv.` input:
Blocking Active Supervision/blocking input switch supervision: If a logical 1 is applied to this connection, switch supervision will be deactivated.

`Coil supervision Card1 Coil1/St. Ca.1 Co.1` output:
Start board 1 coil 1: If a logical 1 can be tapped at this output, the trip circuit supervision for the corresponding coil has detected an error.

`Coil supervision Card1 Coil2/St. Ca.1 Co.2` output:
Start board 1 coil 2: If a logical 1 can be tapped at this output, the trip circuit supervision for the corresponding coil has detected an error.

`Coil supervision Card2 Coil1/St. Ca.2 Co.1` output:
Start board 2 coil 1: If a logical 1 can be tapped at this output, the trip circuit supervision for the corresponding coil has detected an error.

`Coil supervision Card1 Coil2/St. Ca.2 Co.2` output:
Start board 2 coil 2: If a logical 1 can be tapped at this output, the trip circuit supervision for the corresponding coil has detected an error.

`Active Supervision/St. active superv.` output:
Start switch supervision: If a logical 1 can be tapped at this output, the switch supervision is operating. If a logical 0 can be tapped, the switch supervision is not active because it has been blocked via the B.A.S. input.

Typical application

The trip circuit supervision can be used to detect defective trip solenoids on the power circuit-breaker. For example, the return confirmation over the function block trip circuit supervision can be used to generate an event for a higher-order control system. Interlocking of the power circuit-breaker is also possible.

Configuration

Only the function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible. The names of the connections in the configuration dialog are German and in the FUPLA display English. Both labels can be found in the connection description.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.3 Digital logic 1

The subsections contain the descriptions of the function blocks that are available via the menu `Drawing Menu/Insert/Digital Logic 1`.

5.4.3.1 Inverter

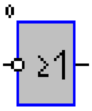


Figure 95: Function block inverter

Function

The inverter inverts the input signal and sends it to its output.

Logic table

On	Off
1	0
0	1

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.3.2 Constant 1/0

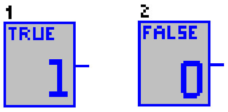


Figure 96: Function blocks constant 1 and constant 0

Function

The two function blocks continuously send a logical 0 and a logical 1 respectively at their outputs.

Logic table

Constant 0 Output	Constant 1 Output
0	1

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.3.3 AND logic gate with inverted output

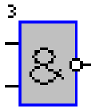


Figure 97: Function block AND logic gate with inverting output

Function

This AND logic gate inverts the output signal. Otherwise, the function is identical to the standard AND logic gate.

Logic table

On 1	On 2	Off
0	0	1
0	1	1
1	0	1
1	1	0

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.3.4 AND logic gate with an inverting input

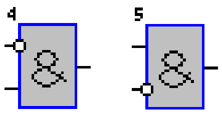


Figure 98: Function blocks AND logic gate with inverting inputs

Function

These AND logic gates all have an inverting input. Because only the inverted input exchanged, only one function block is described here.

Logic table

On 1	On 2	Off
0	0	0
0	1	1
1	0	0
1	1	0

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.3.5 AND logic gate

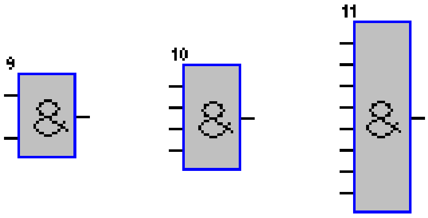


Figure 99: Function blocks AND logic gate with varying input number

Function

The AND logic gates execute a logical AND interconnection on their inputs (left on the function block). The result of this logical operation is available at the output (right on the function block).

Therefore a logical 1 appears at the output when all inputs are set to logical 1.

The AND logic gates shown above differ only in the number of inputs.

Logic table

The logic table shown below shows as an example the function of the AND logic gate with two inputs.

On 1	On 2	Off
0	0	0
0	1	0
1	0	0
1	1	1

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.3.6 OR logic gate

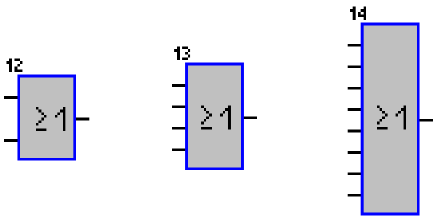


Figure 100: Function blocks OR logic gate with varying output numbers

Function

The OR logic gates execute a logical OR interconnection of their inputs (left on the function block). The result of this logical operation is available at the output (right on the function block).

Therefore a logical 1 appears at the output when one of the inputs is set to logical 1.

The OR logic gates shown above differ only in the number of inputs.

Logic table

The logic table shown below shows as an example the function of the OR logic gate with two inputs.

On 1	On 2	Off
0	0	0
0	1	1
1	0	1
1	1	1

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.3.7 OR logic gate with inverting output

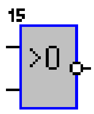


Figure 101: Function block OR logic gate with inverting output (NOR logic gate)

Function

This OR logic gate inverts the output signal. Otherwise, the function is identical to the standard OR logic gate.

Logic table

On 1	On 2	Off
0	0	1
0	1	0
1	0	0
1	1	0

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.4 Digital logic 2

The subsections contain the descriptions of the function blocks that are available via the menu `Drawing Menu/Insert/Digital Logic 2.`

5.4.4.1 Exclusive OR logic gate

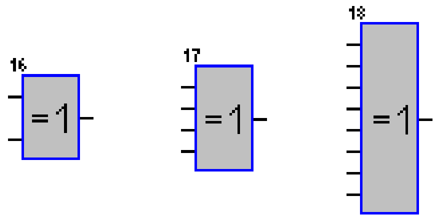


Figure 102: Function block exclusive OR logic gate with varying input number

Function

The exclusive OR logic gates execute a logical exclusive OR interconnection of their inputs (left on the function block). The result of this logical operation is available at the output (right on the function block).

Therefore a logical 1 appears at the output when at least one of the inputs is set to logical 1. In contrast to the OR logic gate, a logical 0 appears at the output if all inputs are set to logical 1. The exclusive OR logic gates shown above differ only in the number of inputs.

Logic table

The logic table shown below shows as an example the function of the exclusive OR logic gate with two inputs.

On 1	On 2	Off
0	0	0
0	1	1
1	0	1
1	1	0

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.4.2 Exclusive OR logic gates with inverting output

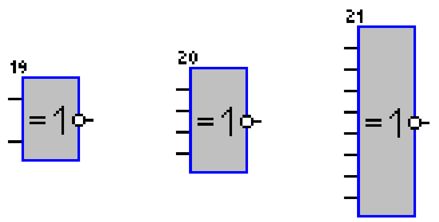


Figure 103: Function block exclusive OR logic gate with inverting output and varying number of inputs

Function

The exclusive OR logic gates with inverting output execute a logical exclusive OR interconnection of their inputs (left on the function block). The result of this logical operation is available in inverted form at the output (right on the function block).

Therefore, a logical 1 appears at the output if all inputs are set to logical 0 or logical 1. In contrast to OR logic gates with inverting output, a logical 1 appears at the output if all inputs are set to logical 1.

Logic table

The logic table shown below shows as an example the function of the exclusive OR logic gate with two inputs.

On 1	On 2	Off
0	0	1
0	1	0
1	0	0
1	1	1

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.5 Flip-Flops

The subsections contain the descriptions of the function blocks that are available via the menu `Drawing Menu/Insert/Flip-Flops`.

Flip-Flops are memory elements with two stable states. Switching between the states is referred to as toggling. A suitable actuation (depending on the type of flip-flop) will switch it to the other state. Because this state remains effective at the outputs of the flip-flop if there are no input signals, they are referred to as memory elements. Some flip-flops are also actuated by a timing input.

To enable the time sequence to be taken into account in the logic tables as well, a time before toggling (switching) the flip-flop (t_n) and a time after toggling (t_{n+1}) is defined. Therefore, output signals before toggling are labeled as Q_n and as Q_{n+1} after toggling.

If the flip-flop also has a timing input, the state before the timing input is labeled as index n and the state after the timing input as index n+1. The change of state at the timing input from logical 0 to logical 1 or vice versa is decisive for the switching process. It is referred to as the rising or falling slope.

5.4.5.1 RS Flip-Flop

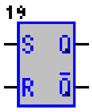


Figure 104: Function block RS flip-flop

Function

A logical 1 at the S-input results in a logical 1 at the Q-output. A logical 1 at the R-input results in a logical 0 at the Q-output.

If the input signals are reset to logical 0, the signals will remain active at the outputs. If both inputs are at logical 1, the R-input is dominant. However, this state contradicts the basic flip-flop principle of two stable states and must therefore be avoided.

Logic table

$\overline{Q}$ is not included in the table below because the state is always set opposite to Q.

R	S	Q
0	0	Qn
0	1	1
1	0	0
1	1	0

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.5.2 RS flip-flop with timing input (clock)

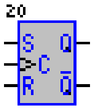


Figure 105: Function block RS flip-flop with timing input

Function

A logical 1 at the S-input combined with a rising slope at the timing input (C) results in a logical 1 at the Q-output. A logical 1 at the R-input combined with a rising slope at the timing input (C) results in a logical 0 at the Q-output.

If the input signals are reset to logical 0, the signals at the outputs will remain active if there is no longer a rising slope at the timing input. With the rising slope the signals at the inputs will be input.

If both inputs are at logical 1, both outputs are at logical 1 with the rising slope at the timing input. However, this state contradicts the basic flip-flop principle of two stable states and therefore must be avoided.

Logic table

$\overline{Q}$ is not included in the table below, because the state is always set opposite to Q. t_n is the time before the rising slope at the timing input and t_{n+1} is the time after it.

t_n		t_{n+1}	
R	**S**	**Q**	**Remark**
0	0	Q_n	
0	1	0	
1	0	1	
1	1	–	illegal state

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.5.3 JK Flip-Flop

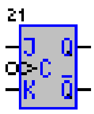


Figure 106: Function block JK flip-flop with timing input (clock)

Function

A logical 1 at the J-input (logical 0 at the K-input) combined with a falling slope at the timing input (C) results in a logical 1 at the Q-output. A logical 1 at the K-input (logical 0 at the J-input) combined with a falling slope at the timing input (C) results in a logical 0 at the Q-output.

If the input signals are reset to logical 0, the signals will remain active at the outputs regardless of the timing input.

If both inputs are at logical 1, the signals at the two outputs with the falling slope are inverted at the timing input.

Logic table

$\overline{Q}$ is not included in the table below, because the state is always set opposite to Q. t_n is the time before the falling slope at the timing input and t_{n+1} is the time after it.

t_n		t_{n+1}	
J	**K**	**Q**	**Remarks**
0	0	Qn	The prior state remains.
0	1	0	
1	0	1	
1	1	Qn	The prior state is inverted.

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.5.4 D Flip-Flop

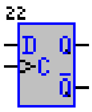


Figure 107: Function block D flip-flop

Function

The signal at the D-input of the flip-flop is transferred with the next positive slope of the Q-output. The timing pulses (clock) cause the delayed output of the input signal at the output.

Logic table

$\overline{Q}$ is not included in the table below, because the state is always set opposite to Q. t_n is the time before the rising slope at the timing input and t_{n+1} is the time after it.

t_n	t_{n+1}
D	**Q**
0	0
1	1

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.5.5 T Flip-Flop

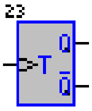


Figure 108: Function block T flip-flop

Function

The signals at the outputs will be inverted with the positive slope at the timing input T. Q is logical 0 as the output state, to ensure that there is a defined state during the REF542 starting procedure. The signal at the output $\overline{Q}$ is always opposite to the signal at the output Q.

This enables the T flip-flop to operate as a binary divider; the period duration of the signals at the outputs is double the length of the clock at the T-input. A constant frequency clock signal is required.

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.5.6 Monoflop retriggerable

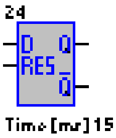


Figure 109: Function block retriggerable monoflop

Function

The logical value at the D-input is directly incorporated (in practice with its own rising slope) into the Q-output. It remains there for the configurable time. Finally, the output falls back to the only stable state of logical 0 again. The Q-output is set immediately to logical 0 by a logical 1 on the reset input (RES or K). If a rising slope occurs at the D-input again while the output is also still at logical 1, the timing circuit will be restarted.

The signal at the output $\overline{Q}$ is always opposite to the signal at the output Q.

Configuration

Input field `time [ms]`: Enter the time in ms here for which the output signal should be retained after a rising slope of the input signal.
Setting range: 15 … 65 000 ms (increment: 1 ms)
Default: 15

Information field `pins`: The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.5.7 Monoflop non-retriggerable

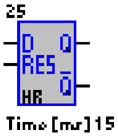


Figure 110: Function block non-retriggerable monoflop

Function

The logical value at the D-input is directly incorporated (in practice with its own rising slope) into the Q-output. It remains there for the configurable time. Finally, the output falls back to the only stable state of logical 0 again. The Q-output is set immediately to logical 0 by a logical 1 on the reset input (RES or K). If a rising slope occurs at the D-input again while the output is also still at logical 1, this signal will be ignored.

The signal at the output $\overline{Q}$ is always opposite to the signal at the output Q.

Configuration

Input field `time [ms]`: Enter the time in ms here for which the output signal should be retained after a rising slope of the input signal.
Setting range: 15 … 65 000 ms (increment: 1 ms)
Default: 15

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.5.8 Drop Delay/Rise Delay (slope delay)

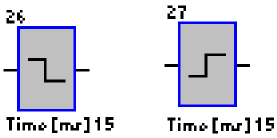


Figure 111: Function blocks slope delay rising and falling

Function

These two function blocks delay the falling and rising slope of a logical signal at the input (left connection).

The delayed logical signal is then available at the output (right connection). The delay period may be input in the configuration dialog.

The diagram below shows how the two function blocks work.

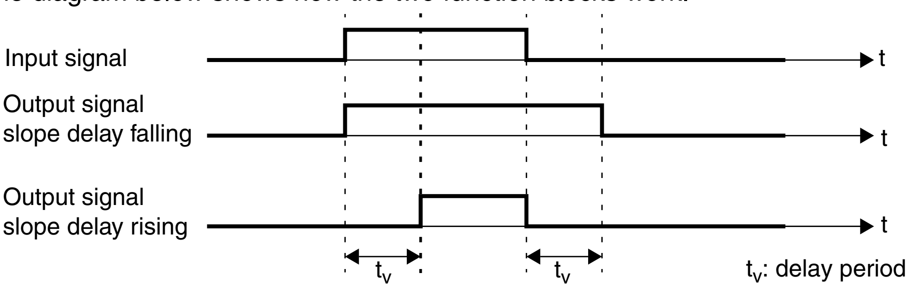


Figure 112: Flow chart of the slope delay function blocks

Configuration dialogue

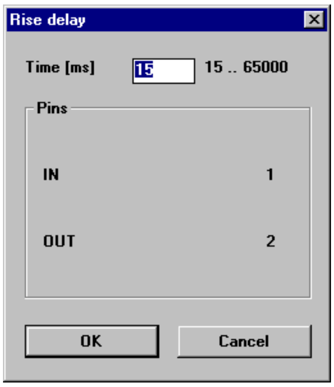


Figure 113: Configuration dialog slope delay rising (and falling)

The setting options are identical in both configuration dialogs. Only the name of the function block in the window title is different.

Input field `time [ms]`: Input of the delay period in ms. The rising/falling slope of the output signal is delayed for this period relative to the input signal. The input period is also shown in the function chart below the FUPLA icon.
Setting range: 15 … 65 000 ms (increment: 1 ms)
Default: 15

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.5.9 Counter

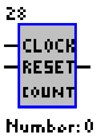


Figure 114: Function block counter

Function

The function block counter sends a logical 1 at its output (right on the function block) after a preset No. of cycles has been sent to its CLOCK input (timing input, left on the function block). The output is set with the rising slope of the last required input impulse.

If a logical 1 is set to the RESET input (left on the function block), the output is reset to logical 0 or the counting process is stopped and the internal counter is set to 0.

Configuration dialogue

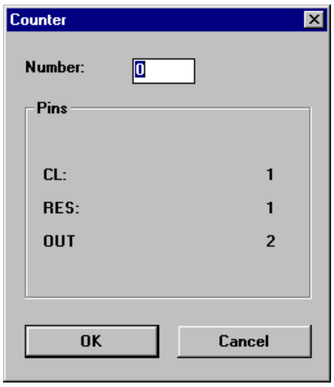


Figure 115: Configuration dialog counter

Input field `number`: Input of the number of input impulses required to generate a logical 1 at the output of the function block (right on the FUPLA icon). Here, the rising slopes of the input signal are decisive for the function block. The number input is also shown in the function chart below the FUPLA icon.
Setting range: 0 … 65 000 ms (increment: 1 ms)
Default: 0

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.5.10 Pulse generator

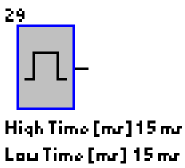


Figure 116: Function block pulse generator

Function

The function block pulse generator sends a pulse sequence at its output (right on the function block). Logical 1 and logical 0 values alternate in this process. Their duration can be set in the configuration dialog.

The diagram below shows the setting options for the pulse generator:

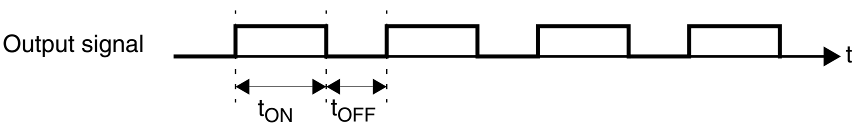


Figure 117: Output signal of the pulse generator

Output (right on the function block): The generated pulse sequence can be tapped here.

Configuration

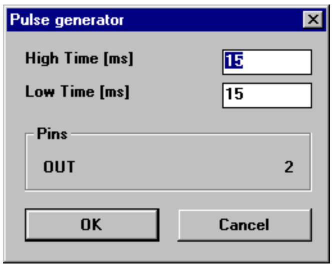


Figure 118: Configuration dialog pulse generator

Input field `High Time(ms)`: The duration in ms of the logical 1 impulse (t_{ON}) is entered here. The input period is also visible in the FUPLA below the function block.
Setting range: 15 … 65 000 ms (increment: 1 ms)
Default: 15

Input field `Low Time(ms)`: The duration in ms of the logical 0 impulse (t_{OFF}) is entered here. The input period is also visible in the FUPLA below the function block.
Setting range: 15 … 65 000 ms (increment: 1 ms)
Default: 15

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.5.11 Digital Store object

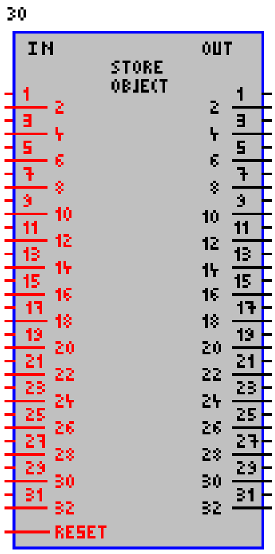


Figure 119: Function block digital Store object

Function

The digital store object continuously saves the current digital values at its input. If the auxiliary supply voltage fails, the last saved values are retained. In this event they will be available at the appropriate outputs after the REF542 has restarted. If the reset or RESET input is at logical 1, the output signals will all be set to logical 0.

Typical application

The signals, that, for example, have generated a switching authorization, are retained in this way after a power failure. Otherwise the switching authorization would be lost, because all outputs and inputs on the REF542 take a defined state.

Configuration

The connections of the function block are shown in the configuration dialog with the connection numbers to which they are connected. Inputs are not possible.
The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.6 Analog components

The subsections contain the descriptions of the function blocks that are available via the menu `Drawing Menu/Insert/Analog Objects`.

5.4.6.1 Analog Threshold

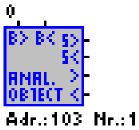


Figure 120: Function block analog threshold

Function

Each of the seven analog measuring inputs can be monitored to detect if it falls below or exceeds a threshold value. If the measured value falls below or exceeds the configurable trip threshold (threshold value), the supervision function is activated. If the trip threshold is exceeds or is below the threshold after a configurable period, a trip signal is generated. The trip threshold and the period for exceeding or falling below the measured value may be configured separately.

Connections:

`B>` input: If there is a logical 1 at this input, the trip signal for signaling that the threshold value has been exceeded will be suppressed.

`B<` input: If there is a logical 1 at this input, the trip signal for signaling that the threshold value has not been reached will be suppressed.

`S>` output: The starting signal (logical 1) can be tapped here if the threshold value has been exceeded.

`S<` output: The starting signal (logical 1) can be tapped here if the threshold value has not been reached.

`>` output: The trip signal (logical 1) can be tapped here if the threshold value has been exceeded.

`<` output: The trip signal (logical 1) can be tapped here if the threshold value has not been reached.

Typical application

The threshold values can be used to ascertain that a bay has no voltage. It makes sense to generate various interlock conditions with this signal. Please observe the restrictions regarding the threshold object:

- Maximum of 10 threshold objects per measuring input (=> 70 per configuration),

- Minimum reaction time: 500 ms,
- The threshold objects cannot select a direct switching output.

Configuration

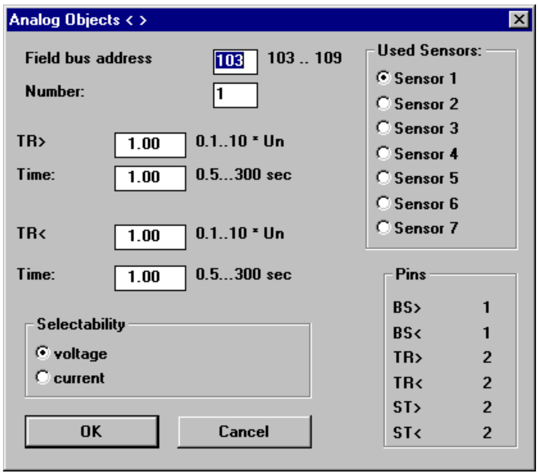


Figure 121: Configuration dialog threshold object

Input field `Field bus address`: This is automatically assigned but can also be changed in the adjacent set limits. All (max. 10) threshold objects that refer to a measuring input have the same Field bus address. The Field bus address is used for addressing the function block in the event of interbay bus commands. It is also shown in the function chart below the function block.

Input field `number`: The sequential number of the threshold object is input here. It is also shown in the function chart below the function block. It is also used to distinguish a maximum of 10 threshold objects per analog measuring input.

Input field `TR >`: The trip threshold for exceeding the threshold is input here in multiples of the rated voltage or of the rated current.
Setting range: 0.1 … 10 (increment: 0.01)
Default: 1.00

Input field `time` (under TR >): Enter the time in s here for which the measured value must exceed the threshold value before a trip signal is generated.
Setting range: 0.5 … 300 s (increment 0.01 s)
Default: 1.00

Input field `TR <`: The trip threshold for falling below the threshold is input here in multiples of the rated voltage or of the rated current.
Setting range: 0.1 … 10 (increment: 0.01)
Default: 1.00

Input field `time` (under TR <): Enter the time in s here for which the measured value must fall below the threshold value before a trip signal is generated.
Setting range: 0.5 … 300 s (increment 0.01 s)
Default: 1.00

Option field `selectability`: Enter whether a specific measuring input is an input for current or voltage.
Setting range: [voltage, current]
Default: Current

Option field `used sensors`: The measuring input that is to be monitored by the threshold object can be marked here. Measuring inputs fitted with transducers can also be monitored.
Setting range: [Sensor 1 … sensor 7]
Default: Sensor 1

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.6.2 Energy management

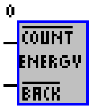


Figure 122: Function block energy management

Function

This function block is used to influence the internal energy calculations in the REF542. On one hand the count process can be stopped and on the other hand a return block can be activated. In this case the energy is not counted backwards if the energy direction changes.

Depending on the hardware configuration the power is calculated from the current and voltage values at the analog inputs. The internal REF542 time clock is then used to calculate the energy. The energy values can be displayed at the LCU.

Note The internal energy calculation only functions with configured power calculation.

↳Chapter "5.3.2 Global Settings" on page 5-2

Connections:

`COUNT/no count` input: The count process is stopped if there is a logical 1 at this input.

`BACK/no back` input: If there is a logical 1 at this input, backwards counting is suppressed if the energy direction changes.

Typical application

The energy count provides an overview of the generated/consumed bay-specific energy.

Configuration

The function block connections with the connection numbers attached to them appear in the configuration dialog. Inputs are not possible.

The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made. These inputs are then confirmed with the `OK` button.

5.4.6.3 Energy counter

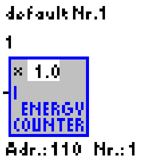


Figure 123: Function block energy counter

Function

This function block uses impulses to meter energy. Every impulse is assigned to a configurable energy value. The energy metered here is then displayed in the measured value display on the LC display screen of the REF542.

Typical application

Use this function block if there is an energy measuring instrument in the bay that is being configured. Its impulses can be sent to the energy counter in the function chart over a binary input.

Configuration

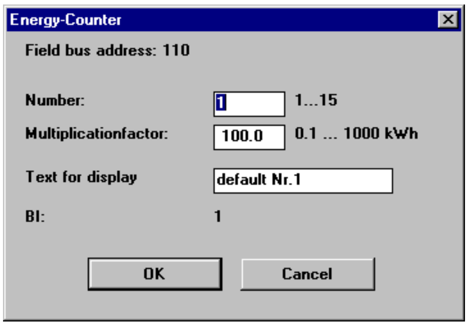


Figure 124: Configuration energy counter

Information field `Field bus address`: The permanently assigned Field bus address is displayed here. All energy counters have the same address.

Input field `number`: Enter a number to distinguish several configured energy counters. The number is also shown in the function chart above the function block.
Setting range: 1 … 15 (increment: 1)
Default: [The next free energy counter number]

Input field `multiplicationfactor`: The energy in kWh that represents an incoming impulse is entered here. The multiplier is shown in the function chart in the function block.
Setting range: 0.1 … 1000 (increment: 0.1)
Default: 100

Input field `text for display`: Enter text here that is to be displayed on the LC display screen to enable several energy counters to be distinguished more easily.
Setting range: 0 … 18 characters (standard character set)
Default: Default no. [number of the energy counter]

Information field `BI`: The number of the connection is shown here. If there is no connection yet, a 1 is shown.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.6.4 Energy pulse output

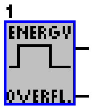


Figure 125: Function block energy impulse output

Function

This function block sends impulses that represent a specific energy quantity to its output (`energy`). The impulses are generated based on the internal energy calculations of the REF542.

The DSP calculates the energy and sends standardized energy packets to the microcontroller. This receives a number of standardized energy packets about twice a second and calculates the absolute energy amount from them according to the following formula:

$$Energy\ quantity = standardized\ energy\ packets \cdot I_n \cdot \frac{U_n}{953}$$

The energy amount is then converted to the corresponding No. of cycles. If there is a remainder after the conversion into pulses, it will be included in the next conversion.

The energy impulse output can send up to 70 pulses after a calculation. Additional pulses are ignored and the `overflow` output is then set to logical 1. If the number of calculated pulses is reduced below 65 again, the `overflow` output is reset to logical 0. Note that I_n and U_n in the above formula are the rated values of the sensors/transducers in use.

Note To add this function block, the power calculation must be activated.

↳Chapter "5.3.6 Calculated values" on page 5-12

Note Use this function block only with binary input/output boards with transistor relays. The conventional relays are limited in their number of switching cycles and therefore are not suited for this.

Typical application

Use this function block to control an external energy display with the impulses from the REF542.

Configuration

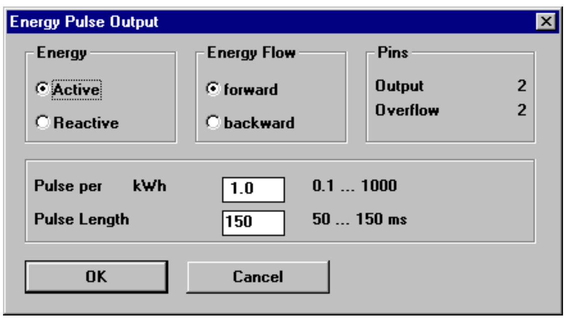


Figure 126: Configuration dialog energy impulse output

Option field `energy`: Mark here whether the impulse should represent active or reactive energy.

Option field `energy flow`: Select the direction of the energy flow. Only energy of this direction will be converted to the corresponding impulse.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Input field `pulse per kWh`: Enter in kWh the calculated energy amount that an impulse represents.
Setting range: 0.1 … 1000 (increment: 0.1)
Default: 1.0

Input field `pulse length`: The duration of the output impulse in ms can be varied here to ensure that the external energy display functions correctly.
Setting range: 50 … 150 ms (increment: 1 ms)
Default: 150

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.6.5 LON sensor

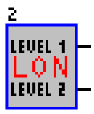


Figure 127: Function block LON

Function

Note: In this version of the configuration program only LON temperature sensors can be connected. Gas density and speed sensors cannot be connected at present.

This function block represents a LON sensor connected to the LON process bus. The two outputs each send a logical 1 signal so long as a specific, configurable threshold value is exceeded.

Typical application

If the protective function “dependent thermal protection“ for motor supervision is used, the LON sensor will provide the required temperature information.

Configuration

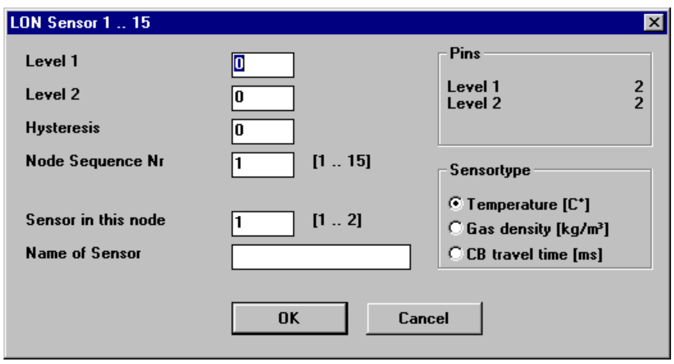


Figure 128: Configuration dialog LON sensor

Input field `level 1/level 2`: Enter the temperature values here in °C from which the outputs `level 1` or `level 2` should send a logical 1.
Setting range: 0 … 65 000 ° (increment: 1 °C)
Default: 0

Input field `Hysteresis`: Enter a percentage of the trip value from which the logical 1 of the output can be reset here. The percentage is valid for both trip values.
Setting range: 0 … 65 000% (increment: 1%)
Default: 0

Input field `node sequence no.`: Enter the node number of the LON network to which the LON sensor connected.
Setting range: 1 … 15 (increment 1)
Default: 1

Input field `sensor in this node`: Enter the number of the sensor on the above node.
Setting range: 1 or 2
Default: 1

Input field `name of sensor`: Enter the name or description of the sensors to distinguish it from other configured sensors.
Setting range: 0 … 18 characters (standard character set)
Default: Empty

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Option field `sensortype`: Mark the option temperature [°C]. The other options are already integrated in the dialog for future use, but at present have no function.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.7 General Information on the protective functions

Caution **Note the following three restrictions when configuring the protective functions. If one of them is not taken into consideration, proper functioning of the REF542 cannot be guaranteed:**

1) A maximum of 12 protective functions can be configured.

2) The load imposed on the protection and measuring unit (DSP) by the protective functions is a maximum of 100%.

3) A maximum of 120 protective parameters can be configured.

All three requirements will also be checked by the configuration program. If specific protective functions cannot be configured, please check the basic setting and the device configuration in the configuration program. Some functions can only be used under specific conditions, which can be found in the function block descriptions.

Setting the delay periods in the protective functions

The configuration program adapts the initial value of the setting range of the delay periods to the binary input/output board in use. The configuration dialogs shown in the documentation may therefore have a different appearance from those displayed in your configuration program.

Therefore, the following will be found in the descriptions of the input fields in the documentation:

Setting range: [initial value + t_{relay}] … end value (increment: xx)

The time t_{relay} is the time from the output of the trip signal of a protective function over the direct output channel to the time at which this signal can be tapped at the terminals of the binary output board.

It is

- 15 ms for the transistor relay boards and
- 30 ms for the conventional relay boards.

Frequency ranges of the protective functions

Unless otherwise specified, all protective functions operate either at 50 or 60 Hz.

Caution **If frequency variations of more than ±0.5 Hz occur in the protected network, the precision of the protective response will be reduced.**

Please note that the above information is particularly applicable to networks with low frequency stability such as island networks. For example, the frequency imprecisions affect the power calculation as follows:

If the output frequency of 50 or 60 Hz deviates by 5 Hz up or down, a deviation of of ± 10 % in the power calculation will result.

Direct output channel

One binary output channel each, over which, for example, the trip signal is fed to the power circuit-breaker, can be set in the configuration dialog for the protective functions. This guarantees the fastest possible tripping. For documentation purposes the output must also be made via a switching object in the function chart. If the trip signal is only forwarded over the FUPLA, the period between the generation of the trip signal and the tripping may be significantly longer. The operating time of the signal then depends directly on the cycle time of the application. The direct output channel is also referred to as the interrupt channel.

Combination options for the protective functions in connection with the analog measuring inputs

The following table shows the required wiring for the analog measuring inputs for every protective function. A selection of standard circuits for the analog measuring inputs is shown in the header with the gray background. The numbers indicate the number of the analog input and the following letter indicates whether it is in use as a current input (I) or as a voltage input (U).

If the seventh analog input is used, the earth current I_0 or the residual voltage U_0 can be recorded. In the case of the other analog inputs, three are always used in combination for the three line currents or the three phase voltages.

If there is a sigma (Σ) before the numbers of the analog measuring inputs in use, the three input quantities are added vectorially for this protective function. Therefore, either the neutral current I_0 or the neutral voltage U_0 is calculated.

↳Chapter "11.7.2 Measurement or calculation of Uo, Io" on page 11-33

For this reason only protective functions that place the same demands on the wiring of the analog measuring inputs with sensors or transducers may be combined.

Table 40: Use of the protective functions depending on the configuration of the analog measuring inputs

Protective function	**Configuration of the analog measuring inputs**					
	1-3: I 4-6: U 7: I	**1-3: U 4-6: I 7: I**	**1-3: I 4-6: U 7: U**	**1-3: U 4-6: I 7: U**	**1-3: I 4-6: I 7: U**	**1-3: I 4-6: I 7: I**
Inrush current blocking	1-3	4-6	1-3	4-6	1-3 or 4-6	1-3 or 4-6
Overcurrent directional high	✓	✓	✓	✓	–	–
Overcurrent directional low	✓	✓	✓	✓	–	–
Overcurrent instantaneous	1-3	4-6	1-3	4-6	1-3 or 4-6	1-3 or 4-6
Overcurrent high	1-3	4-6	1-3	4-6	1-3 or 4-6	1-3 or 4-6
overcurrent low	1-3	4-6	1-3	4-6	1-3 or 4-6	1-3 or 4-6
IDMT	1-3	4-6	1-3	4-6	1-3 or 4-6	1-3 or 4-6
Eartfault high	∑ 1-3 or 7	∑ 4-6 or 7	∑ 1-3	∑ 4-6	∑ 1-3 or∑ 4-6	∑ 1-3 or ∑ 4-6 or 7
Eartfault low	∑ 1-3 or 7	∑ 4-6 or 7	∑ 1-3	∑ 4-6	∑ 1-3 or ∑ 4-6	∑ 1-3 or ∑ 4-6 or 7
Eartfault directional high	∑ 1-3 or 7	∑ 4-6 or 7	∑ 1-3	∑ 4-6	–	–
Eartfault directional low	∑ 1-3 or 7	∑ 4-6 or 7	∑ 1-3	∑ 4-6	–	–
Earth fault IDMT	∑ 1-3 or 7	∑ 4-6 or 7	∑ 1-3	∑ 4-6	∑ 1-3 or ∑ 4-6	∑ 1-3 or ∑ 4-6 or 7
Overvoltage instantaneous	4-6	1-3	4-6	1-3	–	–
Overvoltage high	4-6	1-3	4-6	1-3	–	–
Overvoltage low	4-6	1-3	4-6	1-3	–	–
Undervoltage instantaneous	4-6	1-3	4-6	1-3	–	–
Undervoltage high	4-6	1-3	4-6	1-3	–	–
Undervoltage low	4-6	1-3	4-6	1-3	–	–
Residual overvoltage high	∑ 4-6	∑ 1-3	∑ 4-6 or 7	∑ 1-3 or 7	7	–
Residual overvoltage low	∑ 4-6	∑ 1-3	∑ 4-6 or 7	∑ 1-3 or 7	7	–
Dependent thermal protection	1-3	4-6	1-3	4-6	1-3 or 4-6	1-3 or 4-6
Motor start monitoring	1-3	4-6	1-3	4-6	1-3 or 4-6	1-3 or 4-6
Blocking rotor	1-3	4-6	1-3	4-6	1-3 or 4-6	1-3 or 4-6
Number of starts	✓	✓	✓	✓	✓	✓
distance protection (only in the 50 Hz network)	✓	✓	✓	✓	–	–
Thermal supervision [1]	only in connection with a LON temperature sensor					
Unbalanced load	1-3	4-6	1-3	4-6	1-3 or 4-6	1-3 or 4-6
Directional power	requires three-phase power calculation				–	–
Low load	1-3	4-6	1-3	4-6	1-3 or 4-6	1-3 or 4-6
Frequency supervision	✓	✓	✓	✓	✓	✓
Synchrocheck	–	–	✓	✓	–	–

1) This protective function requires a LON temperature sensor on the process bus

5.4.8 Current protective functions

The following subsections describe the function blocks that are available with the menu `Drawing Menu/Insert/Current Protection.`

Application

The overcurrent time protection, definite time or inverse time (IDMT), directional or non-directional, acts as the main protection for simple feeder fields. It switch off overcurrents that are above the maximum load current with a time delay. Which overcurrent time protection will be used depends on the operator's protection policy and also on the network configuration.

A non-directional definite time overcurrent protection is sufficient for a simple radial network with a defined power direction from one power supply to several consumers. The time delay set here depends on where the protection device is installed and is specified in the setting table. The shortest delay period is set on the overcurrent time protection that has the shortest distance to the end user. The delay period is adjusted to the smallest phase fault current or the largest load current. In the setting table the next higher-order overcurrent time protection contains a longer delay period and a higher tripping current.

↳Chapter "7.7.1 Testing the current protective functions" on page 7-11

In some countries the inverse time overcurrent protection (IDMT) is used instead of the definite time version. In this case, the delay period is inversely proportional to the flowing fault current; if the fault currents are increasing, the trip time decreases. Several hyperbolic (inverse time) time characteristics are available. To optimize the relay setting, the same time characteristic for all overcurrent relays should be set for the entire network.

↳Chapter "7.7.1 Testing the current protective functions" on page 7-11

If a ring or mesh network is being configured, definite time and inverse time (IDMT) can no longer be selectively graded. In this case, as a minimum, directional definite time overcurrent functions must be used. The protection system will then operate selectively. With complex mesh networks even the directional definite time overcurrent is no longer sufficient. Distance protection is required in this case.

↳Chapter "5.4.11 Distance protection" on page 5-158

All overcurrent protective functions can also be implemented as backup protective functions in transformer and carrier feeders or cable feeders. This implementation is also referred to as an emergency overcurrent definite time with carrier and cable feeders.

In motor feeders the overcurrent definite time functions are included as permanent components of the motor protection.

↳Chapter "5.4.10 Motor Protection" on page 5-143

The items described above refer to overcurrent time protective functions for phase to phase and also for phase to earth fault. In the latter case the analog measured quantities can be calculated from the total of the line currents or can be tapped as measured quantities at the seventh measuring input of the REF542.

The functioning and setting of the earth fault time protective functions depend, particularly with the directional protection, on how the system earthing of the network is handled. With low-resistance neutral point treatment the earth fault currents reach values in the range of the multiphase phase fault currents.
Therefore, the term "zero-sequence current" is used. If the network neutral point has a high-resistance earth resistance or even insulated, the earth fault current has very low values, and it is referred to as earth fault current.

Depending on whether the network neutral point is earthed directly, via a resistor or a coil or operated unearthed, the phase angle between the residual current and the zero-sequence voltage changes. This must be observed with the earth fault directional function for locating earth faults.

↳Chapter "11.8 Network neutral point earthing" on page 11-35

5.4.8.1 Inrush

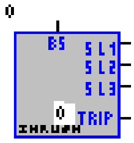


Figure 129: Function block inrush current blocking

Function

The following current protective functions can be impeded by the inrush current blokking on tripping. Additional circuitry in the function chart is not required for this.

- Overcurrent definite time protection/overcurrent instantaneous
- Overcurrent definite time protection/overcurrent high
- Overcurrent definite time protection/overcurrent low
- Directional overcurrent definite time protection/overcurrent directional high
- Directional overcurrent definite time protection/overcurrent directional low

If other protective functions are impeded by the inrush current blocking on their tripping, their blocking must be implemented in the FUPLA.

Note: To ensure that the inrush current blocking functions properly, the overcurrent definite time functions must be included in the application.

The inrush current blocking can be activated on the basis of the evaluation of the temporal course of the measured current (rms value). To represent a switch-on process, the measured current must exceed the configurable value M · I> within 60 ms and then after another 100 ms fall to less than M · 0.65 · I>. Overall, the inrush current blocking remains active during the parametrizable period (t_{ESB}). Here I> is the starting value of the overcurrent low protective function. If this function is not configured, a standard value of 0.05 · I_N is used.

The inrush current blocking itself is activated if the measured current exceeds the limit N · I>> in less than 20 ms after the starting procedure. If this limit remains exceeded for at least 60 ms after the starting process, the inrush current blocking is immediately tripped. In this case, the tripping of the surge short circuit protective function I>> would still be delayed by the delay period t>> set there.

The following two diagrams are not to scale and are provided solely for better understanding of the explanations of how the inrush current blocking functions. The variables M and N and also t_{ESB} (`time`) may be set in the configuration program.

The first diagram describes a detected switch-on process. The three conditions required for this have been met. Therefore, the inrush current blocking prevents the protective functions from being tripped for the time t_{ESB}.

- First condition: The current exceeds the M · I> limit within 60 ms.
- Second condition: The current falls below the 0.65 · M · I> limit within the next 100 ms.
- Third condition: The current remains below the N · I>> limit within the period t_{ESB}.

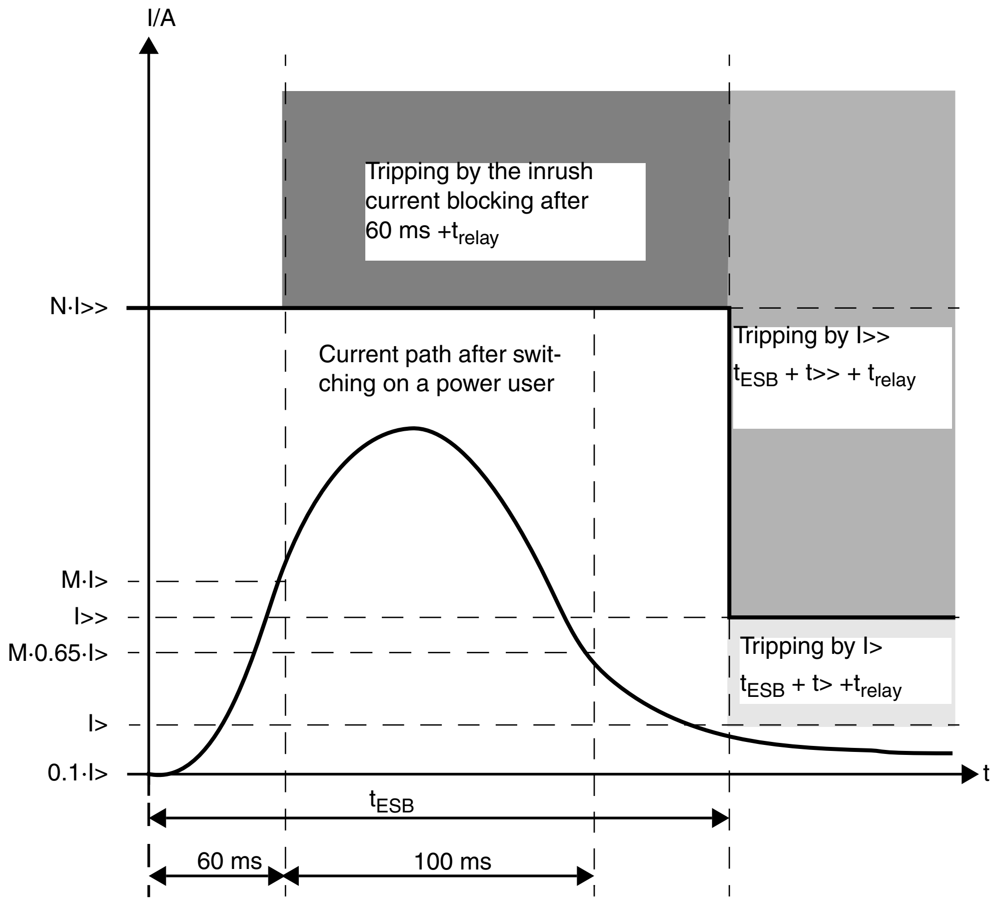


Figure 130: Current-time characteristic of the detected switch-on process when using inrush current blocking

The following diagram describes a detected fault. The three conditions required for detecting a switch-on process are not all met. The inrush current blocking prevents the protective functions described initially from being tripped for only 160 ms.

- First condition: The current exceeds the M · I> limit within 60 ms.
- Second condition: The current does NOT fall below the 0.65 · M · I> limit within the next 100 ms. Depending on the amount of the current, either the overcurrent high protective function or the overcurrent low I> protective function is activated. It is then tripped after the 160 ms plus the relay period and the minimum delay period set in the protective function for which that of the fault current must flow.
- Third condition: The current remains below the N · I>> limit within the period t_{ESB}.

The diagram shows the current paths that are possible in principle in which one of the two current protective functions is addressed.

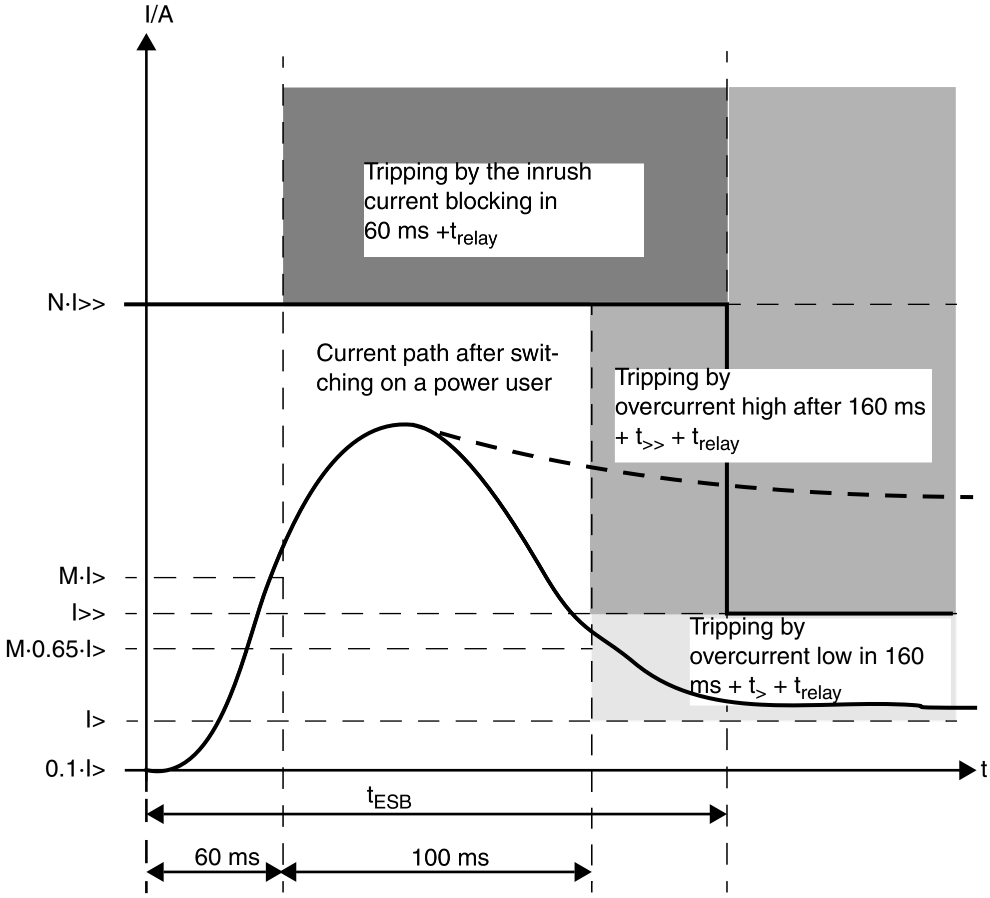


Figure 131: Current-time characteristic of the detected fault when using inrush current blocking

The last diagram describes a detected fault (overload). The three conditions required for detecting a switch-on process are not all met. The inrush current blocking prevents other protective functions from being tripped for only 60 ms.

- First condition: The current does NOT exceed the M · I> limit within 60 ms. Depending on the height of the current, either the overcurrent high protective function or the overcurrent low I> protective function is activated. It is then tripped after the 60 ms plus the relay period and the minimum delay period set in the protective function for which that of the fault current must flow.
- Second condition: The current does NOT fall below the 0.65 · M · I> limit within the next 100 ms. This condition is not evaluated by the inrush current blocking, because a current protective function has already been activated and if necessary tripped.
- Third condition: The current remains below the N · I>> limit within the period t_{ESB}.

The diagram shows the current paths that are possible in principle in which one of the two current protective functions is addressed.

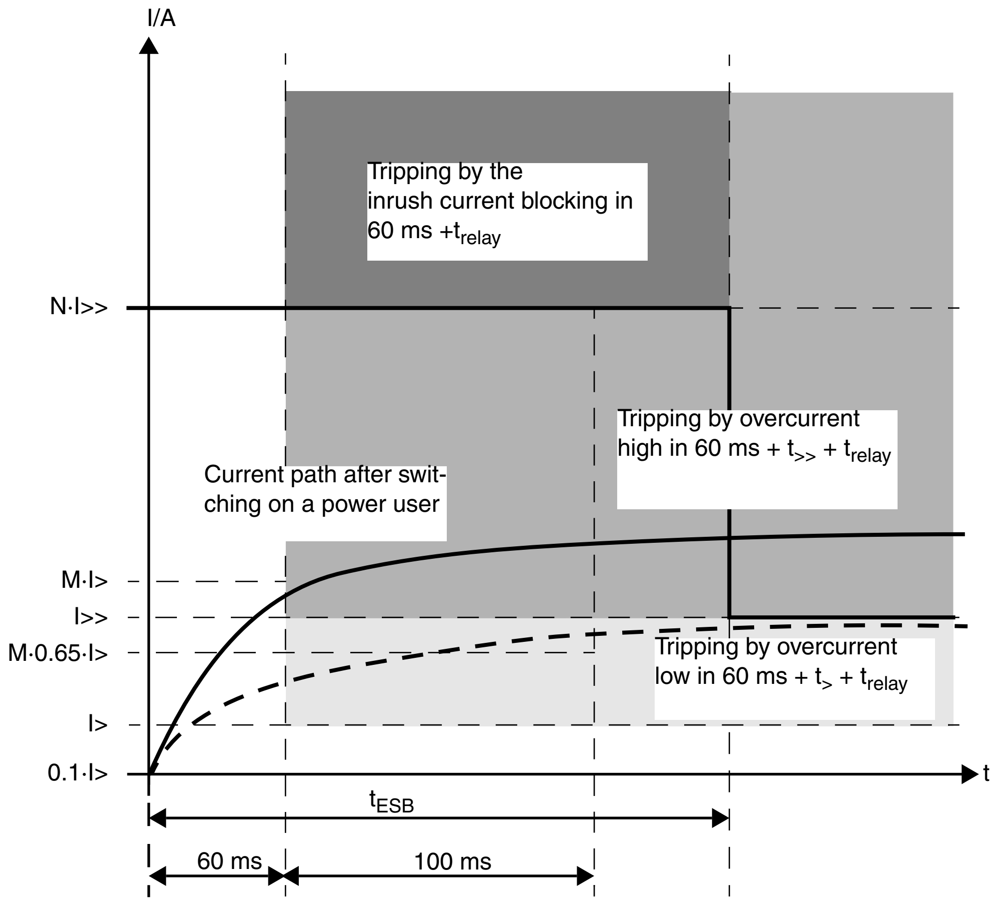


Figure 132: Current-time characteristic of the detected overload when using inrush current blocking

Connections:

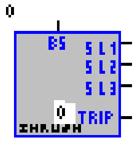


Figure 133: Function block inrush current blocking

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Typical application

When switching on transformers or starting large motors high switch-on inrush currents occur because of the non-linear magnetizing characteristic. These high currents are limited in time.

The inrush current blocking can also be used to prevent the current protective functions described at the beginning from being tripped.

Configuration

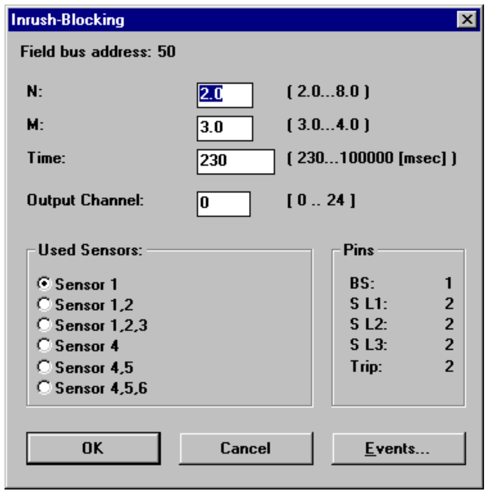


Figure 134: Configuration dialog function block inrush current blocking.

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Entry field `N`: It is the multiplier for the trip threshold of the definite time high protective function overcurrent high.
Setting range: 2.00 … 8.00 (increment 0.1)
Default: 2.0

Entry field `M`: It is the multiplier for the trip threshold of the definite time of the protective function overcurrent low.
Setting range: 3.00 … 4.00 (increment 0.1)
Default: 3.0

Entry field `time`: The total time in ms in which the inrush current blocking is activated. It is referred to as t_{ESB} in the previous examples. Once this time has expired, the protective function is automatically deactivated and the previously blocked protective functions operate with their set parameters.
Setting range: [200 + t_{relay}] … 100 000 ms (increment 10)
Default: [200 + t_{relay}] ms

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping.
The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.8.2 Overcurrent directional high

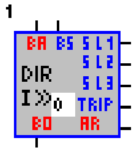


Figure 135: Function block overcurrent directional high.

Function of the directional definite time functions

There are two directional definite time functions in the REF542, each of which can be independently activated and have parameters set:

- Overcurrent directional low and
- Overcurrent directional high.

They can both be configured as two-phase or three-phase. Current and voltage quantities must be connected to the function to record the direction.

The directional phase fault current protective functions evaluate the measured rms value of the measured current and voltage value. If there is a minimum required voltage value (required for deciding the direction) and the set current response time is exceeded, the protective function will be activated. If the response time is exceeded at least during the set time delay, the protective function will be tripped.

Because the REF542 always processes the phase voltage, all three voltages must always be configured and connected with the directional functions. The protective function has a voltage memory, to enable a directional decision to be made even if a fault occurs in the immediate area of the voltage transformer/sensor.

A directional signal can be sent to the opposite station with the output (trip) and/or (BO). The content of a directional signal from the opposite station (BS output) can be used to release tripping of its own directional protective function. This enables a directional comparison protection to be established if there is a signal connection between the stations.

The forward direction of the directional phase-fault current functions is defined as an angle of -180 over -90 to 0 degrees between current and voltage. The symmetrical phase voltage is used as a reference quantity here. The REF542 connection is important here.

✎Chapter "7.7.1 Testing the current protective functions" on page 7-11

The one or two-stage, three-phase autoreclosure (AR) can be activated with the directional surge short circuit protection I>>dir.

✎Chapter "5.5.1 Autoreclosure" on page 5-209

The following vector diagram clarifies the directional definition.

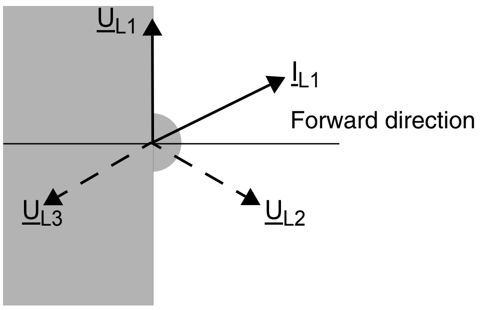


Figure 136: Vector diagram of the directional phase fault current protective functions

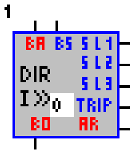


Figure 137: Function block overcurrent directional high.

Connections:

`BA` input: A logical 1 signal at this input blocks the autoreclosure (AWE).

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

`AR` output: A logical 1 signal appears at this output when an autoreclosure attempt is active and running.

`BO` output: If the protective function detects an activation in the opposite direction to the set tripping direction, a logical 1 signal will be output. It can be used for directional comparison protection.

Configuration

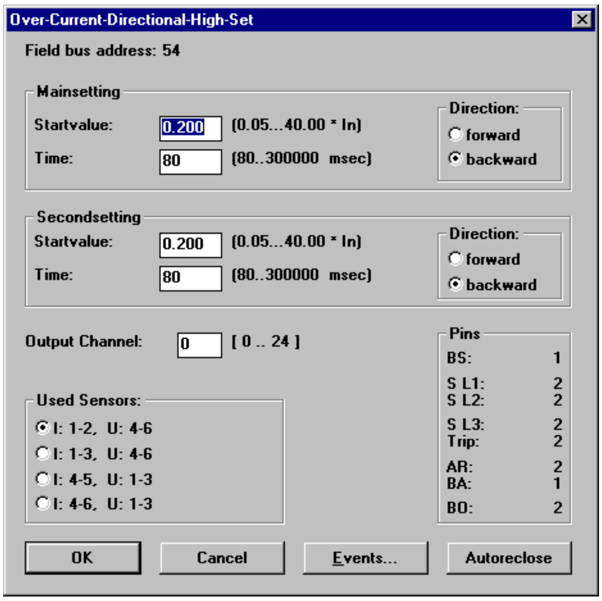


Figure 138: Configuration dialog function block overcurrent directional high.

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.05 … 40.00 (increment: 0.01)
Default: 0.20

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded and the tripping direction conforms to the parameter setting.
Setting range: [50 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Option field `direction` (once per parameter set/setting): The direction in which the protective function should trip is marked here. The angular definition between voltage and current and the connection of the REF542 are important here.
Setting range: Forward, backward
Default: backwards

✎Chapter "7.7.1 Testing the current protective functions" on page 7-11

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `autoreclosure`: The configuration dialog for setting parameters for the autoreclosure is opened.

✎Chapter "5.5.1 Autoreclosure" on page 5-209

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

✎Chapter "5.3.2 Global Settings" on page 5-2
✎Chapter "11.3 Event list of protective functions" on page 11-6

5.4.8.3 Overcurrent directional low

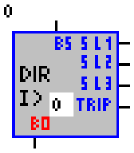


Figure 139: Function block overcurrent directional low.

↳Chapter "Function of the directional definite time functions" on page 5-97

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

`BO` output: If the protective function detects an activation in the opposite direction to the set tripping direction, a logical 1 signal will be output. It can be used for directional comparison protection.

Configuration

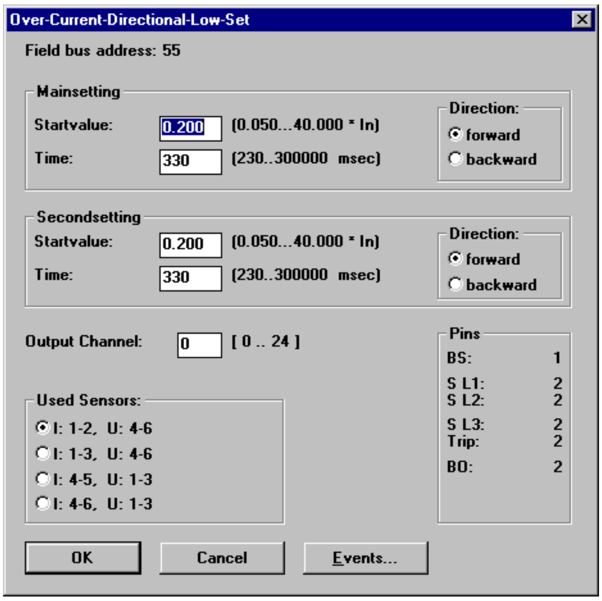


Figure 140: Configuration dialog overcurrent directional low.

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.05 … 40.00 (increment: 0.01)
Default: 0.20

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded and the tripping direction conforms to the parameter setting.
Setting range: [50 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Option field `direction` (once per parameter set/setting): The parameters for the direction in which the protective function should trip are set here. The angular definition between voltage and current and the connection of the REF542 are important here.
Setting range: Forward, backward
Default: backwards

↳Chapter "7.7.1 Testing the current protective functions" on page 7-11

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.8.4 Overcurrent instantaneous

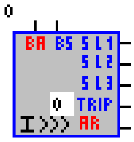


Figure 141: Function block overcurrent instantaneous

Function of the definite time functions

The REF542 has three independent overcurrent time protective functions, which can be independently activated and the parameters set:

- Overcurrent definite time low
- Overcurrent definite time high and Overcurrent definite time instantaneous.

Each one can be configured as two-phase or three-phase. The definite time functions evaluate the rms value and the initial phase-fault current function also evaluates the 1/√2- peak value of the measured current value. If the set response time is exceeded, the activation occurs first. If the response time is exceeded for at least the time setting parameter, it is tripped. It is phase-selective for these functions.

The three definite time functions enable an overcurrent time-step characteristic to be generated for one feeder, which is shown in the following figure.

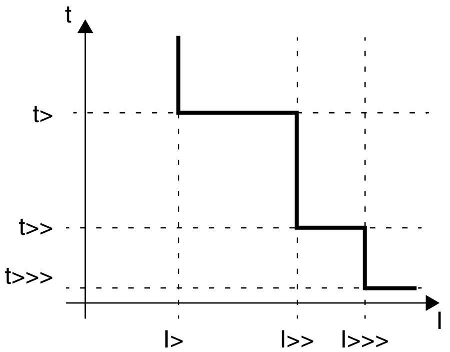


Figure 142: Schematic view of the definite time tripping steps

The one or two-stage autoreclosure (AR) can be activated with the surge I>> and the initial I>>> phase-fault current function.

↳Chapter "5.5.1 Autoreclosure" on page 5-209

Two parameter sets can be configured for each of the three independent overcurrent time protective functions.

Connections:

`BA` input: A logical 1 signal at this input blocks the autoreclosure (AWE).

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

`AR` output: A logical 1 signal appears at this output when an autoreclosure attempt is active and running.

Configuration

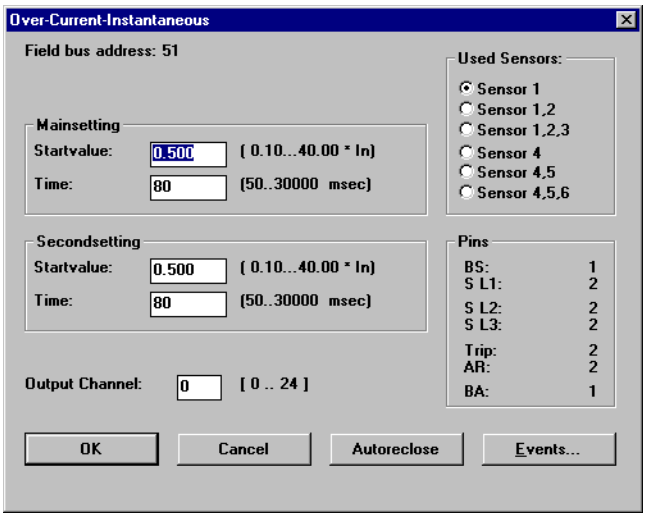


Figure 143: Configuration dialog function block Overcurrent instantaneous I>>>

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.10 … 40.00 (increment: 0.01)
Default: 0.50

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [20 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `autoreclosure`: The configuration dialog for setting parameters for the autoreclosure is opened.

↳Chapter "5.5.1 Autoreclosure" on page 5-209

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.8.5 Overcurrent high

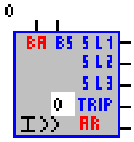


Figure 144: Function block overcurrent high

↳Chapter "Function of the definite time functions" on page 5-102

Connections:

`BA` input: A logical 1 signal at this input blocks the autoreclosure (AWE).

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

`AR` output: A logical 1 signal appears at this output when an autoreclosure attempt is active and running.

Configuration

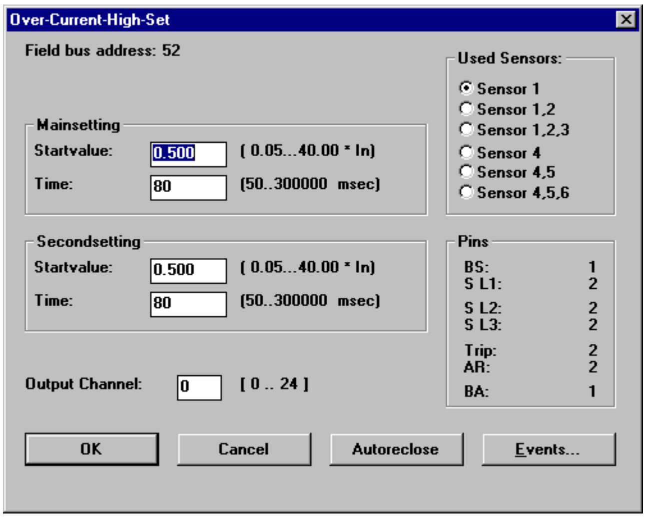


Figure 145: Configuration dialog function block overcurrent high

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.05 … 40.00 (increment: 0.01)
Default: 0.05

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [20 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping.

The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `autoreclosure`: The configuration dialog for setting parameters for the autoreclosure is opened.

↳Chapter "5.5.1 Autoreclosure" on page 5-209

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.8.6 Overcurrent low

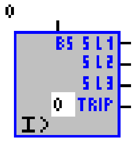


Figure 146: Function block overcurrent low

Chapter " Function of the definite time functions" on page 5-102

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

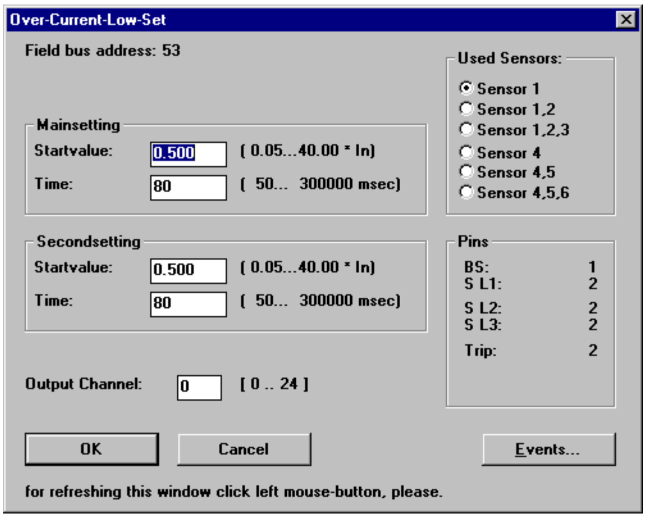


Figure 147: Configuration dialog function block overcurrent low

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.05 … 40.00 (increment: 0.01)
Default: 0.05

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [20 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.8.7 IDMT

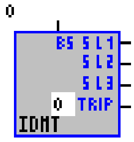


Figure 148: IDMT protection

Function

The REF542 enables an IDMT function in which the four current-time characteristics can be selected to be activated:

- Normal inverse,
- Very inverse,
- Extremely inverse
- and long-term inverse.

The function can be configured as single-phase or three-phase. The trip signal for the function is not phase-selective. Two parameter sets can be configured for the function.

The IDMT function evaluates the rms value of the measured current value. If the fault current factor is exceeded by 1.14 times the activation occurs first. If the response time is exceeded for at least the time setting, it will be tripped. The time delay depends here on the current quantity and the selected current-time characteristic. The formula for the trip time according to British Standard (BS) 142 and IEC 60255-3 is as follows:

$$t = \frac{k \cdot \beta}{I/I_{EB}^{\alpha} - 1} \qquad t = \frac{k}{((G/G_S)^{\alpha} - 1)}$$

BS 142 *IEC 60266-3*

t:	Time until the protective function trips under sustained overcurrent
k:	Curve parameter ($0 \leq k \leq 1$) (BS 142) or time value (IEC 60255-3)
α:	Constant according to the list below
β:	Constant according to the list below (BS 142)
I/I_{EB}:	Fault current factor
$I = G$:	Actual measured current; already transformed by the transducer/sensor
$I_{EB} = G_S$:	Base current setting value: Minimum current at which the protection is activated; already transformed by the transducer/sensor

The following table shows the two constants α and β of the four different current-time characteristics. To retain the specific families of curves, the formula in accordance with BS 142 is used and the k-factor of 0.1 to 1 is increased in increments of 0.1.

Current-time characteristic	α	β (BS142)	k (IEC 60255-3)
normal inverse	0.02	0.14	0.14
very inverse	1.0	13.5	13.5
extremely inverse	2.0	80.0	80.0
long time inverse	1.0	120.0	120.0

Note

The relay period must also be added to the trip times determined from the current-time characteristics. (Binary input/output board with transistor relays: 15 ms, and with conventional relays: 30 ms)

↳Chapter "11.5 IDMT protection and earthfault IDMT protection families of curves" on page 11-20

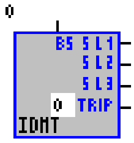


Figure 149: Function block dependent overcurrent timer protection

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

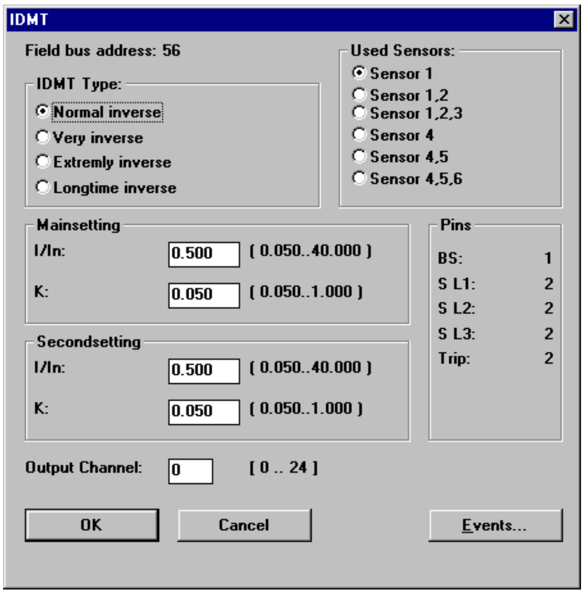


Figure 150: Configuration dialog function block dependent overcurrent timer protection

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Option field `IDMT type`: The desired current-time characteristic for tripping is marked here.
Setting range: normal inverse, very inverse, extremely inverse, long-term inverse
Default: normal inverse

↳Chapter "11.5 IDMT protection and earthfault IDMT protection families of curves" on page 11-20

Input field `I/In` (once per parameter set/setting): Input of the fault current factor (=I / I_{EB}). After reaching 1.14 times the value the protective function is activated.
Setting range: 0.05 … 40.00 (increment: 0.01)
Default: 0.1

↳Chapter "11.5 IDMT protection and earthfault IDMT protection families of curves" on page 11-20

Input field `k` (once per parameter set/setting): Input of the curve parameter according to the BS 142 formula. One curve is selected from the family of curves with this.
Setting range: 0.05 … 1.00 (increment: 0.01)
Default: 0.05

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.8.8 Earth fault high

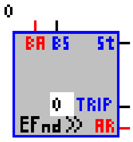


Figure 151: Function block earthfault high

Function of the earthfault timer functions

The REF542 has two earthfault timer functions, which can be activated and the parameters set independently of each other:

- Earthfault low and
- Earthfault high.

Each earthfault function is single-phase configured. This gives the option of calculating the earthfault current from the sum of the three phase currents. This can be done in networks with low-resistance neutral earthing in which large zero-sequence currents occur with no other settings.

The second option is to connect the earthfault current measuring input to a separate residual current transformer. This option should be used in networks with high-resistance, compensated or isolated neutral point. Very small earthfault currents occur here. A separate residual current transformer in the primary circuit for this purpose. This can be implemented very easily with cable feeders as a converted transformer.

↳Chapter "11.8 Network neutral point earthing" on page 11-35

The earthfault current timer functions evaluate the rms value of the measured residual current or the calculated neutral current. As soon as the response time is exceeded, the protective function is activated. If the response time is exceeded for at least the set time delay, the protective function will be tripped.

The one or two-stage autoreclosure (AR) can be activated with the Earthfault high protection

↳Chapter "5.5.1 Autoreclosure" on page 5-209

Two parameter sets can be configured for both earthfault stages.

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`BA` input: A logical 1 signal at this input blocks the autoreclosure (AWE).

`AR` output: A logical 1 signal appears at this output when an autoreclosure attempt is active and running.

`St` output: A logical 1 signal can be tapped here so long as the protective function is started.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

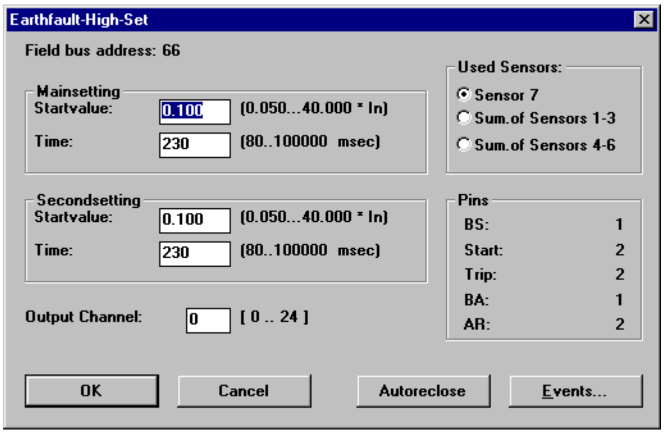


Figure 152: Configuration dialog function block earth fault high

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.05 … 40.00 (increment: 0.01)
Default: 0.1

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [50 ms + t_{relay}] … 100 000 ms (increment: 10)
Default: [200 + t_{relay}]

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `autoreclosure`: The configuration dialog for setting parameters for the autoreclosure is opened.

↳Chapter "5.5.1 Autoreclosure" on page 5-209

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.8.9 Earthfault low

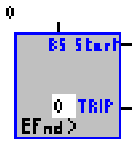


Figure 153: Function block earhfault low

↳Chapter " Function of the earthfault timer functions" on page 5-112

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

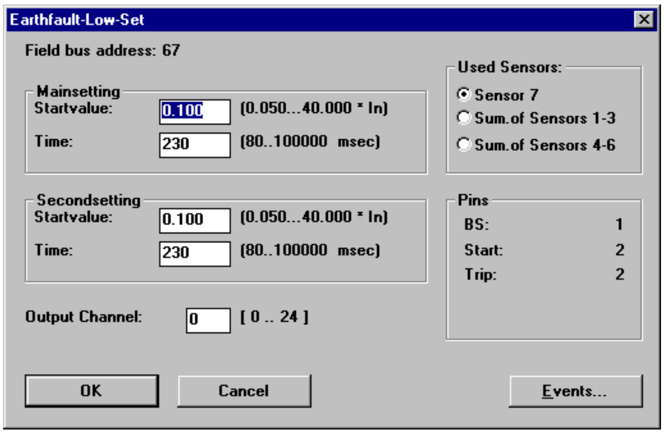


Figure 154: Configuration dialog function block earthfault low

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.05 … 40.00 (increment: 0.01)
Default: 0.1

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [50 ms + t_{relay}] … 100 000 ms (increment: 10)
Default: [200 + t_{relay}]

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.8.10 Earthfault directional high

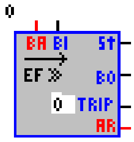


Figure 155: Function block earth fault directional high

Function of the directional earthfault current timer functions

The REF542 has two directional earth fault timer functions, each of which can be independently activated and the parameters set:

- Earthfault directional low
- Earthfault directional high.

Each earth fault current function is single-phase configured. This gives the option of calculating the earth fault current from the sum of the three phase currents, which can be done in networks with low-resistance neutral earthing in which large zero-sequence currents occur with no other settings. The second option is to connect the earth fault current measuring input to a separate residual current transformer. This option should be used in networks with high-resistance, compensated or isolated neutral point. Very small earth fault currents occur here. A separate residual current transformer is included in the primary circuit for this purpose. This can be implemented very easily with cable feeders as a converted transformer.

Current and voltage quantities must be connected to the function to record the direction. The required zero-sequence voltage is calculated from the three phase voltages. The earth fault directional protective functions evaluate the rms values of the neutral current and the neutral voltage. Calculated or measured quantities may be used. In the case of the earth fault directional protection, all three voltages must always be configured and connected, because the REF542 uses the sum of the three phase voltage values.

↳Chapter "11.8 Network neutral point earthing" on page 11-35

To decide the direction for networks with permanent, low or high-resistance and with a compensated neutral point, the effective power proportion of the neutral system is calculated and evaluated. The reactive power proportion of the neutral system is used for networks with isolated neutral point.
A minimum neutral current and neutral voltage value is required to calculate the effective or reactive power proportion of the power of the neutral system. The minimum neutral current value corresponds to the earth fault current setting value of the function. The minimum neutral voltage value is permanently set and equals 10% of the conductor earth voltage value.
If the set earth fault current response time is exceeded and the minimum required voltage value for specifying the directional decision is present, the protective function will be activated. If it remains activated for at least the set time delay, the protective function will trip.
When measuring the effective power (cos φ), the forward direction of the functions is defined in an angular range of 90° over 180° to 270° between neutral current $3 \cdot I_0$ and neutral voltage $3 \cdot U_0$. The neutral voltage $3 \cdot U_0$ is the reference quantity in this case.

↳Chapter "7.7.1 Testing the current protective functions" on page 7-11

Two parameter sets can be configured for both protective functions.

The diagram below shows the directional definition for the directional earth fault protection (GFP) for earthed networks.

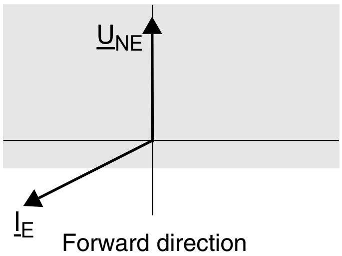


Figure 156: Vector diagrams of the directional earth fault protection (earthed networks (cos φ))

When measuring the reactive power (sin φ), the forward direction of the functions is defined in an angular range of 0° over 90° between neutral current $3 \cdot I_0$ and neutral voltage $3 \cdot U_0$. The neutral voltage $3 \cdot U_0$ is also the reference quantity. The connection of the REF542 to the transducers or sensors is very important here. The following diagram clarifies the directional definition.

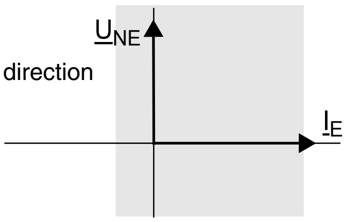


Figure 157: Vector diagrams of the directional earth fault protection (isolated networks (sin φ))

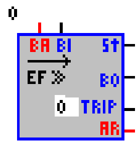


Figure 158: Function block Eartfault directional high

Connections:

`BA` input: A logical 1 signal at this input blocks the autoreclosure (AWE).

`BI` input: If there is a logical 1 at this input, the protective function trip signal will be suppressed. The functions on the tripping side will still be displayed.

`St` output: A logical 1 signal can be tapped here so long as the protective function is started.

`BO` output: If the protective function detects an activation in the opposite direction to the set tripping direction, a logical 1 signal will be output.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

`AR` output: A logical 1 signal appears at this output when an autoreclosure attempt is active and running.

Configuration

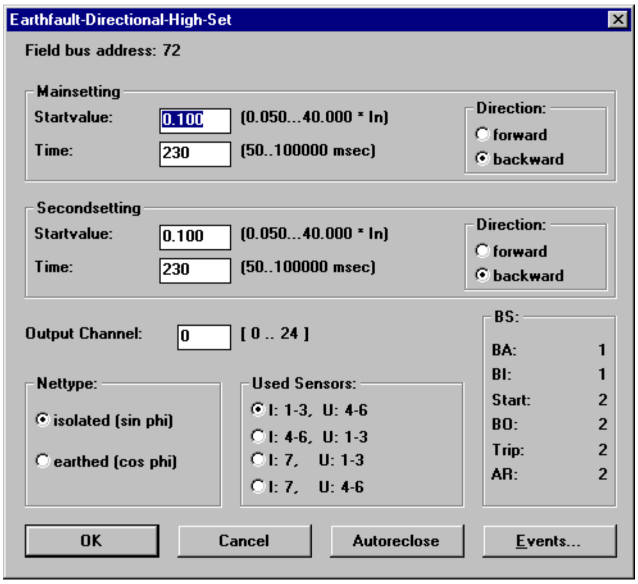


Figure 159: Configuration dialog function block earth fault directional high

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.05 … 40.00 (increment: 0.01)
Default: 0.10

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded and the tripping direction conforms to the parameter setting.
Setting range: [20 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [200 + t_{relay}]

Option field `direction` (once per parameter set/setting): The direction in which the protective function should trip is marked here. The angular definition between voltage and current and the connection of the REF542 are important here.
Setting range: Forward, backward
Default: backwards

↳Chapter "7.7.1 Testing the current protective functions" on page 7-11

Option field `nettype`: Specifies how the network neutral point is treated and what zero-power proportion (effective or reactive power) the function draw on to determine the direction.
Setting range: isolated (sin φ), earthed (cos φ)
Default: isolated (sin φ)

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `autoreclosure`: The configuration dialog for setting parameters for the autoreclosure is opened.

↳Chapter "5.5.1 Autoreclosure" on page 5-209

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.8.11 Earthfault directional low

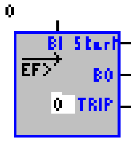


Figure 160: Function block earthfault directional low

↳Chapter " Function of the directional earthfault current timer functions" on page 5-116

Connections:

`BI` Input: If there is a logical 1 at this input, the protective function trip signal will be suppressed. The functions on the tripping side will still be displayed.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`BO` output: If the protective function detects an activation in the opposite direction to the set tripping direction, a logical 1 signal will be output.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

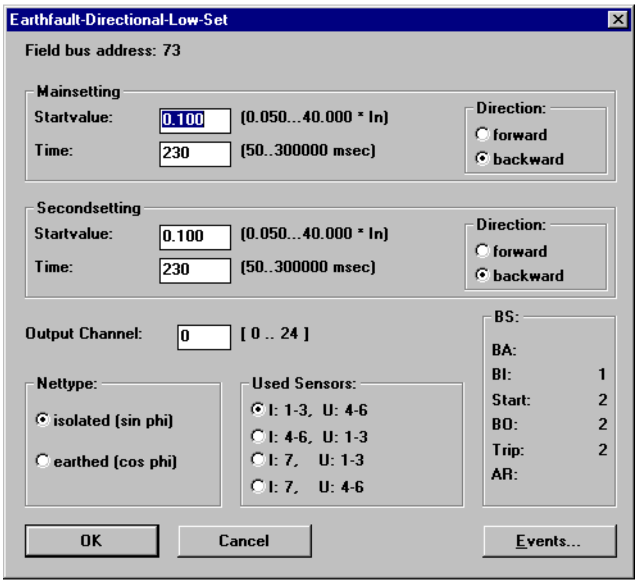


Figure 161: Configuration dialog function block earthfault directional low

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.05 … 40.00 (increment: 0.01)
Default: 0.10

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded and the tripping direction conforms to the parameter setting.
Setting range: [20 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [200 + t_{relay}]

Option field `direction` (once per parameter set/setting): The direction in which the protective function should trip is marked here. The angular definition between voltage and current and the connection of the REF542 are important here.
Setting range: Forward, backward
Default: backwards

↳Chapter "7.7.1 Testing the current protective functions" on page 7-11

Option field `nettype`: Specifies how the network neutral point is treated and what zero-power proportion (effective or reactive power) the function draws on to determine the direction.
Setting range: isolated (sin φ), earthed (cos φ)
Default: isolated (sin φ)

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.8.12 Earthfault IDMT

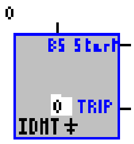


Figure 162: Function block earthfault IDMT

Function

The deopendent earth fault current timer protection, like the IDMT, is a time-delay function with a set of hyperbolic current-time characteristics. A earthfault IDMT function in which four current-time characteristics, may be selected, can be activated in the REF542:

- Normal inverse,
- Very inverse,
- extremely inverse and
- long-term inverse.

Two parameter sets can be configured for the dependent earth fault stage.

The function is single-phase configured. This gives the option of calculating the earth fault current from the sum of the three phase currents. This can be done in networks with low-resistance neutral earthing in which large zero-sequence currents occur with no other settings.

The second option is to connect the earth fault current measuring input to a separate residual current transformer. This option should be used in networks with high-resistance, compensated or isolated neutral point. Very small earth-fault currents occur here. A separate residual current transformer in the primary circuit for this purpose. This can be implemented very easily with cable feeders as a converted transformer.

Chapter "11.8 Network neutral point earthing" on page 11-35

If the fault current factor is exceeded by 1.14 the activation occurs first. If the response time is exceeded for at least the time setting, it will be tripped. The time delay depends here on the current quantity and the selected current-time characteristic. The formula for the trip time according to British Standard (BS) 142 and IEC 60255-3 is as follows:

$$t = \frac{k \cdot \beta}{(I/I_{EB})^{\alpha} - 1} \qquad t = \frac{k}{((G/G_S)^{\alpha} - 1)}$$

BS 142 *IEC 60266-3*

t:	Time until the protective function trips under sustained overcurrent
k:	Curve parameter ($0 \le k \le 1$) (BS 142) or time value (IEC 60255-3)
α:	Constant according to the list below
β:	Constant according to the list below (BS 142)
I/I_{EB}:	Fault current factor
$I = G$:	Actual measured current; already transformed by the transducer/sensor
$I_{EB} = G_S$:	Base current setting value: Minimum current at which the protection is activated; already transformed by the transducer/sensor

The following table shows the two constants α and β of the four different current-time characteristics. To retain the specific families of curves, the formula in accordance with BS 142 is used and the k-factor of 0.1 to 1 is increased in increments of 0.1

.

Current-time characteristic	α	β (BS142)	k (IEC 60255-3)
normal inverse	0.02	0.14	0.14
very inverse	1.0	13.5	13.5
extremely inverse	2.0	80.0	80.0
long time inverse	1.0	120.0	120.0

Note The relay period must also be added to the trip times determined from the current-time characteristics. (Binary input/output board with transistor relays: 15 ms, and with conventional relays: 30 ms)

↳Chapter "11.5 IDMT protection and earthfault IDMT protection families of curves" on page 11-20

Connections:

`BS` input: If a logical 1 acts on this input, the protective function trip signal will be suppressed. However, the functions on the tripping side will still be displayed.

`Start` output: In the residual current an activation occurs and is documented at this output with a logical 1 signal so long as the residual current function remains active.

`TRIP` output: An activation criterion together with expiry of the set time delay has resulted in a tripping and generated a logical 1 signal here so long as the tripping criterion is present. This signal is used to control the power circuit-breaker OFF command.

Configuration

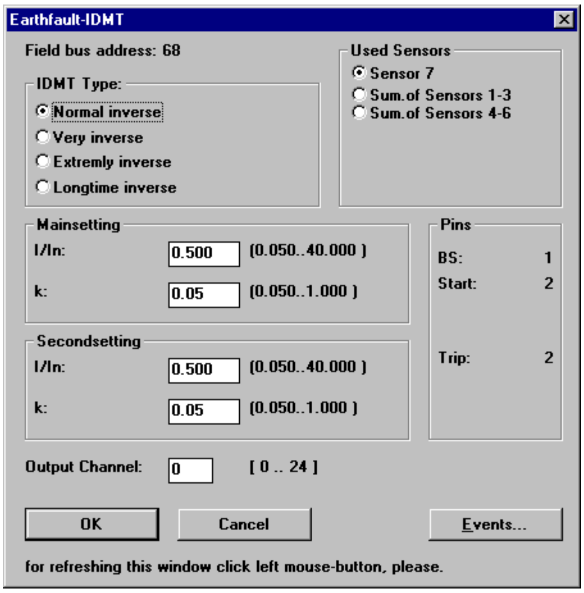


Figure 163: Configuration dialog function block earthfault IDMT

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Option field `IDMT type`: The desired current-time characteristic for tripping is marked here.
Setting range: normal inverse, very inverse, extremely inverse, long-term inverse
Default: normal inverse

↳Chapter "11.5 IDMT protection and earthfault IDMT protection families of curves" on page 11-20

Input field `I/In` (once per parameter set/setting): Input of the fault current factor (=I / I_{EB}). After reaching 1.14 times the value the protective function is activated.
Setting range: 0.05 … 40.00 (increment: 0.01)
Default: 0.1

↳Chapter "11.5 IDMT protection and earthfault IDMT protection families of curves" on page 11-20

Input field `k` (once per parameter set/setting): Yields the multiplication factor according to the BS 142 formula. One of the curves from the family of curves is selected with it.
Setting range: 0.05 … 1.00 (increment: 0.01)
Default: 0.05

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.9 Voltage supervision

The following subsections describe the function blocks that are available with the menu `Drawing Menu/Insert/Voltage Protection.`

Application of the independent overvoltage timer protective functions

If the generator or transformer voltage control fails, the downstream station components and users will be exposed to excess voltage from which they will have to be protected by trips.

In the case of long open-circuit overhead line and cable segments, excessive voltages caused by their capacitive load power may occur at the end of the lines. Overvoltage protective functions that monitor the station components and users are used to trip these overvoltages caused by operational conditions.

Application of the independent undervoltage timer protective functions

As the result of a fault occurring in equipment, the voltage to the faulty object drops along the transmission components. This effect also occurs if the power supply is not readjusted in the event of increased user load. The voltage drop to the fault site can be used as a criterion for shutting off the fault by a undervoltage protective function. The undervoltage function is also used as a backup protective function for generators, transformers, carriers and cables.

In three-phase asynchronous motors a voltage drop causes an increase in the load current, because the motor attempts to drive the connected load machine at a constant speed. This causes an overload current that heats the motor. For this reason the voltage should not remain low for too long, otherwise the motor may overheat. It makes sense to use an undervoltage protective function to monitor the motor operation.

Application of the residual overvoltage protective function

In the event of a earth fault, the neutral point to earth voltage occurs in the neutral system of the symmetrical components. If a earth fault occurs, this asymmetry will affect the compensated and isolated network so the zero-sequence voltage is very high and may increase to a maximum of three times the value of the phase voltage. This effect enables a earth fault in isolated, compensated and high-resistance earthed networks to be measured relatively easily by the high zero-sequence voltage at every point of the network. This enables relatively easy earth fault detection by measuring this zero sequence or residual voltage.

Measuring the residual voltage is therefore generally used only for reporting purposes or as backup protection for the earthing equipment, such as resistors and earth fault compensator coils.

5.4.9.1 Overvoltage instantaneous

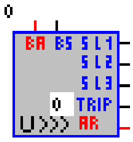


Figure 164: Function block overvoltage instantaneous

Function of the overvoltage timer protective function

There are three overvoltage timer protective functions in the REF542, which can be activated and the parameters set independent of one another:

- Overvoltage low,
- Overvoltage high and
- Overvoltage instantaneous.

Every overvoltage timer protective function can be one, two or three-phase configured. All overvoltage timer protective functions evaluate the rms values, the overvoltage instantaneous function and also 1/√2 times the peak value of the external phase-to-neutral voltages. If the response time is exceeded, it is first activated. If the response time is exceeded for at least the time set in the parameters, it will be tripped.

The overvoltage protective functions, like the overcurrent protective function, are used in a graded fashion in the response time and in the trip time. An example of grading is shown in the following diagram.

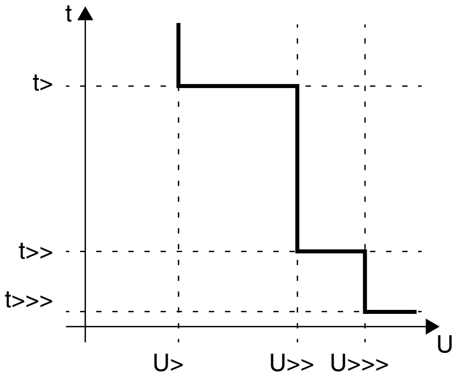


Figure 165: Overvoltage response grading.

Two parameter sets can be configured for each of the three overvoltage time protective functions.

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

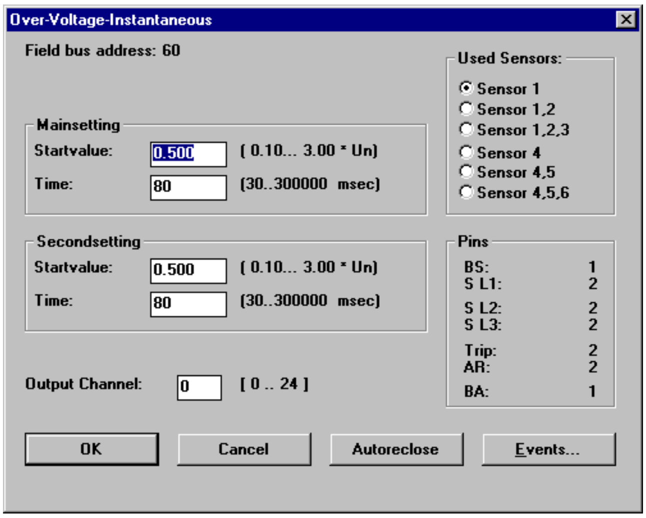


Figure 166: Configuration dialog function block overvoltage instantaneous

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.10 … 3.00 (increment: 0.01)
Default: 0.50

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [50 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping.
The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors are connected and to whose values the protective function should react.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

✎Chapter "5.3.2 Global Settings" on page 5-2

✎Chapter "11.3 Event list of protective functions" on page 11-6

5.4.9.2 Overvoltage high

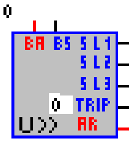


Figure 167: Function block overvoltage high

Chapter " Function of the overvoltage timer protective function" on page 5-126

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

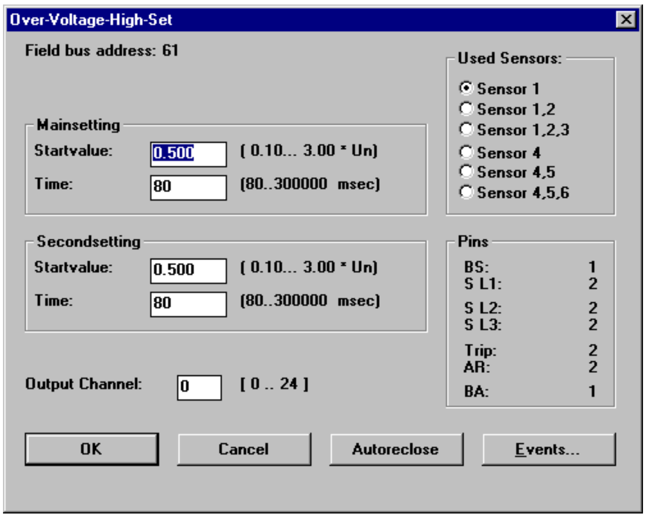


Figure 168: Configuration dialog function block overvoltage high

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.10 … 3.00 (increment: 0.01)
Default: 0.50

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [50 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors are connected and to whose values the protective function should react.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

✎Chapter "5.3.2 Global Settings" on page 5-2
✎Chapter "11.3 Event list of protective functions" on page 11-6

5.4.9.3 Overvoltage low

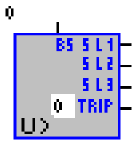


Figure 169: Function block overvoltage low

Chapter " Function of the overvoltage timer protective function" on page 5-126

Connections:

BS input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

SL1, SL2, SL3 outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

Trip output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

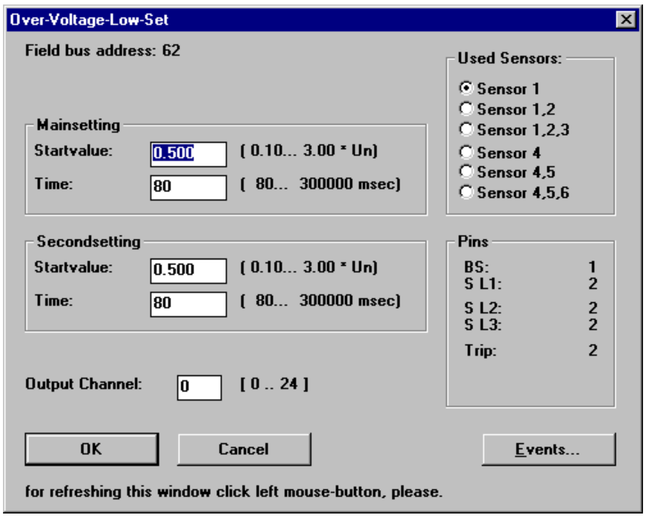


Figure 170: Configuration dialog function block overvoltage low protection

Information field field bus address: Set for every protective function and used to address the function block for interbay bus commands.

Input field startvalue (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.10 … 3.00 (increment: 0.01)
Default: 0.50

Input field time (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [50 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Input field output channel: Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors are connected and to whose values the protective function should react.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.9.4 Undervoltage instantaneous

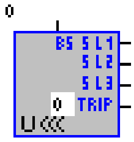


Figure 171: Function block undervoltage instantaneous

Function of the undervoltage timer protective functions

There are three undervoltage timer protective functions in the REF542, which can be activated and parameters set independently of one another:

- Undervoltage low,
- Undervoltage high and
- Undervoltage instantaneous.

Every undervoltage timer protective function can be one, two or three-phase configured. All undervoltage timer protective functions evaluate the rms values, the undervoltage instantaneous function and also 1/√2 times the peak value of the external phase-to-neutral voltages.

If it falls below the set response time, the activation occurs first. If it falls below the response time for at least the time set in the parameters, it will be tripped.

The undervoltage protective functions are used in a graded fashion in the response time and in the trip time. An example of staging is shown in the following diagram.

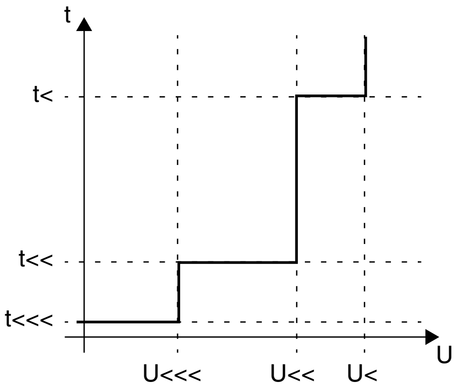


Figure 172: Undervoltage protection response stages

Because a feeder has no voltage when switched off, an undervoltage timer protective function would remain activated. It would not be possible to switch the feeder on again. Therefore, the relevant configuration dialog provides the option of deactivating the undervoltage function if the monitored voltage is in the range of 0 to 40% of the response time. The diagram below shows how this functions.

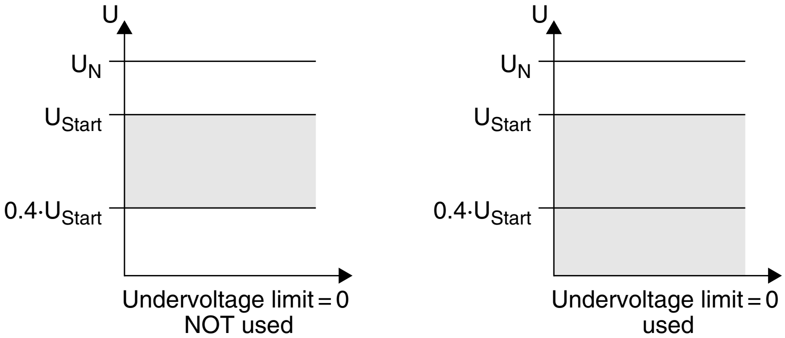


Figure 173: Configuration of the undervoltage limit = 0

If the voltage level of 40% of the response time is too high, the undervoltage function can also be blocked via the circuit-breaker auxiliary contact. Then the entire duration for which the feeder was switched off will be shown on the tripping side. After the circuit-breaker blocking is deactivated by the circuit-breaker auxiliary contact, activation of the undervoltage function must be delayed. Otherwise it would trip immediately, because its own time delay has long expired during the blocking process.

Two parameter sets can be configured for each of the three undervoltage time protective functions.

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

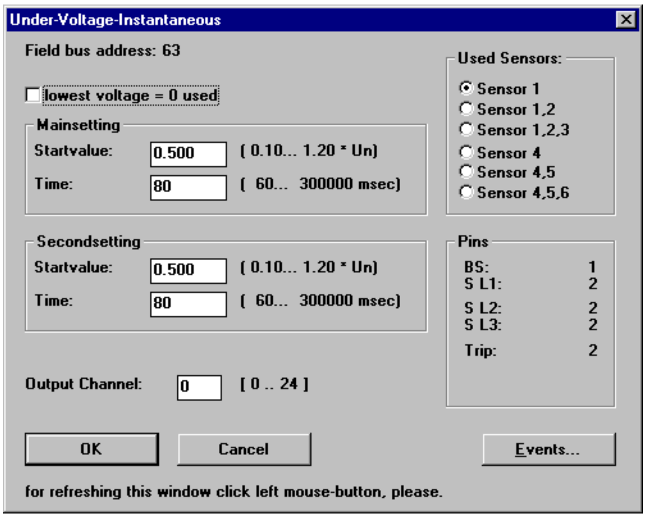


Figure 174: Configuration dialog function block undervoltage instantaneous

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Option field `lowest voltage = 0 used`: If this is marked, the voltage range from 0 to 40% of the start value will be taken into account.

↳Figure 173: „Configuration of the undervoltage limit = 0“

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.10 … 1.20 (increment: 0.01)
Default: 0.50

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [50 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Input field `output channel`: Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors are connected and to whose values the protective function should react.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.9.5 Undervoltage high

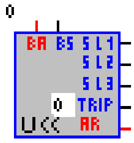


Figure 175: Function block undervoltage high

↳Chapter "Function of the undervoltage timer protective functions" on page 5-132

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

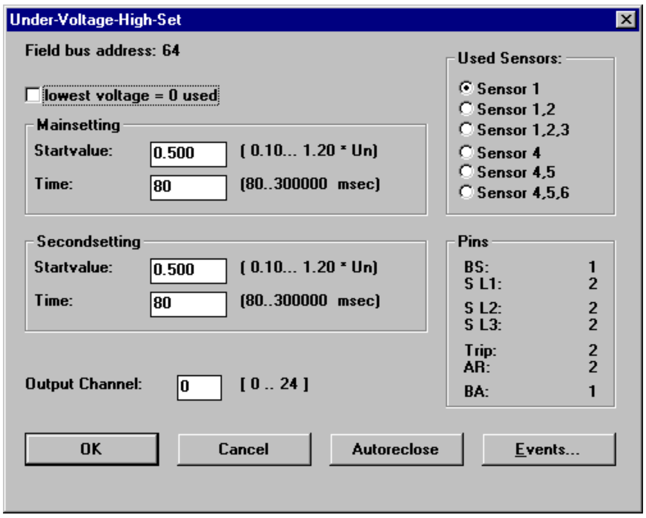


Figure 176: Configuration dialog function block undervoltage high

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Option field `lowest voltage = 0 used`: If this is marked, the voltage range from 0 to 40% of the start value will be taken into account.

↳Figure 173: „Configuration of the undervoltage limit = 0“

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.10 … 1.20 (increment: 0.01)
Default: 0.50

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [50 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors are connected and to whose values the protective function should react.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.9.6 Undervoltage low

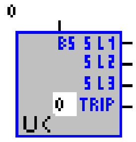


Figure 177: Function block undervoltage low protection

↳Chapter "Function of the undervoltage timer protective functions" on page 5-132

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

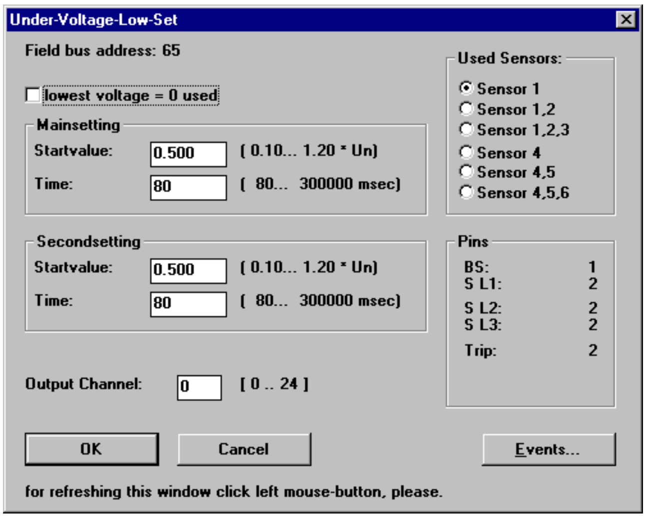


Figure 178: Configuration dialog function block undervoltage low protection

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Option field `lowest voltage = 0 used`: If this is marked, the voltage range from 0 to 40% of the start value will be taken into account.

↳Figure 173: „Configuration of the undervoltage limit = 0“

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.10 … 1.20 (increment: 0.01)
Default: 0.50

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [50 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors are connected and to whose values the protective function should react.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.9.7 Residual overvoltage high

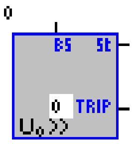


Figure 179: Function block residual overvoltage high

Function of the residual (zero sequence) voltage protective functions

There are two residual voltage protective functions in the REF542, which can be activated and parameters set independently of one another:

- Residual overvoltage low and
- Residual overvoltage high.

Both functions use the rms value of the residual voltage, which is fed to them over an external neutral to earth voltage transformer (sensor). As an alternative they use the sum of the measured phase voltages.

↳Chapter "11.8 Network neutral point earthing" on page 11-35

As soon as the response time is exceeded, the protective function is activated. If the response time is exceeded for at least the set time delay, the protective function will be tripped.

Two parameter sets can be configured for each of the two residual voltage protective functions.

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

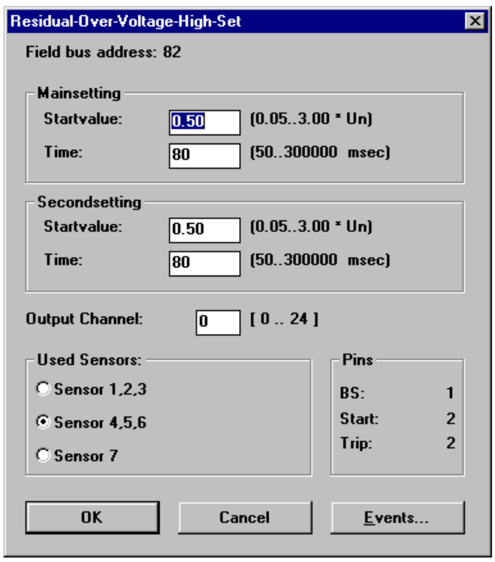


Figure 180: Configuration dialog function block residual overvoltage high

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for U_N to specify the response time of the protective function.
Setting range: 0.05 … 3 (increment: 0.01)
Default: 0.50

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [20 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors are connected and to whose values the protective function should react.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.9.8 Residual overvoltage low

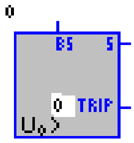


Figure 181: Function block residual overvoltage low

✎Chapter "Function of the residual (zero sequence) voltage protective functions" on page 5-139

Connections

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

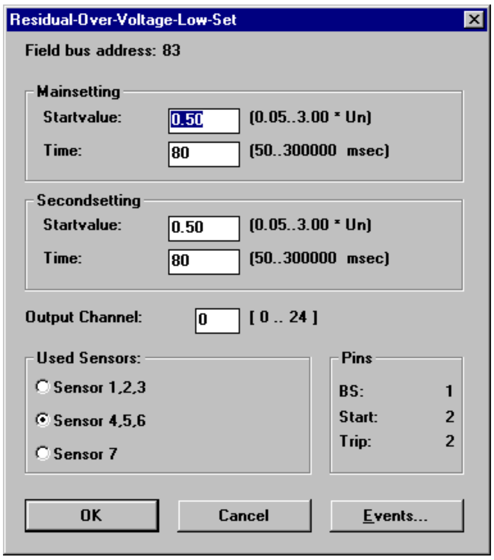


Figure 182: Configuration dialog function block residual overvoltage low

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the multiplier for I_N to specify the response time of the protective function.
Setting range: 0.05 … 3 (increment: 0.01)
Default: 0.50

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [20 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [50 ms + t_{relay}]

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors are connected and to whose values the protective function should react.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.10 Motor Protection

The subsections contain the descriptions of the function blocks that are available via the menu `Drawing Menu/Insert/Motor Protection`.

Damage caused by defects in electrical drives risks not only complex repair work but also, and most important, loss of production.

To reduce the effects of faults to the minimum possible, overload and insulation defects must be detected promptly. For this reason, protection equipment, particularly for high-voltage motors, comes in the form of numerical protection devices – such as the REF542. This enables them to be closely adapted to the machine characteristics and they are also space-saving solutions.

In the case of AC motors, the following dangerous operating conditions may result in a fault:

- Mechanical overload
  - Continuous overload
  - Heavy starting
  - Blocked rotor
- Irregularities in the power-supply network
  - Phase asymmetry
  - Overvoltage and undervoltage
- Faults in the electrical feeds and switchgear
  - Phase breaks
  - Failure of switchgear
  - Insulation faults
- Internal motor faults
  - Phase and earth faults
  - Phase breaks in stator and rotor circuits

The protective functions described in the following subsections are provided for protection from the above overloads and faults.

Please also note the examples for setup of the various motor protective functions. Setting parameters on the basis of typical motor data is explained there.
↳Chapter "11.9 Setup example for motor protection" on page 11-43

5.4.10.1 Thermal overload protection

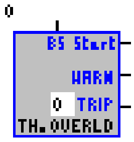


Figure 183: Function block thermal overload protection

Function

The thermal overload protection in the REF542 operates with the thermal replica of the object that is being protected. The function block can operate with one, two or three-phase current measured values. In addition, three time constants are used as follows:

- For invalid operating status (overload status),
- For faults or starting process
- For the cooling phase

The response times of the temperature for warning and tripping can be configured and if necessary a corresponding output signal will be sent. The ambient temperature is also taken into account in the thermal replica. The thermal replica of the object to be protected corresponds to an exponential curve of the thermal total time constant. The exponential change here is proportional to the square of the quotients of overload and rated operating current, corresponding to the thermal power dissipation on the motor. The time delay of the protective function is therefore dependent on the magnitude of the overload current. The time required for the warm-up phase can be calculated with the following formula:

$$\frac{\Delta\vartheta(t)}{\Delta\vartheta_N} = \frac{\vartheta(t)-\vartheta_U}{\vartheta_N-\vartheta_U} = \left(\frac{\vartheta_0-\vartheta_U}{\vartheta_N-\vartheta_U}\cdot e^{-\frac{t}{\tau}}\right)+\left[\left(\frac{I}{I_{MN}}\right)^2\cdot\left(1-e^{-\frac{t}{\tau}}\right)\right]$$

Therefore, for time t of the warm-up phase:

$$t = \tau\cdot ln\left[\frac{\left(\frac{I}{I_{MN}}\right)^2-\frac{\vartheta_0-\vartheta_U}{\vartheta_N-\vartheta_U}}{\left(\frac{I}{I_{MN}}\right)^2-\frac{\vartheta(t)-\vartheta_U}{\vartheta_N-\vartheta_U}}\right]$$

The time required for the cooling phase can be calculated with the following formula:

$$\vartheta(t) = \vartheta_U+(\vartheta_{AB}-\vartheta_U)\cdot e^{-\frac{t}{\tau}}$$

Therefore, for time t of the cooling process:

$$t = \tau\cdot ln\left[\frac{\vartheta_{AB}-\vartheta_U}{\vartheta(t)-\vartheta_U}\right]$$

The variables are defined as follows in all equations:

$\Delta\vartheta(t)$: Temperature difference to ambient temperature
$\Delta\vartheta N$: Rated excess temperature
$\vartheta(t)$: Current temperature
ϑ_U: Ambient temperature
ϑ_0: Start temperature
ϑ_N: Rated operating temperature of motor
ϑ_{AB}: Start temperature of the cooling process
I: Current flowing motor current
I_{MN}: Rated motor current
τ: Thermal total time constant of motor

The REF542 overload protective function operates in two stages to generate an alarm signal when the warning temperature is reached and a trip signal when the trip temperature is reached. In the REF542 the trip signal can also be delayed by an adjustable period. The thermal total time constant can be set separately for three current ranges in the REF542:

- The 1st range is in the rated motor current range
  $0.10 \cdot I_{MN} < I < 2,00 \cdot I_{MN}$ (time constant TC normal active)
- The 2nd range applies for the motor starting current range
  $I > 2.00 \cdot I_{MN}$ or in the event of a fault (time constant TC fault active)
- The 3rd range is for the cooling period
  $I < 0.10 \cdot I_{MN}$ (time constant TC off active)

The 2nd range is designed for the star characteristics of rotor-critical motors. In this range the temperature time constant is dependent on the instantaneous current.

The current temperature at any time is saved in the REF542 until the set start temperature is reached during the cooling process. If a trip is caused by the thermal overload protective function, it remains activated until the warning temperature falls below the set value. A starting block can be implemented in the REF542 function chart (FUPLA) with the warning temperature signaling output.

Note

If the auxiliary voltage fails, the current temperature value will be deleted. Once the bay control and protection unit has been restarted, the start temperature value parameter (`T ini`) will be applied. This value is also used after the standard device starting process.

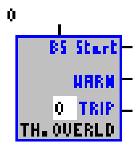


Figure 184: Function block thermal overload protection

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`WARN` output: A logical 1 signal can be tapped here so long as the warning temperature is exceeded.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Typical application

Electrical equipment is subject to the following states during its life:

- Normal operation,
- Overload and
- Malfunction.

The overload status represents a transition between standard operation and malfunction. The thermal overload protective function is used to monitor the overload range. It can be used for all equipment, but is most frequently used with generators, transformers, chokes and three-phase asynchronous motors.

Configuration

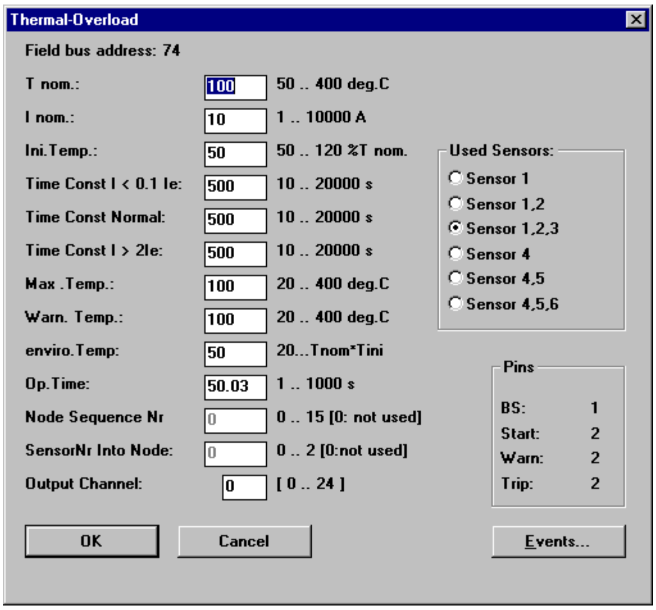


Figure 185: Configuration dialog function block thermal overload protection

↳Chapter "11.9 Setup example for motor protection" on page 11-43

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `T nom`: Input of the operating temperature in °C of the equipment to be protected.
Setting range: 50 … 400 °C (increment: 1)
Default: 100 °C

Input field `I nom`: Input of the rated current of the equipment to be protected.
Setting range: 1 … 10 000 A (increment: 1)
Default: 10 A

Input field `ini. Temp.`: Input of the start temperature as a percentage of the operating temperature of the equipment to be protected.
Setting range: 50 … 120% · T nom (increment: 1)
Default: 50%

Input field `Time const. I < 0.1 Ie`: Input of the cooling time constant of the equipment to be protected. It is active if the current I < 0.10 · I nom.
Setting range: 10 … 20 000 s (increment: 1)
Default: 500 s

Input field `Time const. normal`: Input of the standard operating time constant of the equipment to be protected.
It is active if the current is in the range 0.10 to 2.00 · I nom.
Setting range: 10 … 20 000 s (increment: 1 s)
Default: 500 s?

Input field `Time const. I > 2Ie`: Input of the time constant for starting or malfunction. It is active if the current is I > 2.00 · I nom.
Setting range: 10 … 20 000 s (increment: 1)
Default: 500 s

Input field `max. temp.`: Input of the trip threshold. If it is exceeded for at least the set delay period, a trip signal will be generated (`Start`).
Setting range: 20 … 400 °C (increment: 1)
Default: 100°C

Input field warn temp.: Input of the threshold for the warning event. If the threshold is exceeded, a logical 1 can be tapped at the WARN output.
Setting range: 20 … 400 °C (increment: 1)
Default: 100°C

Input field enviro. temp.: Input of the typical ambient temperature.
Setting range: 20 …T nom · T ini (increment: 1)
Default: 20

Input field op. time: Delay period in ms after which the protective function trips if the trip threshold T max remains exceeded.
Setting range: 1 … 1000 s (increment: 1)
Default: 1 s?

Input field node sequence number: Shows the node number at which the function is registered in the LON process bus interface.

Input field sensor nr into node: Selects the sensor input to whose value the protective function is to react on the registered node in the LON process bus interface.

Input field output channel: Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field used sensors: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Information field pins: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button OK: All settings are saved in the configuration program. The dialog window is closed.

Button Cancel: Settings are not saved in the configuration program. The dialog window is closed.

Button events: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

✎Chapter "5.3.2 Global Settings" on page 5-2
✎Chapter "11.3 Event list of protective functions" on page 11-6

5.4.10.2 Motor start

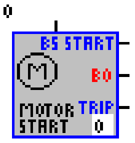


Figure 186: Function block motor start

Function

The three-phase asynchronous motor can be overloaded if the star duration or current increase. The motor star behavior depends on the switching torque of the specific load machine.

In general, these overloads are more critical for the rotor (rotor-critical motor) than for the stator. The manufacturer assigns an allowable current-time star integral $I^2 \cdot T$ for motors. As an alternative, information on the maximum allowable star current and the maximum allowable star time is provided.

The current-time star integral is proportional to the short-term thermal load on the motor. It is calculated by the integration of the current path i(t) in the time interval from 0 to T_{star}:

$$I^2 \cdot T = \int_0^{T_{MStart}} i(t)^2 dt$$

In a simplified form the following applies:

$$I^2 \cdot T = I^2_{MStart} \cdot T_{MStart}$$

I:	Current rms value
T:	Duration
i(t):	Temporal current path
I_{MStart}:	Motor star current rms value
T_{MStart}:	Motor star time

The starting protective function in the REF542 monitors the motor star behavior with the values described. The current-time-starting integral is measured if the set starting current value $I_{starting}$ is exceeded within the first 100 ms while the motor is starting and it is tripped, if the current-time integration exceeds the default $I^2 \cdot T$ value.

A starting is registered when a step change increases from $I < 0.10 \cdot I_{n,M}$ (= rated motor current) to $I > I_{starting}$ within 100 ms. The starting start signal is reset if I is $< I_{starting}$. If the motor current falls below $0.10 \cdot I_{n,M}$, the motor will shut down. The corresponding thermal total cooling time constant will be activated. The starting supervision can then react to the next motor start.

The starting supervision protective function totals the current-time-starting integrals of the three conductors, divides them by three and compares them to the product $I^2_{MStart} \cdot T_{MStart}$. The setting values `start value` and `time` of the active parameter set are used for this product.

The following diagram shows a graph of the function, with the time t standardized to T_{Start} and the current I to I_{Start}.

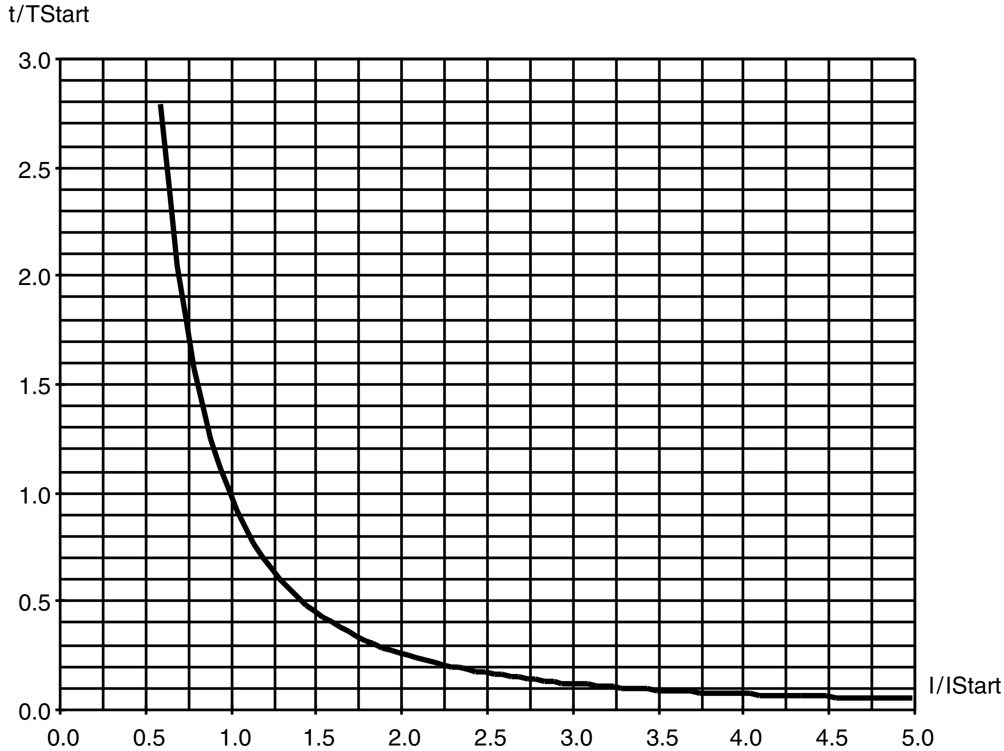


Figure 187: Standardized current-time characteristic of the starting supervision

The starting supervision function block has two output signals that can be used for control and blocking in the FUPLA. The protective function is activated (`Start`) if a motor start has been detected and the response time has been exceeded. If the response time is exceeded for at least the time set in the parameters, it will be tripped (`Trip`). Functions available in the event of a malfunction in the motor standard operating status can be blocked during the motor starting procedure with the starting output signal.

However, because blocked functions expire with the set time delays, they would trip immediately after the blocking signal stops if the activation criterion were still present. Therefore a delayed reset timing circuit (slope delay falling) should be installed downstream from the blocking signal. This will delay the blocking for the time range during which the motor current falls back from the starting response value $I_{starting}$ to the rated motor current $I_{n,M}$. A setting of 1% of the starting time of the motor is recommended as the reset delay time.

The cold and warm start are counted with the starting output signal (`START`) and they also have to be configured in the FUPLA.

Two parameter sets can be configured for the starting supervision function.

Typical application

For example, starting supervision is used with three-phase asynchronous motors, because their starting characteristics have a special character in the current behavior. The starting current from the motor start phase to the rated speed is several times the rated current.

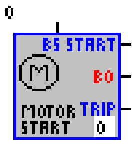


Figure 188: Function block motor start

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`BO` output: A logical 1 signal can be tapped here so long as the motor starts correctly.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

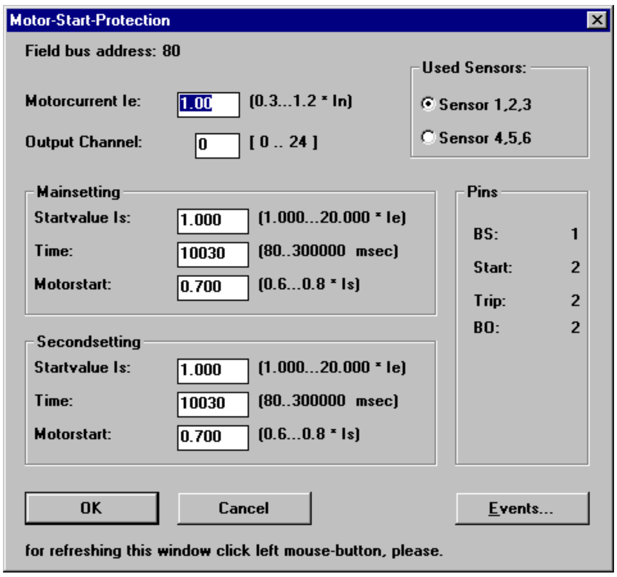


Figure 189: Configuration dialog function block motor start

↳Chapter "11.9 Setup example for motor protection" on page 11-43

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `motor current Ie`: Input of the multiplier for I_n to specify the motor current I_e.
Setting range: 0.30 … 1.20 (increment: 0.01)
Default: 1.00

Input field `output channel`: Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input field `start value Is` (once per parameter set/setting): Input of the multiplier for Ie to specify the response time of the protective function. The upper limit of the setting range is set dynamically by the configuration program in accordance with the formula below.
Setting range: 1,0 … [$20 \cdot 1 / I_e$] (increment: 0.01)
Default: 1.00

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: [50 ms + t_{relay}] … 300 000 ms (increment: 10)
Default: [10 000 + t_{relay}]

Input field `motor start` (once per parameter set/setting): Input of the multiplier for Ie to specify the motor starting current from which the starting supervision protective function will be activated.
Setting range: 1.0 … 20.00(increment: 0.01)
Default: 1.00

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.10.3 Blocking rotor

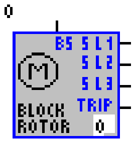


Figure 190: Function block blocking rotor

Function

The blocking rotor protective function on the `BS` input is blocked via a tachometer generator or a speed switch, which send a defined signal at a specified speed. If the rotor of the monitored motor is blocked, the missing speed signal will ensure that the overcurrent function integrated in the protective function will continue to remain active. If the set response time (`start value`) is exceeded, it will initially be activated. If the response time is exceeded for at least the delay period (`Trip`) set in the parameters, it will be tripped.

The protective function can also be used like this without a speed signal. However, in this case the trip threshold and the delay period must be selected so a standard starting procedure will not be deactivated. The advantage of the fast tripping is only available with the speed signal. The trip signal can then be sent after a shorter time than the set motor starting time if the speed signal is not received.

Note The signal of a tachometer generator or a rpm gauge should be available in the FUPLA for the blocking rotor protective function.

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page. This input is assigned by the speed indicator signal.

`SL1, SL2, SL3` outputs: A logical 1 signal can be tapped here so long as the protective function is started through the L1, L2 or L3 conductors.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Typical application

This protective function is used to monitor the starting characteristics of three-phase asynchronous motors to check whether the rotor braking is on and that is causing the motor to speed up. If this malfunction occurs, the starting current would flow permanently and the motor would be thermally overloaded.

Configuration

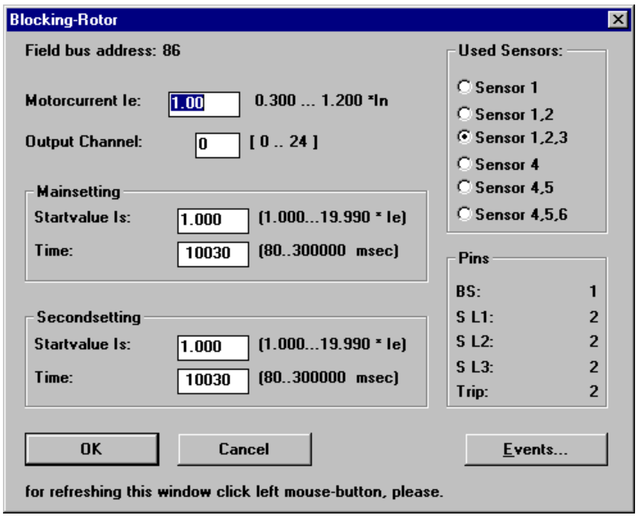


Figure 191: Configuration dialog function block blocking rotor

↳Chapter "11.9 Setup example for motor protection" on page 11-43

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `motor current Ie`: Input of the multiplier for I_n to specify the motor current I_e.
Setting range: 0.30 … 1.20 (increment: 0.01)
Default: 1.00

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input field `start value Is` (once per parameter set/setting): Input of the multiplier for Ie to specify the response time of the protective function. The upper limit of the setting range is set dynamically by the configuration program in accordance with the formula below.
Setting range: 1.0 … [$20 \cdot 1 / I_e$] (increment: 0.01)
Default: 1.00

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded.
Setting range: 50 ms … 300 000 ms (increment: 10)
Default: 10 000

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.10.4 Number of starts

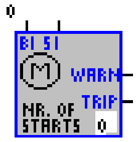


Figure 192: Function block number of starts

Function

The REF542 has an additional motor protective function that monitors the number of motor starts. It distinguishes between cold starts and warm starts, the allowable number of which is generally provided by the motor manufacturer. If this is not the case, in accordance with IEC 60034 and IEC 60050 three cold and two warm starts are recommended. The starting signal (`Start` output) of the starting supervision protective function is used to count the starts. This must be set and configured in the FUPLA.

The REF542 temperature calculation specifies whether a start is a cold or warm start. A temperature from which starts are classified as warm starts can be set. If the calculated temperature is below this value, a cold start will be assumed.

A reset period is also set. This has two tasks:

- If the start is successful only after several allowable attempts, the counted number of starts will be reset to one after expiry of the reset period (cooling period).
- If the set number of starts has been reached, the protective function will be activated and a logical 1 can be tapped at the `WARN` output. If there is another start, the protective function will trip. The trip signal (`TRIP` output) remains in effect until the reset period has expired. A starting block can be implemented in the FUPLA with this warning signal.

The manufacturer's information on the thermal cooling period is taken into account for the reset period.

Two parameter sets can be configured for the number of starts function.

Connections:

`BI` input: A logical 1 at this input will suppress the protective function trip signal. The function on the tripping side will still be displayed.

`BI` input: A logical 1 signal at this input increases the number of cold or warm starts (depending on the evaluation) by one. The input reacts to the rising slope.

`WARN` output: A logical 1 signal can be tapped here so long as the protective function is activated.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Typical application

Supervision the number of starts of three-phase asynchronous motors, because in most cases when the motor starts the rotor reaches a critical temperature.

Configuration

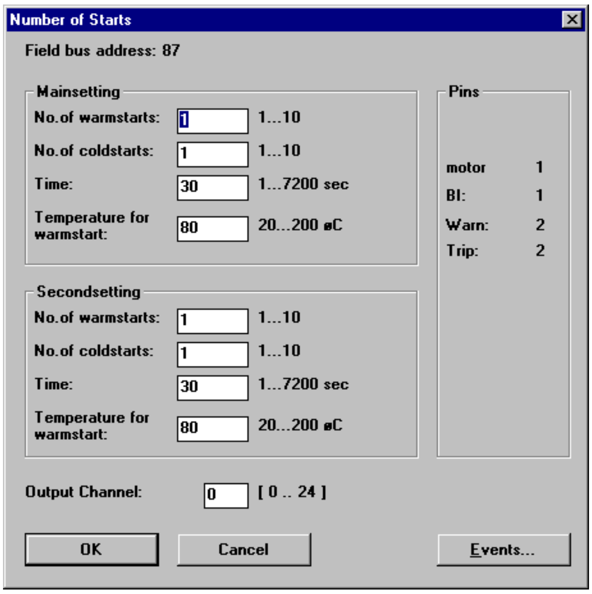


Figure 193: Configuration dialog function block number of starts

↳Chapter "11.9 Setup example for motor protection" on page 11-43

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `No. of warm starts` (once per parameter set/setting): The allowable number of warm starts is entered here.
No. setting range: 1 … 10 (increment: 1)
Default: 1

Input field `No. of cold starts` (once per parameter set/setting): The allowable number of cold starts is entered here.
No. setting range: 1 … 10 (increment: 1)
Default: 1

Input field `time` (once per parameter set/setting): Input of the reset period after the expiry of which the number of cold or warm starts is reduced by one.
Setting range: 1 … 7200 s (increment: 1)
Default: 30 s

Input field `temperature for warm start` (once per parameter set/setting): Input of the temperature limit value for distinguishing between a cold or a warm start.
Setting range: 20 … 400 °C (increment: 1)
Default: 100 °C

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.11 Distance protection

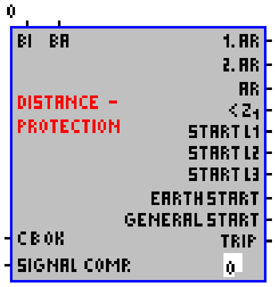


Figure 194: Function block distance protection

Application

The distance protection is intended to protect meshed medium-voltage networks and simple high-voltage networks. In this case it is irrelevant how the neutral point is treated. The distance protection comprises the following subordinate functions:

- Activation,
- Impedance determination,
- Directional memory and
- Tripping logic.

Function

The starting is intended to check for the presence of a malfunction and selectively to detect the type of malfunction. The appropriate measured quantities for determining the impedance and the directional decision are selected depending on the type of malfunction. Once the direction and the zone of the malfunction have been determined, the tripping logic is used to determine the trip time in accordance with the set impedance time characteristic.

The distance protection also includes the autoreclosure function, also referred to below as AWE. This enables short disconnections (SDs or autoreclosure cycles) to be conducted. A maximum of two autoreclosures is possible. It must be noted that after the second autoreclosure the power circuit-breaker will require a longer dead time to be able to restore the complete On-Off cycle.

The underlying signal comparison protective function, with which a very short line unit can also be selectively protected, is also integrated. This requires a pair of pilot wires for signal exchange.

For network operation it is important to localize the fault as soon as possible after malfunction to repair the damage. Because medium-voltage networks are usually spread over wide areas, fault tracking information in km is desirable for network operation after the malfunction has caused a trip. For this reason, the fault locator, which can derive the fault distance from the measured fault impedance, is also implemented in the distance protection. It calculates the distance in km to the fault from the carrier or cable reactance.

Once the malfunction in the network has been deactivated and localized, it may also be of interest to network operation to run a fault analysis from the sequence of disturbance variables and signaling events. The fault recorder function for recording the faulty network variables is provided in the REF542 for this purpose.

↳Chapter "5.4.13 Faultrecorder" on page 5-202

The fault recorder function is started either by an external signal (via a binary input) or by a signal from the distance protection. The general start, general starting or tripping outputs may be used for this purpose.

If the fault recorder is started with the general starting signal, the disturbance variables will be recorded for every fault that occurs in the network where the distance protection is in operated position on the basis of the set activation. However, if the recording should only be done in the event of faults in the protection zone of the distance protection, the fault recorder should be started with the tripping signal.

In networks with an isolated neutral point or with earth fault compensation, the directional earth fault supervision function can be added to the distance protection.

↳Chapter "5.4.8.10 Earthfault directional high" on page 5-116

↳Chapter "5.4.8.11 Earthfault directional low" on page 5-120

The option of switching the protective function of the distance protection over to the IDMT is also provided. This procedure is generally referred to as emergency definite time and is required if the voltage input variables are not available because of an automatic device failure. The function chart programming (FUPLA) provided in the configuration program must be used to block the distance protection with the aid of a binary input signal.

↳Chapter "5.4.8.4 Overcurrent instantaneous" on page 5-102

↳Chapter "5.4.8.5 Overcurrent high" on page 5-105

↳Chapter "5.4.8.6 Overcurrent low" on page 5-107

The FUPLA also aids in implementing any additional logic. This enables project-specific additional circuits to be implemented with relatively little effort.

↳Chapter "4 Configuration Program" on page 4-1

A fiber optic cable is provided for connection to a station control system.

↳Chapter "3.4.7 Interbay bus system" on page 3-36

Analog inputs

Measured quantities proportional to the current or the voltage are required from the distance protection to run the protective function.

The line currents and the phase voltages are always arranged in consecutive groups of three. The following combinations can be configured here:

- Measuring input 1,2,3:
  current transformer or sensor in line L1, L2, L3,
- Measuring input 4,5,6:
  voltage transformer or sensor in line L1, L2, L3,

or

- Measuring input 1,2,3:
  voltage transformer or sensor in line L1, L2, L3,
- Measuring input 4,5,6:
  current transformer or sensor in line L1, L2, L3,

The seventh measuring input is usually intended for acquisition of the current measured quantities for the watt-metric directional earth fault supervision.

Activation

The activation in the distance protection is there to detect faults in the network quickly and selectively. The activation must be capable of enabling the distance protection to function properly both in networks with high-resistance earthing and also in networks with low-resistance earthing. Here, high-resistance earthing means that the network is operated with an isolated neutral point or with earth fault compensation. The distance protection must also function properly when the network operation is switched over from earth fault compensation to low-resistance neutral earthing for a short time for the purpose of earth fault tripping.

The activation, with a suitable selection of measured quantities, must be capable of adapting to the variable phase-fault power in the network. During the day the minimum fault current is mostly very much greater than the maximum occurring load current, because of the high available phase-fault power. Over this period one overcurrent starting is sufficient to detect the fault quickly and selectively.

However, at night the phase-fault power can decrease to such an extent that the fault current may be less than the above-mentioned load current. Under these circumstances reliable fault detection is not possible without processing the voltage information.

To ensure fault-free function for the distance protection in all situations, the activation consists of:

- Overcurrent starting I>,
- Earthearth fault current starting I_E> or I_0> and
- Voltage controlled overcurrent starting UF</ IF>

The overcurrent starting I> is used to monitor for the line currents exceeding the threshold values. The following diagram shows the associated signal processing.

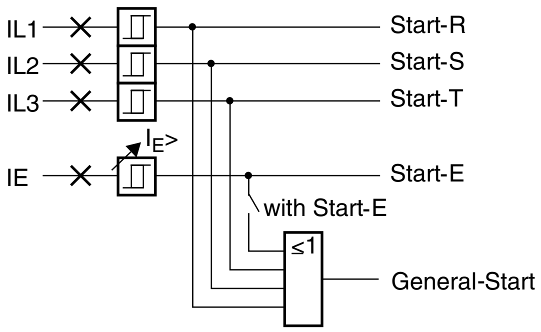


Figure 195: Logic diagram of overcurrent starting

If the overcurrent criterion is exceeded in a conductor, the starting signals Start-R, Start-S and Start-T for the corresponding conductor appear. The Start-E signal is derived from the earth current supervision, which is calculated from the sum of all line currents. Then the General-Start signal is generated with the OR interconnection of all starting signals (optionally also with the Start-E signal). However, it is important to note that the setting for the Start-E starting must be selected to prevent a starting resulting from a earth fault occurring in the network with isolated neutral point or with earth fault compensation.

The voltage-controlled overcurrent starting is formed from the logical interconnection between the footing point current I_F> and the footing point voltage U_F<. The system voltage in this case must be less than the footing point voltage U_F< setting and the associated line current must exceed the footing point current I_F>.

As shown in the following diagram, the start signals for the two or three-pole malfunction without earth contact are formed from the combinations of two line currents each with the corresponding external phase-to-neutral voltage. Only one start signal is generated if the footing point currents are exceeded in the two conductors and the undervoltage condition of the external phase-to-neutral voltage is met.

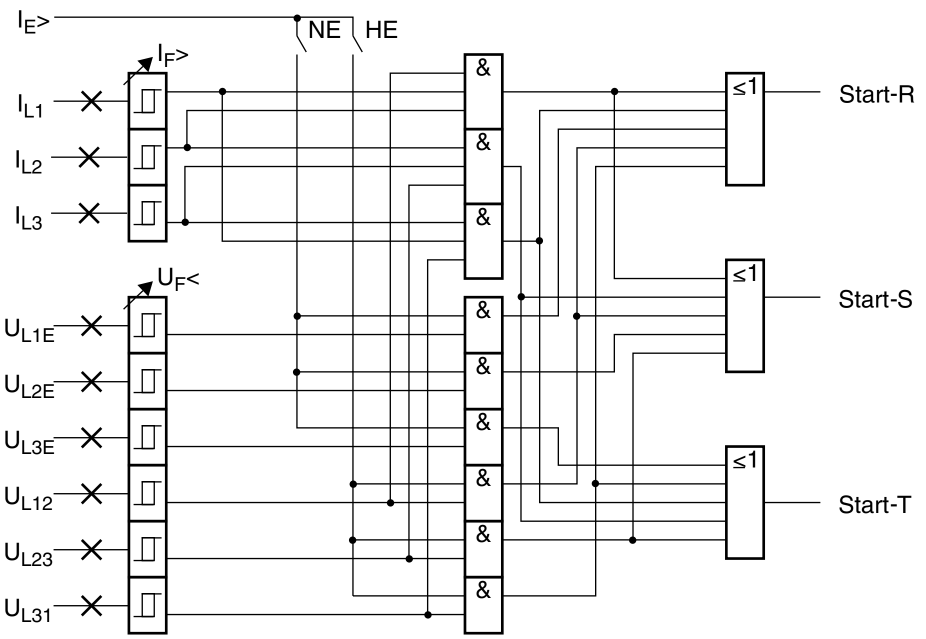


Figure 196: Logic diagram of the voltage-controlled overcurrent starting

In the event of faults with earth contact, depending on the neutral treatment only the phase voltages or the line voltages are combined with the earth current. In this case the presence of the earth current is already sufficient to detect the faulty system status. The line currents are then not monitored at all. Finally, the undervoltage condition is used to detect the faulty conductor.
In networks with low-resistance earthing the signal from the earth current is connected to the signals from phase voltages.
In contrast, in networks with high-resistance earthing the signal from the earth current is logically combined with the signals from the external phase-to-neutral voltages. The combination with the external phase-to-neutral voltage enables starting to take place only with a cross-country fault.
The logical interconnections (Boolean algebra) of the signals for forming the corresponding start signals are formulated as below:

For networks with high-resistance earthing:

- Start R = $I_R> \,/\, \{(IF_R> \wedge IF_S> \wedge UF_{RS}<) \wedge (IF_T> \wedge IF_R> \wedge UF_{TR}<)\}$ $/\, \{(IE> \wedge UF_{RS}<) \wedge (IE> \wedge UF_{TR}<)\}$
- Start S = $I_S> \,/\, \{(IF_S> \wedge IF_T> \wedge UF_{ST}<) \wedge (IF_R> \wedge IF_S> \wedge UF_{RS}<)\}$ $/\, \{(IE> \wedge UF_{ST}<) \wedge (IE> \wedge UF_{RS}<)\}$
- Start T = $I_T> \,/\, \{(IF_T> \wedge IF_R> \wedge UF_{TR}<) \wedge (IF_S> \wedge IF_T> \wedge UF_{ST}<)\}$ $/\, \{(IE> \wedge UF_{TR}<) \wedge (IE> \wedge UF_{ST}<)\}$

and for networks with low-resistance earthing:

- Start R = $I_R> \,/\, \{(IF_R> \wedge IF_S> \wedge UF_{RS}<) \wedge (IF_T> \wedge IF_R> \wedge UF_{TR}<)\}$ $/\, \{(IE_R> \wedge UF_{RE}<)\}$
- Start S = $I_S> \,/\, \{(IF_S> \wedge IF_T> \wedge UF_{ST}<) \wedge (IF_R> \wedge IF_S> \wedge UF_{RSRS}<)\}$ $/\, \{(IE_S> \wedge UF_{SE}<)\}$
- Start T = $I_T> \,/\, \{(IF_T> \wedge IF_R> \wedge UF_{TR}<) \wedge (IF_S> \wedge IF_T> \wedge UF_{ST}<)\}$ $/\, \{(IE_T> \wedge UF_{TE}<)\}$

/: OR interconnection
$\wedge$: AND interconnection

Note In networks with short-term low-resistance earthing the "low-resistance earthing" network type should be selected.

Conductor preference/Phase selection

Networks with isolated neutral point or with earth fault compensation, for reasons of supply dependability by the network operation, are required not to shut down a earth fault. However, if the earth fault develops into a cross-country fault, again because of the above-mentioned dependability reasons, only one of the two earth fault footing points may be shut down.

To coordinate the shutdown of the earth fault footing point, a "conductor preference" is programmed into the distance protection. This enables the distance protection to shut down the conductor with the earth fault according to a set sequence. The following conductor preferences can be set:

- Acyclical: L3 before L1 before L2
- Cyclical: L1 before L2 before L3 before L1
- Acyclical: L1 before L3 before L2
- Cyclical: L3 before L2 before L1 before L3

For example, if the acyclical conductor preference L3 before L1 before L2 is set in the distance protection, in the event of a L2-L3-E cross-country fault the earth fault footing point in conductor L3 will be shut down first. The earth fault in conductor L2 will remain active until it is shut down from the system control center after appropriate switchover action in the network.

Note To ensure correct functioning of the conductor preference, the measured quantities of the phase voltages must be correctly connected (correct phase sequence).

Determining the impedance

After the starting has caught the fault and correctly detected it, the impedance is calculated. First, the discrete Fourier transformation (DFT) is used as an aid to calculate the associated real and imaginary components from the digitalized current and voltage-proportional measured quantities. The DFT is used here because the measured quantities are mostly superimposed by transient influences or disturbance variables of varying frequency. The DFT allows disturbance variables above the base frequency to be eliminated so effectively that the calculation of the impedance is improved.

The equation for calculating the real and imaginary component of a current variable with DFT is shown as an example:

Real component: $$Re\{I\} = \frac{2}{n}\sum_{k=0}^{n-1} i_k \cdot \cos\left(\frac{k \cdot 2\pi}{n}\right)$$

Imaginary component: $$Im\{I\} = \frac{2}{n}\sum_{k=0}^{n-1} i_k \cdot \sin\left(\frac{k \cdot 2\pi}{n}\right)$$

The sampling frequency in the REF542 is 1.2 kHz. The number of sampling values n is 24 at a network frequency of 50 Hz.

After calculating the real and imaginary components, the fault impedance is determined with the following ratio for the two-pole fault without earth contact:

$$\underline{Z}_{L-L} = \frac{\underline{U}_{L-L}}{\underline{I}_{L-L}}$$

$\underline{Z}_{L-L}$ is the fault impedance to be determined and $\underline{U}_{L-L}$ or $\underline{I}_{L-L}$ is the associated voltage or current variable. They are each formed from the geometrical difference of the voltage or the currents in the relevant conductors.

The following equation must be used with a fault with earth contact:

$$\underline{Z}_{L-E} = \frac{\underline{U}_{L-E}}{\underline{I}_L + \underline{k} \cdot \underline{I}_E}$$

$\underline{Z}_{L-E}$ is again the fault impedance to be determined, $\underline{U}_{L-E}$ or $\underline{I}_L$ is the associated voltage or current variable of the relevant conductor and $\underline{I}_E$ is the earth current resulting from the sum of all line currents.

$$\underline{I}_E = \underline{I}_R + \underline{I}_S + \underline{I}_T$$

However, for the final calculation of the impedance, the earth current must first be corrected with the complex earth factor $\underline{k}$ as follows:

$$\underline{k} = \frac{1}{3} \cdot \left(\frac{\underline{Z}_0}{\underline{Z}_1} - 1 \right)$$

In this case $\underline{Z}_0$ is the impedance of the neutral system and $\underline{Z}_1$ is the impedance of the positive-sequence system. Positive-sequence, negative-sequence and neutral system are defined in the theory of the symmetrical components.

To acquire all fault types correctly, six impedance loops must be calculated; three loops for faults without earth contact and three loops for faults with earth contact. The calculation of the impedance should be shown here based on the determination of the fault impedance for a fault between the conductors L2 and L3. Corresponding to the ratio previously shown, the external phase-to-neutral voltage $\underline{U}_{23}$ and the delta current $\underline{I}_{23}$ must first be derived from the difference of the two conductor-earth voltages and line currents.

External phase-to-neutral voltage $\underline{U}_{23}$:

$$Re\{U_{L23}\} = Re\{U_{L2}\} - Re\{U_{L3}\}$$
$$Im\{U_{L23}\} = Im\{U_{L2}\} - Im\{U_{L3}\}$$

Delta current $\underline{I}_{23}$:

$$Re\{I_{L23}\} = Re\{I_{L2}\} - Re\{I_{L3}\}$$
$$Im\{I_{L23}\} = Im\{I_{L2}\} - Im\{I_{L3}\}$$

Once the calculation operation has been completed, the ratio for calculating the real resistance R and the reactive resistance X is derived:

$$R = \frac{Re\{U_{L23}\} \cdot Re\{I_{L23}\} + Im\{U_{L23}\} \cdot Im\{I_{L23}\}}{(Re\{I_{L23}\})^2 + (Im\{I_{L23}\})^2}$$

$$X = \frac{Im\{U_{L23}\} \cdot Re\{I_{L23}\} - Re\{U_{L23}\} \cdot Im\{I_{L23}\}}{(Re\{I_{L23}\})^2 + (Im\{I_{L23}\})^2}$$

The impedance is then calculated with the following equation.

$$\underline{Z} = R + jX$$

Because of various influencing quantities the fault impedance may deviate greatly from the theoretical impedance value of the line unit. A typical example for this is an arc short circuit. In this case, the fault impedance is overlain with the non-linear arc resistor. To prevent faults resulting from the tripping, a tripping surface is the default for forming the OFF command.

The following shows this polygon tripping surface for the distance protection.

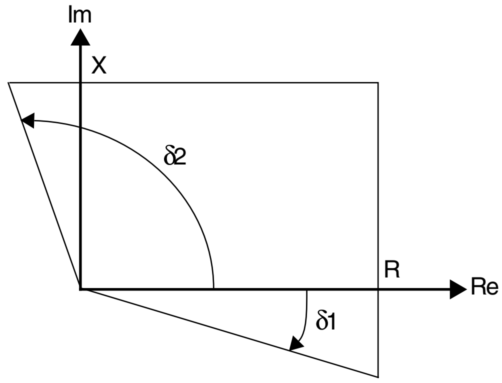


Figure 197: Tripping surface for the distance protection

In the first quadrant the tripping surface is set by a horizontal and a vertical line. The reactance setting X is the standard for the horizontal line and the resistor setting R for the vertical line. The tripping surface is eventually connected by two rays in the second and the fourth quadrants. The angle of rotation of the ray is δ2 in the second quandrant and δ1 in the fourth quadrant.

Directional memory

The directional decision is normally derived from the complex fault impedance variable. Therefore, the voltage measured variable contained in the fault is used to determine the direction. However, if the fault occurs in the immediate vicinity of where the voltage transformers/sensors are installed, the formation of the directional decision can be seriously affected because of the low voltage measured variable and the interspersed disturbance variables.

For this reason a voltage memory is always used to form the directional decision. All voltages (external conductor and conductor-earth voltages) that were measured before the fault occurred are saved there.

After the fault occurs a phase displacement angle of approximately ± 30° may occur. For example, this occurs on the transition from fault-free network operation to the cross-country fault. This fact should be taken into account when setting the tripping surface.

The tripping surface should be set as follows to retain a correct directional decision permanently:

In the second quadrant at

$$\delta_2 = 90° + 30° = 120°$$

and in the fourth quadrant at

$$\delta_1 = 0° - 30° = - 30°.$$

Tripping logic

The tripping logic connects the distance and directional decision from determining the impedance with the set timer function to impedance-timer characteristics or setting characteristics. In total, three impedance zones, one impedance-independent directional zone and five timer functions are available. The adjustable impedance-timer characteristics can be seen in the following diagram.

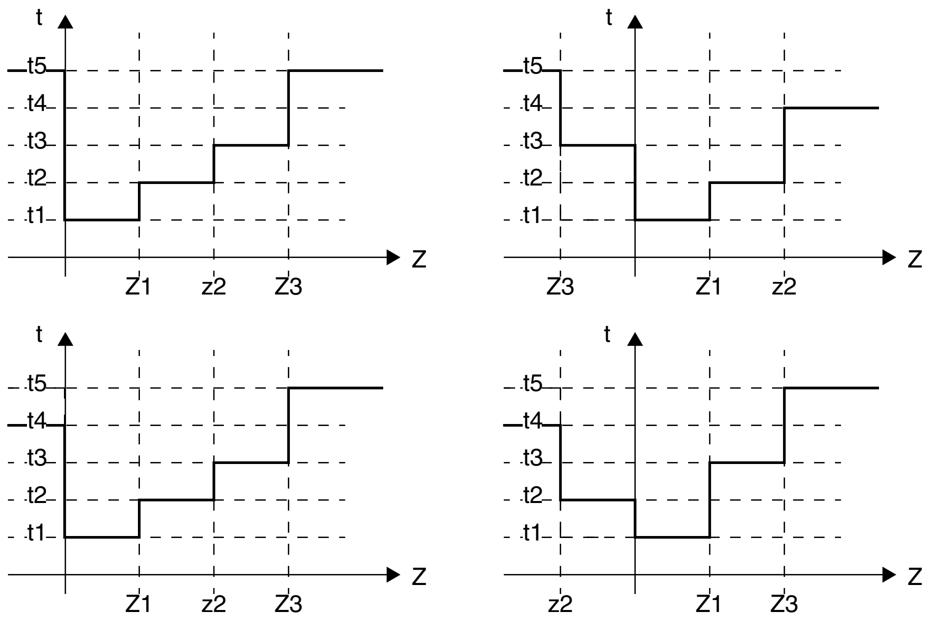


Figure 198: Impedance-timer characteristics

As can be seen in the above diagram, every impedance zone and the impedance-independent directional zone can be set either backwards or forwards. The timer functions are assigned as follows:

- Time t_1 of impedance zone Z_1,
- Time t_2 of impedance zone Z_2,
- Time t_3 of impedance zone Z_3,
- Time t_4 of impedance-independent directional zone as directional backup and
- Time t_5 of impedance and direction-independent zone as non-directional backup.

Every single zone can be deactivated. Which of the impedance-timer characteristics should be selected is determined on one hand by the network topology and on the other hand by the draft of the protection concept.

In addition, the tripping logic shows the interface for autoreclosure (AWE), signal comparison protection (SVS) and acquisition of switching on in the event of faults. Therefore, the functioning of the impedance zone Z_1 is superimposed by two special zones, the "overreach zone" and the autoreclosure blocking zone. The setting parameters that must be taken into account are described in the following sections.

Autoreclosure

The autoreclosure (AWE) is provided to restore network operation after a fault tripping. The VDEW damage statistics show that faults in overhead cables are mostly of a transient nature. A fault in an overhead cable, such as from a lightning strike, can be corrected after an autoreclosure cycle (Off–On–Off). Network operation can then be restarted without problems.

An autoreclosure-capable power circuit-breaker is required for this function. It must be capable of running a complete autoreclosure cycle within a preset period. If several autoreclosure-cycles are run, the power circuit-breaker must be able to recover relatively quickly for the next cycle. This function must be activated in the distance protection to enable an autoreclosure in the network.

The autoreclosure may only go over to being ready for operation when the power circuit-breaker has reported that it is ready for operation (CB-OK). In this connection the blocking time from any previously occurring autoreclosure must have expired. Once the autoreclosure is ready for operation, the overreach zone $Z_{Ü}$ is activated in the distance protection with the associated time $t_{ü}$. The overreach zone is superimposed on the first impedance zone Z_1.

The following two diagrams show the flow chart and the signal flow chart of the autoreclosure for the distance protection.

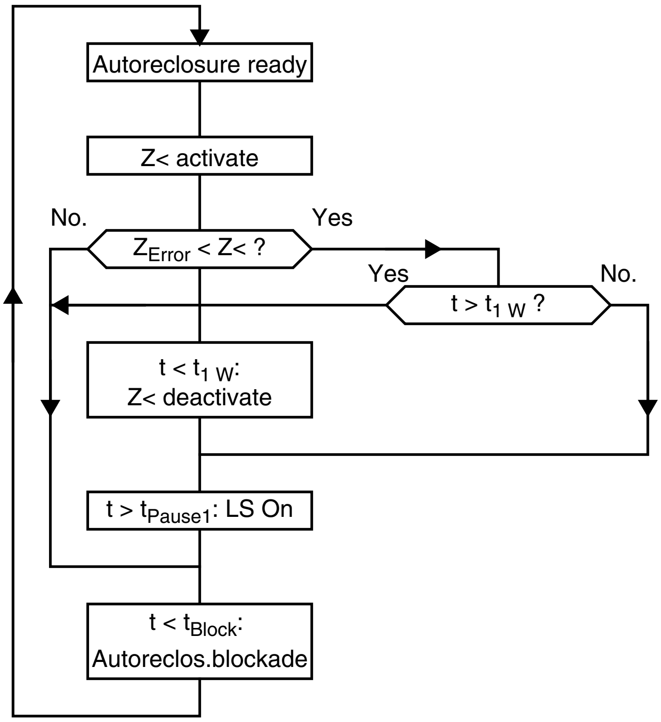


Figure 199: Flow chart for the distance protection autoreclosure

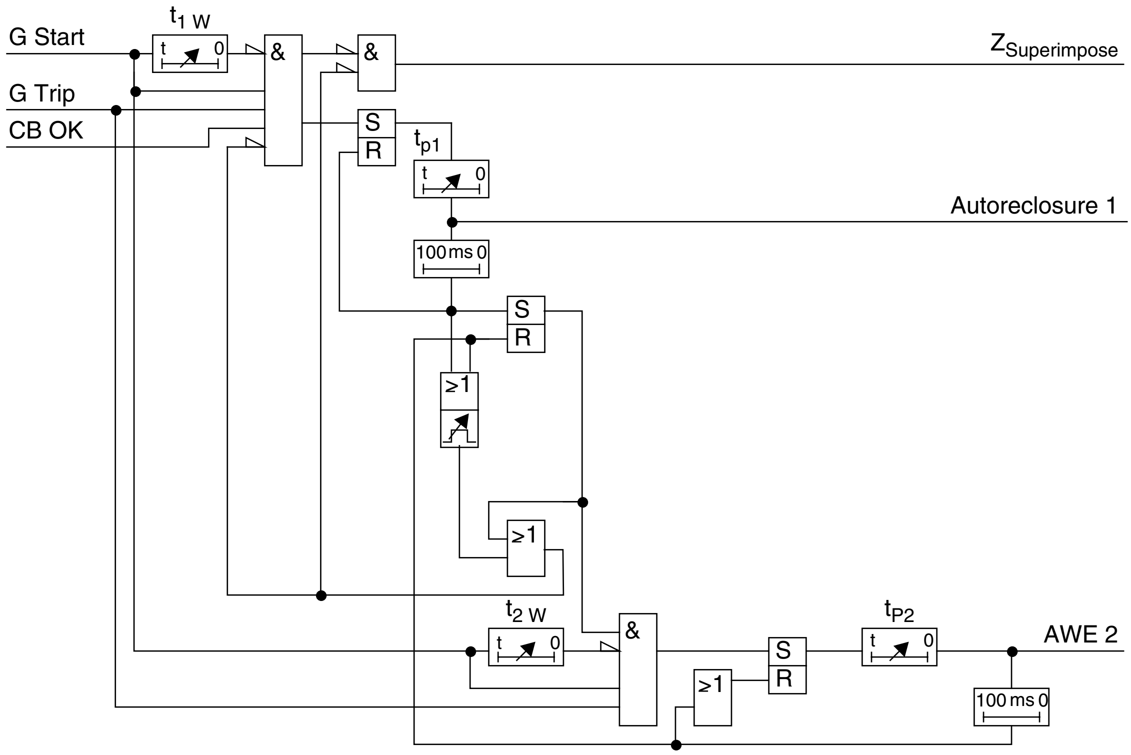


Figure 200: Signal flow chart for distance protection autoreclosure

The following diagram shows the principal view of the impedance-time characteristic. The line unit that is to be protected is between stations A and B. The impedance-time characteristic is shown with autoreclosure for distance protection in station A.

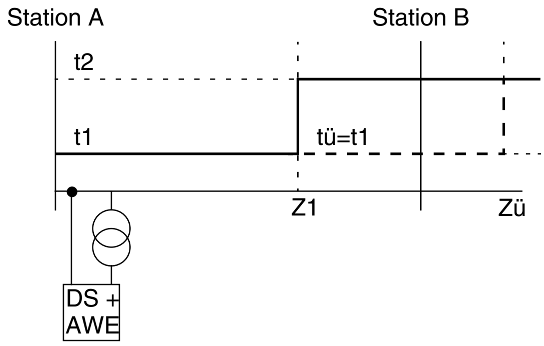


Figure 201: Impedance-time characteristics for autoreclosure on an overhead cable

In overhead cable networks the overreach zone $Z_{Ü}$ is generally set approximately 120 to 150% of the line impedance Z_L. The timer setting $t_{Ü}$ should in this case be set for the time t_1 of the first impedance zone Z_1. The autoreclosure blocking zone should be set to inactive here.

When the General-Start signal occurs the fault time t_{w1} is started in the event of a fault in the network. It should also be set for the period of the overreach zone $t_{Ü}$. If a tripping is actuated within this fault time by the distance protection, the autoreclosure is started. In the event of a tripping outside this fault time the autoreclosure is blocked. If the dead time t_{p1} has expired after the autoreclosure has started, the power circuit-breaker will be reactivated. The signal `first AR` (autoreclose) will be sent in this event. The autoreclosure will then be blocked for the duration of the blocking time t_{sp} if the number of autoreclosure is set to equal one.

If the fault is still present after the autoreclosure, the line unit will be definitely shut off if only one autoreclosure cycle has been configured. The autoreclosure did not succeed in this case.

If the autoreclosure is successful, another autoreclosure cycle will not be allowed within the blocking time t_{sp}. Another cycle is possible if the next fault occurs after expiry of the blocking time t_{sp}.

On expiry of the fault time t_{w1} the overreach zone $Z_{Ü}$ will be deactivated again. If the fault is still present after the autoreclosure in the event of the unsuccessful autoreclosure, it will be tripped in accordance with the impedance-time characteristic. This means that only faults within the zone Z_1 with time t_1 will be tripped. The reach of zone Z_1 is normally 85 - 90% of the total line unit.

Faults outside this zone are tripped with the grading time in accordance with the set impedance-time characteristic. Therefore, the discrimination is maintained with an autoreclosure.

If the number of autoreclosures is set to equal 2, another autoreclosure is released if one is unsuccessful. In this case, the blocking time running after the first autoreclosure has no influence on the course of the second autoreclosure. Here also, similarly to the first autoreclosure, the fault time t_{w2} is activated when the General-Start signal is sent. This should be adapted to the time setting t_2 of the second impedance zone Z_2. The second impedance zone should be set to the forward direction and the first impedance zone Z_1 should be immediately above. In some circumstances, this setting enables a fault to be corrected with the second autoreclosure when it occurs in the last range of the line unit beyond the impedance zone Z_1.

If the tripping occurs after the first autoreclosure within the fault time t_{w2}, the dead time t_{p2} will be started. This must be set correspondingly longer to ensure the required recovery time of the power circuit-breaker. The autoreclosure readiness must then be set to safety. The autoreclosure will be set to the output state after expiry of this dead time t_{p2}. The power circuit-breaker is no longer directly monitored at this time and if necessary has to be implemented via the FUPLA.

However, if the first of two possible autoreclosures is successful, when the blocking time expires the autoreclosure will be reset to the output state. If a system fault occurs at this time, the autoreclosure cycle will be restarted again.

In the event that a mixed line unit comprising cable and overhead cable has to be protected, an autoreclosure is allowed only in the area of the overhead cable. From the distance protection point of view, if the line unit begins with the overhead cable and ends with the cable, in principle the same setting as described above with the standard autoreclosure is valid. The autoreclosure blocking zone Z_B will only be set to approximately 90% of the overhead cable impedance of the first section of the unit. The following diagram shows the corresponding impedance-time characteristic.

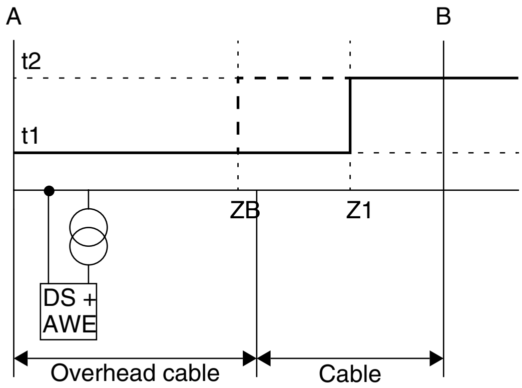


Figure 202: Impedance-time characteristics for autoreclosure on overhead cable-cable

In this case, the autoreclosure blocking zone operates to release the autoreclosure within the set zone. If the fault occurs in the cable area, the autoreclosure will be blocked.

The restriction on the reach of the overreach zone is required because it is known that faults of approximately 5% must be expected with the current and voltage measurement. If the current and voltage measurement is more precise, the reach of the overreach zone should be set correspondingly.

From the distance protection point of view, if the cable to be monitored first and then the overhead cable, the autoreclosure blocking zone Z_B is used for the blockade. The following figure shows the impedance-time characteristic that must be set.

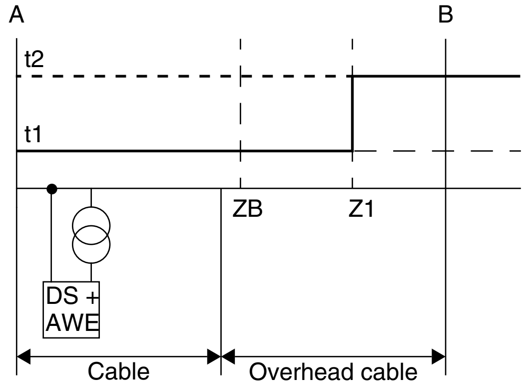


Figure 203: Impedance-time characteristics for autoreclosure on cable-overhead cable

If there is a fault on the cable the autoreclosure will be blocked by the blocking zone Z_B. The autoreclosure blocking zone Z_B, because of the above-mentioned faults with current and voltage measurement, should be set to approximately 110% of the total cable impedance. The reach of the overreach zone $Z_Ü$ with the associated time $t_Ü$ sets the range for activating the autoreclosure on the overhead cable side.

Signal comparison protection

If the carrier protection range is less than the smallest setting range in the REF542, the distance protection must be supplemented with the underlying signal comparison protection. This enables the time-graded protection to function intermittently as comparison protection. With the signal comparison protection the distance protection becomes a protection system with a communications connection. However, there are no specific requirements on the signal connection and transmission as would be the case with the line differential protection. A part of the protection system, in this case the distance protection, also functions without the communications connection.

The following figure shows the principle of the distance protection with the underlying signal comparison protection and the pair of pilot wires required for this.

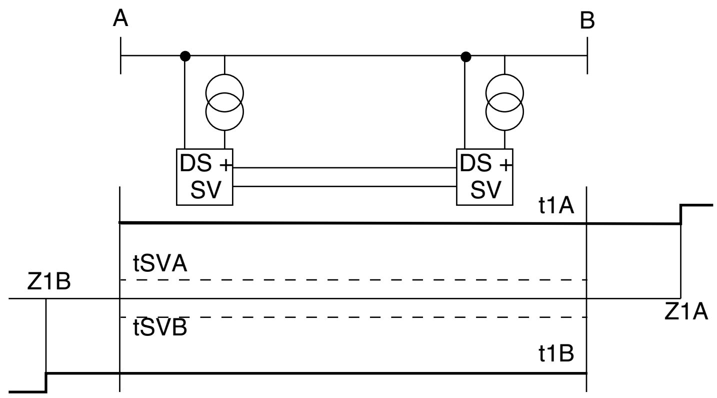


Figure 204: Impedance-time characteristic for the distance protection with underlying signal comparison protection

As noted above, the impedance of the line unit to be protected to ensure the discrimination can be so small that the first impedance zone Z_1 must be set greater than the impedance of the entire line unit. To ensure selective tripping, a signal comparison must be underlying. Therefore, the time t_1 of the first impedance zone is initially increased to, for example, 0.2 to 0.3 s. In this way, a fault can always be tripped by the distance protection in the increased base time independent of the status of the communications connection.

The two distance protection units at the ends of the line unit are connected to each other with the pair of pilot wires to form a comparison protection system. This enables the General-Start and impedance Z_1< protection signals occurring during the fault to be compared with each other. The following image shows an example of the functioning of the signal comparison protection with the aid of simple relay contacts.

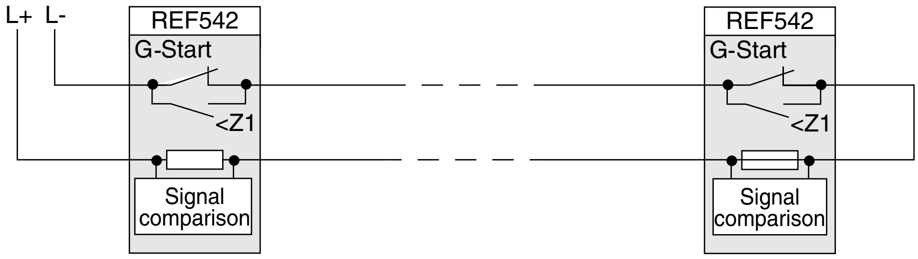


Figure 205: Functional principle of the distance protection with underlying signal comparison protection

The two distance protection units are connected with the pair of pilot wires. This forms a loop over the two protection devices. An auxiliary voltage is applied at the ends of the loop. Half each of the auxiliary voltage is assigned to the two binary inputs in use. It can also be used to monitor the pair of pilot wires. If the auxiliary voltage is faulty an interference signal can be generated after expiry of a configurable time delay of, for example, 5 s. If necessary, this will then be forwarded to the control station. As described above, in the case of the faulty pair of pilot wires the line unit will continue to be protected by the distance protection with increased base time.

If a fault occurs in the network now, both distance protection units (at the line ends) will be tripped. They will each send a General-Start signal. The G-Start N/C contacts and with them the comparison loop will be opened. The connection to the signal comparison is initially broken. Because the loop is only open for a fraction of 1 s, an interference signal is not sent.

However, a tripping by the distance protection is only possible if both protection units send a fault impedance within the first impedance zone Z_1. In this case, the signal Z_1< which closes the comparison loop again is sent. The closed state of the loop means that the fault is within the protection zone of both distance protection units at this time. In the event of a fault outside the protection zone, the loop cannot be closed by a distance protection unit because of the missing signal Z_1<. Therefore, a trip does not occur.

The signal comparison protection also functions if the line unit is fed from only one side after switchover actions in the network. A quasi-echo circuit is implemented with the implemented comparison loop. The loop remains closed because the distance protection at the other end of the line is and remains in quiescent status with a fault within the protection zone. The tripping is then generated on the supply side by the distance protection.

A fault within the protection zones can be tripped quickly and selectively with the signal comparison protection. However, when making the settings the operating time of the signals must be taken into account. It is important that the G-Start signal always appears before the signal Z_1< to ensure that the loop is opened at the right time.

In addition, the fact that the signals required for the signal comparison protection are not always received simultaneously at both ends of the line unit must be considered. Sufficient closing delays must be defined at the binary inputs.

Switching onto faults

The distance protection also has a function for switching on persistent faults. This is generally referred to as manual-on acquisition. With this setting activated, the tripping response of the distance protection can be remotely or locally influenced with the closing command of the power circuit-breaker as follows:

- Standard operation
  In this case the function "switching on persistent fault“ is not activated. The distance protection ignores the On command of the power circuit-breaker.
  A fault is only tripped in accordance with the set impedance-time characteristic or the setting characteristic. This means that a fault will be tripped in the first impedance zone with the time t_1 and in the second impedance zone with the time t_2.
- Use overreach zone
  With this setting the overreach stage will be activated for about 200 ms by the closing command of the power circuit-breaker. The protection zone is determined by the setting of the overreach stage $Z_{Ü}$. This is normally about 120 … 150% of the line impedance Z_L. The tripping then occurs with the associated time $t_{Ü}$.
  When the power circuit-breaker is closed by the autoreclosure function, the overreach zone is not activated.
- Tripping after general starting:
  In this setting the General-Start signal or the general starting is standard. If the general starting signal occurs when the power circuit-breaker is closed, the distance protection trips immediately. The impedance measurement is not used here.

Switchover to emergency definite time

In the event of an automatic device failure in the voltage instrument transformer the distance protection will be unable to function correctly because of faulty voltage measured variables. For this reason it is necessary to block the distance protection and to switch over to the emergency definite time (independent IDMT).
The automatic switchover to the emergency definite time is currently only possible via the automatic device failure signal.

➯Chapter " Function of the definite time functions" on page 5-102

Directional earth fault supervision

The directional earth fault supervision is an ancillary module for locating earth faults in networks with isolated neutral point or with earth fault compensation.

➯Chapter " Function of the directional earthfault current timer functions" on page 5-116

Connections:

Figure 206: Function block distance protection

BI input: A logical 1 at this input will suppress the protective function trip signal. The function on the tripping side will still be displayed.

BA input: A logical 1 signal at this input blocks the autoreclosure (AWE).

CB OK input: A logical 1 signal at this input signals the function block that the power circuit-breaker is ready for the autoreclosure.

SIGNAL COMP input: A logical 1 signal at this input signals the function block that the pair of pilot wires for the signal comparison protection is not broken.

1. AR /2. AR outputs: A logical 1 signal can be tapped here when the function block trips the first or second autoreclosure cycle. These signals must be linked with the LS ON command.

AR output: A logical 1 signal appears at this output when an autoreclosure attempt is active and running.

< Z1 output: A logical 1 signal can be tapped here when the fault impedance is less than the first impedance zone.

START L1, START L2, START L3 outputs: A logical 1 signal can be tapped here so long as the protective function is started by the corresponding conductor.

EARTH START output: A logical 1 signal can be tapped here when a fault with earth contact has been detected.

GENERAL START output: A logical 1 signal can be tapped here when a fault in the system has been detected.

Trip output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

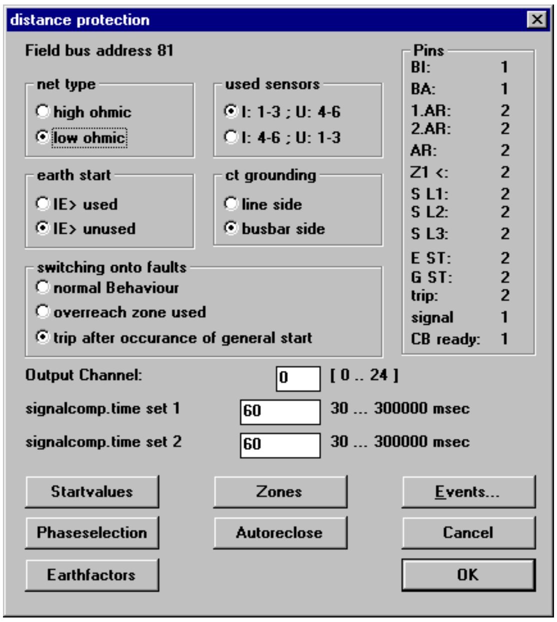


Figure 207: Configuration dialog function block distance protection

Information field field bus address: Set for every protective function and used to address the function block for interbay bus commands.

Option field net type: The type of neutral treatment of the system to be monitored is marked here. The setting influences the consideration of the earth current when selecting the phase for the undervoltage-controlled overcurrent starting.

- High-ohmic earthing: Networks with isolated neutral point or earth fault compensation.
- Low-ohmic earthing: Networks with low-ohmic neutral earthing. The neutral point is connected with the earth directly or via a earth resistance or a earth reactance.

↳Chapter "Activation" on page 5-159
↳Chapter "11.8 Network neutral point earthing" on page 11-35

Note — In networks with short-term low-ohmic earthing the network type "low-ohmic earthing" should be selected.

Option field `earth start`: How the earth fault current starting is included in the general starting is marked here.

- I_E> used: A earth fault current starting (EARTH START) results in the general starting or GENERAL START
- I_E> unused: The general starting is not derived from a earth fault current starting.

↳Chapter " Activation" on page 5-159

Note — The I_E> used selection should generally not be used.

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

↳Chapter " Analog inputs" on page 5-159

Option field `ct grounding`: Whether the current transformer is earthed on the feeder (line) side or the busbar side is marked here.

The definition of the forward direction for determining the direction of the impedance and the directional backup starting zones depends on this. It is important for the set earthing point to conform to the connection diagram.

↳Chapter " Defined circuit diagram for directional protective function" on page 7-8
↳Chapter "7.5 Determining the transformer direction" on page 7-4

Option field `switching onto faults`: How the distance protection responds to a switching on an existing fault is marked here.

- Normal behaviour: The fault is tripped in accordance with the set impedance-time characteristic.
- Overreach zone used: The first impedance zone is switched over to the overreach zone for a short time to enable a fault on the entire line unit to be tripped quickly.
- Tripp after occurance of general start: An immediate trip occurs if a starting occurs immediately after the closure.

↳Chapter "Switching onto faults" on page 5-171

Note — The setting "Overreach zone used“ should be preferred so the discrimination is guaranteed and a fault at the end of the line unit is always detected.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.

Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Input field `signalcomp. time set 1/set 2`: Input of the time in ms for implementing the underlying signal comparison protection. This binary input SIGNAL COMP is used to query the signal status from the remote side. The signals derived in the distance protection, general starting (GENERAL START) and tripping in zone 1 (< Z_1), can be used to derive the tripping after comparison with the remote side over the pair of pilot wires. A time can be input for every parameter set.
Setting range: 30 … 300 000 (increment 1)
Default: 60

↳Chapter "Signal comparison protection" on page 5-169

Button `startvalues`: The configuration dialog for setting the starting values is opened.

↳Chapter "Start values configuration dialog" on page 5-175

Button `Phaseselection`: The configuration dialog for setting the conductor preference is opened.

↳Chapter "Phase selection configuration dialog" on page 5-176

Button `earthfactors`: The configuration dialog for inputting the earth factors for correcting the impedance determination in the event of faults with earth contact is opened.

↳Chapter "Earth factors configuration dialog" on page 5-176

Button `zones`: The configuration dialog for inputting the impedance zones is opened.

Chapter "Selecting the zone configuration dialog" on page 5-178

Button `autoreclose`: The configuration dialog for autoreclosure of the distance protection is opened. The button can only be selected when the autoreclosure function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "Autoreclosure configuration dialog" on page 5-177

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

Start values configuration dialog

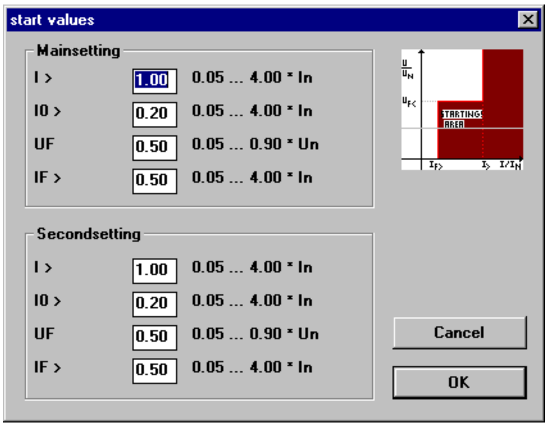


Figure 208: Configuration dialog starting values, function block distance protection

Chapter "Activation" on page 5-159

Input field `I>` (once per parameter set/setting): Input of the multiplier for I_N to define the overcurrent starting threshold.
Setting range: 0.05 … 4.00 (increment 0.01)
Default: 1.00

Input field `I0>` (once per parameter set/setting): Input of the multiplier for I_n to define the earth fault current starting threshold.
Setting range: 0.05 … 4.00 (increment 0.01)
Default: 0.20

Input field `UF<` (once per parameter set/setting): Input of the multiplier for I_N to define the undervoltage starting threshold.
Setting range: 0.05 … 0.90 (increment 0.01)
Default: 0.50

Input field `IF>` (once per parameter set/setting): Input of the multiplier for I_n to specify the voltage-controlled overcurrent starting threshold.
Setting range: 0.05 … 4.00 (increment 0.01)
Default: 0.50

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Phase selection configuration dialog

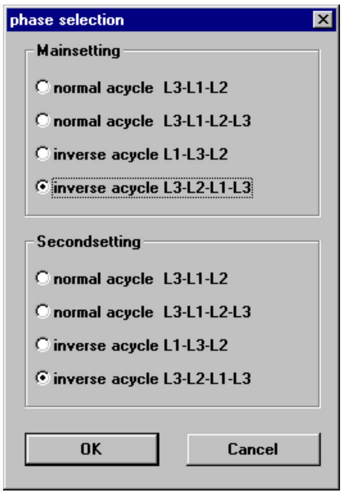


Figure 209: Input screen for setting the phase selection

↳Chapter "Conductor preference/Phase selection" on page 5-162

Option range parameter set 1/parameter set 2: The definition of the conductor preference for determining the impedance in the event of the cross-country fault for networks with high-resistance earthing is marked here for the specific parameter set.

- `normal acycle L3-L1-L2`
- `normal acycle L1-L2-L3-L1`
- `inverse acycle L1-L3-L2`
- `inverse acycle L3-L2-L1-L3`

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Note

The conductor preference can be used to secure selective tripping of the earth fault footing point only if all distance protection units in the entire network have identical conductor preference. Because in many cases they have to operate with electromechanical protection equipment, the acyclical conductor preference L3 before L1 before L2 should be used.

Earth factors configuration dialog

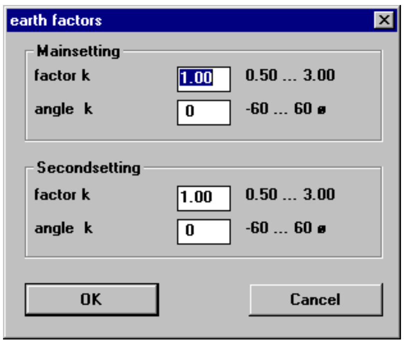


Figure 210: Earth factors configuration dialog

↳Chapter "Determining the impedance" on page 5-162

Input field `factor k` (once per parameter set/setting): Input of the amplitude of the complex earth factor.
Setting range: 0.05 … 3.00 (increment 0.01)
Default: 1.00

Input field `angle k` (once per parameter set/setting): Input of the angle of the complex earth factor.
Setting range: -60 … 60° (increment 1)
Default: 0°

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Note

Because only one earth factor is provided in the distance protection, for reasons of selectivity the earth factor must taken from the zero-sequence and positive-sequence impedance of the first impedance zone Z_1.

Autoreclosure configuration dialog

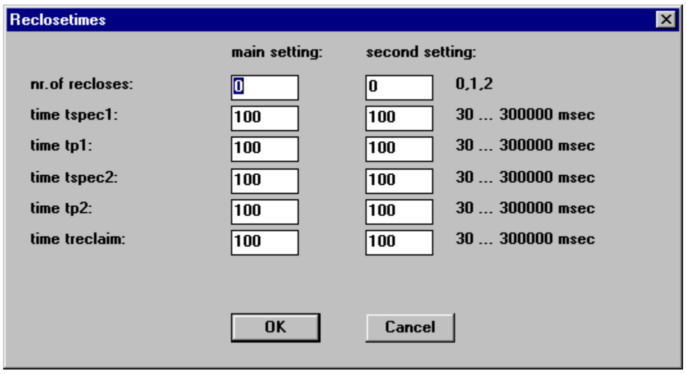


Figure 211: Autoreclosure times configuration dialog

Every column of input fields is used to set parameters of the various quantities for a parameter set.

↳Chapter "Autoreclosure" on page 5-165

Input field `nr. of reclosure` (once per parameter set/setting): Input of the number of autoreclosure cycles that must be run.
Setting range: 0, 1 or 2
Default: 0

Input field `time tspec1` (once per parameter set/setting): Input of the first fault time in ms.
Setting range: 15 … 300 000 ms (increment 1)
Default: 100 ms

Input field `time tp1` (once per parameter set/setting): Input of the first dead time in ms.
Setting range: 15 … 300 000 ms (increment 1)
Default: 100 ms

Input field `time tspec2` (once per parameter set/setting): Input of the second fault time in ms.
Setting range: 15 … 300 000 ms (increment 1)
Default: 100 ms

Input field `time tp 2`(once per parameter set/setting): Input of the second dead time in ms.

Setting range: 15 … 300 000 ms (increment 1)
Default: 100 ms

Input field `time treclaim` (once per parameter set/setting): Input of the blocking time in ms.
Setting range: 15 … 300 000 ms (increment 1)
Default: 100 ms

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Selecting the zone configuration dialog

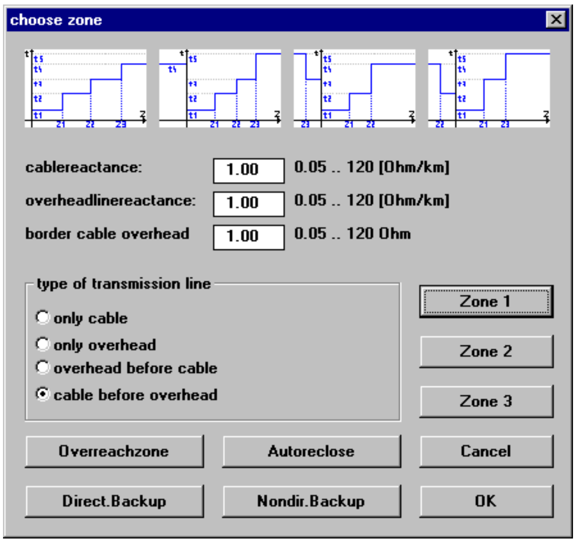


Figure 212: Selecting the zone configuration dialog

Chapter "Tripping logic" on page 5-164

Input field `cablereactance`: Input of the value in Ω/km for calculation of the fault distance.
Setting range: 0.05 … 120 Ω/km (increment 0.01)
Default: 1.00 Ω/km

Input field `overheadlinereactance`: Input of the value in Ω/km for calculation of the fault distance.
Setting range: 0.05 … 120 Ω/km (increment 0.01)
Default: 1.00 Ω/km

Input field `border cable overhead`: Input of the correction value in Ω for calculation of the fault distance in a mixed line unit.
Setting range: 0.05 … 120 Ω(increment 0.01)
Default: 1.00 Ω

Option field `type of power transmission line`: The line unit combination for the first impedance zone is defined here.

- Only cable
- Only overhead
- Overhead before cable: The line unit of the first impedance zone consists of an overhead cable and finally a cable section. This option is also used for autoreclosure; it is only implemented in the range of the input `autoreclosure blocking zone`.

- Cable before overhead : The line unit of the first impedance zone consists of a cable and finally an overhead cable section. This option is also used for autoreclosure; it is blocked in the range of the input `autoreclosure blocking zone`.

Buttons `zone 1, zone 2` or `zone 3`: The configuration dialog for setting the specific impedance zone is opened.

↳Chapter "Configuration dialogs zone 1, zone 2 and zone 3" on page 5-179

Button `overreach zone`: The configuration dialog for setting the overreach zone is opened.

↳Chapter "Overreach zone configuration dialog" on page 5-181

Button `autoreclose`: The configuration dialog for setting the autoreclosure blokking zone or unblocking zone is opened.

↳Chapter "Autoreclosure blocking zone configuration dialog" on page 5-182

Button `direct. backup`: The configuration dialog for setting the directional backup zone is opened.

↳Chapter "Configuration dialog for the directional backup protection" on page 5-183

Button `nondir. backup`: The configuration dialog for setting the non-directional backup zone is opened.

↳Chapter "Configuration dialog for the non-directional backup protection" on page 5-184

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Configuration dialogs `zone 1`, `zone 2` and `zone 3`

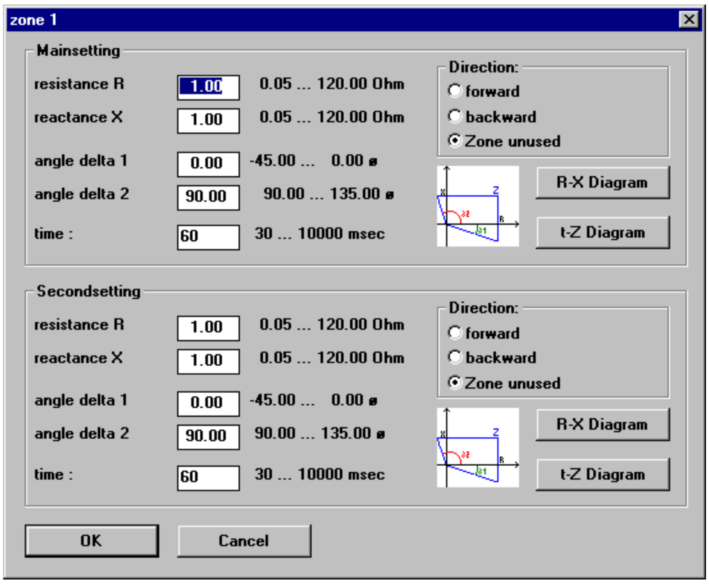


Figure 213: Example of a configuration dialog for the zones of the function block distance protection

Because the configuration dialogs for zones 1 to 3 have the same structure, they are only described once here. The zones are specified by four lines in the impedance level. The quantities that are to be input here can be found in the diagram in the configuration dialog.

↳Chapter "Tripping logic" on page 5-164

Input field `resistance R` (once per parameter set/setting): Input of the value in Ω for limiting the tripping surface of the corresponding impedance zone on the R-axis.
Setting range: 0.05 … 120.00 Ω (increment 0.01)
Default: 1.00 Ω

Input field `reactance X` (once per parameter set/setting): Input of the value in Ω for limiting the tripping surface of the corresponding impedance zone on the X-axis.
Setting range: 0.05 … 120.00 Ω (increment 0.01)
Default: 1.00 Ω

Input field `angle delta 1` (once per parameter set/setting): Input of the angle in degrees for limiting the tripping surface of the corresponding impedance zone in the fourth quadrant.
Setting range: -45.00 … 0.00° (increment 0.01)
Default: 0.00°

Input field `angle delta 2` (once per parameter set/setting): Input of the angle in degrees for limiting the tripping surface of the corresponding impedance zone in the second quadrant.
Setting range: 90.00 … 135.00° (increment 0.01)
Default: 90.00°

Input field `time` (once per parameter set/setting): Setting the grading time in ms for the corresponding impedance zone.
Setting range: [0 + t_{relay}] … 100 000 ms (increment 1)
Default: [0 + t_{relay}] ms

Option field `direction` (once per parameter set/setting): The activity and the input direction of the first impedance zone are defined here.

- Forward
- Backward
- Zone unused

Button `R-X diagram` (once per parameter set/setting): The zone is shown in a new dialog window in accordance with the parameters in the impedance level.

Button `t-Z diagram` (once per parameter set/setting): The setting characteristic or the impedance-time characteristic of the specific zone is shown in a new dialog window in accordance with the parameters.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Overreach zone configuration dialog

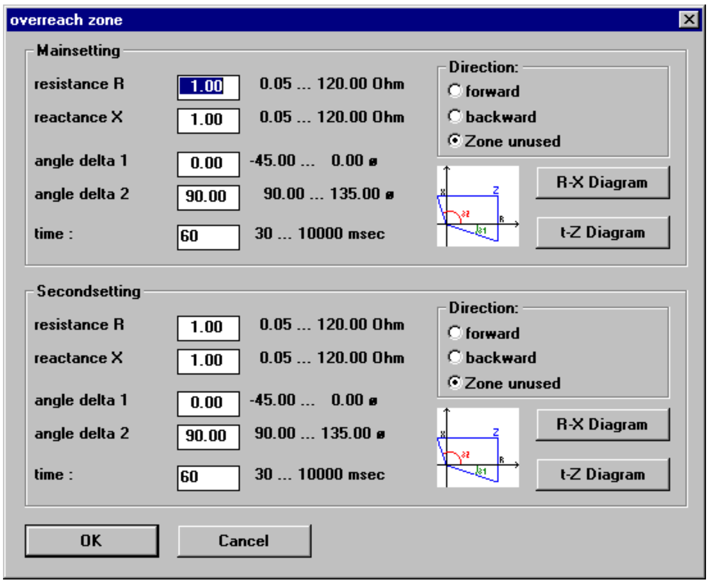


Figure 214: Overreach zone configuration dialog for the function block distance protection

Chapter "Tripping logic" on page 5-164

Input field `resistance R` (once per parameter set/setting): Input of the value in Ω for limiting the tripping surface of the corresponding impedance zone on the R-axis.
Setting range: 0.05 … 120.00 Ω (increment 0.01)
Default: 1.00 Ω

Input field `reactance X` (once per parameter set/setting): Input of the value in Ω for limiting the tripping surface of the corresponding impedance zone on the X-axis.
Setting range: 0.05 … 120.00 Ω (increment 0.01)
Default: 1.00 Ω

Input field `angle delta 1` (once per parameter set/setting): Input of the angle in degrees for limiting the tripping surface of the corresponding impedance zone in the fourth quadrant.
Setting range: -45.00 … 0.00° (increment 0.01)
Default: 0.00°

Input field `angle delta 2` (once per parameter set/setting): Input of the angle in degrees for limiting the tripping surface of the corresponding impedance zone in the second quadrant.
Setting range: 90.00 … 135.00° (increment 0.01)
Default: 90.00°

Input field `time` (once per parameter set/setting): Setting the grading time in ms for the corresponding impedance zone.
Setting range: [0 + t_{relay}] … 100 000 ms (increment 1)
Default: [0 + t_{relay}] ms

Option field `direction` (once per parameter set/setting): The activity and the input direction of the first impedance zone are defined here.

- Forward
- Backward
- Zone unused

Button `R-X diagram` (once per parameter set/setting): The zone is shown in a new dialog window in accordance with the parameters in the impedance level.

Button `t-Z diagram` (once per parameter set/setting): The setting characteristic or the impedance-time characteristic of the specific zone is shown in a new dialog window in accordance with the parameters.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Autoreclosure blocking zone configuration dialog

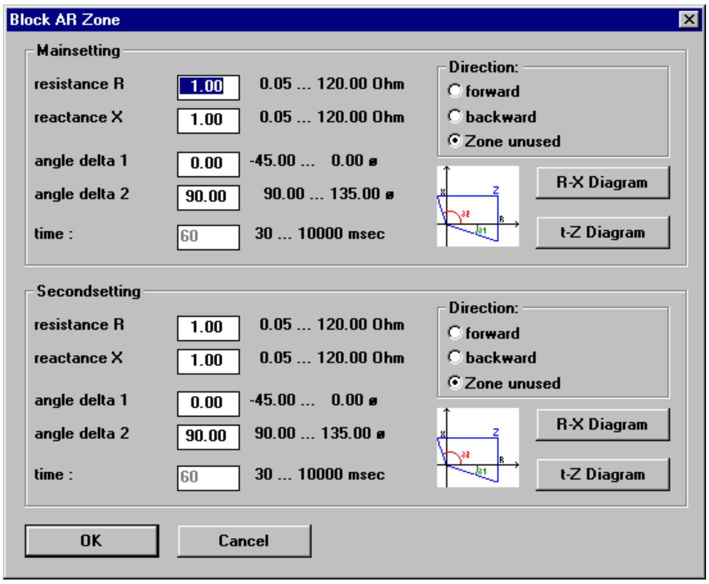


Figure 215: Configuration dialog autoreclosure blocking zone 1

↳Chapter "Tripping logic" on page 5-164

Input field `resistance R` (once per parameter set/setting): Input of the value in Ω for limiting the tripping surface of the corresponding impedance zone on the R-axis.
Setting range: 0.05 … 120.00 Ω (increment 0.01)
Default: 1.00 Ω

Input field `reactance X` (once per parameter set/setting): Input of the value in Ω for limiting the tripping surface of the corresponding impedance zone on the X-axis.
Setting range: 0.05 … 120.00 Ω (increment 0.01)
Default: 1.00 Ω

Input field `angle delta 1` (once per parameter set/setting): Input of the angle in degrees for limiting the tripping surface of the corresponding impedance zone in the fourth quadrant.
Setting range: -45.00 … 0.00° (increment 0.01)
Default: 0.00°

Input field `angle delta 2` (once per parameter set/setting): Input of the angle in degrees for limiting the tripping surface of the corresponding impedance zone in the second quadrant.
Setting range: 90.00 … 135.00° (increment 0.01)
Default: 90.00°

Input field `time` (once per parameter set/setting): Setting the grading time in ms for the corresponding impedance zone.
Setting range: [0 + t_{relay}] … 100 000 ms (increment 1)
Default: [0 + t_{relay}] ms

Option field `direction` (once per parameter set/setting): The activity and the input direction of the first impedance zone are defined here.

- Forward
- Backward
- Zone unused

Button `R-X diagram` (once per parameter set/setting): The zone is shown in a new dialog window in accordance with the parameters in the impedance level.

Button `t-Z diagram` (once per parameter set/setting): The setting characteristic or the impedance-time characteristic of the specific zone is shown in a new dialog window in accordance with the parameters.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Configuration dialog for the directional backup protection

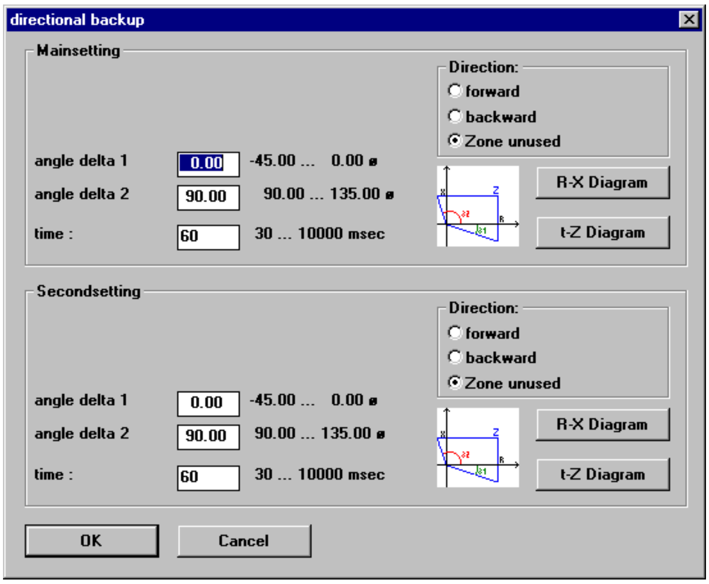


Figure 216: Configuration dialog for the directional backup protection of the function block distance protection

Chapter "Tripping logic" on page 5-164

Input field `angle delta 1` (once per parameter set/setting): Input of the angle in degrees for limiting the tripping surface of the corresponding impedance zone in the fourth quadrant.
Setting range: -45.00 … 0.00° (increment 0.01)
Default: 0.00°

Input field `angle delta 2` (once per parameter set/setting): Input of the angle in degrees for limiting the tripping surface of the corresponding impedance zone in the second quadrant.
Setting range: 90.00 … 135.00° (increment 0.01)
Default: 90.00°

Input field `time` (once per parameter set/setting): Setting the grading time in ms for the corresponding impedance zone.
Setting range: $[0 + t_{relay}]$ … 100 000 ms (increment 1)
Default: $[0 + t_{relay}]$ ms

Option field `direction` (once per parameter set/setting): The activity and the input direction of the first impedance zone are defined here.

- Forward
- Backward
- Zone unused

Button `R-X diagram` (once per parameter set/setting): The zone is shown in a new dialog window in accordance with the parameters in the impedance level.

Button `t-Z diagram` (once per parameter set/setting): The setting characteristic or the impedance-time characteristic of the specific zone is shown in a new dialog window in accordance with the parameters.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Configuration dialog for the non-directional backup protection

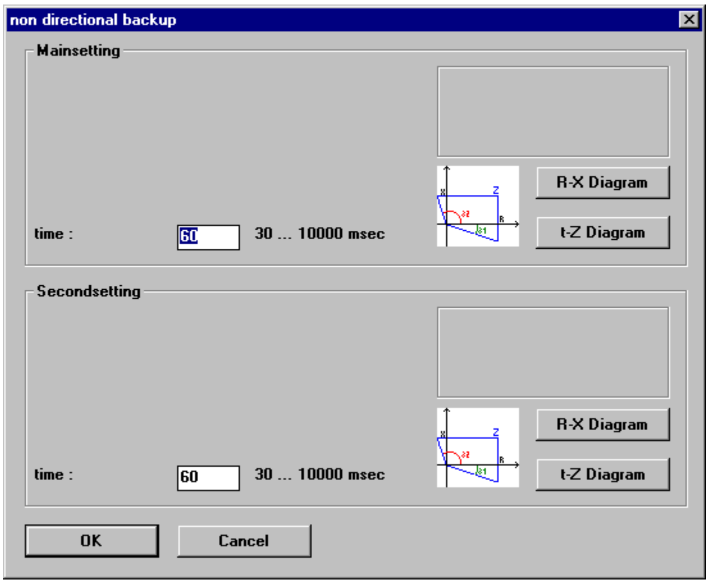


Figure 217: Configuration dialog for the non-directional backup protection of the function block distance protection

Input field `time` (once per parameter set/setting): Setting the grading time in ms for the corresponding impedance zone.
Setting range: $[0 + t_{relay}]$ … 100 000 ms (increment 1)
Default: $[0 + t_{relay}]$

Button `R-X diagram` (once per parameter set/setting): The zone is shown in a new dialog window in accordance with the parameters in the impedance level.

Button `t-Z diagram` (once per parameter set/setting): The setting characteristic or the impedance-time characteristic of the specific zone is shown in a new dialog window in accordance with the parameters.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.12 Additional protective functions

The subsections contain the descriptions of the function blocks that are available via the menu `Drawing Menu/Insert/Other Protection`.

5.4.12.1 Thermal supervision

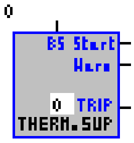


Figure 218: Function block thermal supervision

Function

The function thermal supervision, which compares temperature measured values with set limit temperatures, is implemented in the REF542. In the LON process bus protocol, the measured values are sent to the separate LON bus connection over electrical conductors.

↳Chapter "3.4.3 Power supply and process bus (LON)" on page 3-18

The option of configuring a warning and a trip temperature is provided. If the warning temperature is exceeded, a warning signal is generated immediately and appears on the tripping side and can be tapped at the function block. When the trip value is exceeded, the starting is activated first. If the trip value is exceeded for at least the set delay period, a trip signal is generated. Like the warning signal it appears on the tripping side and can be tapped at the function block.

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`Warn` output: A logical 1 signal can be tapped here so long as the warning temperature is exceeded.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Typical application

In large equipment (e.g. electrical machines and transformers) the temperature at the critical points, the "hot spots“, is measured directly with temperature probes.

The temperature probes are generally temperature-dependent resistors, such as the PT 100. A constant direct current flows through the resistor and the temperature is determined from the measured voltage drop at the resistor. It is processed by the thermal supervision, which then generates warning and trip signals.

Configuration

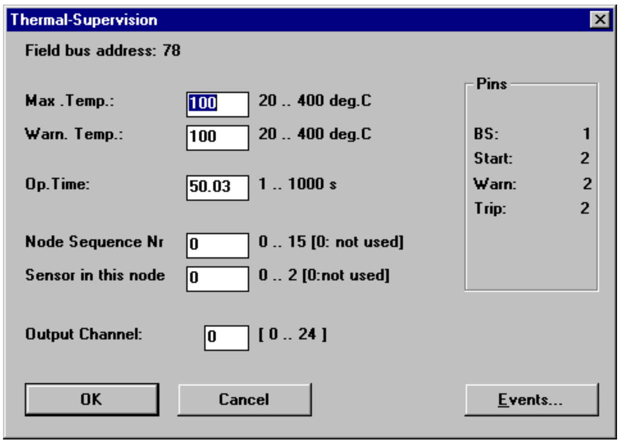


Figure 219: Configuration dialog function block thermal supervision

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `Max.Temp:` The temperature value that sets the response time of the protective function is input here.
Setting range: 20 … 400 °C (increment: 1)
Default: 100

Input field `Warn Temp`: The temperature value at which the protective function generates a warning signal is input here.
Setting range: 20 … 400 °C (increment: 1)
Default: 100

Input field `Op. Time`: Delay period in ms after which the protective function trips if the response time T max remains exceeded.
Setting range: 0.1 … 1000 s (increment: 1)
Default: 50 + t_{relay}

Input field `node sequence nr`: Shows the node number at which the function is registered in the LON process bus interface.
Setting range: 0 … 15 (increment: 1)
Default: 0

Input field `sensor in this node`: Selects the sensor input to whose value the protective function reacts on the registered node in the LON process bus interface.
Setting range: 0 … 2 (Increment: 1)
Default: 0

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.12.2 Unbalanced load

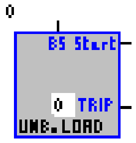


Figure 220: Function block unbalanced load supervision

Function

Asymmetries in the system result in asymmetrical currents. These asymmetrical currents generate a "negative-sequence system" in the display of the symmetrical components of the currents. The negative-sequence system is a negative sequence three-phase system, i. e. the phase sequence is L1 - L3 - L2. This system is superimposed on the three-phase system that corresponds to the standard phase sequence. This results in different field intensities in the magnetic laminated cores. Points with particularly high field intensities, "hot spots", lead to local overheating. The increasing size of the equipment also reinforces this effect.

The unbalanced load function is implemented in one stage and a minimum active current below which the unbalanced load function is inactive can be set. As soon as one of the three phase currents exceeds this minimum active current, the unbalanced load supervision is activated.

In the REF542 it is not the negative-sequence components of the currents that are measured but asymmetries. To enable this the rms values of the line currents are compared with one another: I_{L1} with I_{L2}, I_{L2} with I_{L3} and I_{L3} with I_{L1}. Therefore, the unbalanced load supervision can be used in two or three-phase networks.

The trip value is derived as the amplitude of the difference of the currents based on the smaller of the two compared line currents. If this trip value is exceeded, the protective function is started. If the trip value remains exceeded for at least the parameters set in the time delay, the unbalanced load supervision is tripped.

An example of calculating the comparison of the line currents I_{L1} with I_{L2} is given below. The other calculations are equivalent:

$$I_{asy} = \frac{|I_{L1}| - |I_{L2}|}{MIN\{I_{L1}, I_{L2}\}}$$

I_{asy}:	Negative-phase current
I_{L1}:	Current rms value in conductor L1
I_{L2}:	Current rms value in conductor L2
MIN $\{I_{L1}, I_{L2}\}$:	Minimum of I_{L1} and I_{L2}

The above formula demonstrates that the percentage error of the unbalanced load supervision is based on the rms value of the minimum line current involved in the calculation.

Note

The described processing method of unbalanced load supervision detects the unbalanced load current and also any residual currents caused by earth faults that may occur.
Unbalanced load current can therefore only be distinguished from residual current by the configuration of the unbalanced load supervision and a earth fault current protective function.

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Typical application

Increasing size of the equipment results in an increase in "hot spots“ if asymmetries occur in the network.

The negative sequence protection is most frequently used with generators, transformers, chokes and three-phase asynchronous motors.

Configuration

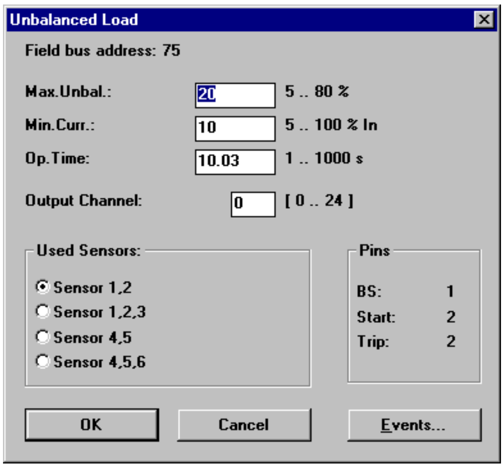


Figure 221: Configuration dialog function block unbalanced load supervision

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `max.Unbal.`: Input of the response time of the protective function I_{PEVAN} in % parts of I_{MIN} according to the formula described.
Setting range: 5 … 80% (increment: 1)
Default: 20

Input field `Min.Curr`: Input of the minimum active current I_{MIN} in % parts of the rated current, which must be exceeded by one of the line currents to activate the protective function.
Setting range: 5 … 100% (increment: 1)
Default: 10

Entry field `Op.Time`: Delay period in ms after which the protective function trips if the response time remains exceeded.
Setting range: 1 … 1000 s (increment: 1)
Default: 10

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.12.3 Directional power

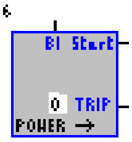


Figure 222: Function block directional power

Function

Directional power supervision can be added as a supervision function with generators, transformers and three-phase asynchronous motors. It monitors the direction of the power flow and generates an alarm or a tripping after detecting reverse power.

The directional power supervision is based on comparing the calculated effective power with a configured limit value. If the result of the internal power calculation is negative, reactive power is measured. If this exceeds the set response time, a starting follows. If the response time is exceeded for at least the time set in the parameters, it will be tripped.

The nominal effective power that must be set (`P nom`) is based on the three-phase calculated effective power. This is determined from the voltage and current measured quantities, which are always based on the rated quantities of the analog inputs of the REF542.

↳Chapter "11.7.5.1 Active power calculation" on page 11-33

The correct directional condition must be present at the transducer and sensor terminal, because otherwise the power calculation will not function correctly.

↳Chapter " Defined circuit diagram for directional protective function" on page 7-8

Connections:

`BI` input: A logical 1 at this input will suppress the protective function trip signal. The function on the tripping side will still be displayed.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

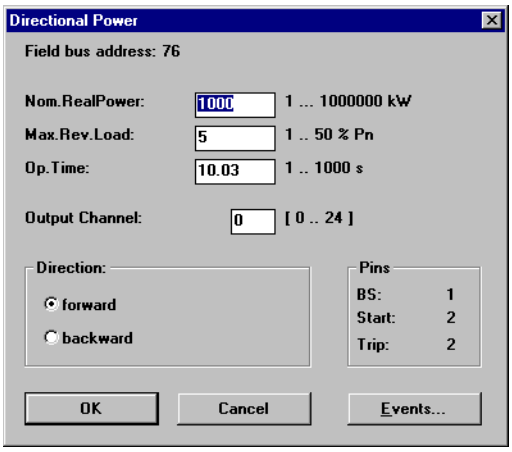


Figure 223: Configuration dialog function block directional power

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `Nom.RealPower`: Input of the three-phase rated effective power of the equipment that is to be monitored.
Setting range: 1 … 1 000 000 kW (increment: 1)
Default: 1000

Input field `Max.Rev.Load`: Input of the trip threshold in percent of the rated effective power. The trip threshold is equivalent to the maximum allowable effective power against the usual power direction.
Setting range: 1 … 50% of P_n (increment: 1)
Default: 5

Entry field `Op.Time`: Delay period in ms after which the protective function trips if the response time (`P max rev`) remains exceeded.
Setting range: 1 … 1000 s (increment: 1)
Default: 10 + t_{relay}

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `direction`: The direction is marked here in which the protective function should trip; i.e. the direction is opposite to the usual power direction of the equipment that is to be monitored.

✎Chapter " Defined circuit diagram for directional protective function" on page 7-8

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

✎Chapter "5.3.2 Global Settings" on page 5-2
✎Chapter "11.3 Event list of protective functions" on page 11-6

5.4.12.4 Low load

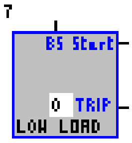


Figure 224: Function block low load supervision

Function

Low load supervision calculates the effective power from the configured REF542 current measurement inputs and automatically adds the corresponding voltage measurement inputs. For this reason the parameters for the relevant voltage inputs at the analog inputs must be set.

↳Chapter "5.3.4 Analog inputs" on page 5-6

The low load supervision is based on comparing the calculated effective power with the configured response time. If the response time falls below the set response time, the protective function will be activated. If it falls below the response time for at least the time set in the parameters, it will be tripped. The rated effective power that must be set is based on the one, two or three-phase effective power calculated from the rated values of the current and voltage measurement inputs.

↳Chapter "11.7.5.1 Active power calculation" on page 11-33

In addition, a pick-up current (`Min.Current`) can be configured from which the low load supervision is first activated. Offload and pick-up ratios can be taken into account with this parameter.

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page..

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Typical application

Three-phase asynchronous motors are subject to intermittent stresses, which have to accept a certain load. The low load supervision is provided for these stress cases to monitor for conditions below the required load.

Configuration

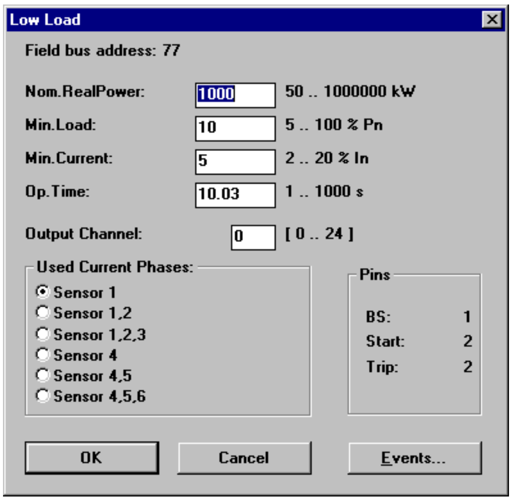


Figure 225: Configuration dialog function block low load

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `Nom.RealPower`: Input of the three-phase rated effective power of the equipment that is to be monitored.
Setting range: 50 … 1 000 000 kW (increment: 1)
Default: 1000

Input field `Min.Load`: Input of the trip threshold in percent of the rated effective power. The trip threshold is equivalent to the allowable minimum low load.
Setting range: 5 … 100% of P_n (increment: 1)
Default: 10

Input field `Min.Current`: Input of the minimum line current in percent of the rated current that must flow in at least one conductor to activate the low load supervision function block.
Setting range: 2 … 20% of I_n (increment: 1)
Default: 5

Input field `Op.Time`: Delay period in s after which the protective function trips if the response time (`P min`) remains low.
Setting range: 1 … 1000 s (increment: 0.1)
Default: 10 + t_{relay}

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Option field `used current phases`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective funktion reacts are connected.

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.12.5 Frequency supervision

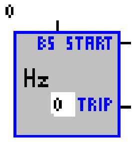


Figure 226: Function block frequency supervision

Function

Frequency changes influence, for example, the power dissipation, the speed (motors) and the firing characteristics (converters) of equipment. There are also consumers that control their time settings over the network frequency.

The frequency supervision function block is used to report frequency variations in a frequency band with configurable positive and negative frequency difference. A starting is activated initially after the response time has been exceeded or underrun. If the frequency range is exceeded or underrun for at least the parameters in the time setting, it will be tripped. The frequency is automatically determined from the voltage measured value of an analog input.

✎Chapter "11.7.4 Calculation of the frequency" on page 11-33

The rated frequency is specified in the basic settings for the calculated quantities during the configuration.

✎Chapter "5.3.6 Calculated values" on page 5-12

Two parameter sets can be configured for frequency supervision.

Connections:

`BS` input: A logical 1 signal at this input suppresses the protective function trip signal. The function is still displayed on the tripping page.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Typical application

Anywhere where time and frequency-dependent processes are involved, it is worthwhile checking the network frequency so it remains within set limits (generators, transformers, chokes, three-phase machines and converters).

In addition, the frequency supervision enables the frequency variations to be documented.

Configuration

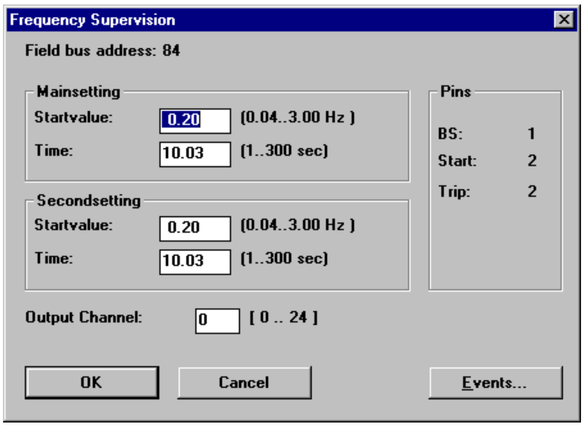


Figure 227: Configuration dialog function block frequency supervision

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `startvalue` (once per parameter set/setting): Input of the frequency difference in Hz around which the rated frequency can positively or negatively vary.
Setting range: 0.04 … 3.00 Hz (increment: 0.01)
Default: 0.20

Input field `time` (once per parameter set/setting): Delay period in ms after which the supervision function trips if the start value (response time) remains exceeded.
Setting range: 1 … 300 s (increment: 0.01)
Default: 10

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.12.6 Synchrocheck

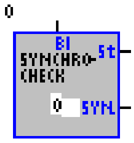


Figure 228: Function block synchrocheck

Function

The synchrocheck checks these quantities from two voltage systems and only sends a closing command if the difference of the voltage amplitudes, the phase difference and the frequency vary within the set allowable limits over a certain period.

The synchrocheck requires two phase voltages of the networks that are to be parallel switched to do this. The line voltage is calculated from each of the two phase voltages. The vectorially determined differential voltage of the line voltage in the two networks are checked for their phase angle and amplitude in order to enable the synchrocheck. An allowable differential amplitude can be configured for each case. Frequency variations between the two networks are detected by the time delay in which the differential voltage must remain within the limits in amplitude and phase.

If the values of amplitude and phase of the differential voltage are within the set limits, the starting (`St`) of the protective function is activated first. If the values remain within the limits for at least the parameters in the time setting, both networks are also equalized in their frequencies. Then the protective function will be tripped (`SYN`). The switching operation for coupling the separate systems can be released with this signal. An example of the voltage ratios is shown in the following diagram.

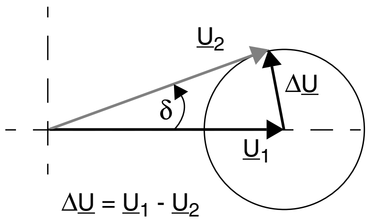


Figure 229: Vector diagram of the Synchronization condition

As shown in the diagram, the phase difference angle that is to be set depends on the setting of the voltage difference as follows:

$$\Delta\delta = arctan\left(\frac{\Delta U}{\underline{U}}\right)$$

$\Delta\delta$: Phase difference angle setting
ΔU: Voltage difference setting as start value
U: External phase-to-neutral voltage of a network as reference quantity

Two parameter sets can be configured for synchrocheck.

Connections:

`BI` input: A logical 1 at this input will suppress the protective function trip signal. The function on the tripping side will still be displayed.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`Syn` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip treshhold for the set period. The switching operation for coupling the separate systems can be released with this signal.

Application

Synchrocheck is required if two networks are interconnected whose voltages may differ in quantity, phase angle and frequency as a result of different power supplies. Because system partitioning into two subsystems may occur because of a three-pole autoreclosure, if required it may be useful to apply synchrocheck in the event of reswitching.

The synchrocheck can only be used with specific protective functions because of the use of analog inputs.
"Table 40: Use of the protective functions depending on the configuration of the analog measuring inputs" on page 5-89

Configuration

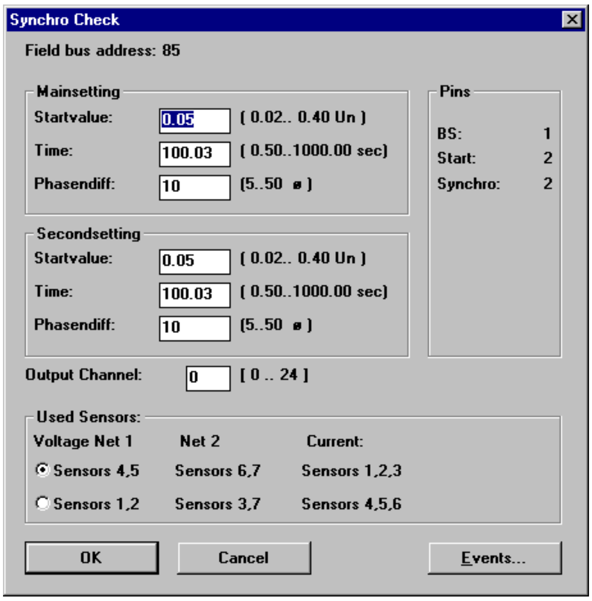


Figure 230: Configuration dialog function block synchrocheck

Information field `field bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `start value` (once per parameter set/setting): Input of the multiplier for U_n to specify the response time of the protective function. The amplitude of the allowable differential voltage is set here.
Setting range: 0.02 … 0.40 (increment: 0.01)
Default: 0.05

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value and the phase difference remains exceeded.
Setting range: 0.50 … 1000.00 s (increment: 0.01)
Default: 100

Input field `(phasendiff.) phase difference` (once per parameter set/setting): Input of the maximum phase difference between the networks that are to be coupled or the maximum phase difference of the differential voltage.
Setting range: 5 … 50° (increment: 1)
Default: 10°

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2
↳Chapter "11.3 Event list of protective functions" on page 11-6

5.4.13 Faultrecorder

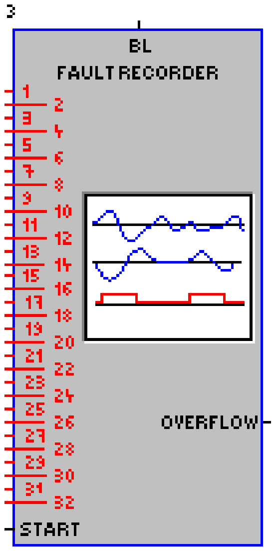


Figure 231: Function block faultrecorder

Function

This function block allows the seven REF542 analog input signals to be recorded for a period of at least 1 second and for a maximum of 5 seconds. It is also possible to record up to 32 digital signals simultaneously from the function chart.

The faultrecorder is started within the application. The recording time of the fault recorder is a combination of the time before the fault and the time after the fault. The time before the fault refers to the period recorded before the fault recorder is actually started. The time after the fault is the period after the fault recorder is started. Dynamic recording of the fault record (e.g. from start signal to signal LS OFF) is not possible.

The specific fault record is saved by the ring buffer process, i.e. the oldest fault record is always overwritten with a new one. The number of saved fault records depends on the record time. The total duration of all saved fault records is 5 seconds. For example, 5 fault records can be saved with a record time of 1 s (time before the fault + time after the fault).

The fault records are exported with the configuration software and then converted to the COMTRADE format. The fault records can also be exported over the interbay bus.

↳Chapter "4.5.1.14 Exporting the fault recorder" on page 4-11

Please also observe the following limitations on the use of the fault recorder:

- At least one protective function must be configured and
- The start signal for the fault recorder must be implemented in the FUPLA.

Recording precision

The analog signals are digitized and processed with a 1.2 kHz sampling rate, because they are decisive for the protective trips. They therefore within a time grid of 0.833 ms. Trip signals from protective functions are then also sent to the REF542 binary output immediately.

↳Chapter "11.7.1 Measured-value processing" on page 11-30

In contrast, the digital signals are processed in accordance with the FUPLA cycle time. The cycle time depends on the application in this case.

↳Chapter " Determining the cycle time" on page 4-11

The digital signals are therefore in a grid that is significantly larger than the analog signal grid.

A start or trip signal of a protective function is sent to the fault recorder only once per FUPLA cycle. Therefore, the fault recorder operates at a maximum precision of one FUPLA cycle time.

Connections:

`BL` input: A logical 1 at this input will suppress this function block trip signal.

`1 ... 32`: Signal inputs for the digital signals that are to be recorded.

`START`: Signaling input for the digital signal that trips the fault recording.

`OVERFLOW`: Signaling output set to logical 1 if there are too many records in a short time. The data can no longer be saved in this case. A rough estimate of 15 s memory period can be assumed for 5 s of fault record data.

Typical application

Recording fault data during a short circuit in the network. The data can be exported from the REF542 later and displayed with suitable program.

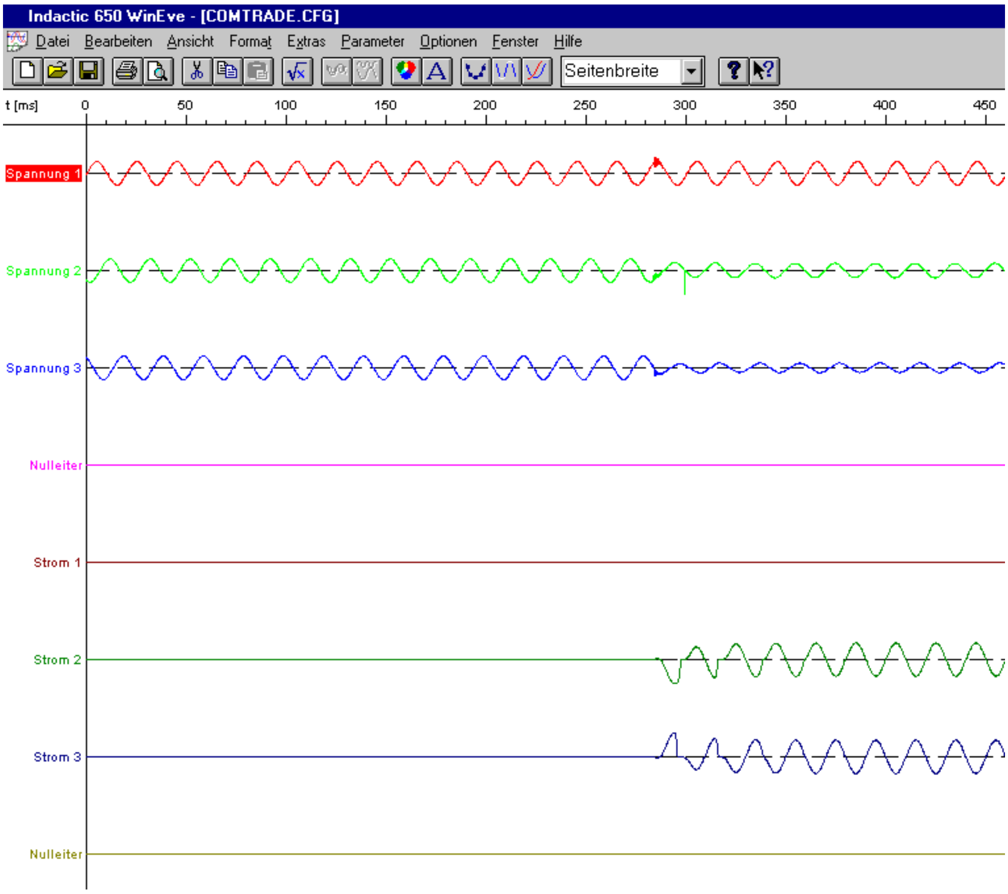


Figure 232: Example showing the graphic display of fault record data of a two-pole short circuit with the WINEVE program

Configuration

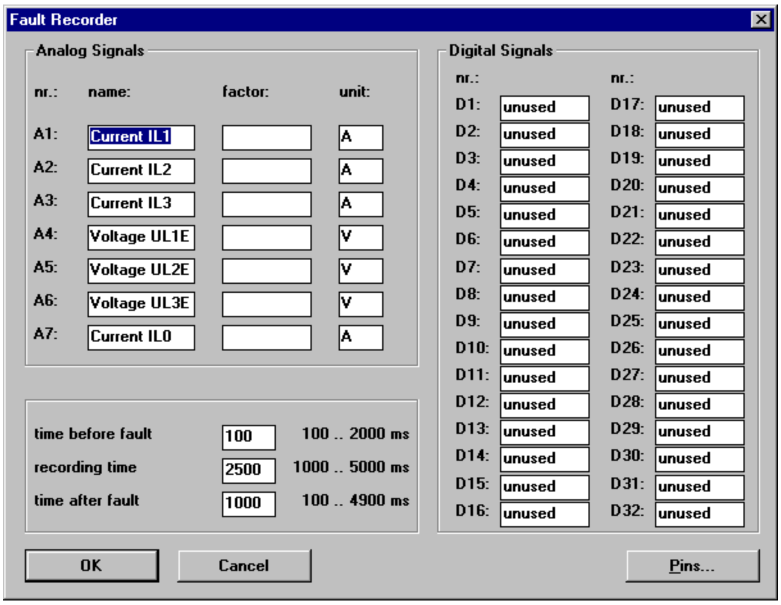


Figure 233: Example of a configuration dialog for the function block fault recorder

Input range `analog signals`: Various parameter settings that are important for recording analog signals of every analog input:

- Input fields `name`: Input of a name for the recorded analog signal of the input whose number is before the field. This parameter is used by the processing program to assign a physical quantity to the recorded signal.
  Setting range: 0 … 10 characters (standard character set)
  Default: Set in accordance with the use of the analog inputs
- Input fields `factor`: Input of a scaling factor for the signals recorded at the specific input. This value is used by the processing program. There are no detailed specifications for this factor in the COMTRADE format, in which the data are converted by the configuration program. The input "1“ avoids any problems that might occur.
  Setting range: 0 … 1000 (increment: 1)
  Default: Empty
- Entry field `unit`: Input of a physical unit for the signal recorded at the specific input. This value is used by the processing program.
  Setting range: 0 … 3 characters (standard character set)
  Default: Set in accordance with the use of the analog inputs

Input field `time before fault`: Input of the time in ms actually recorded before the fault recorder is started.
Setting range: 100 … 2000 ms (increment: 1 ms)
Default: 100

Input field `recording time: Input` of the time in ms that should be used to record fault records.
Setting range: 1000 … 5000 ms (increment: 1 ms)
Default: 2500

Input field `time after fault: Input` of the time in ms actually recorded after the fault recorder is started.
Setting range: 100 … 4900 ms (increment: 1 ms)
Default: 1000

Input fields `digital signals`: A comment can be input here for every digital input 1 … 32 of the fault recorder. The comment is used by the processing program to link the recorded signal and its origin.
Setting range: 0 … 8 characters (standard character set)
Default: “unused“

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `pins`: Clicking this button opens a dialog window in which the connections of the fault recorder are listed. The number of the terminal connection and the indication of whether it is an input or output of the function block is adjacent. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.
Click the `OK` button to close this dialog window.

5.4.14 Other components

The subsections contain the descriptions of the function blocks that are available via the menu `Drawing Menu/Insert/Miscellaneous Objects`.

5.4.14.1 Operating hours

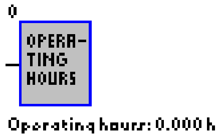


Figure 234: Function block operating hours

Function

This function block counts the operating hours as long as there is a logical 1 at its input. A number of operating hours can be set as the start value.

If an operating hours counter function block is implemented, the internal operating hours counter counts only the hours for which the REF542 is connected to the auxiliary voltage. The number of operating hours is shown on the REF542 LC display screen in the operational measured values ring menu. Here the count of the internal counter or of the operating hours counter function block, if activated, is used.

Note — Only one operating hours counter function block may be used in the application.

Connections:

Input left: If this input is set to logical 1, the operating hours count will begin.

Typical application

The operating hours of any equipment can be recorded.

Configuration

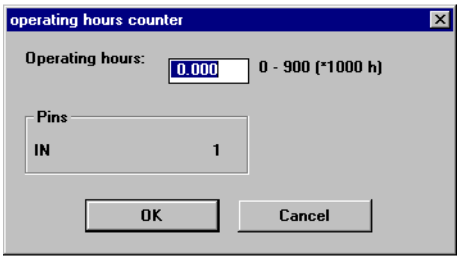


Figure 235: Configuration dialog function block operating hours counter

Input field `operating hours`: Input of the factor multiplied by 1000 that sets the initial value of the operating hours counter.
Setting range: 0 … 9 (increment: 0.001)
Default: 0.000

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

5.4.14.2 Event generator

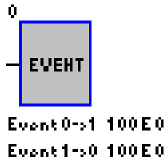


Figure 236: Function block event generator

Function

This function block generates an event if the state at the input changes from logical 0 to logical 1 or vice versa. This event can be processed by the higher-order control system.

Note — A maximum of 63 events can be generated with event generators, with every event generator being able to transmit 2 events.

Connections

Input left: Every change of the logical state generates an event.

Typical application

Generating a real-time event for the higher-order control system if a function block does not provide a corresponding event.

Configuration

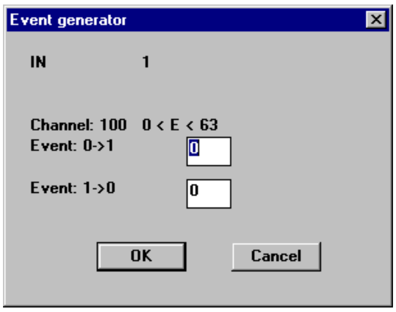


Figure 237: Configuration dialog function block event generator

Information window `IN`: Indicates the function block input with adjacent connection number. The connection number 1 is shown if the function block still does not have a connection.

Input field `event: 0->1`: Input of the event number assigned to the event as sent. The event is generated if the logical state at the input changes from 0 to 1 and is sent via channel 100 (default) with the selected event number. The input "0“ prevents an event from being transmitted.
Setting range: 0 … 63 (increment: 1)
Default: 0

Input field `event: 1->0`: Input of the event number assigned to the event as sent. The event is generated if the logical state at the input changes from 0 to 1 and is sent via channel 100 (default) with the selected event number. The input "0“ prevents an event from being transmitted.
Setting range: 0 … 63 (increment: 1)
Default: 0

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button Cancel: Settings are not saved in the configuration program. The dialog window is closed.

5.4.14.3 Direct read-write

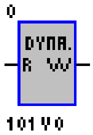


Figure 238: Function block direct read-write

Function

This function block enables logical signals to be exported from the function chart to a higher-order control system. Logical signals can also be sent in the reverse direction from the control system to the function chart.

Note A maximum of 100 direct write-read commands may be entered.

Connections

Input R: Connection of the logical signal that is to be sent to the higher-order control system.

Output W: Signaling output of the logical signal that the higher-order control system will send to the function chart.

Typical application

Implementing station-level interlocking over the interbay bus.

Configuration

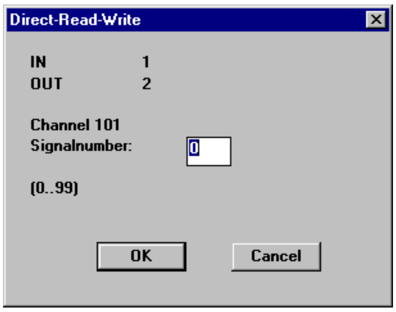


Figure 239: Configuration dialog function block direct write-read command

Information window IN/OUT: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Input field signalnumber: Input of the signal number/event number over which a logical signal is sent or received. Channel number 101 is the default. Channel and signal/event number are also shown in the function chart below the function block.
Setting range: 0 … 99 (increment: 1)
Default: Next free signal number

Button OK: All settings are saved in the configuration program. The dialog window is closed.

Button Cancel: Settings are not saved in the configuration program. The dialog window is closed.

5.5 Additional functions

The function described in the following subsections cannot be started as an independent function block, but it is a component of some protective functions.

5.5.1 Autoreclosure

Note — Autoreclosure for the distance protection is described in the distance protection section.

↳Chapter "5.4.11 Distance protection" on page 5-158

Function

In overhead cable networks most faults are short circuits with arcing. The line has to be temporarily switched off to stop the arc. It can be reactivated after deionizing the arc section. The fault is tripped by protection equipment and the subsequent quick, independent autoreclosure is also referred to as a short disconnection (SD) (also AR, “autoreclose“ or “refermeture automatique“).

To enable this procedure, the following protective functions implemented in the REF542 can be combined with the autoreclosure (AR) function:

- Overcurrent instantaneous
- Overcurrent high
- Overcurrent directional high
- Earthfault high
- Earthfault directional low

Two parameter sets can be configured for the autoreclosure.

Configuration

Please observe the following basic conditions for proper functioning of the autoreclosure:

- The autoreclosure must be generally released in the REF542 hardware configuration.

  ↳Chapter "5.3.2 Global Settings" on page 5-2
- The blocking time must be set longer than the longest dead time.
- The fault time must be longer than the trip time of the protection for which the autoreclosure is configured.
- The power circuit-breaker closing command may not be interlocked while the autoreclosure is running.

The dialog window is the same for all autoreclosure-compatible protective functions and is reached via the autoreclosure button in the configuration dialog of the corresponding protective function.

Caution — **The definition of the fault time used here is not the same as the standard definition of the fault time.**

The definition used here is in the following description of the configuration dialog. In contrast to this, the definition of the fault time for the distance protection-autoreclosure is the same as the standard definition.

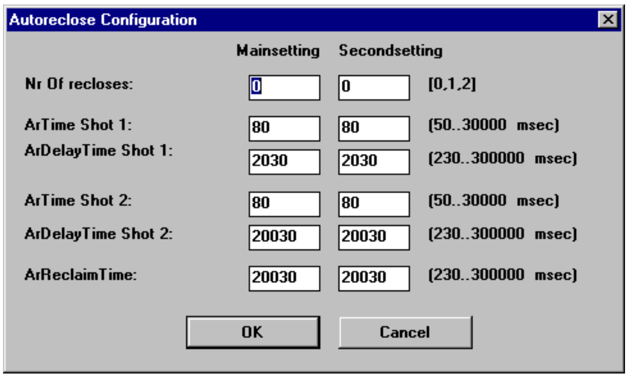


Figure 240: Configuration window autoreclosure (AR)

Input field `number of recloses` (once per parameter set/setting): Indicates how often the autoreclosure is activated in succession.
Setting range: 0, 1 or 2
Default: 0

Input field `ArTime Shot 1` (once per parameter set/setting): Input of the time in ms for which a protective starting must persist after the first tripping before a second tripping.
Setting range: [50 ms + t_{relay}] … 300 000 ms (increment: 1 ms)
Default: [300 ms + t_{relay}]

Note — The time set in the configuration dialog of the protective function will be overwritten by this parameter (fault time 1).

Input field `ArDelayTime Shot 1` (once per parameter set/setting): The time in ms for which the power circuit-breaker (LS) remains open before the first autoreclosure. Finally a LS-On command is generated.
Setting range: [200 ms + t_{relay}] … 300 000 ms (increment: 1 ms)
Default: [2.000 ms + t_{relay}]

Input field `Artime Shot 2` (once per parameter set/setting): Input of the time in ms for which a protective starting must persist after the second tripping before a third tripping.
Setting range: [50 ms + t_{relay}] … 300 000 ms (increment: 1 ms)
Default: [300 ms + t_{relay}]

Note — The time set in the configuration dialog of the protective function will be overwritten by this parameter (fault time 2).

Input field `ArDelayTime Shot 2` (once per parameter set/setting): The time in ms for which the power circuit-breaker (LS) remains open before the second autoreclosure. Finally a LS-On command is generated.
Setting range: [200 ms + t_{relay}] … 300 000 ms (increment: 1 ms)
Default: [20 000 ms + t_{relay}]

Input field `ArReclaimTime` (once per parameter set/setting): Recovery time in ms for the power circuit-breaker; i.e. the time in which the autoreclosure is generally blocked. If the protective function is tripped during the blocking time, there will be no autoreclosure.
Setting range: [200 ms + t_{relay}] … 300 000 ms (increment: 1 ms)
Default: [2000 ms + t_{relay}]

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Note

An unsuccessful autoreclosure must be acknowledged. The autoreclosure-active signal persists until it is acknowledged. A successful autoreclosure need not be acknowledged.

↳Chapter "8.1.4.2 Acknowledging messages and alarms" on page 8-5

Some flow charts of autoreclosures are shown below to clarify its functioning.

Autoreclosure 1 attempt successful

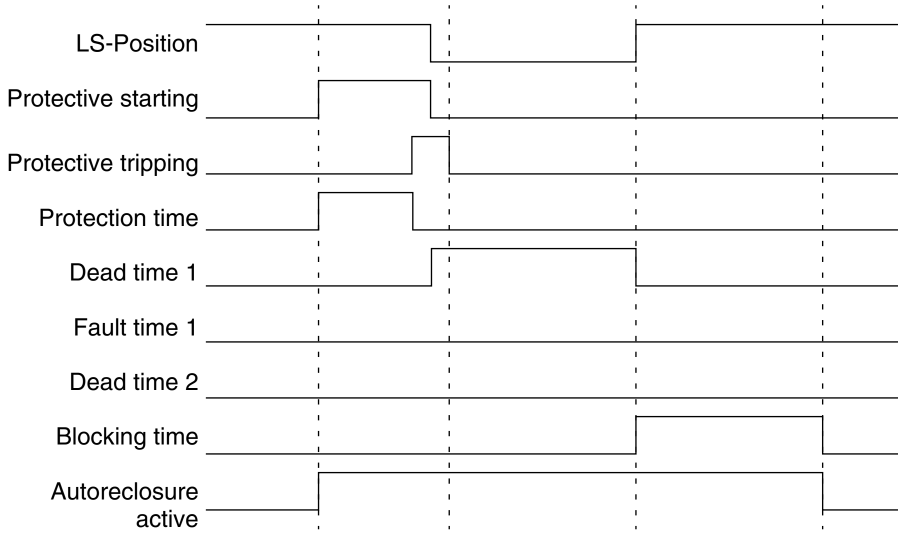


Figure 241: autoreclosure flow chart, one successful attempt

Autoreclosure 1 attempt unsuccessful

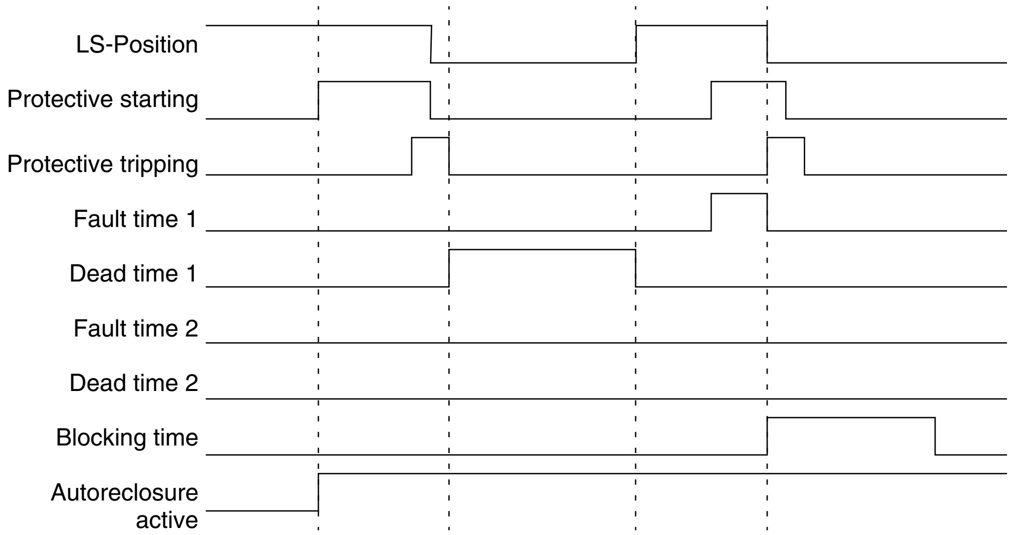


Figure 242: Autoreclosure flow chart, an unsuccessful attempt

Autoreclosure 2 attempts successful

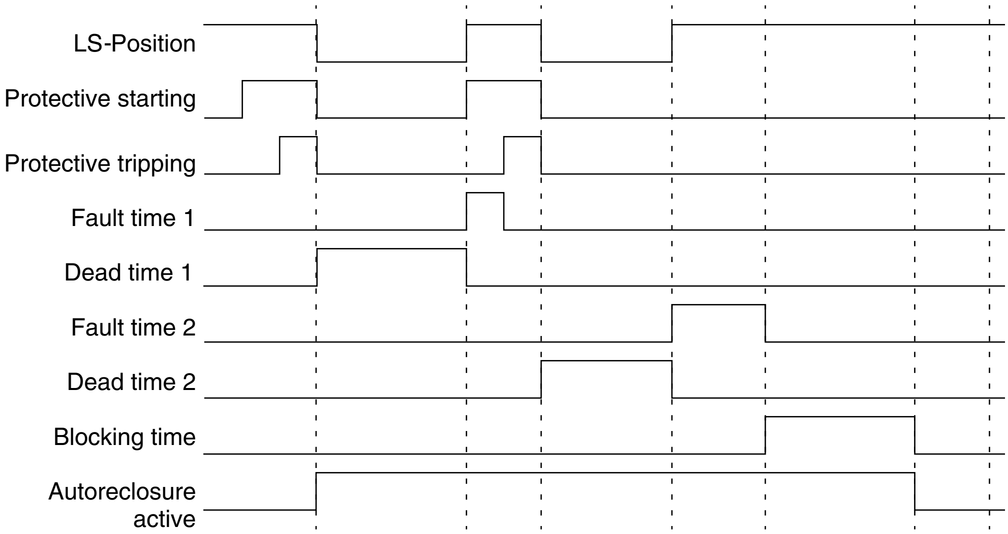


Figure 243: Autoreclosure flow chart, two successful attempts

Autoreclosure 2 attempts unsuccessful

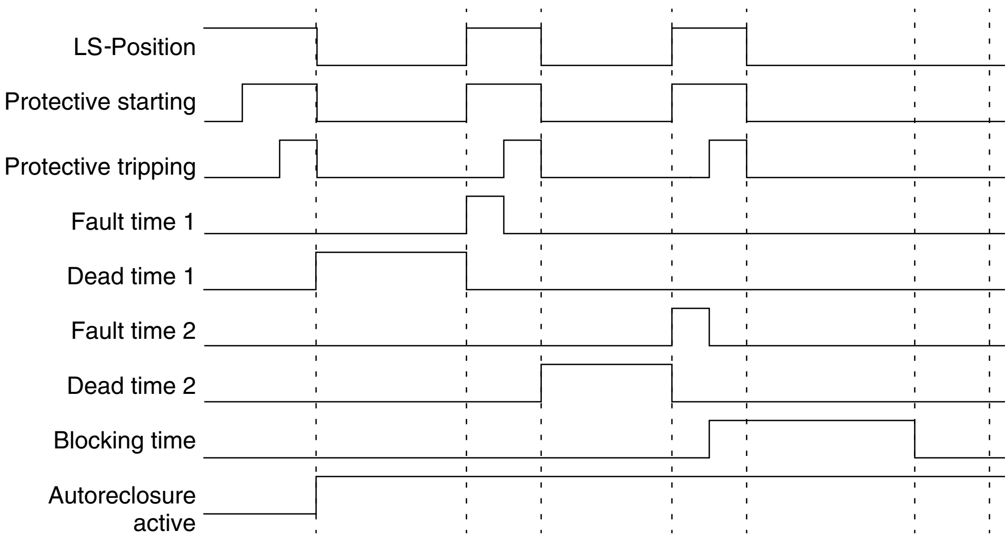


Figure 244: Autoreclosure flow chart, two unsuccessful attempts

6 Mounting and Installation

In this chapter you will find information

- on what to do first on delivery of the REF542,
- the requirements for the installation location and the environmental conditions,
- how to set up the REF542 and integrate it into the bay and
- how to check the wiring to run the commissioning process.

6.1 Safety Information

Warning! **Always disconnect the bay before setting up the device!**

6.2 Unpacking

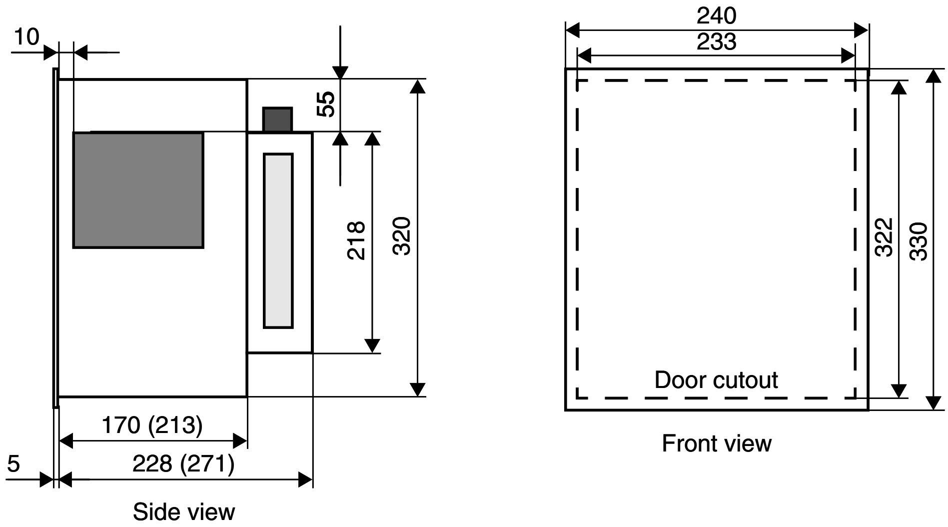
The REF542 bay control and protection unit does not require special shipping protection. The packaging is adapted for the shipping type and destination. Please proceed as follows:

- Visually inspect the unit and the packaging when unpacking it.
  Any shipping damage found in the packaging or the unit should be reported immediately to the last shipper, who should be informed in writing of liability for the damage.
- Check the delivery for completeness using the order documentation.
  If there is anything missing or any discrepancies with the order documentation, contact the ABB sales office immediately.
- Mount the unit as described in the following section. If the unit is not for immediate use, store it in a suitable place in its original packaging.

↳Chapter "10.1 Storage" on page 10-1

6.3 Mounting

The diagram below shows the general dimensions of the unit. The table shows the technical data relevant for mounting.



The figures in parentheses apply to the deep housing.
All dimensions are in mm.
The drawings are not to scale.

- -X2 interface: Signal converter with core-balance current transformers
- -X2 interfaces: Signal converter with connected U-core transducers
- Sensor terminal adapter; alternative to the signal converters

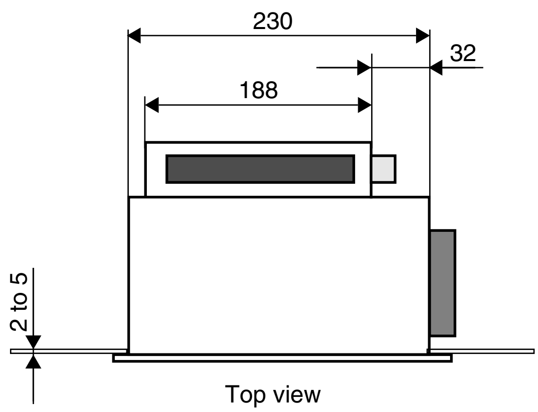


Figure 245: Dimensions of the REF542 housing

Table 41: Technical data

Design		
Weight	Short housing: 5 kg … 6 kg	depending on equipment
	Long housing: 5.5 kg … 7 kg	depending on equipment
Installation type	Semiflush, terminal above	Terminals for core-balance current transformer are on the side
Connections:	DIN 41612	
Dimensions	240 x 330 x 228 mm (W x H x D)	Short housing
	240 x 330 x 271 mm (W x H x D)	Long housing
Panel cutout for semiflush mounting	231 x 321 mm (W x H)	

6.3.1 Set-up Area and Required Environmental Conditions

Please note the following information regarding the set-up area:

- Allow sufficient space for access to the front panel of the unit. The connections must be easily accessible.
- Access to the top of the unit with semiflush mounting must be free for the following reasons:
  - To replace the unit,
  - to expand the unit,
  - to replace specific electronic equipment racks/boards and
  - to replace specific modules if necessary.

Because the unit is sensitive to non-permitted severe environmental conditions, please observe the following:

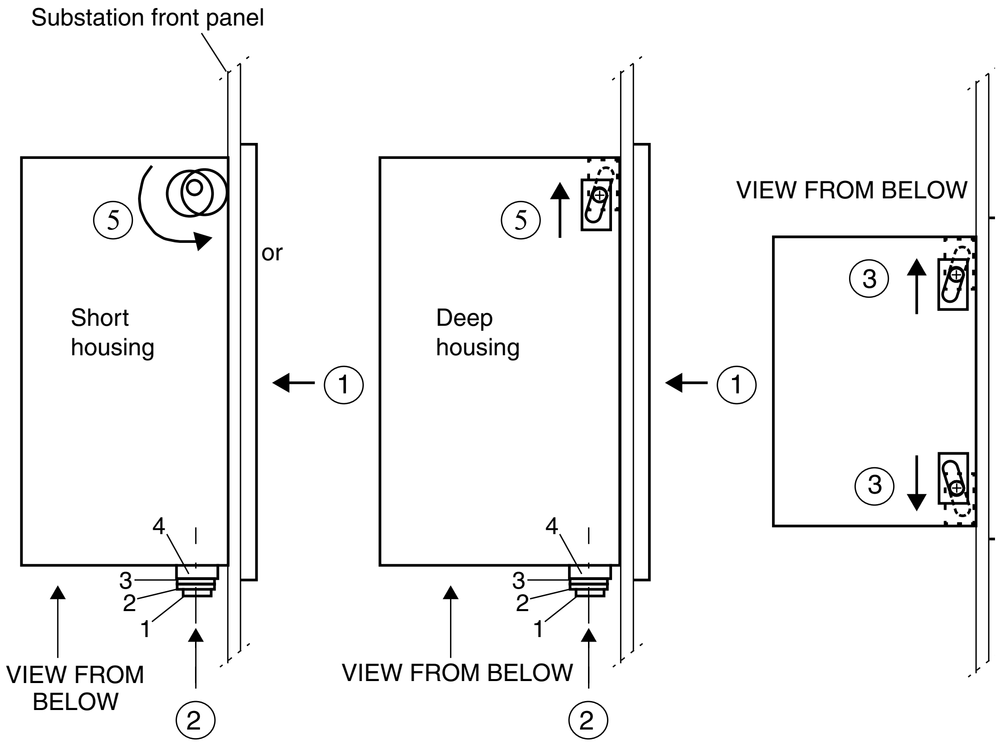
- The set-up area must be free of excessive air contamination (dust, aggressive substances …).
- The natural air circulation around the unit must be free.
- The set-up area must maintain the specified environmental conditions:

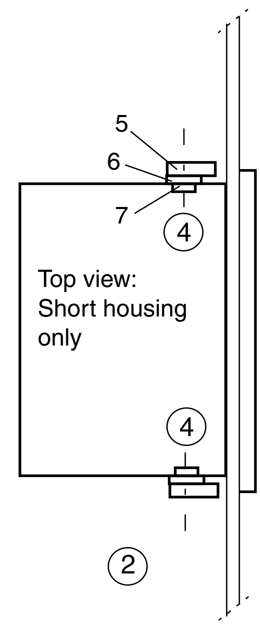
The unit is not sensitive to its position. It should be vertically mounted to ensure that the LC display screen and the labels on the front panel can be read without problem.

Table 42: Technical data for the set-up area and the environmental conditions

General Data			
Temperature Range	Operation: -10 °C … +55 °C Storage: -20 °C … +70 °C Transport: -20 °C … +70 °C		Non-condensing humidity < 95%
Earthquake safety	DIN IEC 60068-3-3 DIN IEC 60068-2-6 DIN IEC 60068-2-59 CEI IEC 61166 CEI IEC 60980		
Insulation voltage	IEC 60255-5/2 kV, 1 Min., 50 Hz		except for power supply input
Fast Transient Test	IEC 60801-4/4 kV		
Electrostatic discharge (ESD)	IEC 60801-2		
Resistance to electromagnetic fields	IEC 60801-3/30 V/m		
Environmental Conditions	IEC 60255-4		
Protection class	Housing:	IP 30 or IP 54	Standard design on request
	Connection:	IP 20 or IP4X	Standard design on request

6.3.2 Installation on the front panel of a substation





Installation instructions

- (1) Slide the REF542 from the front into the substation front panel cutout to the stop
- (2) Loosely screw 2 right-angle washers (no. 4) with an angular slot to the bottom of the REF542
- (3) Slide the washer outwards so the lower part of the REF542 is pressed to the substation front panel. Then tighten the screws.
- (4) Loosely screw 2 round washers (no. 5) with eccentric holes to both side panels of the REF542 – do not tighten yet!
- (5) Turn or slide the washers so the top panel of the REF542 is pressed to the substation front panel.
  Then tighten the screws.

Legend

No. 1: M5x12 philips screwdriver
No. 2: M5 spring washer
No. 3: M5 U-washer
No. 4: right-angle washer
No. 5: round washer
No. 6: M5 spring washer
No. 7: M5x12 16-kt

Figure 246: REF542 installation diagram in the front panel of a substation

6.3.3 Wiring the REF542

Follow the bay documentation supplied for the wiring.

In conclusion, the checks described in the following paragraphs can be done to ensure that the wiring is correctly installed.

Checking the current transformer circuits

To check that the current transformer and the current transformer circuits are wired correctly, run the following checks:

- Polarity check
  The polarity check (as close as possible to the REF542) is used to check the current circuit and also the installation position and the polarity of the transducer. The polarity of the transducers to one another can also be checked with load current.

  Chapter "7.5 Determining the transformer direction" on page 7-4
- Current feed with heavy current source (primary test instrument)
  The current feed provides information on the transducer transformation and the correct wiring to the REF542. The power supply should be per conductor and run from conductor to conductor in each case. All line currents and the residual current should be checked here.
  The transducer transformation can also be checked with load current.
- Recording the magnetizing characteristic
  Recording the magnetizing characteristic ensures that the REF542 is connected to a protective core and not to a measuring core.
- Checking the transducer circuit ground
  Every independent current circuit may be grounded at only one point to prevent balancing currents resulting from potential differences.
- Check the grounding of the cable current transformer (when used)
  If the neutral current is measured by a cable current transformer, the cable shielding should first be returned through the cable current transformer before connecting it to the ground.
- This enables weak ground fault currents that flow along the cable sheath to dissipate. In this way, they will not be incorrectly measured at their own relay feeder.

  The following shows another view of the cable current transformer grounding.

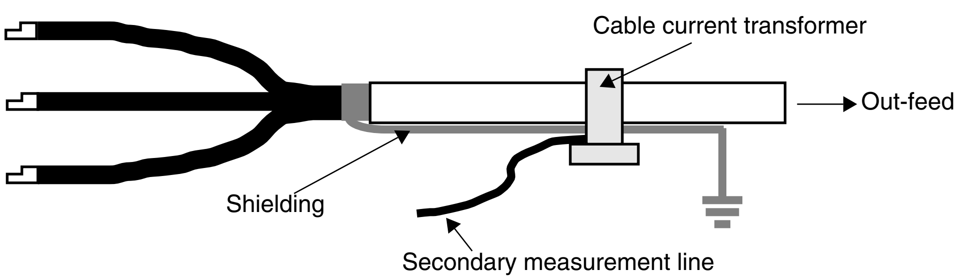


Figure 247: Grounding of a cable current transformer

Chapter "11.7.2 Measurement or calculation of Uo, Io" on page 11-33

Check the voltage transformer circuits

To check that the voltage transformer and the voltage transformer circuits are wired correctly, run the following checks:

- Polarity check
- Wiring check
- Check the transformer circuit grounding

- Check the voltage transformer for neutral point-ground voltage (when used)
  To measure ground faults please proceed as follows: The voltage is referred to as neutral point-ground voltage of a ground fault measurement when it occurs with a metallic ground fault in the network between terminals "e“ and "n“ of the open delta winding.
  In the event of a metallic ground fault in phase L1, the external phase-to-neutral voltages occur in phases L2 and L3 instead of the conductor-ground voltages. They are added geometrically and yield three times the amplitude between terminals "e“ and "n“.

↳Chapter "11.7.2 Measurement or calculation of Uo, Io" on page 11-33

Checking the auxiliary voltage

The auxiliary voltage must be in the tolerance range of the power supply module and have the proper polarity under all operating conditions.

↳Chapter "3.6 Overview of the technical data" on page 3-45

Check the tripping and signaling contacts

Conduct this check as shown in the bay documentation.

Check the binary inputs

Check the polarity and the voltage value of the binary inputs on the REF542 in accordance with the technical data of the binary inputs.

↳Chapter "3.6 Overview of the technical data" on page 3-45

7 Commissioning

The following sections with their subsections contain information on:

- The devices and adapters required for the commissioning inspection.
- The required procedure for the commissioning inspection; For example, depending on the components to be tested: Protection, interlock conditions, communications, measured value recording and determining the direction.

There are also forms for test records, which simplify the tests for the individual protective functions.

7.1 Safety Information

Note

The devices, adapters and procedures described are only examples. Experience and safety in handling the various devices is a requirement.

Switching on the feeder

Warning!

Before switching on the feeder check that the REF542 is fully functional in the corresponding bay. Pay particular attention to the protective functions and the interlocking!

7.2 Required devices and adapters

7.2.1 Converter for the sensor terminal adapter

The converter described below can be used to connect the currents and voltages generated by the Omicron test set to the sensor terminal adapter of the REF542 for testing.

Table 43: Material for manufacturing the converter

Material	Manu-facturer	Manufacturer no.
1 Omicron connector with guide cam and 8-pin tension release OR	LEMOSA	FGG.2B.308.CNAD 92Z
1 Omicron connector with two guide cams and 16-pin tension release	LEMOSA	FGB.2B.316.CLAD 72Z
1 protective cover fo Omicron connector	LEMOSA	GMA.2B.080.DN
6 connectors for the REF542 sensor terminal adapter, 2-pin, with soldered connection	RADIALL	R 605 005 000 Lot E 95 20
Several meters of double shielded cable		
Approx. 1 m 8-pin data line		

Table 44: Pin assignment of the Omicron connector from S/N CMC56 BK xxxxx

8-pin connector		16-pin connector	
PIN	**Signal**	**PIN**	**Signal**
1	Current L1	1	Current L1
2	Current L2	2	Current L2
3	Current L3	3	Current L3
4	Neutral conductor	4	Neutral conductor
5	Voltage L1	5	Voltage L1
6	Voltage L2	6	Voltage L2
7	Voltage L3	7	Voltage L3
8	Not used	8-16	Not used

The following drawing shows the usage of the double shielded cable:

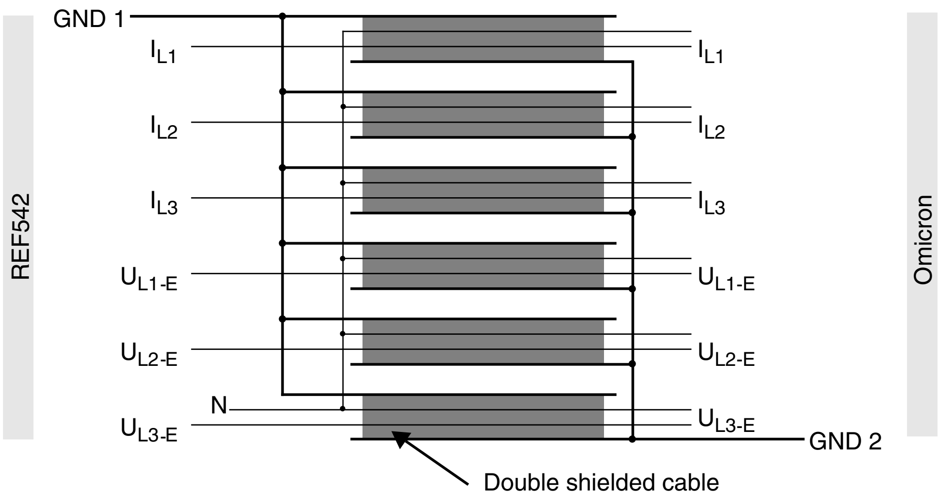


Figure 248: Principal circuit diagram of the REF542 Omicron converter

The test adapter is connected as shown below:

- To the Omicron test set at the connection for external amplifiers.
- To the local control unit on the side at the connections for the sensor terminal adapter

The Omicron test set also requires the generator files to be created:

- 1. current amplifier
  - scu_isen.amp

    BEGIN AMPLIFIER
        NAME SCU_current amplifier
        TYPE Current
        MAX 50
        AMPLF 6.65
        PHOFFS 90.0, 90.0, 90.0
    END AMPLIFIER

  The phase displacement of 90° of the Rogowski coils is already accounted for in this file.

- 2. voltage amplifier
  - scu_usen.amp

```
BEGIN AMPLIFIER
        NAME SCU_voltage amplifier
        TYPE Voltage
        MAX 1000
        AMPLF 50.1
        PHOFFS 0, 0, 0
END AMPLIFIER
```

The rated load for the REF542 is reached with the following setting:

- Voltage: 57.74 V conductor-ground
- Current 1 A

7.3 Calibrating the analog inputs (measuring inputs)

The following devices are required to calibrate the REF542:

- A precise AC voltage source with 2.00000 V and 50.00 Hz
  (e.g. a FLUKE process calibrator)
- A voltage meter to monitor the input voltage at the analog inputs/measuring inputs of the REF542
- A plug adapter to connect the analog inputs of the REF542 to the AC voltage source.

The unit is calibrated as follows:

Note — The calibration should only be conducted with the unit at operating temperature. Calibrations not conducted under standard operating conditions will yield incorrect results.

- Plug adapter connection to the REF542
- Set the keyswitch "input/operation" to the input position.
- Set the keyswitch "local/remote" to the local position.
- Restart the unit:
  - Switch off the auxiliary voltage at the corresponding miniature circuit breakers
  - Press and hold the `<danger-off-left>` and <**O**> keys and simultaneously switch on the auxiliary voltage again.
- Press and hold the <**?**> key and switch the keyswitch "local/remote" to the remote position.
- Press the <🡅> key to run a DSP test. The message "DSP interface OK" should appear on the LC display screen.
- Apply the calibration voltage (2.00000 V and 50.00 Hz).
  Follow the procedure below with the Fluke process calibrator:
  - Switch on the unit.
  - Source (Off)
  - V AC: 5.657V `<Enter>` (=2·2V·√2)
  - Press the <`<Enter>` key to switch to sine.
  - Press the blue soft key `<fertig>`
  - Frequency: 50 Hz `<Enter>`
- Press the <**?** > to return to the initial menu.
- Press the <🡇> key to run the calibration.

- The calibration now runs automatically. When it is finished, the calibration factors for L1-L7 appear on the LC display screen.
- The values should be in the range 6154±5%.
(Press <**?**> and <**↓**> in succession until the values of the various inputs are in the desired range. This repeats the actual calibration process. If a satisfactory result can still not be obtained, please observe the following information.)
- Press the < **?** >.
- Set the keyswitch "local/remote“ to local again. A RAM and watchdog test is run now.
- The analog inputs/measuring inputs are now fully calibrated.

The calibration process yields incorrect results

If the calibration factors for the inputs are not in the range 6154±5%, the following may be the cause:

- Interference in the calibration voltage
  – Transpose the lines and/or shield them.
- The connectors, plug connectors or the cable is defective. This can occur with connectors that are continuously used for calibration.
  – Check the connectors and the line and replace them more often.
- If the CPU board is being calibrated for the first time, there may be a defect on the board.
  – Replace the board (service!).

7.4 Testing the interlock conditions,

This test is intended to check the interlocking of the switchgear that the user wants and is required. The two types of interlocking must be taken into account here:

- Bay-level interlocking of specific switchgear and
- station-level interlocking of the bay versus other bays.

The interlock conditions for the bay under test can be found in the order documentation. The interlock conditions specified by the user can be found there.

All possible circumstances must be checked.

7.5 Determining the transformer direction

The connection of the measuring inputs and the correct polarity of the current and voltage transformers or sensors is very important for distance, comparison and directional functions.

In addition to testing the polarity, the transformation ratio and the magnetizing characteristic, the wiring of the transformers/sensors must also be checked during these test.

➯Chapter "6.3.3 Wiring the REF542" on page 6-5

7.5.1 Current transformer

The transformers must have a positive winding.

This can be easily checked with a 9 V battery and an analog DC voltmeter. If the primary coil of the current transformer is connected to the battery, the analog voltmeter connected on the secondary side must show positive. When the battery is disconnected, the voltmeter must measure a negative impulse.

The positive terminal of the battery must be connected to P1 of the primary coil and the positive input of the voltmeter to s1 for this test. The same applies for the negative terminal at P2 of the primary coil and the voltmeter negative input at s2 of the secondary coil.

The test setup for checking the direction of a core is shown in the following figure.

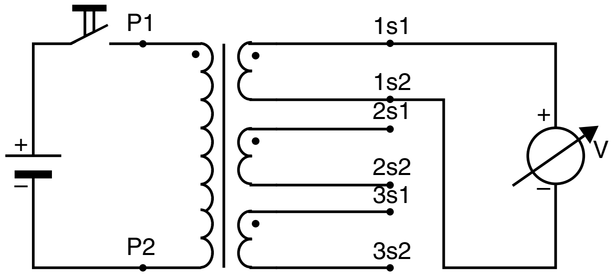


Figure 249: Setup for the polarity test of current transformers

This polarity check, also referred to as patch test, must be run for every core. To guarantee correct operation even with a multicore current transformer with different cores such as protection and measuring cores, it is recommended that the magnetizing characteristic (hysteresis) be recorded. A Variac with appropriately high voltage is connected to the secondary terminals. The flowing current is measured while the output voltage is rising. The characteristic of the measured values, voltage over current, yields the magnetizing characteristic of the core, which can then be compared with the manufacturer's data.

The transformation ratio of the current transformer cores is checked with a special primary current feed device. The feed device is primarily connected to the current transformer and the secondary value is measured at the secondary terminals of the transformer or at the protective cabinet with an ampere meter.

7.5.2 Voltage transformer

The same polarity test or patch test is run with voltage transformers. The difference is that the battery is connected to the secondary side and the analog DC test instrument to the primary coil of the voltage transformer.

The test setup for checking a core is shown in the following figure.

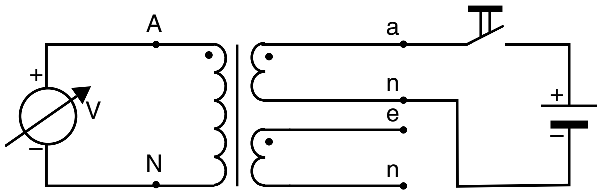


Figure 250: Polarity test of voltage transformers.

Every core must be tested here.

If the Variac described in the current transformer section for recording the magnetizing characteristic has a sufficiently high output voltage (e.g. 500 V), it can also be used to run a qualitative test of the voltage transformer transformation ratio. The Variac voltage is applied to the primary side of the voltage transformer and a voltmeter is used to measure the secondary voltage at the corresponding transformer or protective cabinet terminals.

7.5.3 Current sensor

Because the current sensor, the Rogowski coil, is an air-core coil, it must be subjected to the same polarity test as the current transformers.

The test design is shown in the following diagram. A higher voltage value may be required for the battery.

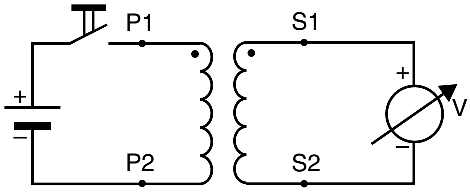


Figure 251: Polarity test of current sensors (Rogowski coil)

The transformation ratio is tested exactly as with a current transformer. The display in the REF542 protection and control unit can also be checked at the same time. It is not necessary to record a magnetizing characteristic with the Rogowski coil, because it is an air-core coil with no saturation characteristics.

7.5.4 Voltage sensor

The polarity of the voltage sensor, which is a resistive precision voltage divider, is chekked as shown in the following diagram. The correct polarity of the voltage is measured by applying an appropriate DC voltage (e.g. 24V/DC) to the secondary terminals. The auxiliary voltage source can also be used if the transformation ratio is very high.

The transformation ratio of the resistive splitter is checked at the same time.

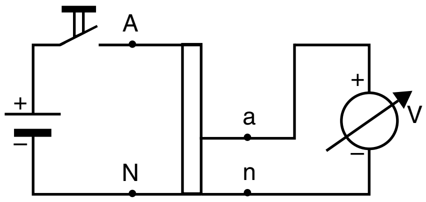


Figure 252: Polarity test of voltage sensors (resistive splitter).

7.6 Testing the measured value recording

Proper functioning of the transformers and sensors is important for proper functioning of the REF542. The measured-value processing of the unit and the set rated values must be tested for this reason.

The line currents and conductor-ground voltages must be taken as measured input quantities. All other measured values are quantities derived from them.

Test as follows:

- Check whether the set rated values match the rated values required by the user (in the order documentation).
  - If necessary, load the application into the PC from the REF542.
    ↳ Chapter "4.5.1.13 Receiving an application from the REF542" on page 4-11
  - Select the menu item `Main Menu/Settings/Connections/Analog Inputs` in the configuration program. The rated values are shown in the dialog window that appears and, if necessary, changed.
    ↳Chapter "5.3.4.1 Setting the rated network values" on page 5-7
- Test the wiring of the transformers or sensors
  ↳ Chapter "6.3.3 Wiring the REF542" on page 6-5
- Disconnect the transducers or sensors from the REF542.
  The current transformers must be short-circuited, combination sensors disconnected.

- Connect the test set to the REF542. The relevant current and voltage signals are applied to the transformer inputs (core-balance or closed U-core transformer) or to the sensor terminal adapter.
- Set the required rated values on the test set

Transducer/sensor	Rated value
Current transformer	1 A or 5 A
Voltage transformer	100 V or 110 V
Rogowski coil	150 mV
Voltage sensor	2V / √3

Note When testing combination sensors with measurements, ensure the precision of the test set in this range.

- To test the phase sequence, set every phase separately to the rated value and then check the value on the LC display screen. At the end reset the phase to zero.
- Generate one symmetrical system each for current and voltage with the rated values.
- Check the calculated values.
  A three-phase current and voltage tester is recommended to test the power.
  By changing the phase angle between the current and the voltage system the calculation of reactive and effective values and of cos φ can be checked.

Possible sources of error in the event of an erroneous display on the LC display screen

Always check the settings on the test set first!

Current values are displayed too low:

- The transducers/combination sensors are still switched parallel to the test set.
- An incorrect transformation ratio was set when configuring the analog inputs.

Current values are displayed too high:

- An incorrect transformation ratio was set when configuring the analog inputs.

Voltage values are displayed too low:

- An incorrect transformation ratio was set when configuring the analog inputs.
- Incorrect phase differences were input when testing the external phase-to-neutral voltages.
- The polarity or the transformer terminal of a transducer were reversed.

Voltage values are displayed too high:

- An incorrect transformation ratio was set when configuring the analog inputs.

Power and energy values are not displayed:

- The power calculation is not configured.
- The rated values for current and/or voltage are two high.
- Only test with current OR with voltage.

Power and energy values are shown with the wrong sign

- An incorrect metering system was configured.
- The current or voltage direction is incorrectly set.
- Current or voltage transformers are connected in the wrong direction.
- The phase sequence of the current and/or voltage system is incorrect.

Power values are incorrect

- A three-phase test is not conducted.
- The phase-angle between the current and the voltage system is incorrect; the systems are not congruent.
- The phase difference between the currents and voltages is not 120°.
- The phase sequence of the current and/or voltage system is incorrect.

7.7 Testing the protective functions

To ensure that no damage has been caused by transport or setup and installation of the protection equipment and systems, secondary tests are run on the REF542 protection and control unit with the configured protective functions.

Warning! **Always observe the applicable safety regulations when conducting the secondary test with an appropriate test set.**

Caution **When testing ensure that the limit values of the measuring inputs and the auxiliary voltage supply are not exceeded.**

↳Chapter "3.6 Overview of the technical data" on page 3-45

Secondary function tests are recommended during commissioning of the protective functions.

The activated and configured automatic autoreclosure and also other functions of the complete system and the power circuit-breaker should be tested to ensure safe operation of these functions.

Defined circuit diagram for directional protective function

The following diagram shows a circuit diagram for the REF542. It is specified for a transformer terminal, but is equally valid for sensors. Circuit diagrams for different applications can also be found in the appendix.

↳Chapter "11.4 Typical examples of sensor or transducer connections" on page 11-14

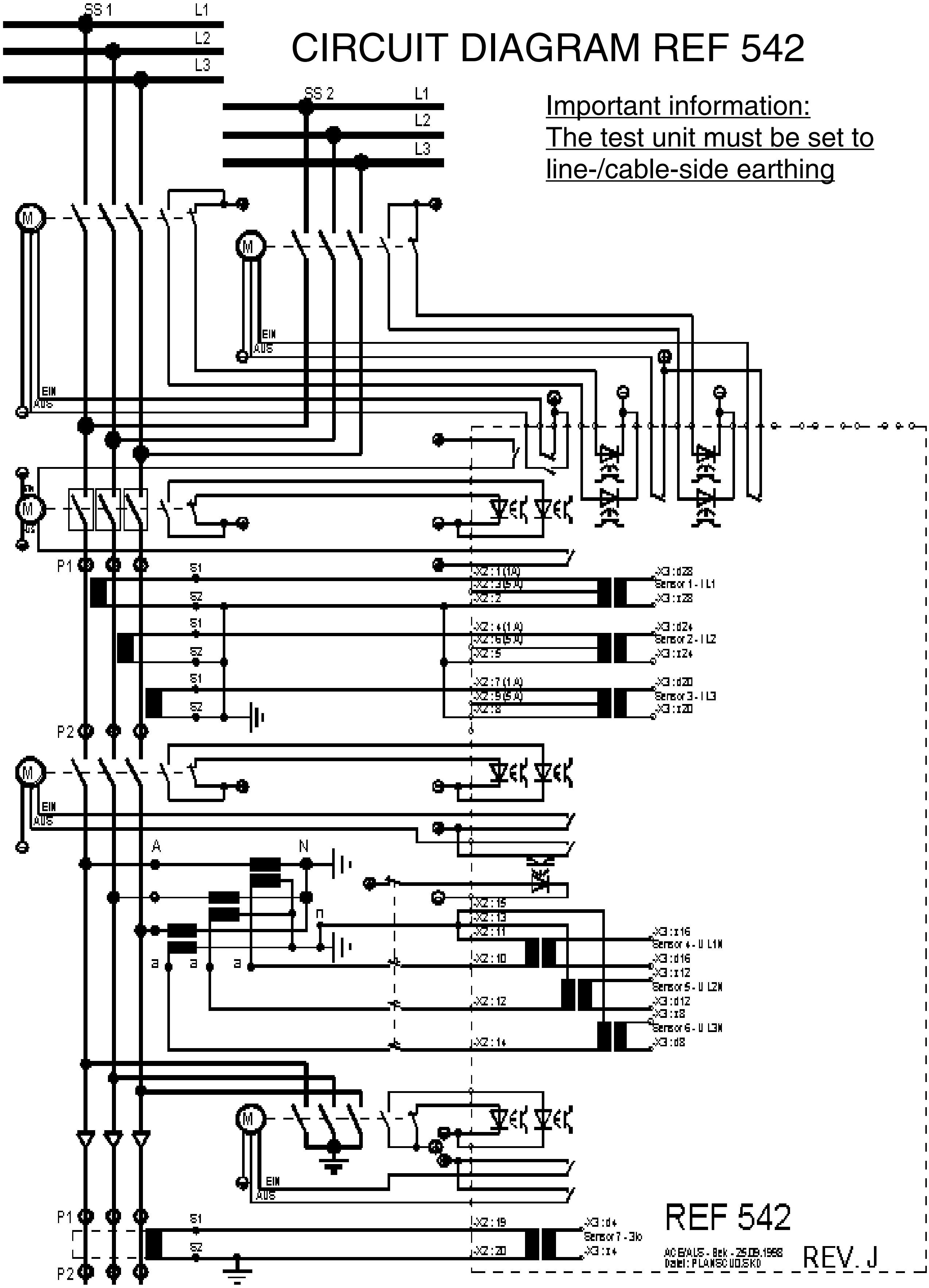


Figure 253: Standard circuit diagram for operating characteristics of the directional functions

General procedure for testing the protective functions

The following points are particularly important for protective functions that must work in connection with a set direction or energy flow quantity.

- Checking the sensor and transformer connections and wiring check of the station circuit diagram,

  ↳Chapter "6.3.3 Wiring the REF542" on page 6-5
- Determining the transformer direction

  ↳Chapter "7.5 Determining the transformer direction" on page 7-4
- Connection and documentation of the test set

  ↳Chapter "7.2.1 Converter for the sensor terminal adapter" on page 7-1
- Testing and documentation of the measured value recording,

  ↳Chapter "7.6 Testing the measured value recording" on page 7-6
- Setting parameters for the protective functions,

  ↳Chapter "5.4.8.1 Inrush" on page 5-91 to

  ↳Chapter "5.4.12.6 Synchrocheck" on page 5-199
- Recording the test settings
  To monitor the test of the correct direction of the specific protective functions in comparison with the measured power and power factors in the event of a later primary test, the following information should be documented in the secondary tests:
  - Directional setting of the test set
  - Measurement of the effective and reactive power and of the cos φ factor
  - Directional setting of the measurement and protective functions

  The default test records can be used to record them:

  ↳Chapter "7.8 Protection test records" on page 7-16

Setting parameters for the directional protective functions

Corresponding effective and reactive power and power factor values and directions are assigned to the directional sector of the protective functions. The setup of the metering system, i.e. the power direction, is significant here.

↳Chapter "5.3.6 Calculated values" on page 5-12

Note — The reference arrow system "load" must be selected to determine the direction of the protective functions with the power.

Details are to found in the description of the specific protective function.
The direction of the energy flow must be known for the primary test.

Equipment for commissioning

The REF542 provides the following equipment:

- Display of the tripping page on the LC display screen
  The tripping page shows the data that have resulted in a protective function being tripped.
  ↳Chapter "8.1.4.5 Starting the tripping page" on page 8-7
- Display of the operational measured values on the LC display screen
  The measured values of the line currents and phase voltage are shown on the LC display screen. All other measured values are calculated from the above.
  ↳Chapter "8.1.4.3 Retrieving measured and calculated values" on page 8-5

Note If one of the connections on the REF542 or the polarity of the transformers is changed, the result is a number of options for reversing the direction again and again. THEREFORE:
Document every change made after a primary directional test. If there is any doubt, run the secondary test again.

7.7.1 Testing the current protective functions

When commissioning the current protective functions, secondary functional tests are recommended. The various requirements listed in Chapter "7.7 Testing the protective functions" on page 7-8 and Chapter "5.4.8 Current protective functions" on page 5-90 must be observed.

Response time

The response time of the line currents and the earth current must be tested. The protective function response is shown by the lower LED (protective function status LED) changing color to orange and the protective function message displayed in the status line of the LC display screen. The fault duration should be in the range of the time delay set for that function. In the case of the AMZ current protective functions, ensure that the response time is at 1.14 times the setting value.

Operating time

The operating time value (delay period) for definite time current protective functions should be tested with a test current increasing by steps from zero to twice the quantity set as the starting value.

When testing AMZ current protective functions, the formulas and families of curves can be found in Chapter "11.5 IDMT protection and earthfault IDMT protection families of curves" on page 11-20.

Note The relay period must also be added to the operating times determined from the current-time characteristics. (Binary input/output board with transistor relays: 15 ms, and with conventional relays: 30 ms)

Directional unit

When testing the directional functions with the line currents, the correct phase voltage must be applied in each case. The limit angle between current and voltage should be determined at twice the starting value of the current and the rated value of the voltage.

The directional earthfault protection (GFP) in cos φ and sin φ circuits must be tested in the same way.

7.7.2 Testing the voltage protective functions

When commissioning the voltage protective functions, secondary functional tests are recommended. The various requirements listed in Chapter "7.7 Testing the protective functions" on page 7-8 and Chapter "5.4.9 Voltage supervision" on page 5-125 must be observed.

Response time

The response time for the external phase-to-neutral voltages and for the neutral voltage in the event of earthfaults must be tested. Ensure that the voltage protective function can be selected to operate as overvoltage or undervoltage protection. The protective function response is shown by the lower LED (protective function status LED) changing color to orange and the protective function message displayed in the status line of the LC display screen. The fault duration should be in the range of the time delay set for that function.

Operating time

The operating time value (delay period) for overvoltage protective functions should be tested with a test current increasing by steps from zero to 1.2 times the quantity set as the voltage response value. However, undervoltage protective functions should be tested with a test voltage declining by steps from the rated value to 0.8 times the voltage response value.

7.7.3 Testing the motor protective functions

When commissioning the voltage protective functions, secondary functional tests are recommended. The various requirements listed in Chapter "7.7 Testing the protective functions" on page 7-8 and Chapter "5.4.10 Motor Protection" on page 5-143 must be observed.

7.7.3.1 Thermal overload

The thermal overload protective function has a temporal course, as described in Chapter "5.4.10.1 Thermal overload protection" on page 5-144.

The trip time depends on the momentary stored temperature in the REF542 and on the supply current. Because there are three power system ranges, each of which has one time constant, the trip time also depends on the power system range.

The ranges are divided as follows depending on the rated motor current I_{MN}:

- $0.10 \cdot I_{MN} < I < 2{,}00 \cdot I_{MN}$ (time constant TC normal active)
- $I > 2.00 \cdot I_{MN}$ (time constant TC fault active for rotor-critical cases)
- $I > 0.10 \cdot I_{MN}$ (time constant TC Off active for cooling when stopped)

The operating time should be determined with a test current equivalent to 6 times the rated motor current. The cooling period is determined by the time constant when stopped. A trip is shown by the lower LED (protective function status LED) changing color to orange and the protective function message displayed in the status line of the LC display screen.

7.7.3.2 Motor start monitoring

The current-time characteristic of the motor starting monitoring is described and shown in Chapter "5.4.10.2 Motor start" on page 5-148.

The operating time is inversely proportional to the square of the flowing current. The operating time should also be determined here with a test current equivalent to 6 times the rated motor current.

7.7.3.3 Monitoring on blocking rotor

The monitoring on blocking rotor protective function is tested in the same way as an overcurrent definite time, as described in Chapter "7.7.1 Testing the current protective functions" on page 7-11. If the signal "rotor blocked“ is simulated, the tripping can be blocked.

↳Chapter "5.4.10.3 Blocking rotor" on page 5-152

A trip is shown by the lower LED (protective function status LED) changing color to orange and the protective function message displayed in the status line of the LC display screen.

7.7.3.4 Number of starts

The number of starts is defined for the warm or cold start. The temperature parameters set for the warm start determine whether a start is warm or cold. This function requires a signal to detect the motor start. The signal may be generated in the function chart.

If the number of starts is exceeded, this is shown by the lower LED (protective function status LED) changing color to orange and the protective function message displayed in the status line of the LC display screen.

7.7.4 Testing the distance protection

When commissioning the distance protective function, a secondary functional test is recommended.

✎Chapter "5.4.11 Distance protection" on page 5-158

Secondary test

The secondary test during commissioning is provided to check the proper and fault-free functioning of the protective function.

Testing the impedance calculation

In the REF542 impedances from all six loops are calculated. A secondary test is recommended to check these measuring loops. When calculating the fault impedance of earth faults, the k_0 factor must be taken into account.

The following set parameters should be checked to test the operating characteristic:

- Setting of the real resistance,
- Setting of the reactive resistance and
- Setting of the zone directional angle δ_1 and δ_2.

Note

The power circuit-breaker should be in an undefined position while the operating characteristic is recorded. The auxiliary voltage for the position message must be shut off for this.
If the power circuit-breaker is in the OFF position during the test, measurement precision and operating time may be influenced.

Response time and operating characteristic

The response times of the voltage-dependent overcurrent starting should be completely specified first. Then the operating characteristic can be tested in accordance with the applicable regulations.

For example, in accordance with VDE the operating characteristic must be tested with constant current and the operating time is determined as twice the setting value of the overcurrent starting.

Switch-on fault/switching on persistent fault

✎Chapter " Switching onto faults" on page 5-171

- Standard operation
  The REF542 reacts here in accordance with its set impedance zones. If a fault is simulated with the secondary test instrument when the power circuit-breaker is switched on simultaneously, the fault will be switched off in the applicable zone time in accordance with the set impedance-time characteristic.

- Use overreach zone
  With this setting the overreach zone is activated for 200 ms when the power circuit-breaker is closed. A fault impedance is placed between the first impedance step and the overreach stage on the test instrument to test it. If the fault current is present within 200 ms after switching on the power circuit-breaker, this results in a tripping as set in the time setting of the overreach zone. If the fault current is present later, it will be tripped in accordance with the set impedance-time characteristic.
- Tripping after general starting
  With this setting the tripping is generated only depending on the general starting. If the fault current is present within 200 ms after switching on the power circuit-breaker, the tripping occurs immediately.

AR – autoreclosure

↳Chapter "Autoreclosure" on page 5-165

An autoreclosure can only be tested with a circuit breaker image or the power circuit-breaker itself. The proper functional sequence should be tested here; for example, how the overreach zone operates with an autoreclosure on a line unit that is overhead cable only or with a mixed unit comprising cable and overhead cable.

Signal comparison protection

↳Chapter "Signal comparison protection" on page 5-169

In this function a fault is simulated within the first zone. If the loop for signal comparison remains closed, a trip with low delay period is formed. If the loop is open, i.e. a fault outside the protection zone, the tripping only occurs with the first time-level delay.

The protective function response is shown by the lower LED (protective function status LED) changing color to orange and the protective function message displayed in the status line of the LC display screen. The fault duration should be in the range of the time delay set for that function.

7.7.5 Testing the supplementary protective functions

When commissioning the voltage protective functions, secondary functional tests are recommended. The various requirements listed in Chapter "7.7 Testing the protective functions" on page 7-8 and Chapter "5.4.12 Additional protective functions" on page 5-186 must be observed.

Note: The protective function response is shown by the lower LED (protective function status LED) changing color to orange and the protective function message displayed in the status line of the LC display screen.

Thermal supervision

↳Chapter "5.4.12.1 Thermal supervision" on page 5-186

The thermal supervision function receives the measured values over the process bus. These values must be checked with the substation and the measured value encoders.

Unbalanced load

↳Chapter "5.4.12.2 Unbalanced load" on page 5-189

The unbalanced load function is executed in one step and runs an assymetrical current test. The unbalanced load components of the currents are not measured but the rms values of the line currents are compared. To activate the function a minimum line current must be present. The trip value is derived as the amplitude of the difference of the currents based on the smaller of the two compared line currents. If this trip value is exceeded, the protective function is started. If the trip value is exceeded for at least the set delay period, a trip signal is generated.

The following example shows the calculation of the negative-phase current for the line currents I_{L1} and I_{L2}:

$$I_{asy} = \frac{|I_{L1}| - |I_{L2}|}{MIN\{I_{L1}, I_{L2}\}}$$

I_{asy}:	Asymmetrical current
I_{L1}:	Current rms value in conductor L1
I_{L2}:	Current rms value in conductor L2
MIN $\{I_{L1}, I_{L2}\}$:	Minimum of I_{L1} and I_{L2}

Directional Power

↳Chapter "5.4.12.3 Directional power" on page 5-192

The directional power supervision is based on comparing the calculated active power with a configured limit value. The rated active power (`P nom`) that must be set is based on the three-phase calculated active power and therefore should always be subjected to a three-phase balanced scheme. The active power is determined from the voltage and current measured quantities, which are always based on the rated quantities of the analog inputs.

Low load

↳Chapter "5.4.12.4 Low load" on page 5-194

The low load supervision is based on comparing the active power with the configured response time. If the calculated active power falls below the response time, the protective function will be activated. If the response time falls below for at least the time set in the parameters, it will be tripped. It must be noted that the set pick-up current (`I min`) must be exceeded to activate the low load supervision.

Frequency supervision function

↳Chapter "5.4.12.5 Frequency supervision" on page 5-197

The frequency limits of the frequency monitoring should be tested by raising and lowering the frequency on the test instrument.

↳Chapter "11.7.4 Calculation of the frequency" on page 11-33

Synchrocheck

↳Chapter "5.4.12.6 Synchrocheck" on page 5-199

The synchrocheck tests the external line voltages of the systems that are to be switched in parallel. A closing command is generated if the differences of the voltage amplitudes, the phase difference and the frequencies vary within preset limits for a specified period. The closing command enables the switching operation to be released to couple the separate systems. A test instrument with two voltage systems that can be set separately is required.

7.8 Protection test records

The following pages have the test records that were addressed in Chapter "7.7 Testing the protective functions" on page 7-8 and its subsections.

The test record itself indicates what protocol can be used for what protective function.

TEST RECORD						
Station:						
Out-feed:						
Current transformer ratio:		A		A		
Closing current blocking		Parameter set 1		Parameter set 2		
	Setting range:	Setting	Response time	Setting	Response time	Remarks
m · I>	2.0 - 8.0					
n	3.0 - 4.0					
Time	200+t_{relay}…1 000 000 ms					
m · I>						
Time						
0.65 · m · I>						
Time						
n · I>>						
Time						
I>						
Time						
I>>						
Time						
Overcurrent low I>						
Start val. conductor L1, L2, L3	0.05…40.0 · I_{nREF}					
Time	20+t_{relay}…300 000 ms					
Overcurrent high I>>						
Start val. conductor L1, L2, L3	0.05…40.0 · I_{nREF}					
Time	20+t_{relay}…300 000 ms					
Overcurrent inst. I>>>						
Start val. conductor L1, L2, L3	0.1…40.0 · I_{nREF}					
Time	20+t_{relay}…300 000 ms					

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
Voltage transformer ratio:		kV			kV		
Overcurrent directional low.	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Angular range
Directional setting							
Current value phase L1 forwards							
Voltage phase L1							
Time phase L1							
Current value phase L2 forwards							
Voltage phase L2							
Time phase L2							
Current value phase L3 forwards							
Voltage phase L3							
Time phase L3							
Real power measurement							
Reactive power measurement							
Current value phase L1 forwards							
Voltage phase L1							
Time phase L1							
Current value phase L2 backwards							
Voltage phase L2							
Time phase L2							
Current value phase L3 backwards							
Voltage phase L3							
Time phase L3							
Real power measurement							
Reactive power measurement							
Test set settings							
Direction or fault code							
Earthing current/voltage transformer							

Continued next page

TEST RECORD continued							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
Voltage transformer ratio:		kV			kV		
Overcurrent directional high	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Angular range
Directional setting							
Current value phase L1 forwards							
Voltage phase L1							
Time phase L1							
Current value phase L2 forwards							
Voltage phase L2							
Time phase L2							
Current value phase L3 forwards							
Voltage phase L3							
Time phase L3							
Real power measurement							
Reactive power measurement							
Current value phase L1 backwards							
Voltage phase L1							
Time phase L1							
Current value phase L2 backwards							
Voltage phase L2							
Time phase L2							
Current value phase L3 backwards							
Voltage phase L3							
Time phase L3							
Number of autoreclosure tries							
Fault time 1							
Dead time 1							
Fault time 2							
Dead time 2							
Blocking time							

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
Overcurrent low							
Start value phase L1							
Start value phase L2							
Start value phase L2							
Time							
Overcurrent high							
Start value phase L1							
Start value phase L2							
Start value phase L3							
Time							
Number of autoreclosure tries							
Fault time 1							
Dead time 1							
Fault time 2							
Dead time 2							
Blocking time							
Overcurrent instantaneous							
Start value phase L1							
Start value phase L2							
Start value phase L3							
Time							
Number of autoreclosure tries							
Fault time 1							
Dead time 1							
Fault time 2							
Dead time 2							
Blocking time							

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
IDMT							
Start value IEB phase L1							
Start value IEB phase L2							
Start value IEB phase L3							
IDMT curve							
2 x phase L1							
Time							
2 x phase L2							
Time							
2 x phase L3							
Time							
4 x phase L1							
Time							
4 x phase L2							
Time							
4 x phase L3							
Time							
8 x phase L1							
Time							
8 x phase L2							
Time							
8 x phase L3							
Time							
Curve setting							
Setting: k-factor							

TEST RECORD							
Station_							
Out-feed:							
Current transformer ratio:		A			A		
	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
Earthfault low							
Start value phase N							
Time							
Earthfault high							
Start value phase N							
Time							
Number of autoreclosure tries							
Fault time 1							
Dead time 1							
Fault time 2							
Dead time 2							
Blocking time							

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
Voltage transformer ratio:		kV			kV		
Earthfault directional low	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Angular range
Directional setting							
Current value phase N forwards							
Voltage phase N							
Time phase N							
Real power display							
Reactive power display							
Current value phase N forwards							
Voltage phase N							
Time phase N							
Earthfault directional high							
Directional setting							
Current value phase N forwards							
Voltage phase N							
Time phase N							
Real power display							
Reactive power display							
Current value phase N backwards							
Voltage phase N							
Time phase N							
Number of autoreclosure tries							
Fault time 1							
Dead time 1							
Fault time 2							
Dead time 2							
Blocking time							
Direction or fault code	Test apparatus						
Grounding current/voltage trans- former	Test apparatus						

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
Earthfault IDMT							
Start value I_{EB0} phase N							
Earthfault IDMT curve							
2 x I_{EB0} phase N							
Time							
4 x I_{EB0} phase N							
Time							
8 x I_{EB0} phase N							
Time							
Curve setting							
Adjustment k-factor							

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		kV			kV		
	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
Overvoltage low							
Start value phase L1							
Start value phase L2							
Start value phase L3							
Time							
Overvoltage high							
Start value phase L1							
Start value phase L2							
Start value phase L3							
Time							
Number of autoreclosure tries							
Fault time 1							
Dead time 1							
Fault time 2							
Dead time 2							
Blocking time							
Overvoltage instantaneous							
Start value phase L1							
Start value phase L2							
Start value phase L3							
Time							
Number of autoreclosure tries							
Fault time 1							
Dead time 1							
Fault time 2							
Dead time 2							
Blocking time							

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		kV			kV		
	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
Undervoltage low							
Start value phase L1							
Time							
Start value phase L2							
Time							
Start value phase L3							
Time							
Undervoltage high							
Start value phase L1							
Time							
Start value phase L2							
Time							
Start value phase L3							
Time							
Number of autoreclosure tries							
Fault time 1							
Dead time 1							
Fault time 2							
Dead time 2							
Blocking time							
Undervoltag instantaneous							
Start value phase L1							
Time							
Start value phase L2							
Time							
Start value phase L3							
Time							

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		kV			kV		
	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
Residual voltage low							
Start value phase N							
Time							
Residual voltage high							
Start value phase N							
Time							

TEST RECORD						
Station:						
Out-feed:						
Current transformer ratio:		A		A		
	Setting	Response time	Start temperature	Tripping page		Remarks
Thermal overload						
Rated motor current						
Warm-up time constant						
Current value phase L1						
Time						
Cooling time constant						
Current value phase L1						
Time						
Startup warm-up time constant						
Current value phase L1						
Time						
Cooling time constant						
Current value phase L2						
Time						
Warm-up time constant						
Current value phase L2						
Time						
Startup warm-up time constant						
Current value phase L2						
Time						
Cooling time constant						
Current value phase L3						
Time						
Warm-up time constant						
Current value phase L3						
Time						
Startup warm-up time constant						
Current value phase L3						
Time						

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
Motor start							
Operational rated motor current							
Motor starting current							
Current value phase L1							
Current value phase L2							
Current value phase L3							
Sys.int. $I^2_{START} \cdot T_{START} / I^2_{ME}$							
Current value phase L1							
Current value phase L2							
Current value phase L3							
Starting time							

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
Blocking rotor protection							
Operational rated motor current							
Blocked rotor starting							
Current value phase L1							
Trip time							
Current value phase L2							
Trip time							
Current value phase L3							
Trip time							
Blocking check							

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
Number of starts							
Number of cold starts							
Number of warm starts							
Limit temperature cold/warm							
Reset period							

REF 542 default settings: distance protection 1/3							I_n:			A				U_n:		V	
Station							Client										
Test apparatus:												Test set settings					
Parameter set:																	
Zone	Phase	R	X	Z	j	t	DR	DX	DZ	Dj	Dt						
1	L1-0																
1	L2-0																
1	L3-0																
1	L1-L2																
1	L2-L3																
1	L3-L1																
1	L1-L2-L3																
2	L1-0																
2	L2-0																
2	L3-0																
2	L1-L2																
2	L2-L3																
2	L3-L1																
2	L1-L2-L3																
3	L1-0																
3	L2-0																
3	L3-0																
3	L1-L2																
3	L2-L3																
3	L3-L1																
3	L1-L2-L3																

Continued next page

Zone	Phase	R	X	Z	j	t	DR	DX	DZ	Dj	Dt						
REF 542 default settings: distance protection 2/3							I_n: A							U_n: V			
Station							Client										
Test apparatus:												Test set settings					
Parameter set:																	
Overreach	L1-0																
Overreach	L2-0																
Overreach	L3-0																
Overreach	L1-L2																
Overreach	L2-L3																
Overreach	L3-L1																
Overreach	L1-L2-L3																
AR	L1-0																
AR	L2-0																
AR	L3-0																
AR	L1-L2																
AR	L2-L3																
AR	L3-L1																
AR	L1-L2-L3																
Backup directional	L1-0																
	L2-0																
	L3-0																
	L1-L2																
	L2-L3																
	L3-L1																
	L1-L2-L3																

Continued next page

REF 542 default settings: distance protection 3/3 — I_n: A — U_n: V

Station — Client

Test apparatus: — Test set settings

Parameter set:

Zone	Phase	R	X	Z	j	t	DR	DX	DZ	Dj	Dt						
Backup without directional	L1-0																
	L2-0																
	L3-0																
	L1-L2																
	L2-L3																
	L3-L1																
	L1-L2-L3																
Autoreclosure																	
AR	L1-0																
AR	L2-L3																
AR	L1-L2-L3																
Overreach	L1-0																
Overreach	L2-L3																
Overreach	L1-L2-L3																
Switch-on fault																	
Zone	Phase																
		$I>/I_0>$	IF>	U<													
Overreach/ Backup without directional	L1-0																
	L2-L3																
	L1-L2-L3																
Signal comparison logic active for signal comparison inactive see zone 1 values above																	
1	L1-0																
1	L2-L3																
1	L1-L2-L3																

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
Thermal supervision	Parameter set 1			Parameter set 2			
	Setting	Response time		Setting	Response time		Remarks
Warning temperature							
Time							
Trip temperature							
Time							

TEST RECORD				
Station:				
Out-feed:				
Current transformer ratio:		A		
	Parameter set 1			
	Setting	Response time	Tripping page	Remarks
Unbalanced load				
Difference in phase L1-L2				
Current value phase L1				
Current value phase L2				
Current value phase L3				
Time				
Difference in phase L1-L3				
Current value phase L1				
Current value phase L2				
Current value phase L3				
Time				
Difference in phase L3-L2				
Current value phase L1				
Current value phase L2				
Current value phase L3				
Time				

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
Voltage transformer ratio:		kV			kV		
Directional Power	Setting	Response time	Tripping page	Angle	Response time	Tripping page	Angle
Directional setting							
Real power setting							
Current value phase L1 forwards							
Voltage phase L1							
Current value phase L2 forwards							
Voltage phase L2							
Current value phase L3 forwards							
Voltage phase L3							
Time power direction							
Real power measurement							
Reactive power measurement							
Current value phase L1 backwards							
Voltage phase L1							
Current value phase L2 backwards							
Voltage phase L2							
Current value phase L3 backwards							
Voltage phase L3							
Time power direction							
Real power measurement							
Reactive power measurement							
Test set settings							
Direction or fault code							
Grounding current/voltage transformer							

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		A			A		
Voltage transformer ratio:		kV			kV		
Low load	Setting	Response time	Tripping page	Angle	Response time	Tripping page	Angle
Real power setting							
Current value phase L1							
Voltage phase L1							
Current value phase L2							
Voltage phase L2							
Current value phase L3							
Voltage phase L3							
Time protection against low load							
Real power measurement							
Reactive power measurement							
Test set settings							
Direction or fault code							
Grounding current/voltage transformer							

TEST RECORD							
Station:							
Out-feed:							
Current transformer ratio:		kV			kV		
Frequency supervision	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
Frequency band							
Rated frequency:							
Overfrequency							
Time							
Underfrequency							
Time							

TEST RECORD							
Station:							
Out-feed:							
Voltage transformer ratio:		kV			kV		
Synchrocheck	Parameter set 1			Parameter set 2			
	Setting	Response time	Tripping page	Setting	Response time	Tripping page	Remarks
Voltage L1 network 1							
Voltage phase L1 network 1							
Voltage L2 network 1							
Voltage phase L2 network 1							
Voltage L12 network 1							
Voltage phase L12 network 1							
Voltage L1 network 2							
Voltage phase L1 network 2							
Voltage L2 network 2							
Voltage phase L2 network 2							
Voltage L12 network 2							
Voltage phase L12 network 2							
Voltage difference							
Phase difference							
Synchrocheck time							
Load check							
Test set settings							
Direction or fault code							
Grounding current/voltage transformer							

7.9 Communications test

Proper functioning of communications is important when using an interbay bus to send data to the control system.

The test is the same regardless of the interbay bus version in use. The messages to the control system (measured values, switching states, alarms …) for the bay under test can be found in the project documentation. The messages specified by the user are specified there.

All relevant signals must be generated in the bay and checked at the control system operating terminal to ensure that the messages have been received correctly.

7.10 REF542 switch-on process

The REF542 startup, i.e. the processes that begin with the application of the auxiliary voltage and end with the unit in a fully functional state, run in the following sequence:

- Switch on the auxiliary voltage, the green READY LED lights.
- Initialization of controller, protection and communications:
  - Basic initialization of the unit.
- Initialization of controller, protection and communications configuration:
  - Loading controller, protection and communications configuration:
  - Initialization of configuration-dependent parts (protection and controller)
  - Read saved quantities
    (operating hours, energy, fault records …)
  - Version check (If the MicroController and the protection and measuring unit, DSP, do not match, a message will be output to the status line on the LC display screen)
  - Load the configuration from the EEPROM into the DSP.
- Start protection and controller.
- Approximately 10 seconds after activation of the auxiliary voltage:
  - Open binary and analog inputs and outputs. The protection is active from now on. The interlocking status LED and the protective function status LED show green.
  - Starting the function chart
  - If the SPA bus is used as the interbay bus, communications begin now.
- Initialization of communications is complete. If the MVB is used as the interbay bus, communications begin about 1 minute after activation of the auxiliary voltage.

Note During the function chart start all connections are set to the logical “0“ state. To enable the application to reach a stable state, there should be a delay in releasing the binary outputs; for example, by delaying release of the blocking input at the switching objects.

7.11 Commissioning with a replacement EPROM

Caution **After replacing an EPROM the analog inputs/measuring inputs must be calibrated!**

The following steps are required for commissioning the REF542 if the EPROMs are also replaced.

- Replace the EPROMS on the CPU board. Depending on the design there are one or two EPROMS for the MC (microcontroller: Processor for controller and messages) and one EPROM for the DSP (Digital Signal Processor: Processor for protection and measuring) are required. They must be removed with a special EPROM tool to avoid damaging the modules.
  ↳Chapter "3.4.1 CPU Board 1" on page 3-14
  ↳Chapter "3.4.2 CPU board 2" on page 3-16
- Calibrate the analog inputs (measuring inputs) on the REF542.

  ↳Chapter "7.3 Calibrating the analog inputs (measuring inputs)" on page 7-3
- Switch off the miniature circuit breakers on the controller voltage to prevent unwanted switching operations.
- Transfer the application to the REF542.

  ↳Chapter "4.5.1.12 Sending the application to the REF542" on page 4-10
- Test the interlocking: Only the switching operations defined in the function chart may be conducted.
  ↳Chapter "7.4 Testing the interlock conditions," on page 7-4
- Establish the connection of the REF542 analog inputs/measuring inputs to the test instrument (e.g. Omicron test sets).
- Feed in the rated values.

Transformer/sensor	Rated value
Current transformer	1 A or 5 A
Voltage transformer	100 V or 110 V
Rogowski coil	150 mV
Voltage sensor	$2V / \sqrt{3}$

A three-phase current and voltage system must be simulated for test purposes. The above rated values simulate the rated load of the bay.

- Check the display on the upper section of the LC display screen on the REF542:
- Voltage or current displays must show rated load. Real and reactive power and also phase difference cos φ must be shown if they have been configured. In addition, note the signs, which depend on the configured metering system and the transformer assignment.
- Connect the REF542 digital messages to the test instrument. Depending on the substation type, the digital messages can be specifically configured and can be tapped (e.g. at the terminal strip in the switchbox or directly at the power circuit-breaker).
- Digital messages are:
  - LS OFF,
  - LS ON (if an automatic autoreclosure has been configured) and
  - G St (general starting, only if distance protection has been configured!).

- The malfunction simulation should now be run with the test instrument.
- Reset the following pages after the test has been completed:
  - Fault record
  - Tripping page
  - Circuit breaker data
  - Energy values and
  - Maximum values.

  ↳Chapter "8.1.6.6 Resetting the quantities saved in the unit" on page 8-23

7.12 Commissioning without replacing EPROMs

The following steps are required for commissioning the REF542:

- Determine the device software versions in the REF542:
  - Set the keyswitch "input/operation“ to the input position.
  - Set the keyswitch "local/remote“ to the local position.
  - Click the <**?**> button to view the service page with the version information.
  - Check the version numbers for whether the EPROMs and the configuration software match.
- Import the current configuration settings from the REF542 to the PC with the configuration software. Save the configuration settings.

  ↳Chapter "4.5.1.13 Receiving an application from the REF542" on page 4-11
- Connect the REF542 analog inputs/measuring inputs to the test instrument (e.g. Omicron test sets).
- Feed in the rated values.

Transformer/sensor	Rated value
Current transformer	1 A or 5 A
Voltage transformer	100 V or 110 V
Rogowski coil	150 mV
Voltage sensor	2V / √3

A three-phase current and three-phase voltage system must be simulated for test purposes. The above rated values simulate the rated load of the bay.

- Check the display on the upper section of the LC display screen on the REF542:
- Voltage and current displays must show rated load. Real and reactive power and also phase difference cos φ must be shown if they have been configured. In addition note the signs, which depend on the configured metering system and the transformer assignment.
- Connect the REF542 digital messages to the test instrument. Depending on the substation type, the digital messages can be specifically configured and tapped (e.g. at the terminal strip in the low-voltage box or directly at the power circuit-breaker).
- Digital messages are:
  - LS OFF,
  - LS ON (if automatic autoreclosure has been configured) and
  - G St (general starting, if distance protection has been configured!).

- The malfunction simulation should now be run with the test instrument.
- Reset the following pages after the test has been completed:
  - Fault record
  - Tripping page
  - Circuit breaker data
  - Energy values and
  - Maximum values.

8 Operation and Maintenance

The following section and its subsections contain information on:

- The control elements of the local command unit (LCU)
- The different operating modes of the LCU
- The control options available in the various operating modes
- The different descriptions of the protective functions and their parameters in the configuration program and on some pages that can be shown on the LC display screen
- Regular tests that should be run on the REF542
- The maintenance schedule
- The durability of single components of the REF542.

8.1 Operating the LCU

The next subsection shows what the operator needs to know to work with the local command unit. Additional information can be found in the referenced sections.

✎Chapter "1.2.2 Special designations in the LCU documentation" on page 1-6
✎Chapter "3.5 Principles of LCU control" on page 3-42

Table 45: Technical data of the operator view and the control elements

General Data			
	LEDs on the control panel of the REF542	1 Ready LED not configurable color: green	Signals that the REF542 is ready for operation
		1 protective function status LED not configurable color: green orange red	No protective function activated One protective function activated One protective function tripped
		1 interlocking status LED not configurable color: green red	No interlocking violation Interlocking violation; Illegal switching operation
		1 ALARM LED freely configurable color: black (off) red	
		7 LEDs freely configurable color: black (off) green orange red	
	Remote communications	Interface: RS232 (9-pin)	
		Transmission speed: 9600 bit/s	

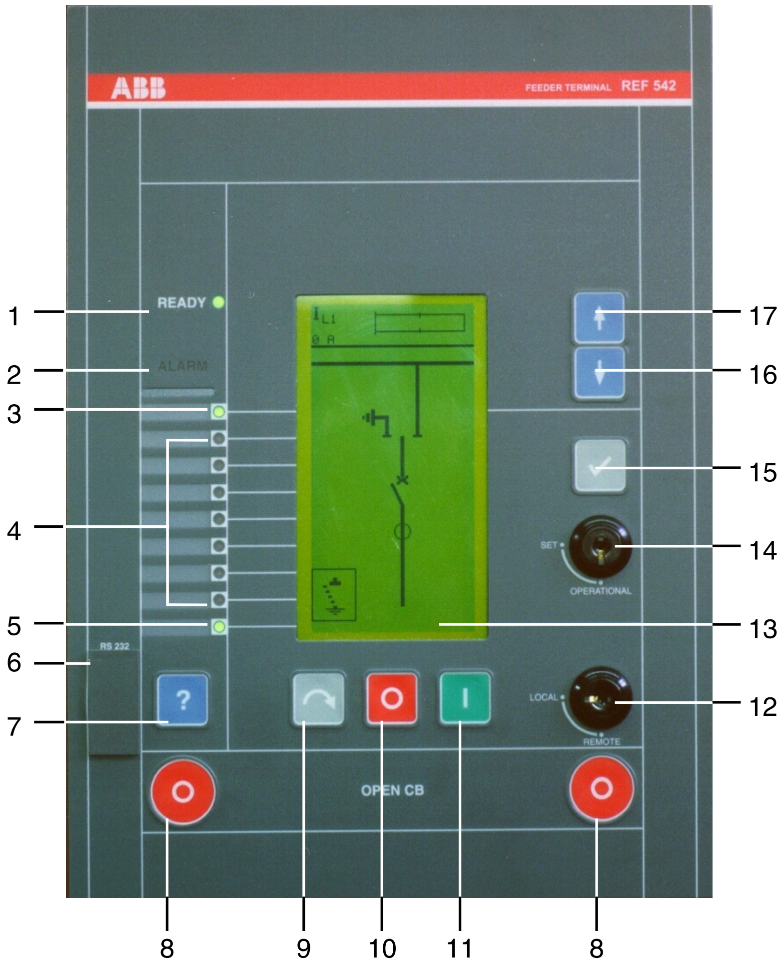
8.1.1 The control elements of the LCU

Depending on the equipment option, the control panel of the REF542 local command unit has a backlit LC display screen. LC here stands for liquid crystal and describes the functional principal of the display screen. It has a resolution of 128 x 256 pixels and enables functions such as the user-friendly menu operation and the display of up to eight switchgear items in one mimic diagram. The editor for the LC display screen is used to configure the mimic diagram in accordance with the equipment being monitored.

↳Chapter "5.3.7 Display" on page 5-13

In addition, the front panel of the REF542 has nine keys and two keyswitches plus eleven LEDs (light-emitting diodes). Their configuration is shown in the following illustration. The local command unit is also referred to as the LCU (Local Controlling Unit).

↳Chapter "3.5 Principles of LCU control" on page 3-42



1: Operating LED,

2: Red alarm LED,

3: Interlocking status LED,

4: 7 three-color LEDs,

5: Protective function status LED,

6: RS232-Interface,

7: Key for selecting message texts <**?**>,

8: Danger-Off keys,

9: Key for selecting switchgear <**↘**>,

10: Key for opening the selected switchgear <**O**>,

11: Key for closing the selected switchgear <**O**>,

12: Keyswitch “local/remote“,

13: LC display screen

14: Keyswitch “set/operational“,

15: Acknowledgment key,

16, 17: Page up/page down keys <**↑**>, <**↓**>

Figure 254: REF542 control panel

8.1.2 The operating modes of the LCU

There are three operating modes available for operating the LCU. They can be selected with the two keyswitches: local/remote and operational/set:

- Local-operational
  This is the operating mode of the REF542 with no provision for a higher-order control system. The unit is locally controlled. Information can be scanned and switching operations initiated.
- Local-set
  For example, this mode enables scanning and partial resetting of parameters. The REF542 test mode can also be activated.
- Remote-operational
  In this operating mode the REF542 is operated from a higher-order control system. For example, information can be scanned and switching operations initiated from there.

The combination of the keyswitches "remote-set“ is not allowed and will send an error message to the status line at the bottom of the LC display screen as follows: "Operating mode error. Keyswitch on local or operational“.

There is also the test mode. It is started from the local-set mode if this option was enabled when the application was set up.

↳Chapter "5.3.2 Global Settings" on page 5-2

The test mode control options are described with the "local-set“ mode.

Some functions are available in all operating modes and are explained in the following subsection:

↳Chapter "8.1.3 Functions in all operating modes" on page 8-3.

Other functions depend on the operating mode and are described in the appropriate sections:

↳Chapter "8.1.4 Functions in the mode: Local-operational" on page 8-4,

↳Chapter "8.1.6 Functions in the mode: Local-set" on page 8-17 and

↳Chapter "8.1.5 Functions in mode: Remote-operational" on page 8-15.

Note: Many protective functions and their parameters are labeled differently in the configuration program and on some pages that can be shown on the LC display screen ↳Chapter "8.2 Parameter names" on page 8-24

8.1.3 Functions in all operating modes

The following functions of the LCU are available in every operating mode; and therefore are independent of the position of the keyswitch.

8.1.3.1 Loading a configuration from the PC into the REF542

This function is selected by the configuration software and is independent of the position of the keyswitch.

↳Chapter "4.5.1.12 Sending the application to the REF542" on page 4-10

8.1.3.2 Loading a configuration from the REF542 into the PC

This function is selected by the configuration software and is independent of the position of the keyswitch.

↳Chapter "4.5.1.13 Receiving an application from the REF542" on page 4-11

8.1.3.3 Export of the fault recorder (when configured)

This function is selected by the configuration software and is independent of the position of the keyswitch.

↳Chapter "4.5.1.14 Exporting the fault recorder" on page 4-11

8.1.3.4 Setting the LC display screen contrast

The procedure described below is used to set the contrast of the LC display screen for the lighting conditions at the installation location of the unit.

Increase contrast (darker)

- Press the <✓> and <🡅> keys simultaneously.

Reduce contrast (lighter)

- Press the <✓> and <🡇> keys simultaneously.

8.1.3.5 Deleting the EEPROMs

Deleting the EEPROMs deletes the application completely. Even the values saved in the unit (tripping page, maximum values, fault records …) are deleted. The calibration of the analog inputs is not changed.

Note
It always makes sense to delete the EEPROMs if a new application is to be copied.

- Switch off the REF542 auxiliary voltage. (Usually at the corresponding miniature circuit breakers; depends on where the unit is installed.)
- Press the <🡅> and <🡇> keys and simultaneously switch on the auxiliary voltage again.

8.1.4 Functions in the mode: Local-operational

Note
Please note that all available control options are also described in Chapter "8.1.3 Functions in all operating modes" on page 8-3.

Note
Many protective functions and their parameters are labeled differently in the configuration program and on some pages that can be shown on the LC display screen.
↳Chapter "8.2 Parameter names" on page 8-24

8.1.4.1 Display LED message texts

The message texts of the nine LEDs can be set up as desired in the configuration program (with the exception of the interlocking status and the protective function status LED). They should provide information on what the LED is signaling.

- Press the < **?** >.
  After a few seconds the previous display is shown on the LC display screen again. To keep the message texts on screen for longer, hold the <**?**> key down.

8.1.4.2 Acknowledging messages and alarms

A persistent alarm or a message must be acknowledged, depending on the configuration. Persistent alarms can be detected immediately by the protective function status LED (5) lighting. Persistent messages, which must be acknowledged, remain displayed on the LC display screen in the status line (bottom).

- Press the <**?**> and <✓> keys simultaneously.

An alarm can only be successfully acknowledged when the situation that caused the trip no longer exists.

8.1.4.3 Retrieving measured and calculated values

The measured and calculated values of the REF542 are continuously displayed on the LC display screen above the mimic diagram. They are displayed as absolute values. In addition, voltages and currents are represented by a bar graph. A measurement range of 0 … 200% of the rated value is displayed with the voltages, the earth current and the line currents.

With the line currents a trailing pointer function is also used to indicate the maximum value of a configurable time interval. The calculation of the maximum value must be configured in the configuration program with the menu `<Configure/Calculated Values …>`.

The displayed values are arranged in a ring menu. Only those that have been measured or whose calculation has been configured are displayed. The calculated values must also be required by a protective function. This minimizes the DSP (protection and measuring processor) processing requirements.

Selection of next/previous value

- Press the <🡅> or <🡇> keys to call up the next or previous value in the ring menu.

The following table shows an overview of all possible displayed values, the corresponding unit and the conditions required to display the value.

Table 46: Measured value display on the REF542 LC display screen

Displayed value	Unit	Condition
Communication address	–	is always displayed
Current I_{L1}	A	Min. 1 measurement recorder for current (analog input 1 or 4)
Current I_{L2}	A	Min. 2 measurement recorders for current (analog input 1, 2 or 4, 5)
Current I_{L3}	A	Min. 3 measurement recorders for current (analog input 1, 2, 3 or 4, 5, 6)
Current I_{1L1}	A	Min. 6 measurement recorders for current
Current I_{1L2}	A	
Current I_{1L3}	A	
Current I_{2L1}	A	
Current I_{2L2}	A	
Current I_{2L3}	A	
Current I_{L0}	A	Measurement recorder for current at analog input 7 or I_0 calculated from a earthfault protection function, when active .
Voltage U_{1E}	kV	Min. 1 measurement recorder for voltage (analog input 1 or 4)

Continued next page

Table 46: Measured value display on the REF542 LC display screen

Displayed value	Unit	Condition
Voltage U_{2E}	kV	Min. 2 measurement recorders for voltage (analog input 1, 2 or 4, 5)
Voltage U_{3E}	kV	Min. 3 measurement recorders for voltage (analog input 1, 2, 3 or 4, 5. 6)
Voltage U_{12}	kV	At least 2 measurement recorders for voltage (U_{1E} and U_{2E}).
Voltage U_{23}	kV	At least 3 measurement recorders for voltage (U_{2E} and U_{3E}).
Voltage U_{31}	kV	At least 3 measurement recorders for voltage (U_{3E} and U_{1E}).
Voltage U_0	kV	Measurement recorder for voltage at analog input 7 or U_0 calculated from residual overvoltage protection function, when active.
Voltage $U1_{L1E}$	kV	Min. 6 measurement recorders for voltage
Voltage $U1_{L2E}$	kV	
Voltage $U1_{L3E}$	kV	
Voltage $U1_{L12}$	kV	
Voltage $U1_{L23}$	kV	
Voltage $U1_{L31}$	kV	
Voltage $U2_{L1E}$	kV	Min. 6 measurement recorders for voltage
Voltage $U2_{L2E}$	kV	
Voltage $U2_{L3E}$	kV	
Voltage $U2_{L1E}$	kV	
Voltage $U2_{L23}$	kV	
Voltage $U2_{L31}$	kV	
Current I_{L1m}	A	Maximum values are configured and measurement recorder for I_{L1}.
Current I_{L2m}	A	Maximum values are configured and measurement recorder for I_{L2}.
Current I_{L3m}	A	Maximum values are configured and measurement recorder for I_{L3}.
Active power	kW	The power calculation is activated and the associated analog inputs have corresponding measurement recorders.
Reactive power	kVAr	
cos phi	–	
Active energy	kWh	
Reactive energy	kVAhr	
Frequency	Hz	always
Operating hours	h	always (If the function block operating hours counter is not activated, the time for which the REF542 is on the auxiliary voltage is counted. If the function block operating hours counter is activated, the time for which its starting condition is met is counted.) ↳Chapter "5.4.14.1 Operating hours" on page 5-206
Switching cycles	–	A power circuit-breaker is configured.
Switched current	kA	

Continued next page

Table 46: Measured value display on the REF542 LC display screen

Displayed value	Unit	Condition
Phase diff.	°	Display indicates when the synchrocheck has been activated.
Voltage diff.	V	
U1L1E	kV	
U1L2E	kV	
U2L1E	kV	
U2L2E	kV	
U1L12	kV	
U2L12	kV	
Motor temperature	˚C	Application with the thermal replica function for protecting a motor from thermal overload.
Motor start in	min	
Transformer temperature	˚C	Application with the thermal replica function for protecting a transformer from thermal overload.
Transformer ON in	min	
Cable temperature	˚C	Application with the thermal replica function for protecting a cable unit from thermal overload.
Cable ON in	min	
max. 15 energy counters	–	There may be as many displays with the corresponding display texts as the number of configured energy counters.

8.1.4.4 Selecting and actuating switchgear

A switching device shown in the mimic diagram can be selected and switched directly in the operator view of the REF542 . If an interlock condition is violated, it cannot be switched. The interlocking status LED (top in the row directly beside the LC display screen) will then show red.

- Press the <➘> key one or more times until the desired switching device is selected.
  The selected switching device will be shown inverted. Which switching device is selected with the first press of the key and which switchgear can be selected is set in the configuration program.

  ↳Chapter "5.3.7 Display" on page 5-13
- Press the <**O**> or <**I**> key to open or close the selected switching device.

  ↳Chapter "5.3.2 Global Settings" on page 5-2.

If double actuation is activated there, two switching commands in succession can be executed in a defined period with the selected switching device. Otherwise the switching device must be selected before every switching command.

8.1.4.5 Starting the tripping page

The tripping pages show information based on the starting and tripping of the configured protective functions. This information is specific to the protective functions and is available as soon as a protective function is started. The tripping page is structured as shown below:

- Sequential number (0 … 65537, then 0 again)
- Name of protective function,
- Action of protective function (start or trip) and
- Various relevant values with units.

The data for the tripping page are saved in a ring buffer with a capacity of 29 entries. If the ring buffer fills up, the oldest data will be deleted and the new data saved (FIFO strategy: First In, First Out). The data are not timestamped.

- Press the < **?**> keys and <🡻> to open the tripping page.
- Press the <🡹> or <🡻> keys to call up the previous or the next values.
- To close the tripping page again, press the <✓> key.

If the tripping page was opened in the event of a persistent fault, the times and trip values are shown by "***". If the fault is successfully acknowledged, the corresponding values will be shown instead of the asterisks.

The following table shows an overview of the messages regarding the specific protective functions in the status line and on the tripping page. If there are several information blocks in the "messages on the tripping page" column, their display is optional, depending on the fault.

Note: Many protective functions and their parameters are shown differently in the configuration program and on the tripping pages.
Chapter "8.2 Parameter names" on page 8-24.

Table 47: Protective function entries on the tripping page and in the status line

Protective function	Message (Status bar)	Messages on the tripping page	
		Single-line faults	**Multi-line faults**
Inrush current blocking	Inrush	Fault Ln-E inrush current Start Ln: X.XX Sec inrush current Trip.: XXX.X A	Fault Ln-Lm inrush current Start Ln: X.XX Sec inrush current Trip.: XXX.X A inrush current Start Lm: X.XX Sec
		with n=[1,2,3] and and m=[1,2,3]	Fault L1-L2-L3 inrush current Start L1: X.XX Sec inrush current Trip: XXX.X A inrush current Start L2: X.XX Sec inrush current Start L3: X.XX Sec
Overcurrent Directional High Set	Overl Def Dir High	Fault Ln-E Overl Def Dir High Start Ln: X.XX Sec Overl Def Dir High Trip: XXX.X A	Fault Ln-Lm Overl Def Dir High Start Ln: X.XX Sec Overl Def Dir High Trip: XXX.X A Overl Def Dir High Start Lm: X.XX Sec
		with n=[1,2,3] and and m=[1,2,3]	Fault L1-L2-L3 Overl Def Dir High Start L1: X.XX Sec Overl Def Dir High Trip: XXX.X A Overl Def Dir High Start L2: X.XX Sec Overl Def Dir High Start L3: X.XX Sec

Continued next page

Table 47: Protective function entries on the tripping page and in the status line

Protective function	Message (Status bar)	Messages on the tripping page	
		Single-line faults	Multi-line faults
Overcurrent Directional Low Set	Overl Def Dir Low	Fault Ln-E Overl Def Dir Low Start Ln: X.XX Sec Overl Def Dir Low Trip: XXX.X A	Fault Ln-Lm Overl Def Dir Low Start Ln: X.XX Sec Overl Def Dir Low Trip: XXX.X A Overl Def Dir Low Start Lm: X.XX Sec
		with n=[1,2,3] and m=[1,2,3]	Fault L1-L2-L3 Overl Def Dir Low Start L1: X.XX Sec Overl Def Dir Low Trip: XXX.X A Overl Def Dir Low Start L2: X.XX Sec Overl Def Dir Low Start L3: X.XX Sec
Overcurrent Instantaneous	Overcurrent Inst	Fault Ln-E Overcurrent Inst Start Ln: X.XX Sec Definite time I>>> Trip: XXX.X A	Fault Ln-Lm Overcurrent Inst Start Ln: X.XX Sec Overcurrent Inst Trip: XXX.X A Overcurrent Inst Start Lm: X.XX Sec
		with n=[1,2,3] and m=[1,2,3]	Fault L1-L2-L3 Overcurrent Inst Start L1: X.XX Sec Overcurrent Inst Trip: XXX.X A Overcurrent Inst Start L2: X.XX Sec Overcurrent Inst Start L3: X.XX Sec
Overcurrent High Set	Overcurrent Def High	Fault Ln-E Overcurrent Def High Start Ln: X.XX Sec Overcurrent Def High Trip: XXX.X A	Fault Ln-Lm Overcurrent Def High Start Ln: X.XX Sec Overcurrent Def High Trip: XXX.X A Overcurrent Def High Start Lm: X.XX Sec
		with n=[1,2,3] and m=[1,2,3]	Fault L1-L2-L3 Overcurrent Def High Start L1: X.XX Sec Overcurrent Def High Trip: XXX.X A Overcurrent Def High Start L2: X.XX Sec Overcurrent Def High Start L3: X.XX Sec

Continued next page

Table 47: Protective function entries on the tripping page and in the status line

<table>
<tr><th rowspan="2">Protective function</th><th rowspan="2">Message (Status bar)</th><th colspan="2">Messages on the tripping page</th></tr>
<tr><th>Single-line faults</th><th>Multi-line faults</th></tr>
<tr><td rowspan="2">Overcurrent Low Set</td><td rowspan="2">Overcurrent Def Low</td><td>Fault Ln-E
Overcurrent Def Low
Start Ln: X.XX Sec
Overcurrent Def Low
Trip: XXX.X A</td><td>Fault Ln-Lm
Overcurrent Def Low
Start Ln: X.XX Sec
Overcurrent Def Low
Trip: XXX.X A
Overcurrent Def Low
Start Lm: X.XX Sec</td></tr>
<tr><td>with n=[1,2,3] and
m=[1,2,3]</td><td>Fault L1-L2-L3
Overcurrent Def Low
Start L1: X.XX Sec
Overcurrent Def Low
Trip: XXX.X A
Overcurrent Def Low
Start L2: X.XX Sec
Overcurrent Def Low
Start L3: X.XX Sec</td></tr>
<tr><td rowspan="3">IDMT:

normal inverse

very inverse

extremely inv.

long-term inv.
IDMT</td><td rowspan="3">

IDMT Normal Inv

IDMT Very Inv

IDMT Extremely Inv

IDMT long time Inv</td><td>IDMT normal inv
IDMT normal inv
Start Ln: X.XX Sec
IDMT normal inv
Trip: XXX.X A</td><td>IDMT very inv
IDMT very inv
Start Ln: X.XX Sec
IDMT very inv
Trip: XXX.X A</td></tr>
<tr><td>IDMT extremely inv
IDMT extremely inv
Start Ln: X.XX Sec
IDMT extremely inv
Trip: XXX.X A</td><td>IDMT long-term inv
IDMT long-term inv
Start Ln: X.XX Sec
IDMT long-term inv
Trip: XXX.X A</td></tr>
<tr><td colspan="2">with n=[1,2,3]</td></tr>
<tr><td>Earthfault High Set</td><td>Gnd Non Dir Hi</td><td colspan="2">Gnd Non Dir Hi
Start: X.XX Sec
Gnd Non Dir Hi
Trip: XXX.X A</td></tr>
<tr><td>Earthfault Low Set</td><td>Gnd Non Dir Low</td><td colspan="2">Gnd Non Dir Low
Start: X.XX Sec
Gnd Non Dir Low
Trip: XXX.X A</td></tr>
<tr><td>Earthfault directional High Set</td><td>Gnd Dir High</td><td colspan="2">Gnd Dir High
Start: X.XX Sec
Gnd Dir High
Trip: XXX.X A</td></tr>
<tr><td>Earthfault directional Low Set</td><td>Gnd Dir Low</td><td colspan="2">Gnd Dir Low
Start: X.XX Sec
Gnd Dir Low
Trip: XXX.X A</td></tr>
</table>

Continued next page

Table 47: Protective function entries on the tripping page and in the status line

Protective function	Message (Status bar)	Messages on the tripping page	
		Single-line faults	Multi-line faults
Earthfault IDMT: normal inverse very inverse extremely inv. long-term inv.	GndIDMT Normal Inv: Very Inv or Extremely Inv or Long Time Inv	GndIDMT Normal Inv Start Ln: X.XX Sec GndIDMT Normal Inv Trip: XXX.X A	
		GndIDMT Extremey Inv Start Ln: X.XX Sec GndIDMT Extremey Inv Trip: XXX.X A	
		GndIDMT Very Inv Start Ln: X.XX Sec GndIDMT Very Inv Trip: XXX.X A	
		GndIDMT Long Time Inv Start Ln: X.XX Sec GndIDMT Long Time Inv Trip: XXX.X A	
Overvoltage Instantaneous	Overvoltage Inst	Overvoltage Inst Start L1: X.X Sec Overvoltage Inst Start L2: X.X Sec Overvoltage Inst Start L3: X.X Sec Overvoltage Inst Trip: XXXX.X V	
Overvoltage High Set	Overvoltage Def High	Overvoltage Def High Start L1: X.X Sec Overvoltage Def High Start L2: X.X Sec Overvoltage Def High Start L3: X.X Sec Overvoltage Def High Trip: XXXX.X V	
Overvoltage Low Set	Overvoltage Def Low	Overvoltage Def Low Start L1: X.X Sec Overvoltage Def Low Start L2: X.X Sec Overvoltage Def Low Start L3: X.X Sec Overvoltage Def Low Trip: XXXX.X V	
Undervoltage Instanteneous	Undervoltage Inst	Undervoltage Inst Start L1: X.X Sec Undervoltage Inst Start L2: X.X Sec Undervoltage Inst Start L3: X.X Sec Undervoltage Inst Trip: XXXX.X V	

Continued next page

Table 47: Protective function entries on the tripping page and in the status line

Protective function	Message (Status bar)	Messages on the tripping page	
		Single-line faults	Multi-line faults
Undervoltage High Set	Undervoltage Def High	Undervoltage Def High Start L1: X.X Sec Undervoltage Def High Start L2: X.X Sec Undervoltage Def High Start L3: X.X Sec Undervoltage Def High Trip: XXXX.X V	
Undervoltage Low Set	Undervoltage Def Low	Undervoltage Def low Start L1: X.X Sec Undervoltage Def low Start L2: X.X Sec Undervoltage Def low Start L3: X.X Sec Undervoltage Def low Trip: XXXX.X V	
Residual Overvoltage High Set	Resid OverV Def High	Resid OverV Def High Start L1: X.X Sec Resid OverV Def High Trip: XXXX.X V	
Residual Overvoltage Low Set	Resid OverV Def Low	Resid OverV Def Low Start L1: X.X Sec Resid OverV Def Low Trip: XXXX.X V	
Thermal Overload protection for motors	Thermal Overload	Thermal Overload Start: XXX.X Sec Thermal overload Trip: XXX.XX ˚C	
Thermal Overload protection for transformers	Thermal Overload	Thermal Overload Start: XXX.X Sec Thermal overload Trip: XXX.XX ˚C	
Thermal Overload protection for cables	Thermal Overload	Thermal Overload Start: XXX.X Sec Thermal overload Trip: XXX.XX ˚C	
Motor Start Protection	Motor Start	Motor Start Start: XXX.X Sec Motor Start Trip: XXX.X A	
Blocking Rotor	Blocking Rotor	Blocking Rotor Start L1: XXX.X Sec Blocking Rotor Start L2: XXX.X Sec Blocking Rotor Start L3: XXX.X Sec Blocking Rotor Trip: XXX.X A	
Number of Starts	Nr. Of Starts	Nr. Of Starts --- Nr. Of Starts Trip: k	with k=[1 … 10]

Continued next page

Table 47: Protective function entries on the tripping page and in the status line

Protective function	Message (Status bar)	Messages on the tripping page	
		Single-line faults	Multi-line faults
Distance protection	Distance protection	Fault Ln-E with earth contact Distance protection Start Ln: X.XX Sec Distance protection Start E: X.XX Sec Distance protection G-Start: X.XX Sec Distance protection Trip: --- Distance protection Impedance: X.X Ohm Distance protection Distance: X.X km Distance protection Resistance: X.X Ohm Distance protection Reactance: X.X Ohm Distance protection Phi Z: X.X ° Distance protection Zone X Distance protection Min Z: X.XX Sec	Fault Ln-Lm with earth contact Distance protection Start Ln: X.XX Sec Distance protection Start Lm: X.XX Sec Distance protection Start E: X.XX Sec Distance protection G-Start: X.XX Sec Distance protection Trip: --- Distance protection Impedance: X.X Ohm Distance protection Distance: X.X km Distance protection Resistance: X.X Ohm Distance protection Reactance: X.X Ohm Distance protection Phi Z: X.X ° Distance protection Zone X Distance protection Min Z: X.XX Sec
		Fault L1-L2-L3 with earth contact Distance protection Start L1: X.XX Sec Distance protection Start L2: X.XX Sec Distance protection Start L3: X.XX Sec Distance protection Start E: X.XX Sec Distance protection G-Start: X.XX Sec Distance protection Trip: --- Distance protection Impedance: X.X Ohm Distance protection Distance: X.X km Distance protection Resistance: X.X Ohm Distance protection Reactance: X.X Ohm Distance protection Phi Z: X.X ° Distance protection Zone X Distance protection Min Z: X.XX Sec	with n=[1,2,3] and m=[1,2,3]

Continued next page

Table 47: Protective function entries on the tripping page and in the status line

Protective function	Message (Status bar)	Messages on the tripping page	
		Single-line faults	**Multi-line faults**
Distance protection	Distance protection	Fault Ln-E without earth contact Distance protection Start Ln: X.XX Sec Distance protection G-Start: X.XX Sec Distance protection Trip: --- Distance protection Impedance: X.X Ohm Distance protection Distance: X.X km Distance protection Resistance: X.X Ohm Distance protection Reactance: X.X Ohm Distance protection Phi Z: X.X ° Distance protection Zone X Distance protection Min Z: X.XX Sec	Fault Ln-Lm without earth contact Distance protection Start Ln: X.XX Sec Distance protection Start Lm: X.XX Sec Distance protection G-Start: X.XX Sec Distance protection Trip: --- Distance protection Impedance: X.X Ohm Distance protection Distance: X.X km Distance protection Resistance: X.X Ohm Distance protection Reactance: X.X Ohm Distance protection Phi Z: X.X ° Distance protection Zone X Distance protection Min Z: X.XX Sec
		Fault L1-L2-L3 with earth contact Distance protection Start L1: X.XX Sec Distance protection Start L2: X.XX Sec Distance protection Start L3: X.XX Sec Distance protection G-Start: X.XX Sec Distance protection Trip: --- Distance protection Impedance: X.X Ohm Distance protection Distance: X.X km Distance protection Resistance: X.X Ohm Distance protection Reactance: X.X Ohm Distance protection Phi Z: X.X ° Distance protection Zone X Distance protection Min Z: X.XX Sec	with n=[1,2,3] and m=[1,2,3]
Thermal Supervision	Thermal Supervision	no message	
Unbalanced Load	Unbalanced Load	Unbalanced Load Start: XX.X Sec Unbalanced Load Trip: XXX.X%	

Continued next page

Table 47: Protective function entries on the tripping page and in the status line

Protective function	Message (Status bar)	Messages on the tripping page	
		Single-line faults	Multi-line faults
Directional Power	Power direction	Power direction Start: XX.X Sec Power direction Trip: XXX.X kW	
Directional Power	Directional Power	Directional Power Start: XX.X Sec Directional Power Trip: XXX.X kW	
Frequency Supervision	Frequency Supervision	Frequency Supervision Start L1: XX.X Sec Frequency Supervision Trip: XX.X Hz	
Synchrocheck		no message	

8.1.5 Functions in mode: Remote-operational

Note

Please also note that all operating options described in Chapter "8.1.3 Functions in all operating modes" on page 8-3 can be used.

Note

Many protective functions and their parameters are labeled differently in the configuration program and on some pages that can be shown on the LC display screen ↳Chapter "8.2 Parameter names" on page 8-24

8.1.5.1 Display LED message texts

The message texts of the nine LEDs can be set up as desired in the configuration program (with the exception of the interlocking status and the protective function status LED). They are intended to provide information on what the LED is signaling.

- Press the <**?**> button.
  After a few seconds the previous display is shown on the LC display screen again. To keep the message texts on screen for longer, hold the <**?**> key down.

8.1.5.2 Acknowledging messages and alarms

A persistent alarm or a message must be acknowledged, depending on the configuration. Persistent alarms can be detected immediately by the protective function status LED (5) lighting. Persistent messages, which must be acknowledged, remain displayed on the LC display screen in the status line (bottom).

- Press the <**?**> and <✓> keys simultaneously.

An alarm can only be successfully acknowledged when the situation that caused the trip no longer exists.

8.1.5.3 Retrieving measured and calculated values

The measured and calculated values of the REF542 are continuously displayed on the LC display screen above the mimic diagram. They are displayed as absolute values. Voltages and currents are also represented by a bar graph. A measurement range of 0 … 200% of the rated value is displayed with the voltages, the earth current and the line currents. With the phase currents a non return pointer function is also used to indicate the maximum value of a configurable time interval. The calculation of the maximum value must be configured in the configuration program with the menu `<Configure/Calculated Values>`.

The displayed values are arranged in a ring menu. Only those that have been measured or whose calculation has been configured are displayed. The calculated values must also be required by a protective function. This minimizes the DSP (protection and measuring processor) processing requirements.

Selection of next/previous value

- Press the <🡅> or <🡇> keys to call up the next or previous value in the ring menu.

The table shows an overview of all possible displayed values, the associated unit and the conditions applicable to their display.

➭"Table 46: Measured value display on the REF542 LC display screen" on page 8-5

8.1.5.4 Starting the tripping page

The tripping pages show information based on the starting and tripping of the configured protective functions. This information is specific to the protective functions and is available as soon as a protective function is started. The tripping page is structured as shown below:

- Sequential number (0 … 65537, then 0 again)
- Name of protective function,
- Action of protective function (start or tripping) and
- Various relevant values with units.

The data for the tripping page are saved in a ring buffer with a capacity of 29 entries. If the ring buffer fills up, the oldest data will be deleted and the new data saved (FIFO strategy: The data are not timestamped.

- Press the < **?**> keys and <🡇> to open the tripping page.
- Press the <🡅> or <🡇> keys to call up the previous or the next values.
- To close the tripping page again, press the <✓> key.

If the tripping page was opened in the event of a persistent fault, the times and trip values are shown by "***“. If the fault is successfully acknowledged, the corresponding values will be shown instead of the asterisks. The "Table 47: Protective function entries on the tripping page and in the status line" on page 8-8 provides an overview of the messages of the specific protective functions in the status line and on the tripping page. If there are several information blocks in the "messages on the tripping page“ column, their display is optional, depending on the fault.

Note

Many protective functions and their parameters are labeled differently in the configuration program and on some pages that can be shown on the LC display screen.
➭Chapter "8.2 Parameter names" on page 8-24

8.1.6 Functions in the mode: Local-set

The local set mode enables various information and interaction options, described in the following subsections.

The diagram on the next page provides an initial overview of the operating structure available in this mode. The boxes represent the LC display screen.

The REF542 has a convenient control structure. Operation of the various control elements is consistent. The texts on the LC display screen show the subsequent possible and required operational steps.

The descriptions of every function are shown again in the corresponding section of the diagram.

The entire LC display screen including the status line is used in the local set mode. Therefore, neither the current measured and calculated values nor the mimic diagram are displayed.

Note All protection and measurement functions are active with the previously used parameters in the local set mode!

All changes made in the local set mode remain without effect until the operator switches to the local operational or remote operational mode again. This ensures that the REF542 functions properly while in the local set mode. All previously used parameters are used.

Note Please note that all operating options described in Chapter "8.1.3 Functions in all operating modes" on page 8-3 can be used.

Note Many protective functions and their parameters are labeled differently in the configuration program and on some pages that can be shown on the LC display screen. ➪Chapter "8.2 Parameter names" on page 8-24

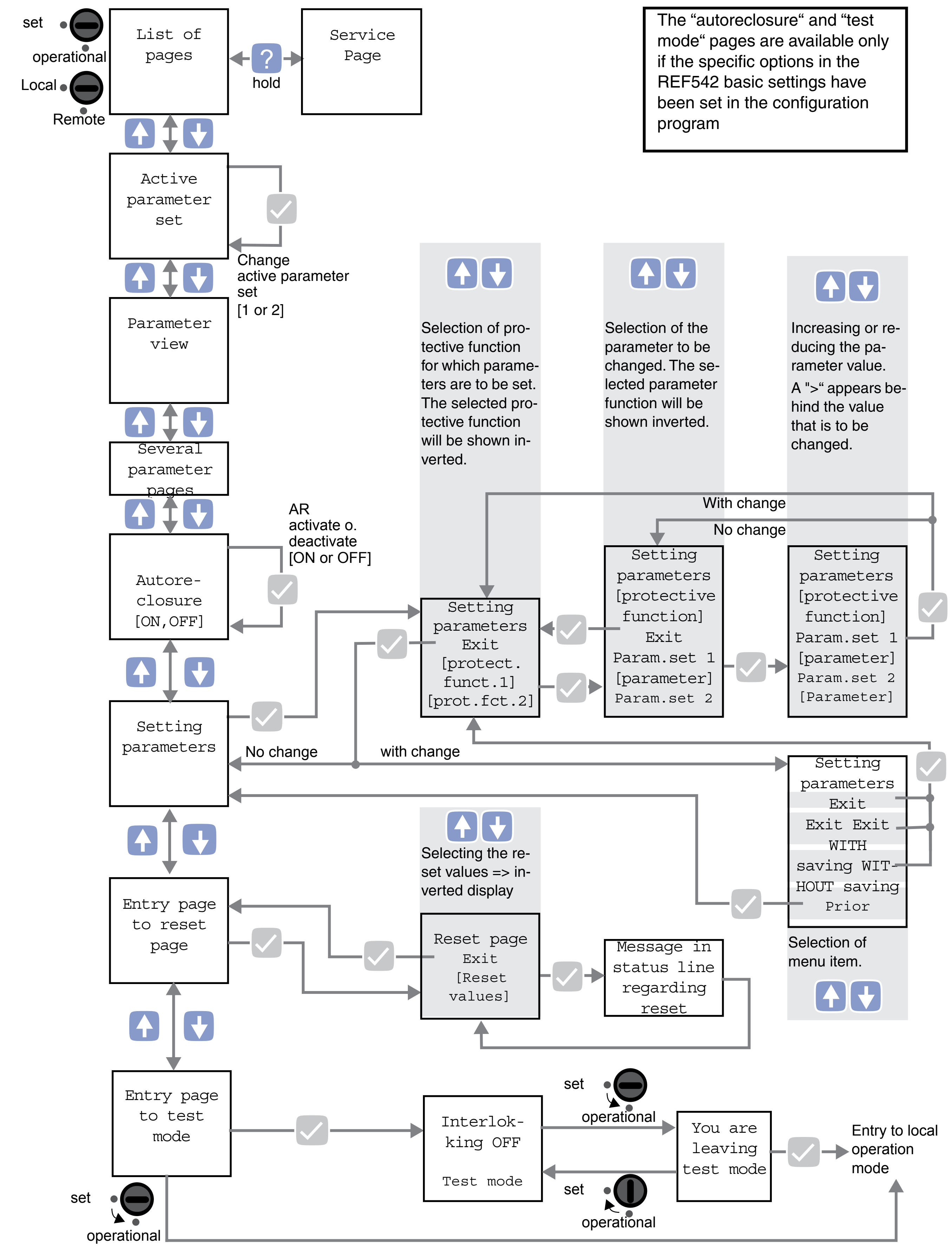


Figure 255: LCU operating structure local set mode

8.1.6.1 Starting the service page

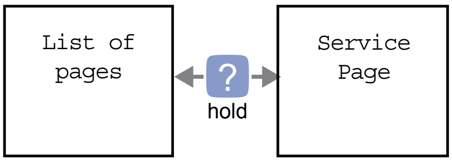


Figure 256: Local set mode, starting the service page

The service page provides the following information:

- The version numbers of the microcontroller (MC – control and command unit) and of the digital signal processor (DSP – protection and measuring unit),
- The version number of the interbay bus in use (optional),
- The resets,
- The LCU temperature,
- The application name,
- The duration of the FUPLA cycle.

A configuration number reserved for future use is also shown.

Proceed as follows:

- Set the keyswitch "operational/set“ to "set“ and the keyswitch "local/remote“ to "local“. The "list of pages" will appear on the LC display screen.
- Press and hold the <**?**> until the service page is displayed.

8.1.6.2 Change the active parameter set

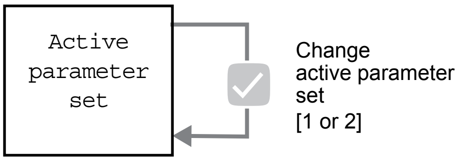


Figure 257: Local set, change active parameter set

Most protective functions have two parameter sets with which various starting and tripping characteristics can be specified. This page can be used to switch back and forth between the two parameter sets.

Proceed as follows:

- Set the keyswitch "operational/set“ to "set“ and the keyswitch "local/remote“ to "local“. The "list of pages" page will appear on the LC display screen.
- Press the <🡻> key to get to the "active parameter set“ page.
- Press the <✓> key to change the active parameter set.

If there is an alarm on the REF542, the active parameter set cannot be changed. The message "range error“ is shown in the status line of the LC display screen. The alarm must be acknowledged first.

8.1.6.3 Viewing the parameters of the individual protective functions

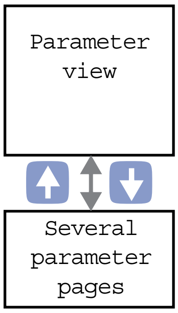


Figure 258: Local set mode, viewing the individual protective function parameters

Most protective functions have two parameter sets with which various starting and tripping characteristics can be specified. Both parameter sets of then protective functions in the application can be viewed on the parameter pages. Depending on the number of configured protective functions, several pages may be used for this purpose.

Proceed as follows:

- Set the keyswitch "operational/set“ to "set“ and the keyswitch "local/remote“ to "local“. The "list of pages" page will appear on the LC display screen.
- Press the <↓> key twice to get to the first "parameter setting“ page.
- Press the <↓> key or the <↑> key, several times if necessary, to go forwards or back through the "parameter“ pages.

Note: Many protective functions and their parameters are shown differently in the configuration program and on the parameter pages.
↳Chapter "8.2 Parameter names" on page 8-24

8.1.6.4 Switching the autoreclosure on and off

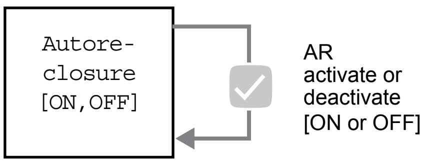


Figure 259: Local set mode, activate and deactivate the autoreclosure

Some protective functions have the option of autoreclosure (AR). The autoreclosure function may be activated or deactivated on this page. Please note that the autoreclosure must generally be enabled when setting up the application.

↳Chapter "5.3.2 Global Settings" on page 5-2

↳Chapter "5.5.1 Autoreclosure" on page 5-209

Proceed as follows to activate or deactivate the autoreclosure:

- Set the keyswitch "operational/set“ to "set“ and the keyswitch "local/remote“ to "local“. The "list of pages" page will appear on the LC display screen.
- Press the <↓> key several times until the "autoreclosure“ page appears. The current autoreclosure status is shown there.
- Press the <✓> key to activate or deactivate autoreclosure.

If there is an alarm on the REF542, the autoreclosure cannot be activated or deactivated. The message "range error“ is shown in the status line of the LC display screen. The alarm must be successfully acknowledged first.

8.1.6.5 Changing a parameter of a protective function

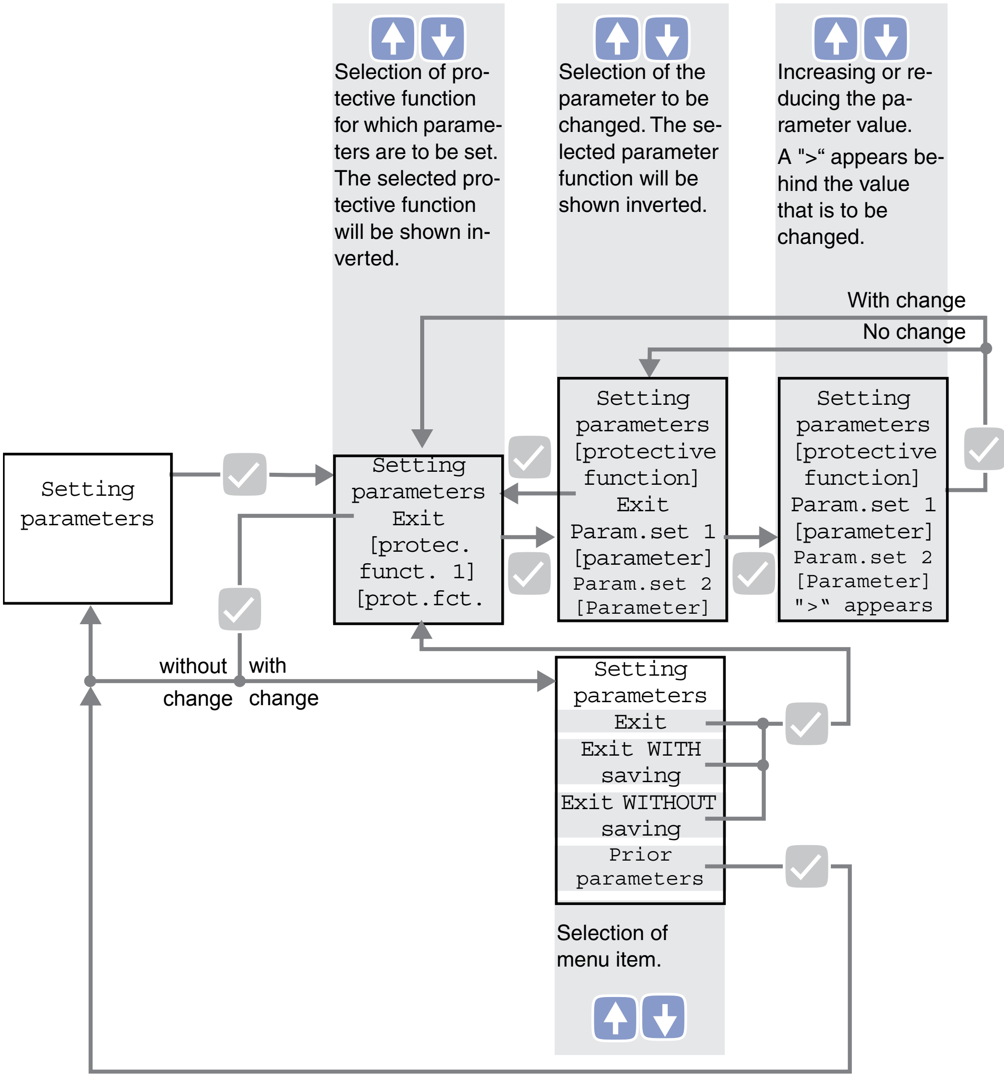


Figure 260: Local set, changing protective function parameters

Most protective functions have two parameter sets with which various response and tripping characteristics can be specified. The various parameters of the configured protective functions can be changed at the setting parameters page. The setting parameters pages can be closed at any time without changing any saved values.

Note

Many protective functions and their parameters are shown differently in the configuration program and on the setting parameters pages.
Chapter "8.2 Parameter names" on page 8-24

Proceed as follows to change the parameters of specific protective functions:

- Set the keyswitch "operational/set“ to "set“ and the keyswitch "local/remote“ to "local“. The "list of pages" page will appear on the LC display screen.
- Press the <↓> key several times until the "setting parameters“ page is shown.
- Press the <✓> key to open the page for selecting the configured protective functions.
- Use the <↑> key or the <↓> key to select a protective function whose parameters are to be changed.
  (Use "exit“ and press <✓> to return to the previous page.)
- Press the <✓> key to open the page with the list of parameters for the selected protective function.
- Use the <↑> key or the <↓> key to select a parameter to be changed.
  (Use "exit“ and press <✓> to return to the previous page.)
- Press the <✓> key to change the parameter.
  The selected parameter will be shown inverted and the character !>“ will be shown behind the parameter that is to be changed.
- Use the <↑> key or the <↓> key to increase or reduce the value of the parameter.
- Press the <✓> key.
  - If a parameter has not been changed, switch to the previous page to select the parameter that is to be changed. Select "exit“ twice with the <↑> or <↓> keys and then press <✓> to confirm to return to the initial page for setting parameters.

    OR
  - If a parameter has been changed, switch to the setting parameters page by selecting the protective functions.
    Now follow the procedure described to select and change the parameters of various protective functions.
  - Select "exit“ with the <↑> or the <↓> key to stop setting parameters.
  - Press the <✓> key and a query page will appear.
  - Use the <↑> key or the <↓> key to select one of the points and confirm the selection with the <✓> key.
  - Use "exit", "exit WITH saving“ or "exit WITHOUT saving“ to get to the selection page of the protective functions whose parameters are to be changed.
    "Exit“: The parameters changed since the last time they were saved will not be saved and also will not remain on the setting parameters pages.
    "Exit WITH saving“: The parameters changed since the last time they were saved will be saved.
    "Exit WITHOUT saving“: The parameters changed since the last time they were saved will remain changed on the setting parameters pages, but will not be saved.

    OR
  - The "previous parameter“ item returns the operator to the initial page for setting parameters. The parameters used since the last time they were saved will be used again. No changes are made.

8.1.6.6 Resetting the quantities saved in the unit

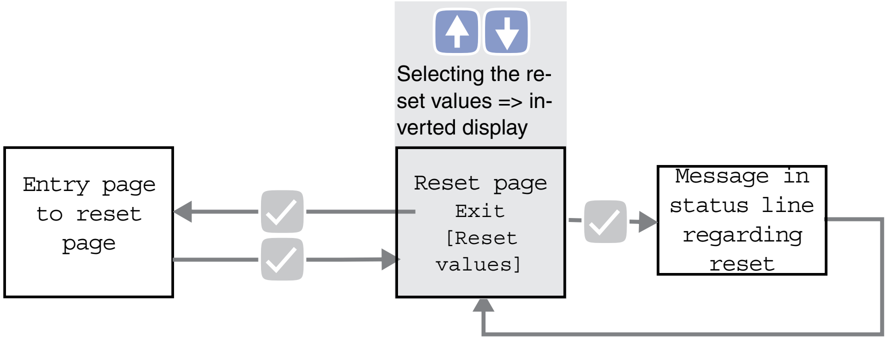


Figure 261: Local set, resetting quantities saved in the unit

Various data are saved in the REF542. For example, this includes the switched currents or the maximum currents per conductor in a specified period. The reset page is used to delete specific data from the unit's memory.

Proceed as follows:

- Set the keyswitch "operational/set“ to "set“ and the keyswitch "local/remote“ to "local“. The "list of pages" page will appear on the LC display screen.
- Press the <🡻> key several times until the "entry page to reset page“ page appears.
- Press the <✓> key to open the reset page.
- Use the <🡹> or <🡻> key to select the data that is to be deleted.
  (Use "exit“ and press <✓> to return to the previous page.)
- Press the <✓> key to delete the data. A message confirming the deletion will appear in the status line of the LC display screen and the entry page to the reset page will reappear.
- Repeat the process to delete more data.

8.1.6.7 Entry point to test mode

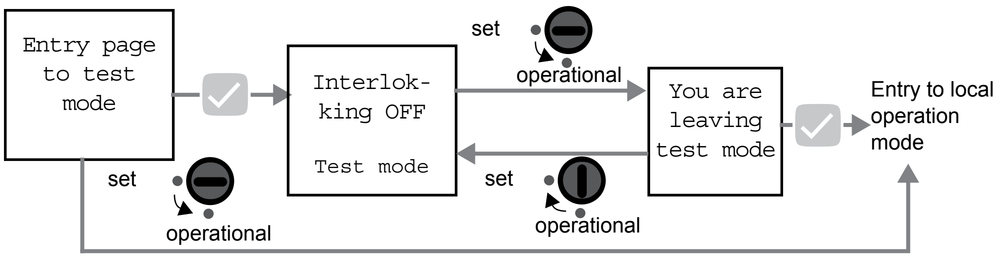


Figure 262: Local set, entry to test mode

All interlocking can be deactivated to test the REF542 protective functions. The test mode is used for this purpose. Please note that the test mode must be enabled when setting up the application.

Chapter "5.3.2 Global Settings" on page 5-2

Only the "local operational“ mode can be reached from the test mode. It is not possible to return to the "local set" mode after leaving the "entry page to test mode“.

To enter the test mode proceed as follows:

- Set the keyswitch "operational/set" to "set" and the keyswitch "local/remote" to "local". The "list of pages" page will appear on the LC display screen.
- Press the <↓> key several times until the "entry page to test mode" appears.
- Press the <✓> key to open test mode.
- The message "interlocking OFF / Test Mode" appears.
  Now the REF542 can be operated as in "local operational" mode. However, all interlocking is deactivated!
- To exit the test mode, set the keyswitch "operational/set" to "operational". The message "you are leaving test mode" appears.
  (To return to test mode, set the keyswitch "operational/set" back to "set".)
- Press the <✓> key to leave test mode finally and to return to "local-operational" mode.

If additional settings are required in "local-set" mode, first set the keyswitch to the appropriate positions.

8.2 Parameter names

Many of the protective functions and their parameters have different names in the configuration program and on the following pages of the LC display screen:

- Pages with the parameter view,
- Parameter setting pages and
- Tripping pages

This is the result of the limitation on the length of texts on the pages of the LC display screen. The following table shows the equivalent names opposite one another.

Table 48: Parameter name in the configuration program and on the parameter setting pages

Configuration Program	Parameter setting pages
Current protection functions	
Inrush Blocking	Inrush
N	n
M	m
Time	Time
Overcurrent Instantaneous	Overcurrent Inst
Overcurrent Definite Time High Set	Overcurrent Def High
Overcurrent Definite Time Low Set	Overcurrent Def Low
Start value	Start
Time	Time

Continued next page

Table 48: Parameter name in the configuration program and on the parameter setting pages

Configuration Program		Parameter setting pages
Overcurrent Directional High Set		Overl Def Dir High
Overcurrent Directional Low Set		Overl Def Dir Low
	Start value	Start
	Time	Time
	Direction	Direction
	forwards	0
	backwards	1
IDMT		IDMT (type of curve)
	I/In	Start
	k	k
Earthfaulf High Set		Gnd Non Dir Hi
Earthfaulf Low Set		Gnd Non Dir Low
Earthfault Directional High Set		Gnd Dir High
Earthfault Directional Low Set		Gnd Dir Low
	Start value	Start
	Time	Time
	Network type	Network type
	isolated	0
	earthed	1
	Direction	Direction
	forwards	0
	backwards	1
Earthfault IDMT		Gnd IDMT [type of curve]
	I/In	Start
	k	k
Voltage protection functions		
Overvoltage Instantaneous		Overvoltage Inst
Overvoltage High Set		Overvoltage Def High
Overvoltage Low Set		Overvoltage Def Low
Residual Overvoltage High Set		Resid OverV Def High
Residual Overvoltage Low Set		Resid OverV Def Low
	Start value	Start
	Time	Time
Undervoltage Instanteneous		Undervoltage Inst
Undervoltage High Set		Undervoltage Def High
Undervoltage Low Set		Undervoltage Def Low
	Start value	Start
	Time	Time
	Undervoltage limit = 0	U<=0
	use	1
	do not use	0

Continued next page

Table 48: Parameter name in the configuration program and on the parameter setting pages

Configuration Program		Parameter setting pages
Motor protection functions		
Number of Starts		Nr. of Starts
	Number of warm starts	N warm
	Number of cold starts	N cold
	Temperature for warm start	T warm
	Time	Blocking time
Motor Start Protection		Motor Start
	Motor current Ie	Ie
	Start value	Is
	Time	Time
	Motor start	It
Thermal Oveerload		Thermal overload
	T nom	T nom
	I nom	Inom
	T ini	T init
	TC Off	TC Off
	TC standard	TC standard
	TC fault	TC fault
	T max	T max
	T warn	T warn
	T ambient	T ambient
	Time	Time
Blocking Rotor		Blocking rotor
	Motor current Ie	Ie
	Starting value	Is
	Time	Time
Further protective functions		
Distance protection:		Distance protection
	Network type:	Network type
	high-res. earthing	0
	low-res. earthing	1
	Earth fault detection	ESt/GSt
	IE> use	0
	IE> do not use	1
	Grd. of current transformer	Tr/Gr
	Feed side	0
	SS side	1
	Switching on persistent faults	Sw.p.f.
	Normal operation	2
	Use overreach zone	0
	Trip after general starting	1
	Type of power transmission line	

Continued next page

Table 48: Parameter name in the configuration program and on the parameter setting pages

Configuration Program		Parameter setting pages	
Distance protection:(continued)		Distance protection	
	Cable only No.warm starts	Cond. = 1	Struct = 0
	Over. cable only.	Cond. = 1	Struct = 1
	Cable before over. cable	Cond. = 0	Struct = 0
	Over. cable before cable	Cond. = 0	Struct = 1
	Conductor preference	L.Bev.	
	acyclical L3-L1-L2	0	
	cyclical L1-L2-L3-L1	1	
	acyclical L1-L3-L2	2	
	cyclical L3-L2-L1-L3	3	
	Limit cable/over. cable	Zb	
	Cable reactance	X cable	
	Overhead cable reactance	X over. cable	
	I>	I>	
	I0>	I0>	
	IF>	IF>	
	UF>	UF>	
	Factor k	k0 amplitude	
	Angle k	k0 angle	
	Intertripping time	Inter. time	
	Zone 1	Zone 1	
	Overreach zone	Overreach zone	
	AR blocking zone	AR Zone	
	Zone 2	Zone 2	
	Zone 3	Zone 3	
	Dir. backup	Dir. backup	
	Non-dir. backup	Non-dir. backup	
	Real resistance R	R	
	Reactive resistance X	X	
	Angle delta 1	d1	
	Angle delta 2	d2	
	Time	Time	
	Direction	Direction	
	forwards	0	
	backwards	1	
	do not use	2	
Thermal Supervision		Thermal Supervision	
	T max	T max	
	Time	Time	
	T warn	T warn	

Continued next page

Table 48: Parameter name in the configuration program and on the parameter setting pages

Configuration Program		Parameter setting pages
Unbalanced Load		Unbalanced Load
	Max. negative phase	Start
	I min	Min. current
	Time	Time
Directional Power		Directional Power
	P nom	Pnom
	P max.rev.	Max.rev.P
	Time	Time
	Direction	Direction
	forwards	0
	backwards	1
Low Load		Low Load
	P nom	P nom
	P min	Start
	I min	Min. current
	Time	Time
Frequency Supervision		Frequency Supervision
	Start value	Start
	Time	Time
Ayncrocheck		Syncrocheck
	Start value	Delta U
	Time	Time
	Phase diff.	Delta Deg

8.3 Regular testing of the REF542

The self-monitoring and diagnosis functions of the unit make periodic testing unnecessary. If a malfunction occurs, the unit outputs a message to the LC display screen.

↳Chapter "9.2.1 Error and status messages at the LCU" on page 9-1

8.4 Maintenance Program

Because of the high quality standards of the REF542 and its components and processing, we suggest the following procedure:

- Function test (automatically done on commissioning)
- Secondary test (protection test – also automatically done on commissioning)

Repeat tests are not really necessary. The REF542's self-monitoring functions immediately signal all faults that occur. However, the following tests are worth carrying out to check the safety technology of the unit.

- Repeat test (function and protection test):
  Six months after commissioning and
  then every 2-5 years.

- Calibration test:
  The calculated long-term drift of the components in use is 0.3% per 10 years. For this reason we recommend that the analog input values be tested every 10 years. Recalibration can be done on site with little effort.

↳Chapter "7.3 Calibrating the analog inputs (measuring inputs)" on page 7-3

8.4.1 Durability of specific components

Power relay contacts

The power relay contacts on the binary input/output board with conventional relays in the REF542 cannot directly trip the trip coil without shortening their life. However, the contact life is at least 10 full load trips.

Normally a mechanical auxiallary switch is switched in series with the trip coil to reduce the load on the power relay contacts. This again increases their life.

↳"Table 13: Maximum switching cycles of the conventional power relays" on page 3-28

Electrolyte capacitors

The durability of the electrolyte capacitors used depends primarily on the ambient temperature. The calculated life in the operation of the REF542 under normal conditions is more than 35 years.

If the REF542 is continuously operated at temperatures over the specifications, the electrolyte capacitors of the power supply board should be replaced every 10 years.

LC display screen

The guaranteed life of the LC display screen is 16 years at ambient temperatures below 55°C and subject to 60°C for no more than 10% of operational time. The end of its life is signaled by black or white spots on the display.

If black spots that do not change when the display changes become obvious well before the end of its life, the seal of the LC display screen is defective and must be replaced.

If the contrast is too low and can no longer be increased, there is a fault in the LC display screen control electronics. The complete display screen module must be replaced in this case.

9 Troubleshooting

In this chapter you will find information on

- Fault and status messages that the local command unit (LCU) shows in the status line
- Error and status messages shown by the configuration program
- The reason for any specific message
- Options for correction and
- The ABB Calor Emag Mittelspannung GmbH sales offices and service centers.

9.1 Safety Information

Note — If there is any doubt regarding the treatment of a message, check with our service representative.

The addresses can be found in Chapter "9.4 Further information" on page 9-38.

9.2 Error and status messages

The next two subsections first show the alphabetically sorted tables of error and status messages that can be shown in the status line of the LCU with the LC display screen or in the configuration program.

Help or information on the faults and status messages may be found in the relevant tables in the following subsections.

Every message in the table of all messages is linked by its number to the necessary help positions or information in the correction options table.

9.2.1 Error and status messages at the LCU

The following messages are displayed in the status line on the LCU LC display screen.

Note — These error messages are not shown on the LCU version with no LC display screen.

The following table shows the number and the message type. The number and the page number enable access to the information required to know the cause and correct the fault.

The messages are classified into two types and are shown when the following events occur:

- Status message: These messages provide information on a current process in the REF542. They are not the result of an operational error.
- Error message: These messages are output as a result of an operational action that may have negative consequences for the application. They are the result of an operational error or malfunction.

Further information or corrective measures can be found in Chapter "9.3.1 Corrective action for error messages on the LCU" on page 9-11.

Table 49: Messages on the LC display screen

No.	Message	Help	Type
1	Address Error	Page 9-11	Error
2	IDMT Extremely Inv	Page 9-11	Status
3	IDMT Long Time Inv	Page 9-11	Status
4	IDMT Normal Inv	Page 9-11	Status
5	IDMT Very Inv	Page 9-11	Status
6	Nr Of Starts	Page 9-11	Status
7	CONFIG_ERROR	Page 9-11	Error
8	Bad FUPLA E1	Page 9-11	Error
9	Bad FUPLA E2	Page 9-12	Error
10	Bad FUPLA E3	Page 9-12	Error
11	Bad FUPLA E4	Page 9-12	Error
12	Bad FUPLA E5	Page 9-12	Error
13	Bad FUPLA E6	Page 9-12	Error
14	Bad FUPLA E7	Page 9-12	Error
15	Bad FUPLA E8	Page 9-12	Error
16	Bad FUPLA E9	Page 9-12	Error
17	Bad FUPLA E10	Page 9-12	Error
18	Bad FUPLA E11	Page 9-12	Error
19	CHANGE SET ERROR	Page 9-12	Error
20	Wait CHECK of Change	Page 9-13	Status
21	Block Error	Page 9-13	Error
22	Blocked Rotor	Page 9-13	Status
23	Bus Error	Page 9-13	Error
24	CALIBRATION DSP FAULT	Page 9-13	Error
25	Clearing EEPROM	Page 9-13	Status
26	Config not loaded	Page 9-13	Status
27	Configuration loaded	Page 9-13	Status
28	Configuration saved	Page 9-13	Status
29	CONFIG DSP ERROR	Page 9-13	Error
30	CONFIG LON ERROR	Page 9-13	Error
31	Files deleted	Page 9-14	Status
32	Diff Protection	Page 9-14	Status
33	Distance Protection	Page 9-14	Status
34	Division by zero	Page 9-14	Error
35	DSP CONFIGURED	Page 9-14	Status
36	EEPROM DATA DISTURBED	Page 9-14	Error
37	Inrush	Page 9-14	Status
38	FUPLA Down Load	Page 9-14	Status
39	LCU Down Load	Page 9-14	Status
40	WIRE Down Load	Page 9-14	Status
41	Erase Addr Block Error	Page 9-14	Error
42	Gnd IDMT Extremely Inv	Page 9-14	Status
43	Gnd IDMT Long Time Inv	Page 9-15	Status
44	Gnd IDMT Normal Inv	Page 9-15	Status
45	Gnd IDMT Very Inv	Page 9-15	Status
46	Wrong Parameter Value	Page 9-15	Error
47	ERROR SUPERVISION	Page 9-15	Error
48	Frequency Supervision	Page 9-15	Status
49	Overl Def Dir Low	Page 9-15	Status
50	Overl Def Dir High	Page 9-15	Status
51	Gnd Dir Low	Page 9-15	Status
52	Gnd Dir High	Page 9-15	Status
53	Illegal Instruction	Page 9-16	Error
54	No R/W with RS-232	Page 9-16	Error
55	Upload Version	Page 9-16	Status
56	Directional Power	Page 9-16	Status
57	Mem Full Error	Page 9-16	Error
58	Motor Start	Page 9-16	Status
59	Nodes Disconnect	Page 9-16	Error
60	NOT IDENT EEPROM DATA	Page 9-16	Error
61	Synchro Check	Page 9-16	Status
62	Parameter NOT saved	Page 9-16	Error
63	Privilege	Page 9-16	Error
64	READ HOST ERROR	Page 9-16	Error
65	READY DSP ERROR	Page 9-17	Error
66	Ready Error	Page 9-17	Error
67	SCU running mode	Page 9-17	Status
68	Runtime error	Page 9-17	Error
69	Unbalanced Load	Page 9-17	Status
70	Upload DSP Data	Page 9-17	Status
71	FUPLA Up Load	Page 9-17	Status
72	LCU Up Load	Page 9-17	Status
73	WIRE Up Load	Page 9-17	Status
74	Software changed	Page 9-17	Error
75	COIL ERROR CARD1I	Page 9-18	Error
76	COIL ERROR CARD1II	Page 9-18	Error
77	COIL ERROR CARD2I	Page 9-18	Error
78	COIL ERROR CARD2II	Page 9-18	Error
79	StatusRegError	Page 9-18	Error
80	Supply down	Page 9-18	Status
81	Suspend Error	Page 9-18	Error
82	Thermal Overload	Page 9-18	Status
83	Thermal Protection	Page 9-18	Status
84	TIMEOUT ERROR	Page 9-18	Error

Continued next page

Table 49: Messages on the LC display screen

No.	Message	Help	Type
86	Trace	Page 9-19	Error
87	Resid OverV Def Low	Page 9-19	Status
88	Resid OverV Def Low	Page 9-19	Status
89	Undervoltage Def Low	Page 9-19	Status
90	Undervoltage Def High	Page 9-19	Status
91	Undervoltage Inst	Page 9-19	Status
92	Overvoltage Def Low	Page 9-19	Status
93	Overvoltage Def High	Page 9-19	Status
94	Overvoltage Inst	Page 9-19	Status
95	Overcurrent Def Low	Page 9-19	Status
96	Overcurrent Def High	Page 9-19	Status
97	Overcurrent Inst	Page 9-19	Status
98	UNDEFINED PROT ERROR	Page 9-20	Error

No.	Message	Help	Type
100	Gnd Non Dir Low	Page 9-20	Status
101	Unit Interrupt	Page 9-20	Error
102	Low Load	Page 9-20	Status
103	VppLowError	Page 9-20	Status
104	Wait new Config	Page 9-20	Error
105	Waiting for DSP ready	Page 9-20	Status/ Error
106	Waiting LON Node	Page 9-20	Status
107	Waiting LON Node 1	Page 9-20	Error
108	WRITE HOST ERROR	Page 9-20	Status/ Error
109	Writing Byte Error	Page 9-21	Error
110	Wrong Parameter Value	Page 9-21	Error
111	WRONG VERSION DSP	Page 9-21	Status/ Error
112	WRONG CONFIGURATION	Page 9-21	Error

9.2.2 Error and status messages of the configuration program

The following messages are displayed while the configuration program is in use. The table below shows the number and the message type. The number and the page number enable access to the information required to know the cause and correct the fault.

The messages are classified into four types and are shown when the following events occur:

- Note: These messages are output as the result of an operational step. They are not the result of an operational error.
- Warning: These messages are output as a result of an operational action that may have negative consequences for the application. They are not the result of an operational error.
- Application error: These messages are output if an operational step causes an error in the application. Application errors may also be displayed after a drawing test.
- System error: The configuration program is not functioning together with the PC. Check whether the computer meets the requirements of the configuration program. If necessary, consult the system administrator.
- Communication error: Displayed during communications processes between the PC and the REF542. If there is a communication error resulting from the configuration program or the REF542, please contact ABB Service. In the event of communication errors resulting from the PC configuration, consult the system administrator as required.

Further information or corrective measures can be found in Chapter "9.3.2 Correction in the event of configuration program error messages" on page 9-22.

Table 50: Configuration program messages

No.	Message	Help	Type
1	8 P Font selection failed	Page 9-22	System error
2	Warning: Uploaded file was generated with version:	Page 9-22	Note
3	Warning: be sure to have no elements chosen, which are no more available !	Page 9-22	Warning
4	Current file not saved ! Really open a new file without saving ?	Page 9-22	Note
5	Analog inputs not configured	Page 9-22	Application error
6	Nr of moving failure	Page 9-22	Application error
7	Failure with open comm	Page 9-22	Application error
8	Number of wires	Page 9-22	Note
9	Choose only energy counter 1 .. 10	Page 9-22	Note
10	Display will be cleared.\nDo you want to continue ?	Page 9-22	Warning
11	Display: Field bus address %hu not used by any switching object. Check symbols !	Page 9-22	Application error
12	LED Text for display	Page 9-22	Application error
13	REF542 texts	Page 9-23	Application error
14	Application is OUT OF MEMORY	Page 9-23	System error
15	AR used without CB	Page 9-23	Application error
16	Now starts drawing check	Page 9-23	Note
17	Binary input 1 == 0	Page 9-23	Application error
18	Binary input 2 == 0	Page 9-23	Application error

Continued next page

Table 50: Configuration program messages

No.	Message	Help	Type
19	Binary input 3 == 0	Page 9-23	Application error
20	Binary input 4 == 0	Page 9-23	Application error
21	Binary input 5 == 0	Page 9-23	Application error
22	Binary input 6 == 0	Page 9-23	Application error
23	The selected symbol will be deleted. Continue?	Page 9-23	Note
24	The device isn’t open	Page 9-23	Communication error
25	The device is already open	Page 9-23	Communication error
26	Downloadfile for objects is too big. Your file is big.	Page 9-23	Application error
27	First character of filename not valid	Page 9-23	Application error
28	LCU upload	Page 9-23	Note
29	Wire upload	Page 9-23	Note
30	LCU upload active	Page 9-24	Note
31	Fupla upload active	Page 9-24	Note
32	Wire upload active	Page 9-24	Note
33	Import operation will overwrite all current data	Page 9-24	Warning
34	Wrong sensor nominal value!	Page 9-24	Application error
35	The device identifer is invalid or unsupported	Page 9-24	Application error
36	The specified byte size is invalid	Page 9-24	Communication error
37	Failure at configuration of an analog output	Page 9-24	Application error
38	Loading of new display texts will overwrite current texts	Page 9-24	Warning
39	Direct read write object: Invalid field bus address	Page 9-24	Application error
40	Direct read write object is more than once configured!	Page 9-24	Application error
41	DSP Load > 100 %	Page 9-24	Warning/application error
42	Validation Error	Page 9-24	Warning/application error
43	LCU upload was fault	Page 9-24	Warning
44	Fupla upload was fault	Page 9-24	Warning
45	Data upload	Page 9-24	Note
46	Wire upload was fault	Page 9-25	Warning
47	Get data from REF542	Page 9-25	Note
48	Reading Fault Recorder Data	Page 9-25	Note
49	Upload file not interpretable	Page 9-25	Application error
50	Energy counter is more than once configured!	Page 9-25	Application error
51	Rising event failure!	Page 9-25	Application error
52	Failure with open comm	Page 9-25	Application error
53	Successful ready	Page 9-25	Note
54	The function can’t allocate the queues	Page 9-25	System error
55	There is still a CB chosen	Page 9-25	Application error
56	Too many characters. max 21.	Page 9-25	Application error
57	Wrong lowtime parameter !	Page 9-25	Application error
58	Wrong hightime parameter !	Page 9-25	Application error
59	Display failure	Page 9-25	Application error
60	Wrong factor (I Transformer/I NetNominal)	Page 9-25	Application error

Continued next page

Table 50: Configuration program messages

No.	Message	Help	Type
61	Wrong interrupt channel.	Page 9-25	Application error
62	Wrong time parameter!	Page 9-25	Application error
63	Failure at configuration of protection functions	Page 9-25	Application error
64	Nominal voltages fault for synchro check	Page 9-26	Application error
65	Error at opening .doc file	Page 9-26	System error
66	Main setting failure	Page 9-26	Application error
67	Second setting failure	Page 9-26	Application error
68	failure with build comm dcb	Page 9-26	Communication error
69	Communication failure	Page 9-26	Communication error
70	Failure in initcom	Page 9-26	Communication error
71	Failure with open comm	Page 9-26	Communication error
72	Failure with setcommstate	Page 9-26	Communication error
73	Failure sensor 1	Page 9-26	Application error
74	Failure sensor 2	Page 9-26	Application error
75	Failure sensor 3	Page 9-26	Application error
76	Failure sensor 4	Page 9-26	Application error
77	Failure sensor 5	Page 9-26	Application error
78	Failure sensor 6	Page 9-26	Application error
79	Failure sensor 7	Page 9-26	Application error
80	Active time failure	Page 9-26	Application error
81	Wrong nr. of starts	Page 9-26	Application error
82	Display failure	Page 9-27	Application error
83	Failure at reading an application	Page 9-27	Application error
84	Selection failed !	Page 9-27	Application error
85	Documentation error	Page 9-27	System error
86	Wrong temperature	Page 9-27	Application error
87	Invalid field bus address in switching object	Page 9-27	Application error
88	Invalid field bus address in analog object	Page 9-27	Application error
89	Invalid node address	Page 9-27	Application error
90	Initialisation temperature failure	Page 9-27	Application error
91	Sequence node nr. failure	Page 9-27	Application error
92	Sensor fault	Page 9-27	Application error
93	Contact wear failure	Page 9-27	Application error
94	Wrong thickness found, choose only 0,1,3	Page 9-27	Application error
95	Line thickness failure	Page 9-27	Application error
96	Maximal temperature	Page 9-27	Application error
97	Minimum load failure	Page 9-27	Application error
98	Wrong motorcurrent	Page 9-27	Application error
99	Nominal temperature	Page 9-27	Application error
100	Nominal real power failure	Page 9-27	Application error
101	Wrong phase parameter	Page 9-28	Application error
102	Environment Temperature failure	Page 9-28	Application error
103	Netnumber failure	Page 9-28	Application error

Continued next page

Table 50: Configuration program messages

No.	Message	Help	Type
104	Warning temperature	Page 9-28	Application error
105	x-parameter bitmap failure	Page 9-28	Application error
106	Wrong x-parameter in x-end found	Page 9-28	Application error
107	Wrong x-parameter in x-start found	Page 9-28	Application error
108	y-parameter bitmap failure	Page 9-28	Application error
109	Wrong y-parameter in y-end found	Page 9-28	Application error
110	Wrong y-parameter in y-start found	Page 9-28	Application error
111	Wrong time configuration !	Page 9-28	Application error
112	Maximum reverse load failure	Page 9-28	Application error
113	Wrong operating hours	Page 9-28	Application error
114	Wrong parameter	Page 9-28	Application error
115	Wrong I/In parameter	Page 9-28	Application error
116	Wrong k parameter	Page 9-28	Application error
117	Wrong minimum motorcurrent parameter	Page 9-28	Application error
118	Wrong motorcurrent start threshold parameter	Page 9-28	Application error
119	Nominal current failure	Page 9-28	Application error
120	Wrong a parameter	Page 9-28	Application error
121	Wrong b parameter	Page 9-28	Application error
122	Select font failed	Page 9-28	System error
123	Active protection set failure	Page 9-28	Application error
124	Signal value failure	Page 9-29	Application error
125	Wrong startvalue	Page 9-29	Application error
126	Wrong time window	Page 9-29	Application error
127	Operating time failure	Page 9-29	Application error
128	Time const off failure	Page 9-29	Application error
129	Time const fault failure	Page 9-29	Application error
130	Time const normal failure	Page 9-29	Application error
131	Minimum operating current failure	Page 9-29	Application error
132	Failure in switching object	Page 9-29	Application error
133	Failure in analog object with field bus address:	Page 9-29	Application error
134	Division rate failure	Page 9-29	Application error
135	Filtertime failure	Page 9-29	Application error
136	Fupla upload	Page 9-29	Note
137	Hardware modified	Page 9-29	Note
138	The device’s baud rate is unsupported	Page 9-29	Communication error
139	Wrong lcumemfile size	Page 9-29	Application error
140	Wrong wirememfile size	Page 9-29	Application error
141	Hardware is not configured!	Page 9-29	Application error
142	Hardware number is a signal output.	Page 9-29	Note
143	Led hardware number failure	Page 9-29	Application error
144	Anlaog object hardware number failure	Page 9-29	Application error
145	Hardware Number failure	Page 9-30	Application error
146	Failed to create main window	Page 9-30	System error

Continued next page

Table 50: Configuration program messages

No.	Message	Help	Type
147	Main window	Page 9-30	System error
148	Your application has got no objects	Page 9-30	Application error
149	Your application has got no wire informations	Page 9-30	Note
150	Your application has got too many wires	Page 9-30	Application error
151	INTERNAL ERROR	Page 9-30	System error
152	Is not accessible	Page 9-30	System error
153	Wrong calibration-/scalingfactor	Page 9-30	Application error
154	Invalid channel given in bitmap	Page 9-30	Application error
155	No display text file available	Page 9-30	System error
156	No connection to REF542	Page 9-30	Communication error
157	No wire information in this file	Page 9-30	Application error
158	Configuration failure	Page 9-30	Application error
159	Led Number is more than once configured	Page 9-30	Application error
160	Power output 2 == 0	Page 9-31	Application error
161	Power output 3 == 0	Page 9-31	Application error
162	Power output 4 == 0	Page 9-31	Application error
163	Power Calculation	Page 9-31	Application error
164	CB failure	Page 9-31	Application error
165	Read error	Page 9-31	Communication error
166	Maximum 21 characters..	Page 9-31	Application error
167	More than 10 energy counter configured	Page 9-31	Application error
168	More than 100 direct read writes configured	Page 9-31	Application error
169	More than 12 protection functions configured	Page 9-31	Application error
170	More than 70 analog objects configured	Page 9-31	Application error
171	Do you want to save your modifications in 1?	Page 9-31	Note
172	Do you want to save your modifications ?	Page 9-31	Note
173	Energy factor failure !	Page 9-31	Application error
174	Net contains more than one output	Page 9-31	Application error
175	Net nominal current failure	Page 9-31	Application error
176	File new	Page 9-32	Note
177	Take new wire text ?	Page 9-32	Note
178	Number parameter failure !	Page 9-32	Application error
179	Number parameter failure !	Page 9-32	Application error
180	Only Netnumbers free	Page 9-32	Note
181	Object with given field bus address not found	Page 9-32	Note
182	Object with given sequence number not found	Page 9-32	Note
183	Object with no valid connections	Page 9-32	Application error
184	Pole change relais not configurable	Page 9-32	Application error
185	Problems with FILE HANDLING	Page 9-32	System error
186	Problems with WINDOWS RESOURCES	Page 9-32	System error
187	Really exit without saving the file?	Page 9-32	Note
188	Reduced hardware size	Page 9-32	Information/application error

Continued next page

Table 50: Configuration program messages

No.	Message	Help	Type
189	Swiobj 0-1 failure !	Page 9-32	Application error
190	Swiobj 0-2 failure	Page 9-32	Application error
191	Swiobj 0-3 failure	Page 9-32	Application error
192	Swiobj 1-0 failure	Page 9-33	Application error
193	Swiobj 1-1 failure	Page 9-33	Application error
194	Swiobj 1-2 failure	Page 9-33	Application error
195	Swiobj 2-1 failure	Page 9-33	Application error
196	Swiobj 2-2 failure	Page 9-33	Application error
197	Swiobj 2-2 no out failure	Page 9-33	Application error
198	Swiobj 4-3 failure	Page 9-33	Application error
199	Swiobj 6-5 failure	Page 9-33	Application error
200	Failure in switching object nr.:	Page 9-33	Application error
201	The hardware isn't available (locked by an other device)	Page 9-33	Communication error
202	Analog object field bus address: is more than once configured!	Page 9-33	Application error
203	LCU download active	Page 9-33	Note
204	Data download	Page 9-33	Note
205	Data download	Page 9-33	Note
206	Fupla download active	Page 9-33	Note
207	Send tel-nr.	Page 9-33	Note
208	Wire download active	Page 9-33	Note
209	Sensor 1-3 nominal value failure	Page 9-33	Application error
210	Sensor 4-6 nominal value failure	Page 9-33	Application error
211	Sensor 7 nominal value failure	Page 9-33	Application error
212	Wrong sensor configuration	Page 9-33	Application error
213	Wrong sensors for power calculation 3 phases	Page 9-34	Application error
214	Wrong sensors for power calculation aaron	Page 9-34	Application error
215	Sensor fault for directional power	Page 9-34	Application error
216	Signal not available	Page 9-34	Communication error
217	Are you sure, that all wires should be deleted?	Page 9-34	Warning
218	Are you sure, that this page should be deleted?	Page 9-34	Warning
219	Are you sure, that all pages should be deleted?	Page 9-34	Warning
220	Are you sure, that this object should be deleted?	Page 9-34	Warning
221	Language DLL missing	Page 9-34	System error
222	Failed to change language	Page 9-34	System error
223	Fault recorder chosen but no protection function	Page 9-34	Application error
224	Select Recordings	Page 9-34	Application error
225	Wire configuration	Page 9-34	Note
226	Drawing check	Page 9-35	Note
227	This will destroy the current configuration!	Page 9-35	Warning
228	Unknown struct found	Page 9-35	Application error
229	Unrecognised data type request	Page 9-35	Application error
230	Unrecognised data type to send	Page 9-35	Application error
231	Invalid net number	Page 9-35	Application error

Continued next page

Table 50: Configuration program messages

No.	Message	Help	Type
232	Invalid parameter: Min. Curr.	Page 9-35	Application error
233	Invalid parameter: Max. Unbal.	Page 9-35	Application error
234	Invalid path	Page 9-35	Application error
235	Different nominal voltages used	Page 9-35	Application error
236	Invalid usage of protection functions	Page 9-35	Application error
237	Wire with given net number not found	Page 9-35	Note
238	Connection to REF542 lost	Page 9-35	Communication error
239	Connection to REF542 broken	Page 9-35	Note
240	Netnumber failure	Page 9-36	Application error
241	REF542 version and configuration program not compatible!	Page 9-36	Warning
242	Choose only positive numbers	Page 9-36	Application error
243	Choose correct number	Page 9-36	Application error
244	Choose menupoint: versions to see current Versions	Page 9-36	Note
245	Warning: maximum of protection functions configured!!	Page 9-36	Application error
246	WARNING!! Problems with internal wires	Page 9-36	Application error
247	Deletion warning	Page 9-36	Warning
248	Warning sensor 1	Page 9-36	Application error
249	Warning sensor 2	Page 9-36	Application error
250	Warning sensor 3	Page 9-36	Application error
251	Warning sensor 4	Page 9-36	Application error
252	Warning sensor 5	Page 9-36	Application error
253	Warning sensor 6	Page 9-36	Application error
254	Warning sensor 7	Page 9-36	Application error
255	Value outside of limits:	Page 9-36	Application error
256	Value not understandable!	Page 9-36	Application error
257	Choose only value: a - b	Page 9-36	Application error
258	Operating hours	Page 9-36	Application error
259	Choose only factor 0.1 .. 1000!	Page 9-37	Application error
260	Only 1 or 2 accepted	Page 9-37	Application error
261	Choose only x:0 .. 96	Page 9-37	Application error
262	Choose only y:66 .. 247	Page 9-37	Application error
263	Choose only	Page 9-37	Application error
264	x-parameter failure	Page 9-37	Application error
265	y-parameter failure	Page 9-37	Application error
266	Drawing	Page 9-37	Note
267	Choose only time 0 .. 30 min	Page 9-37	Application error
268	Time parameter failure!	Page 9-37	Application error
269	Time parameter ignored	Page 9-37	Note
270	Too many Switchobjects used	Page 9-37	Application error
271	Wire file too big! Only ... byte allowed. Your file is ... byte big. Remove some wires! (1 Wire = 14 byte)	Page 9-37	Application error
272	More than 120 protection parameters used!	Page 9-37	Application error

9.3 Causes and corrections for error or status messages

The next two subsections contain information on the reason for the message and if applicable help on correcting errors. The lists are sorted by error numbers and alphabetically by message text. The user can correct many errors without additional help, but for some errors service assistance will be required. See Chapter "9.4 Further information" on page 9-38 for the relevant addresses.

9.3.1 Corrective action for error messages on the LCU

The table below contains additional information on the individual messages. The desired message can be quickly found by the number in "Table 49: Messages on the LC display screen" on page 9-2. The message itself is also listed alphabetically in the error text column.

The other columns show the reason for the message and, if it is an error message, brief instructions on how to deal with the error.

Table 51: Causes and options for correction in the event of LCU error messages

No:	Message/cause	Correction
1	**Address Error:** **Error in configuration file** **EPROM is not properly seated in its socket**	a) Delete the REF542 EEPROM, create a new configuration and import it. b) Check EPROM seating (service)
2	**IDMT Extremely Inv** **The protective function IDMT has been tripped with the current-time characteristic “extremely inverse“. Duration and level of the measured current value are above the set current-time characteristic.**	No error, only status message!
3	**IDMT Long Time Inv** **The protective function IDMT has been tripped with the current-time characteristic “long-time inverse“. Duration and level of the measured current value are above the set current-time characteristic.**	No error, only status message!
4	**IDMT Normal Inv** **The protective function IDMT has been tripped with the current-time characteristic “normal inverse“. Duration and level of the measured current value are above the set current-time characteristic.**	No error, only status message!
5	**IDMT Very Inv** **The protective function IDMT has been tripped with the current-time characteristic “very inverse“. Duration and level of the measured current value are above the set current-time characteristic.**	No error, only status message!
6	**Nr Of Starts** **The protective function number of motor starts has been tripped. Too many startup attempts within a set period were made. The motor is in danger of thermal overload.**	No error, only status message!
7	**CONFIG ERROR** **Internal error**	Notify service.
8	**Bad FUPLA E1** **In normal circumstances this error is caught by the configuration program. An unknown LED number was assigned in the configuration.**	Check the LED numbers in the application and reload the changed application into the REF542.

Table 51: Causes and options for correction in the event of LCU error messages

No:	Message/cause	Correction
9	**Bad FUPLA E2** **In normal circumstances this error is caught by the configuration program. Too many power pulse counter function blocks were configured for the LC display screen.**	Check the number of power pulse counters shown on the LC display screen and then reload the changed application into the REF542.
10	**Bad FUPLA E3** **In normal circumstances this error is caught by the configuration program. The signal number of a direct write-read object is outside the set range.**	Check the signal numbers of the direct write-read objects in the application and reload the changed application into the REF542.
11	**Bad FUPLA E4** **In normal circumstances this error is caught by the configuration program. Too many power pulse counters were configured in the function chart.**	Check the number of power pulse counters in the application and reload the changed application into the REF542.
12	**Bad FUPLA E5** **In normal circumstances this error is caught by the configuration program. The memory list is full and the function block can no longer be stored in the EEPROM (digital memory object or power pulse counter).**	Check the number of digital memory objects or power pulse counters in the application and then reload the changed application into the REF542.
13	**Bad FUPLA E6** **In normal circumstances this error is caught by the configuration program. RESET list for the reset page is full; power pulse counters cannot be deleted via the reset page!**	Check the number of power pulse counters in the application and reload the changed application into the REF542.
14	**Bad FUPLA E7** **In normal circumstances this error is caught by the configuration program. An unknown sensor was configured for a threshold object.**	Check the threshold objects in the application and reload the changed application into the REF542.
15	**Bad FUPLA E8** **In normal circumstances this error is caught by the configuration program. There are more thrust modules than switching objects in the configuration.**	Check the number of thrust modules and switching objects in the application and then reload the changed application into the REF542.
16	**Bad FUPLA E9** **In normal circumstances this error is caught by the configuration program. An incorrect time parameter was set in the fault recorder function block.**	Check the fault recorder configuration in the application and reload the changed application into the REF542.
17	**Bad FUPLA E10** **In normal circumstances this error is caught by the configuration program. There are too many protective functions in the configuration.**	Check the number of protective functions in the application and reload the changed application into the REF542.
18	**Bad FUPLA E11** **In normal circumstances this error is caught by the configuration program. There are too many switching objects in the configuration.**	Check the number of switching objects in the application and reload the changed application into the REF542.
19	**CHANGE SET ERROR** **You have tried to change a protective parameter locally on the LCU although there is still an alarm that has not been acknowledged. When changing a protective parameter an item in its setting range was violated.**	a) Acknowledge the alarm successfully and then change the desired protective parameter. b) Check the setting range of the parameters.

Table 51: Causes and options for correction in the event of LCU error messages

No:	Message/cause	Correction
20	**Wait CHECK of Change** **You have changed the parameter set** **or** **You have changed protective parameters locally.**	No error, only status message!
21	**Block Error** **An error has occurred while saving information in the EEPROM.**	Delete the REF542 EEPROM, create a new configuration and import it; otherwise check the EEPROM seating (Service).
22	**Blocked Rotor** **The protective function monitoring on blocking rotor has been tripped. The measured motor speed has fallen below a set speed value.**	No error, only status message!
23	**Bus Error** **Error in configuration file** **EPROM is not properly seated in its socket**	a) Delete the REF542 EEPROM, create a new configuration and import it. b) Check EPROM seating (service)
24	**CALIBRATION DSP FAULT** **Calibration data deleted or corrupted in EEPROM; the REF542 works with standard values.**	Recalibrate REF542.
25	**Clearing EEPROM** **You have deleted the EEPROM contents while starting the unit by pressing both cursor keys simulaneously.(Under normal conditions this message appears for such a short time that it cannot be read!)**	Delete the configuration and import a new configuration into the REF542.
26	**Config not loaded** **After being successfully imported, the configuration cannot be saved in the EEPROM:** **Configuration too large** **EEPROM defective**	a) Import a smaller test configuration to test the principal functions. If necessary, reduce the size of the configuration. b) Notify service.
27	**Configuration loaded** **Message after successful export of the configuration from the EEPROM**	No error, only status message!
28	**Configuration saved** **Message after the configuration has been successfully saved in the EEPROM.**	No error, only status message!
29	**CONFIG DSP ERROR** **Error in configuration: Message only appears after switching on or after import**	Check the configuration and import a test configuration to test the principal functions. Otherwise: Notify service. This error message generates event E21, which can be processed by a higher-order control system.
30	**CONFIG LON ERROR** **LON sensors cannot be configured: Message only appears after switching on or after import** **LON EPROM is not properly seated in its socket** **LON EPROM defective**	a) Check LON EPROM seating (Service) b) Notify service. This error message generates event E48, which can be processed by a higher-order control system.

Table 51: Causes and options for correction in the event of LCU error messages

No:	Message/cause	Correction
31	**Files deleted** **Data on the reset page on the LCU have been deleted. Depending on the selection, energy values, maximum values, circuit breaker data, trip data or fault records will be deleted.**	No error, only status message!
32	**Diff Protection** **The protective function transformer differential protection has been tripped.**	No error, only status message!
33	**Distance Protection** **The protective function distance protection for selectively tripping short circuits depending on the fault distance has been tripped.**	No error, only status message!
34	**Division by zero** **Error in configuration file.** **EPROM is not properly seated in its socket**	a) Delete the REF542 EEPROM, create a new configuration and import it. b) Check EPROM seating (service)
35	**DSP CONFIGURED** **While importing a configuration from a PC into the REF542 the parameters on the DSP are sent.**	No error, only status message!
36	**EEPROM_DATA_DISTURBED** **Error in data checksum in the EEPROM. The data in the EEPROM no longer match the originally imported configuration.**	Notify service. This error message generates event E10, which can be processed by a higher-order control system.
37	**Inrush** **The protective function inrush current blocking was in working. A maximum current was detected by its characteristic as inrush current. The trip signal of another maximum current protective function was blocked.**	No error, only status message!
38	**FUPLA Down Load** **A new configuration is being imported. The LCU receives the FUPLA (function chart) data.**	No error, only status message!
39	**LCU Down Load** **A new configuration is being imported. The LCU receives the LCU data in which, for example, the display view is defined.**	No error, only status message!
40	**WIRE Down Load** **A new configuration is being imported. The LCU receives the WIRE data. The connections (wire) in the function chart between the various function blocks are saved here.**	No error, only status message!
41	**EraseAddrBlockError** **Error when saving the configuration in the EEPROM; a memory cell cannot be written to or deleted.**	Notify service. This error message generates event E8, which can be processed by a higher-order control system.
42	**GndIDMT Extremely Inv** **The protective function IDMT for earthfault currents with the current-time characteristic “extremely inverse“ has been tripped. Duration and level of the measured current value exceed the set current-time characteristic.**	No error, only status message!

Table 51: Causes and options for correction in the event of LCU error messages

No:	Message/cause	Correction
43	**Gnd IDMT Long Time Inv** **The protective function IDMT for earrthfault currents with the current-time characteristic “long-time inverse“ has been tripped. Duration and level of the measured current value exceed the set current-time characteristic.**	No error, only status message!
44	**Gnd IDMT Normal Inv** **The protective function IDMT for earthfault currents with the current-time characteristic “normal inverse“ has been tripped.** **Duration and level of the measured current value exceed the set current-time characteristic.**	No error, only status message!
45	**Gnd IDMT Very Inv** **The protective function IDMT for earthfault currents with the current-time characteristic “very inverse“ has been tripped.** **Duration and level of the measured current value are above the set current-time characteristic.**	No error, only status message!
46	**Wrong Parameter Value** **You have tried to input an incorrect parameter in local/ input mode.**	Check the setting range of the parameter and input it again.
47	**ERROR SUPERVISION** **The output relay fault monitoring has been tripped. An output relay did not switch.**	Notify service to replace the binary input/output board.
48	**Frequency Supervision** **The protective function frequency monitoring has been tripped. The measured frequency deviates from the rated frequency by more than the set amplitude.**	No error, only status message!
49	**Overl Def Dir Low** **The protective function overcurrent with directional decision (Overl Def Dir Low) has been tripped. The measured current has exceeded a set value for the configured minimum time.**	No error, only status message!
50	**Overl Def Dir High** **The protective function overcurent with directional decision (Overl Def Dir High) has been tripped. The measured current has exceeded a set value for the configured minimum time.**	No error, only status message!
51	**Gnd Dir Low** **The protective function earthfault protection with directional decision (Gnd Dir Low) has been tripped. The measured current has exceeded a set value for the configured minimum time.**	No error, only status message!
52	**Gnd Dir High** **The protective function earthfault protection with directional decision (Gnd Dir High) has been tripped. The measured current has exceeded a set value for the configured minimum time.**	No error, only status message!

Table 51: Causes and options for correction in the event of LCU error messages

No:	Message/cause	Correction
53	**Illegal Instruction** **Error in configuration file.** **EPROM is not properly seated in its socket**	a) Delete the REF542 EEPROM, create a new configuration and import it. b) Check EPROM seating (service)
54	**No R/W with RS-232** **You are attempting to import a configuration to the LCU although the ALARM LED is on. A configuration may not be imported during a persistent alarm.**	Acknowledge the alarm successfully and import the configuration again.
55	**Upload Version** **You are importing the current version numbers into the configuration memory.**	No error, only status message!
56	**Directional Power** **The protective function directional power has been tripped. The result of the internal power calculation of the REF542 has a different sign from the set limit value and exceeds it.**	No error, only status message!
57	**MemFullError** **Error in saving the configuration in the EEPROM; not enough memory!**	Reduce the size of the configuration (optimize). This error message generates event E2, which can be processed by a higher-order control system.
58	**Motor start** **The protective function motor starting monitoring has been tripped. The starting current when the motor was starting was too high.**	No error, only status message!
59	**Nodes disconnected** **This message only appears when the LON bus is activated as the process bus in the hardware configuration: [Number of non-active LON sensors]**	Test the sensors (connection, function). Otherwise: Notify service.
60	**NOT_IDENT_EEPROMDATA** **This message only appears in the production test: The EEPROM has not yet been initialized.**	Notify service. This error message generates event E9, which can be processed by a higher-order control system.
61	**Synchro Check** **The protective function synchrocheck has been tripped. The voltages of two systems that are to be coupled together deviate from each other in phase and/or amplitude in set limits.**	No error, only status message!
62	**Parameter NOT saved** **You attempted to change too many parameters simultaneously on the LCU in local/input mode.**	Change the parameters again and save them more often during the process.
63	**Privilege** **Error in configuration file.** **EPROM is not properly seated in its socket**	a) Delete the REF542 EEPROM, create a new configuration and import it. b) Check EPROM seating (service)
64	**READ HOST ERROR** **This message only appears when the LON bus is activated as the interbay bus in the hardware configuration:** **LON EPROM is not properly seated in its socket** **LON EPROM defective**	a) Check LON EPROM seating (Service) b) Notify service.

Table 51: Causes and options for correction in the event of LCU error messages

No:	Message/cause	Correction
65	**READY DSP ERROR** **This message only appears when the LON bus is activa-ted as the interbay bus in the hardware configuration:** **Internal problem at the SPI interface of the control and command processor (microcontroller).**	Notify service.
66	**Ready Error** **Error in configuration file.** **EPROM is not properly seated in its socket**	a) Delete the REF542 EEPROM, create a new configura-tion and import it. b) Check EPROM seating (service)
67	**SCU running mode** **A new configuration has been imported to the LCU. The subsequent startup phase is now complete and the unit is ready for operation.** **The protective functions are ready for operation shortly after the beginning of the startup phase.**	No error, only status message!
68	**Runtime error** **In the event of a malfunction this message is retrieved from the system libraries.**	Notify service.
69	**Unbalanced Load** **The protective function unbalanced load has been trip-ped. A difference that exceeds a set value has occurred between the measured currents.**	No error, only status message!
70	**Upload DSP Data** **The DSP data are being imported. The LCU sends the current measured values over the RS232 interface to a computer for further processing.**	No error, only status message!
71	**FUPLA Up Load** **The current configuration is being imported. The LCU sends the FUPLA (function chart) data.**	No error, only status message!
72	**LCU Up Load** **The current configuration is being imported. The LCU sends the LCU data in which, for example, the display view is defined.**	No error, only status message!
73	**WIRE Up Load** **The current configuration is being imported. The LCU sends the WIRE data. The connections (wire) in the FUPLA (function chart) between the various function blocks are saved here.**	No error, only status message!
74	**Software changed** **This message only appears after switching on or after the import of a new configuration. The configuration in the EEPROM and the versions of the control and com-mand processor (microcontroller) does not match.**	Delete the REF542 EEPROM, create a new configuration and import it.
75	**COIL ERROR CARD1 I** **The trip circuit 1 is broken on the binary input and out-put board (I/O board) 1.**	Check the trip circuit. This error message generates two events, which can be processed by a higher-order control system. Trip circuit monitoring generates E16 and trip circuit monitoring E17.

Table 51: Causes and options for correction in the event of LCU error messages

No:	Message/cause	Correction
76	**COIL ERROR CARD1 II** **The trip circuit 2 is broken on the binary input and output board (I/O board) 1.**	Check the trip circuit. This error message generates two events, which can be processed by a higher-order control system. Trip circuit monitoring generates E18 and trip circuit monitoring E19.
77	**COIL ERROR CARD2 I** **The trip circuit 1 is broken on the binary input and output board (I/O board) 2.**	Check the trip circuit. This error message generates two events, which can be processed by a higher-order control system. Trip circuit monitoring generates E20 and trip circuit monitoring E21.
78	**COIL ERROR CARD2 II** **The trip circuit 2 is broken on the binary input and output board (I/O board) 2.**	Check the trip circuit. This error message generates two events, which can be processed by a higher-order control system. Trip circuit monitoring generates E22 and trip circuit monitoring E23.
79	**StatusRegError** **Error in configuration file.** **EPROM is not properly seated in its socket**	a) Delete the REF542 EEPROM, create a new configuration and import it. b) Check EPROM seating (service) This error message generates an event E7, which can be processed by a higher-order control system.
80	**Supply down** **Fault in the REF542 auxiliary supply voltage. This message cannot be seen under normal circumstances, because a display without auxiliary supply voltage is not possible.**	Check the auxiliary voltage supply. This error message generates an event E35, which can be processed by a higher-order control system.
81	**Suspend Error** **Error in configuration file.** **EPROM is not properly seated in its socket**	a) Delete the REF542 EEPROM, create a new configuration and import it. b) Check EPROM seating (service) This error message generates an event E6, which can be processed by a higher-order control system.
82	**Thermal overload** **The protective function thermal overload has been tripped. The motor temperature calculated from the phase currents by the REF542 has exceeded a set value.**	No error, only status message!
83	**Thermal Supervision** **The protective function thermal protection has been tripped. The value measured with a LON-compatible temperature probe has exceeded a set value for the configured period.**	No error, only status message!
84	**TIMEOUT_ERROR** **The connection between the REF542 and the configuration PC is faulty.**	• Test the connection between PC and REF542 repeat the transfer. • If necessary, repeat the transfer with another PC. If the error occurs during the import process: Delete the EEPROM of the REF542 beforehand. This error message generates an event E30, which can be processed by a higher-order control system.
85	**Too many str to read** **A command that cannot be processed by the REF542, because it has too many individual queries, is received over the SPABUS (interbay bus). This does not affect the functions of the unit. This error only occurs when SPA bus board version 2.x is used with the microcontroller version from 2C00 or higher**	• Test the interbay bus command and • Test the versions of the SPA bus board and the microcontroller (control and command processor) for a non-compatible version combination. Otherwise: Notify service.

Table 51: Causes and options for correction in the event of LCU error messages

No:	Message/cause	Correction
86	**Trace** **Error in configuration file.** **EPROM is not properly seated in its socket**	a) Delete the REF542 EEPROM, create a new configuration and import it. b) Check EPROM seating (service)
87	**Resid OverV Def Low** **The protective function residual overvoltage has been tripped. The measured residual voltage deviates from that calculated by a set value.**	No error, only status message!
88	**Resid OverV Def High** **The protective function residual overvoltage has been tripped. The measured residual voltage deviates from that calculated by a set value.**	No error, only status message!
89	**Undervoltage Def Low** **The protective function undervoltage def low has been tripped. The measured voltage has fallen below a set value for the configured minimum time.**	No error, only status message!
90	**Undervoltage Def High** **The protective function undervoltage def high has been tripped. The measured voltage has fallen below a set value for the configured minimum time.**	No error, only status message!
91	**Undervoltage Inst** **The protective function undervoltage instantaneous has been tripped. The measured voltage has fallen below a set value for the configured minimum time.**	No error, only status message!
92	**Overvoltage Def Low** **The protective function overvoltage def low has been tripped. The measured voltage has exceeded a set value for the configured minimum time.**	No error, only status message!
93	**Overvoltage Def High** **The protective function overvoltage def high has been tripped. The measured voltage has exceeded a set value for the configured minimum time.**	No error, only status message!
94	**Overvoltage Inst** **The protective function overvoltage instantaneous has been tripped. The measured voltage has exceeded a set value for the configured minimum time.**	No error, only status message!
95	**Overcurrent Inst** **The protective function overcurrent instanteneous has been tripped. The measured current has exceeded a set value for the configured minimum time.**	No error, only status message!
96	**Overcurrent Def High** **The protective function overcurrent def high has been tripped. The measured current has exceeded a set value for the configured minimum time.**	No error, only status message!
97	**Overcurrent Def Low** **The protective function overcurrent def low has been tripped. The measured current has exceeded a set value for the configured minimum time.**	No error, only status message!

Table 51: Causes and options for correction in the event of LCU error messages

No:	Message/cause	Correction
98	**UNDEFINED PROT ERROR** **The protection and measuring processor (DSP) reports an unknown protective function after switching on or after the import of a configuration.**	Check the DSP version and notify service. Older versions do not support all protective functions of the newer configurations. This error message generates an event E42, which can be processed by a higher-order control system.
99	**Gnd Non Dir Hi** **The protective earthfault protection high has been tripped. The measured current has exceeded a set value for the configured minimum time.**	No error, only status message!
100	**Gnd Non Dir Low** **The protective function earthfault protection low has been tripped. The measured current has exceeded a set value for the configured minimum time.**	No error, only status message!
101	**Unit Interrupt** **Internal error.**	Notify service.
102	**Low load** **The protective function low load has been tripped. The calculated effective power has fallen below a set value for the configured minimum time.**	No error, only status message!
103	**VppLowError** **Error when writing the EEPROM. A memory cell cannot be written because the programmer voltage of the EEPROM is too low.**	Notify service.
104	**Wait new config** **No new configuration was found in the EEPROM when the unit was started. Under normal conditions this message appears for such a short time that it cannot be read.**	No error, only status message!
105	**Waiting for DSP ready** **This message appears briefly in the startup phase of the REF542. However, if the message remains visible, communications between the protection and measuring processor (DSP) and the control and command processor (MC) is not possible.**	Check whether the DSP and MC EPROMs are correctly seated in the sockets (Service). Otherwise: Notify service.
106	**Waiting LON node** **Test output on commissioning the LON interbay bus. This message does not appear in normal operation.**	No error, only status message!
107	**Waiting LON node 1** **This message only appears if the LON bus is activated as process bus in the hardware configuration and the unit has just been switched on or a new configuration has been imported:** **LON EPROM is not properly seated in its socket** **LON EPROM defective**	Check whether the LON EPROM is correctly seated in the socket. Otherwise: Notify service.
108	**WRITE HOST ERROR** **Internal error during communication between the control and command processor (MC) and the protection and measurement processor (DSP).**	Notify service. This error message generates an event E20, which can be processed by a higher-order control system.

Table 51: Causes and options for correction in the event of LCU error messages

No:	Message/cause	Correction
109	**Writing Byte Error** **Error in configuration file.** **EPROM is not properly seated in its socket**	a) Delete the REF542 EEPROM, create a new configuration and import it. b) Check EPROM seating (service) This error message generates an event E3, which can be processed by a higher-order control system.
110	**Wrong Parameter Value** **An illegal value for a parameter was input at the LCU.**	Check the setting range of the parameter.
111	**Wrong Version DSP** **The versions of the protection and measuring processor (DSP) and of the control and command processor (MC) do not match.**	Check the DSP and MC versions for compatibility. Notify service.
112	**WRONG CONFIGURATION** **The configuration in the EEPROM and the version of the control and command processor (MC) does not match and therefore the protection and measuring processor (DSP) reports an unknown function block. This message only appears after switching on or after the import of a new configuration.**	Notify service.

9.3.2 Correction in the event of configuration program error messages

The table below contains additional information on the individual messages. The desired message can be quickly found by the number in "Table 50: Configuration program messages" on page 9-4. The message itself is also listed alphabetically in the message column.

The other columns show the reason for the message and, if it is an error message, brief instructions on how to deal with the error.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
1	**8 P Font selection failed**	The program tried to change the font. The required font is not present or the font file is defective.	Reinstall this system font in Microsoft Windows®.
2	**Warning: Uploaded file was generated with version:**	You are trying to import a configuration from the REF542 that was created with a more recent version of the configuration software.	Check and compare the versions of the REF542 and the configuration software.
3	**Warning: be sure to have no elements chosen, which are no more available !**	The type of the binary input and output board as been changed in the existing application.	Check whether the application is using inputs and/or outputs that are no longer available.
4	**Current file not saved ! Really open a new file without saving ?**	Changes have been made in the current application and you are attempting to create a new application without saving the old application beforehand.	Save the current configuration first and only then create a new one!
5	**Analog inputs not configured**	The analog inputs are not configured	Configure at least one analog input.
6	**Nr of moving failure**	The value input is outside the specified range.	Correct corresponding value.
7	**Failure with open comm**	There are more than 10 energy counters in the application.	Reduce the umber of energy counters.
8	**Number of wires**	There are too many connections in the application.	Optimize the number of connections in use.
9	**Choose only energy counter 1 .. 10**	There are more than 10 energy counters in the application.	Reduce the number of energy counters.
10	**Display will be cleared. Do you want to continue ?**	You are about to delete the entire display configuration.	`Accept`: The current display configuration will be deleted; then a new configuration is required. `Cancel`: The existing display configuration will remain.
11	**Display: Field bus address ... not used by any switching object. Check symbols !**	A switching icon with an interbay bus address that does not appear in the FUPLA has been selected in the display.	Change the interbay bus address in the switching icon of the LC display screen with the corresponding editor or change the corresponding interbay bus address in the configuration dialog of the switching object in the FUPLA.
12	**LED Text for display**	An error has occurred when configuring the display text of an indicator light.	Revise the text. More than 21 characters are allowed!

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
13	**REF542 texts**	A problem with the display texts for the REF542 has appeared.	Check whether the *.stc files are in the `Language` directory. If not, save the application on a diskette, uninstall and then reinstall the configuration program.
14	**Application is OUT OF MEMORY**	The configuration software cannot be started.	Use a computer with more RAM.
15	**AR used without CB**	An autoreclosure has been configured, but there is no power circuit-breaker in the application.	Configure a 2-2 switching object as power circuit-breaker. The autoreclosure will only function if there is a power circuit-breaker in the application.
16	**Now starts drawing check**	The drawing test has been started.	After the drawing has been successfully checked, the message `successfully completed` appears. If errors occur during the drawing test, an error list will be output after the test.
17	**Binary input 1 == 0**	When configuring the switching object, no physical input was assigned to binary input 1.	Assign a physical input to the binary input.
18	**Binary input 2 == 0**	When configuring the switching object no physical input was assigned to binary input 2.	Assign a physical input to the binary input.
19	**Binary input 3 == 0**	When configuring the switching object no physical input was assigned to binary input 3.	Assign a physical input to the binary input.
20	**Binary input 4 == 0**	When configuring the switching object no physical input was assigned to binary input 4.	Assign a physical input to the binary input.
21	**Binary input 5 == 0**	When configuring the switching object no physical input was assigned to binary input 5.	Assign a physical input to the binary input.
22	**Binary input 6 == 0**	When configuring the switching object no physical input was assigned to binary input 6.	Assign a physical input to the binary input.
23	**The selected symbol will be deleted. Continue?**	You wish to delete an icon in the display configuration.	`OK`: The selected icon will be deleted. `Cancel`: The selected icon will be deleted.
24	**The device isn't open**	There is a problem with the serial interface on the PC.	Check the relevant PC settings.
25	**The device is already open**	There is a problem with the serial interface on the PC.	Check the relevant PC settings.
26	**Downloadfile for objects is too big. Your file is big.**	When creating the application the Over allowable size was exceeded.	Reduce the size of the application. An application that is too large cannot be sent. The allowed size is shown in the message.
27	**First character of filename not valid**	The name under which the application is to be saved begins with a number.	Change the name.
28	**LCU upload**	Data are being exported from the REF542.	Press the ESC key to stop this action.
29	**Wire upload**	Data are being exported from the REF542.	Press the ESC key to stop this action.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
30	**LCU upload active**	The display data are being received from the REF542.	Press the ESC key to stop this action.
31	**Fupla upload active**	The data are being received from the REF542.	Press the ESC key to stop this action.
32	**Wire upload active**	The connection data are being received from the REF542.	Press the ESC key to stop this action.
33	**Import operation will overwrite all current data**	When exporting data (application or fault record data), data open in the PC will be overwritten.	Press the ESC key to stop this action.
34	**Wrong sensor nominal value!**	An error in the setting of the sensor rated value occurred while configuring the analog inputs of the REF542.	Correct corresponding value.
35	**The device identifer is invalid or unsupported**	The value input is outside the specified range.	Correct corresponding value.
36	**The specified byte size is invalid**	The desired telegram size for data transmission between PC and REF542 is not valid.	Check the PC settings in the menu `Data Transfer/Serial Port`
37	**Failure at configuration of an analog output**	An error has occurred when configuring the analog output.	Correct corresponding value.
38	**Loading of new display texts will overwrite current texts**	The wrong display language has been used in the configuration of the displays.	The former texts will be overwritten. The former texts must be reimported to restore them.
39	**Direct read write object: Invalid field bus address**	The interbay bus address [Variable] of a direct write-read object has been used more than once	Correct the interbay bus address in the configuration dialog of the corresponding function block direct write-read object.
40	**Direct read write object is more than once configured !**	The function block direct write-read object no. [Variable] has been used more than once	Correct the numbers of the function block direct write-read object.
41	**DSP Load > 100 %**	The DSP load is more than 100% because of the implemented protective functions.	Reduce the number of protective functions until the DSP is less than or equal to 100% again. (Observe the upper limit of 120 protective parameters and max. 12 protective functions.)
42	**Validation Error**	The input value for a program parameter is wrong.	Correct corresponding parameter.
43	**LCU upload was fault**	Display data have just been exported from the REF542. The configuration program found corrupt or incomplete data.	Check the versions of the configuration program and of the REF542, if necessary compare them and retry the export.
44	**Fupla upload was fault**	FUPLA data have just been exported from the REF542. The configuration program found corrupt or incomplete data.	Check the versions of the configuration program and of the REF542, if necessary compare them and retry the export.
45	**Data upload**	Data are being exported from the REF542.	Press the ESC key to stop this action.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
46	**Wire upload was fault**	Connection data have just been exported from the REF542. The configuration program found corrupt or incomplete data.	Check the versions of the configuration program and of the REF542, if necessary compare them and retry the export.
47	**Get data from REF542**	The data are being received from the REF542.	Press the ESC key to stop this action.
48	**Reading Fault Recorder Data**	A fault record is being exported from the REF542.	Press the ESC key to stop this action.
49	**Upload file not interpretable**	You are trying to export a new application from the REF542 with older configuration software.	Use the associated configuration program to process the application.
50	**Energy counter %hu is more than once configured!**	The energy counter has been configured with the number [Variable] more than once.	Renumber the energy counter. Setting range: 1 … 10 Every number can only be assigned once.
51	**Rising event failure !**	The value input is outside the specified range.	Correct corresponding value.
52	**Failure with open comm**	The value input is outside the specified range.	Correct corresponding value.
53	**Successful ready**	The current application has been checked. The test algorithm did not find an error.	This application can now be exported from the PC to the REF542 or saved on data media and the configuration program closed, if applicable.
54	**The function can't allocate the queues**	There is a problem with the serial interface on the PC.	Check the relevant PC settings.
55	**There is still a CB chosen**	When configuring another 2-2 switching object you also wanted to define it as a power circuit-breaker.	Only define one power circuit-breaker in the application.
56	**Too many characters. max 21.**	Too many characters were used when entering text	Revise the text. No more than 21 characters are allowed!
57	**Wrong lowtime parameter !**	The value input is outside the specified range.	Correct corresponding value.
58	**Wrong hightime parameter !**	The value input is outside the specified range.	Correct corresponding value.
59	**Display failure**	The value input is outside the specified range.	Correct corresponding value.
60	**Wrong factor (I Transformer/I NetNominal)**	The value input is outside the specified range.	Change the parameter. • Rated transformer current or • network rated current
61	**Wrong interrupt channel.**	The desired interrupt channel for a protective function is not available.	Only the channel number of a physical and configured output can be used. The interrupt channel refers to the direct output channel.
62	**Wrong time parameter !**	The value input is outside the specified range.	Correct corresponding value.
63	**Failure at configuration of protection functions**	An error has occurred when configuring the protective function.	Correct the corresponding parameter in the protective function.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
64	**Nominal voltages fault for synchro check**	a) The sensor or transformer configuration is not suitable. b) Different rated voltages were input for the sensors/transformers.	a) Check and, if necessary, correct the sensor or transformer configuration. b) Correct corresponding values
65	**Error at opening doc file**	A documentation file cannot be created.	The documentation file is defective or open in another program.
66	**Main setting failure**	An invalid value was set in the 1st parameter set.	Correct corresponding value.
67	**Second setting failure**	An invalid value was set in the 2nd parameter set.	Correct corresponding value.
68	**failure with build comm dcb**	There is a problem with the serial interface on the PC.	Check the PC settings.
69	**Communication failure**	You are in the process of trying to exchange data between the PC and the REF542. However, a connection cannot be established.	Possible causes of this communications problem: • You are trying to send data to the REF542 during a persistent alarm on the REF542. =>First acknowledge the alarm OR • The connector cable is defective =>Replace connector cable.
70	**Failure in init com**	There is a problem with the serial interface on the PC.	Check the relevant PC settings.
71	**Failure with open comm**	There is a problem with the serial interface on the PC.	Check the relevant PC settings.
72	**Failure with set comm state**	There is a problem with the serial interface on the PC.	Check the relevant PC settings.
73	**Failure sensor 1**	The value input is outside the specified range.	Correct corresponding value.
74	**Failure sensor 2**	The value input is outside the specified range.	Correct corresponding value.
75	**Failure sensor 3**	The value input is outside the specified range.	Correct corresponding value.
76	**Failure sensor 4**	The value input is outside the specified range.	Correct corresponding value.
77	**Failure sensor 5**	The value input is outside the specified range.	Correct corresponding value.
78	**Failure sensor 6**	The value input is outside the specified range.	Correct corresponding value.
79	**Failure sensor 7**	Error in the configuration of the 7th analog output.	Correct the configuration of the 7th analog output.
80	**Active time failure**	The value input is outside the specified range.	Correct corresponding value.
81	**Wrong nr. of starts**	The value input for the maximum allowable number of startups is outside the specified range.	Correct corresponding value. Setting range: 1 … 10 startups.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
82	**Display failure**	An error has occurred when configuring the LC display screen of the REF542.	Observe the detailed error message in the message window.
83	**Failure at reading an application**	The application has serious errors. It is not being interpreted correctly.	Revise the application or create it again.
84	**Selection failed !**	a) There was an error in selecting the fault recorder. The fault record in the REF542 is incomplete b) No fault record present.	a) Try to select the fault record again. b) Reconfigure the fault recorder.
85	**Documentation error**	A documentation file cannot be created.	The documentation file is defective or open in another program.
86	**Wrong temperature**	The value input for the temperature is outside the specified range.	Correct corresponding value.
87	**Invalid field bus address in switching object**	The value input is outside the specified range.	Correct the corresponding interbay bus address. Setting range: 5 … 49 or 111 … 127
88	**Invalid field bus address in analog object**	The value input is outside the specified range.	Correct the corresponding interbay bus address. Setting range: 103 … 109
89	**Invalid node address**	The value input is outside the specified range.	Correct corresponding value. Setting range: 0 … 255.
90	**Initialisation temperature failure**	The value input is outside the specified range.	Correct corresponding value.
91	**Sequence node nr. failure**	The value input is outside the specified range.	Correct corresponding value.
92	**Sensor fault**	A general error has occurred while configuring the analog inputs of the REF542.	Correct corresponding value.
93	**Contact wear failure**	An error has occurred while configuring the one parameter of the contact monitoring.	Correct corresponding parameter.
94	**Wrong thickness found, choose only 0,1,3**	The value input is outside the specified range.	Correct corresponding value.
95	**Line thickness failure**	The value input is outside the specified range.	Correct corresponding value.
96	**Maximal temperature failure**	The value input is outside the specified range.	Correct corresponding value.
97	**Minimum load failure**	The value input is outside the specified range.	Correct corresponding value.
98	**Wrong motorcurrent parameter**	The value input is outside the specified range.	Correct corresponding value.
99	**Nominal temperature failure**	The value input is outside the specified range.	Correct corresponding value.
100	**Nominal real power failure**	The value input is outside the specified range.	Correct corresponding value.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
101	**Wrong phase parameter**	The selected allowable phase difference is outside the valid range.	Correct corresponding value.
102	**Environment Temperature failure**	The value input is outside the specified range.	Correct the corresponding value for the ambient temperature in the configuration dialog of the protective function thermal replica.
103	**Netnumber failure**	The value input is outside the specified range.	Correct corresponding value.
104	**Warning temperature failure**	The value input is outside the specified range.	Correct corresponding value.
105	**x-parameter bitmap failure**	The value input is outside the specified range.	Correct corresponding value.
106	**Wrong x-parameter in x-end found**	The value input is outside the specified range.	Correct corresponding value.
107	**Wrong x-parameter in x-start found**	The value input is outside the specified range.	Correct corresponding value.
108	**y-parameter bitmap failure**	The value input is outside the specified range.	Correct corresponding value.
109	**Wrong y-parameter in y-end found**	The value input is outside the specified range.	Correct corresponding value.
110	**Wrong y-parameter in y-start found**	The value input is outside the specified range.	Correct corresponding value.
111	**Wrong time configuration**	The value input is outside the specified range.	Correct corresponding value.
112	**Maximum reverse load failure**	The value input is outside the specified range.	Correct corresponding value.
113	**Wrong operating hours**	The value input is outside the specified range.	Correct corresponding value.
114	**Wrong parameter**	The value input is outside the specified range.	Correct corresponding value.
115	**Wrong I/In parameter**	The value input is outside the specified range.	Correct corresponding value.
116	**Wrong k paramete**	The value input is outside the specified range.	Correct corresponding value.
117	**Wrong minimum motorcurrent parameter**	The value input is outside the specified range.	Correct corresponding value.
118	**Wrong motorcurrent start threshold parameter**	The value input is outside the specified range.	Correct corresponding value.
119	**Nominal current failure**	The value input is outside the specified range.	Correct corresponding value.
120	**Wrong a parameter**	The value input for parameter a is outside the specified range.	Please correct parameter a.
121	**Wrong b parameter**	The value input for parameter b is outside the specified range.	Please correct parameter b.
122	**Select font failed**	The program has found that a font is not available or a font file is corrupt.	Please reinstall the system fonts in Microsoft Windows®.
123	**Active protection set failure**	An invalid value was input while entering the parameter set of the protective function that is to be activated.	Correct corresponding value. Setting range: 1 or 2.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
124	**Signal value failure**	The value input is outside the specified range.	Correct corresponding value.
125	**Wrong startvalue**	The value input is outside the specified range.	Correct corresponding value.
126	**Wrong time window**	An invalid time parameter was used in a function block.	Correct corresponding time parameter.
127	**Operating time failure**	The value input is outside the specified range.	Correct corresponding value.
128	**Time const off failure**	The value input is outside the specified range.	Correct corresponding value.
129	**Time const fault failure**	The value input is outside the specified range.	Correct corresponding value.
130	**Time const normal failure**	The value input is outside the specified range.	Correct corresponding value.
131	**Minimum operating current failure**	The value input is outside the specified range.	Correct corresponding value.
132	**Failure in switching object**	An error occurred in the configuration of a switching object.	Correct the corresponding switching object.
133	**Failure in analog object with field bus address: ...**	The interbay bus address n of a threshold object has been used more than once	Correct the interbay bus address in the configuration dialog of the threshold object.
134	**Division rate failure**	The value input is outside the specified range.	Correct corresponding value.
135	**Filtertime failure**	The filter time set in a switching object is not in the allowable range.	Correct the corresponding value in the configuration dialog of the switching object.
136	**Fupla upload**	Data are being exported from the REF542.	Press the ESC key to stop this action.
137	**Hardware modified**	The type of binary input and output board has been changed in the existing application.	Check whether the selected inputs and outputs are still available.
138	**The device's baud rate is unsupported**	The value input is outside the specified range.	Please correct corresponding value.
139	**Wrong Icumemfile size**	The configuration of the REF542 display is too large.	Please reduce the number of icons and lines that can be displayed.
140	**Wrong wirememfile size**	Your application contains too many connections.	Optimize the number of connections.
141	**Hardware is not configured !**	The hardware of the device that is to be configured has not yet been set in the application.	Please configure the hardware of the device that you wish to use. The hardware must be configured first to open the program draw mode!
142	**Hardware number ... is a signal output.**	The selected output is a signaling output. The time parameter for the impulse length will be ignored.	If the time parameter is required, another power output must be selected.
143	**Led hardware number failure**	The value input is outside the specified range.	Correct the number of the corresponding indicator light. Setting range: 3 … 9
144	**Anlaog object hardware number failure**	The value input is outside the specified range.	Please correct number of the threshold object. Setting range: 1 … 70

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
145	**Hardware Number failure**	The interbay bus address set for a switching object is in error.	Please correct the interbay bus address in the configuration dialog of the switching object. Setting range: 5 … 59 and 111 … 127
146	**Failed to create main window**	The configuration program cannot be started.	Use a computer with more RAM. Uninstall the current software and reinstall it again.
147	**Main window**	The program has a problem with the Windows installation. A font is missing	Please reinstall the Microsoft Windows® system fonts.
148	**Your application has got no objects**	You have created an application with no function blocks. The unit cannot carry out control and/or protective functions.	If the unit is to carry out control and/or protective functions, the function blocks required for this must be implemented in the application.
149	**Your application has got no wire informations**	You have created an application with no connections between the function blocks. The unit cannot carry out control and/or protective functions. This application cannot be sent to the REF542.	Connect the function blocks in accordance with the desired functions. Every function block must have at least one connection.
150	**Your application has got too many wires**	There are too many connections in the application.	Optimize the number of connections in use.
151	**INTERNAL ERROR**	The configuration program cannot be started.	• Uninstall the configuration program and reinstall it. Otherwise: • Notify service.
152	**Is not accessible**	The path name is not valid.	Use a valid path name.
153	**Wrong calibration-/scalingfactor**	The calibration factor input for the relevant analog input is wrong.	Correct corresponding value.
154	**Invalid channel given in bitmap**	The value input (interbay bus address) is outside the specified range.	Correct corresponding value.
155	**No display text file available**	You have tried to change the REF542 display language. The program has found that there are no files with display texts.	Check whether the *.stc files are in the `Language` directory. If not, save the application on a diskette and after uninstallation reinstall the configuration program.
156	**No connection to REF542**	You are in the process of trying to exchange data between the PC and the REF542. However, a connection cannot be established.	Possible causes of this communications problem: a) You are trying to send data to the REF542 during a persistent alarm on the REF542. =>First acknowledge the alarm. b) The connector cable is defective =>Replace connector cable.
157	**No wire information in this file**	You have created an application with no connections between the function blocks. The unit cannot carry out control and/or protective functions. This application cannot be sent to the REF542.	Connect the function blocks in accordance with the desired functions. Every function block must have at least one connection.
158	**Configuration failure**	A general error has occurred in the configuration.	Observe the detailed error messages when checking the application.
159	**Led Number... is more than once configured**	The indicator light has been configured with the number [Variable] more than once.	Please renumber the indicator lights. Setting range: 0 … 3

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
160	**Power output 2 == 0**	When configuring the switching object no physical output was assigned to binary input 2.	Assign a physical power output to the binary input.
161	**Power output 3 == 0**	When configuring the switching object no physical output was assigned to binary input 3.	Assign a physical power output to the binary input.
162	**Power output 4 == 0**	When configuring the switching object no physical output was assigned to binary input 4.	Assign a physical power output to the binary input.
163	**Power Calculation**	The configuration of the analog inputs is not suitable for the power calculation.	Check the configuration of the analog inputs. • 3-phase power calculation: 3·current and 3·voltage • Power calculation according to Aron 2·current and 3·voltage It is not significant whether conventional transformers or sensors are involved.
164	**CB failure**	You wished to define another 2-2 switching object as power circuit-breaker.	Only one power circuit-breaker may be defined in the application.
165	**Read error**	There was an error in the export of a fault record.	• Wait a moment and try to export the fault record again. or • Switch off the REF542 and restart it; export the fault record again.
166	**Maximum 21 characters..**	A text input contains more than 21 characters.	Revise the text.
167	**More than 10 energy counter configured**	There are more than 10 energy counters in the application.	Reduce the number of energy counters.
168	**More than 100 direct read writes configured**	More than 100 direct write-read objects are implemented in the application.	Reduce the number of direct write-read object function blocks.
169	**More than 12 protection functions configured**	There are more than 12 protective functions in the application.	Reduce the number of protective function to a maximum of 12. (Also observe the upper limit of 120 protective parameters and 100% DSP load!)
170	**More than 70 analog objects configured**	There are more than 70 threshold objects in the application.	Reduce the number of threshold objects.
171	**Do you want to save your modifications in ... ?**	You have made changes in an existing application and wish to save them under the name XXXX.	`Accept` will save the application under the selected name. `Cancel` will close this menu.
172	**Do you want to save your modifications ?**	You have made changes since the last save and wish to close the program.	Save the file to retain the changes. (If necessary, change the name to retain the original version.)
173	**Energy factor failure !**	The value input is outside the specified range.	Correct corresponding value.
174	**Net contains more than one output**	One network number (connection number) links several binary inputs.	Assign a unique number to every connection with an input. Logical interconnections of binary inputs must be implemented with OR interconnections.
175	**Net nominal current failure**	The value input is outside the specified range.	Correct corresponding value.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
176	**File new**	Changes have been made in the current application and you are attempting to create a new application without saving the old application beforehand.	Save the former configuration if necessary and then create a new application.
177	**Take new wire text ?**	A connection has been implemented with an existing connection number and a new text for this connection has been input. The new text can be applied for all connections with this connection number or the former text can be retained.	`OK`: The currently input text for the connection is applied for all connections with the same number. `Cancel`: The currently input text for the connection will be ignored and the former text applied for the new connection.
178	**Number parameter failure !**	The value input is outside the specified range.	Correct corresponding value.
179	**Number parameter failure !**	There is an error with the internal connections in the application. Possible causes: a) Too many function blocks in the FUPLA. b) An older application was loaded into a newer program	a) Delete all connections in this application and connect the function blocks again. b) Check the version; if necessary, use an older version of the configuration program.
180	**Only %hu Netnumbers free**	There are still [Variable] connections available in the application.	Optimize the application if more connections are still required.
181	**Object with given field bus address not found**	You have searched for a function block with a specific interbay bus address. That function block is not in the application.	Check the input.
182	**Object with given sequence number not found**	You have searched for a function block with a specific number. That function block is not in the application.	Check the input.
183	**Object with no valid connections**	There is a function block in the application to which there are no connections.	Connect the function block in accordance with the desired functions or delete it.
184	**Pole change relais not configurable**	You wanted to configure outputs 5 and 6 of a switching object as pole reversal relays.	Outputs 5 and 6 can only be configured separately (e.g. with 1-0 switching objects).
185	**Problems with FILE HANDLING**	The configuration program cannot be started.	Use a computer with more RAM.
186	**Problems with WINDOWS RESOURCES**	The configuration program cannot be started.	Use a computer with more RAM.
187	**Really exit without saving the file?**	Changes have been made in the current application and you wish to close the program without saving the old application beforehand.	Save the current application (under another name if necessary) and then leave the configuration program.
188	**Reduced hardware size**	There are too many function blocks in the application.	Reduce the number of function blocks used in the application.
189	**Swiobj 0-1 failure**	The configuration of switching object 0-1 is incorrect.	Correct the corresponding switching object.
190	**Swiobj 0-2 failure**	The configuration of switching object 0-2 is incorrect.	Correct the corresponding switching object.
191	**Swiobj 0-3 failure**	The configuration of switching object 0-3 is incorrect.	Correct the corresponding switching object.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
192	**Swiobj 1-0 failure**	The configuration of switching object 1-0 is incorrect.	Correct the corresponding switching object.
193	**Swiobj 1-1 failure**	The configuration of switching object 1-1 is incorrect.	Correct the corresponding switching object.
194	**Swiobj 1-2 failure**	The configuration of switching object 1-2 is incorrect.	Correct the corresponding switching object.
195	**Swiobj 2-0 failure**	The configuration of switching object 1-2 is incorrect.	Correct the corresponding switching object.
196	**Swiobj 2-2 failure**	The configuration of switching object 2-2 is incorrect.	Correct the corresponding switching object.
197	**Swiobj 2-2 no out failure**	The configuration of the switching object 2-2 without power output is incorrect.	Correct the corresponding switching object.
198	**Swiobj 4-3 failure**	The configuration of the switching object 4-3 motor is incorrect.	Correct the corresponding switching object.
199	**Swiobj 6-5 failure**	The configuration of the switching object 6-5 magnet motor is incorrect.	Correct the corresponding switching object.
200	**Failure in switching object nr.: ...**	The address [Variable] of a switching object has been used more than once	Correct the address of the switching object.
201	**The hardware isn't available (locked by an other device)**	The desired interface to the data transmission between PC and REF542 does not exist or is already occupied.	Check the relevant PC settings. It is possible that the interface is occupied by the mouse.
202	**Analog object ... field bus address: ... is more than once configured !**	The interbay bus address [Variable] of a threshold object has been used more than once	Correct the interbay bus address of the threshold object.
203	**LCU download active**	The display data are being sent to the REF542.	You can cancel this action with the ESC key.
204	**Data download**	Data are being sent from the PC to the REF542.	You can cancel this action with the ESC key.
205	**Data download**	Data are being sent to the REF542.	You can cancel this action with the ESC key. Then switch the REF542 and off (reset).
206	**Fupla download active**	FUPLA data are being sent to the REF542.	You can cancel this action with the ESC key.
207	**Send telegram: [Variable]**	This message occurs on download, the measured value scan or on the version query.	You can cancel this action with the ESC key.
208	**Wire download active**	The connection data are being sent to the REF542.	You can cancel this action with the ESC key.
209	**Sensor 1-3 nominal value failure**	The value input is outside the specified range.	Correct corresponding value.
210	**Sensor 4-6 nominal value failure**	The value input is outside the specified range.	Correct corresponding value.
211	**Sensor 7 nominal value failure**	The value input is outside the specified range.	Correct corresponding value.
212	**Wrong sensor configuration**	The configuration of the analog inputs is incorrect.	Configure the analog inputs in accordance with the function shown in the error message. Ensure that it matches the other functions.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
213	**Wrong sensors for power calculation 3 phases**	The configuration of the analog inputs is not suitable for the power calculation.	Configure the analog inputs accordingly. • 3-phase power calculation: 3·current and 3·voltage It is not significant whether conventional transformers or sensors are involved.
214	**Wrong sensors for power calculation aaron**	The configuration of the analog inputs is not suitable for the power calculation.	Configure the analog inputs accordingly. • Power calculation according to Aron 2·current and 3·voltage It is not significant whether conventional transformers or sensors are involved.
215	**Sensor fault for directional power**	The configuration of the analog inputs is incorrect.	Configure the analog inputs in accordance with the options shown in the directional power monitoring. Ensure that it matches the other functions.
216	**Signal not available**	There is a problem with the serial interface on the PC.	Check the relevant PC settings.
217	**Are you sure, that all wires should be deleted?**	You wish to delete all connections in the application.	`OK`: All connections in the application will be deleted. `Cancel`: All connections in the application will be retained.
218	**Are you sure, that this page should be deleted?**	You wish to delete a complete page from the application.	`OK`: The selected page will be deleted from the application. `Cancel`: The selected page will not be deleted.
219	**Are you sure, that all pages should be deleted?**	You wish to delete several pages from the application.	`OK`: The selected pages will be deleted from the application. `Cancel`: The selected pages will not be deleted.
220	**Are you sure, that this object should be deleted ?**	You intend to delete a function block.	`OK`: The selected function block will be deleted from the application. `Cancel`: The selected function block will not be deleted.
221	**Language DLL missing**	The configuration program cannot be started.	Check whether the *.dll files are in the directory as REFconf.exe. Otherwise uninstall the current software and then reinstall it.
222	**Failed to change language**	The file required for the selected language is not available.	Check whether the *.dll files are in the directory as REFconf.exe. Otherwise uninstall the current software and then reinstall it.
223	**Fault recorder chosen but no protection function**	The fault recorder module has been configured but no protective function has been implemented.	Implement at least one protective function.
224	**Select Recordings**	There was an error in selecting the fault recorder.	Try to select the fault record again.
225	**Wire configuration**	A connection has been implemented with an existing connection number and a new text for this connection has been input. The new text can be applied for all connections with this connection number or the former text can be retained.	`OK`: The currently input text for the connection is applied for all connections with the same number. `Cancel`: The currently input text for the connection will be ignored and the former text applied for the new connection.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
226	**Drawing check**	The current application is being checked.	After the drawing has been successfully checked, the message `Successfully completed` appears. If errors occur during the drawing test, an error list will be output after the test.
227	**This will destroy the current configuration!**	You are trying to send new data to the REF542. Any existing configurations will be deleted as a result.	If you wish to overwrite the current configuration in the REF542, press the `Continue` button. If you wish to retain the old configuration in the REF542, press the `Cancel` button
228	**Unknown struct found %hu**	You are trying to export a configuration from the REF542, but have used an older configuration software for this.	Check the versions of the REF542 and the configuration software. If necessary, install the corresponding configuration software and try to export the configuration again.
229	**Unrecognised data type request**	You are trying to read a newer configuration in the configuration software or to open a newer configuration.	Compare the versions of the configuration program and of the REF542. Use the configuration software with which the application was created. Otherwise data loss cannot be ruled out!
230	**Unrecognised data type to send**	You have edited a new application with an older configuration software and are now trying to send the modified file to the REF542.	Use the associated configuration software to edit the application.
231	**Invalid net number**	You have tried to assign an invalid network number.	Correct corresponding value. Setting range: 11 … 512
232	**Invalid parameter: Min. Curr.**	Error in the parameter for the minimum current.	Correct corresponding value.
233	**Invalid parameter: Max. Unbal.**	Error in the parameter for the maximum allowable negative phase.	Correct corresponding value.
234	**Invalid path**	The path name is not valid.	Enter a correct path name.
235	**Different nominal voltages used**	The value input is outside the specified range.	Correct the corresponding rated voltage. The rated voltages at the voltage inputs and the rated voltage of the 7th input must be equal!
236	**Invalid usage of protection functions**	There is an illegal combination of protective functions in the application.	Check that the combination of configured protective functions is allowed.
237	**Wire with given net number not found**	You have searched for a connection with a specific network number. That connection is not in the application.	Check the input.
238	**Connection to REF542 lost**	You are trying to exchange data between the PC and the REF542. However, a connection cannot be established.	Possible causes of this communications problem: • You are trying to send data to the REF542 during a persistent alarm on the REF542. =>First acknowledge the alarm. • The connector cable is defective =>Replace connector cable.
239	**Connection to REF542 broken**	During data transfer the ESC key was used to stop the transmission.	If you want to export data from the PC to the REF542 later: Remember to switch the bay control and protection unit off and on again first!
240	**Netnumber failure**	The value input is outside the specified range.	Correct corresponding value.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
241	**REF542 version and configuration program not compatible!**	The versions of the REF542 and the configuration software are not compatible.	Use compatible versions.
242	**Choose only positive numbers**	The value entered is not positive. Please enter values >0 only	Correct corresponding value.
243	**Choose correct number**	The value input is outside the specified range.	Correct corresponding value.
244	**Choose menupoint: versions to see current Versions**	The versions of the REF542 and the configuration software are not compatible.	Use compatible versions.
245	**Warning: maximum of protection functions configured !!**	You have just implemented the 12th protective function. You cannot implement any more protective functions in this application.	Ensure that no more protective functions are required.
246	**WARNING !! Problems with internal wires**	There is an error with the internal connections in the application. Possible causes: a) Too many function blocks in the FUPLA. b) An older application was loaded with a newer program	a) Delete all connections and connect the function blocks again. b) Use the configuration program version with which the application was created.
247	**Deletion warning**	You want to delete an icon while configuring the LC display screen.	`OK`: The selected icon will be deleted. `Cancel`: The selected icon will not be deleted.
248	**Warning sensor 1**	The calibration factor input for the relevant analog input caused an error.	Please correct this value. Setting range: 0.9 < calibration factor < 1.1
249	**Warning sensor 2**	The calibration factor input for the relevant analog input caused an error.	Please correct this value. Setting range: 0.9 < calibration factor < 1.1
250	**Warning sensor 3**	The calibration factor input for the relevant analog input caused an error.	Please correct this value. Setting range: 0.9 < calibration factor < 1.1
251	**Warning sensor 4**	The calibration factor input for the relevant analog input caused an error.	Please correct this value. Setting range: 0.9 < calibration factor < 1.1
252	**Warning sensor 5**	The calibration factor input for the relevant analog input caused an error.	Please correct this value. Setting range: 0.9 < calibration factor < 1.1
253	**Warning sensor 6**	The calibration factor input for the relevant analog input caused an error.	Please correct this value. Setting range: 0.9 < calibration factor < 1.1
254	**Warning sensor 7**	The calibration factor input for the relevant analog input caused an error.	Please correct this value. Setting range: 0.9 < calibration factor < 1.1
255	**Value outside of limits:**	The value input is outside the specified range.	Correct corresponding value.
256	**Value not understandable!**	The program cannot understand the value that was input.	Please enter the value that corresponds to a parameter. Example: The program expected the input of a number and a letter was entered instead.
257	**Choose only value: a - b**	The value input is outside the specified value range of between a and b.	Correct corresponding value. Value range: a < value < b.
258	**operating hours**	The value input is outside the specified range.	Correct corresponding value.
259	**Choose only factor 0.1 .. 1000**	The value input is outside the specified range.	Correct corresponding value.

Table 52: Causes and options for correction in the event of configuration program error messages

No:	Message	Cause	Correction
260	**only 1 or 2 accepted**	An invalid value was input while entering the parameter set that is to be activated for the protective function.	Correct corresponding value.
261	**choose only x:0 .. 96**	The value input is outside the specified range.	Correct corresponding value.
262	**choose only y:66 .. 247**	The value input is outside the specified range.	Correct corresponding value.
263	**choose only**	The value input is outside the specified range.	Correct corresponding value.
264	**x-parameter failure**	The value input is outside the specified range.	Correct corresponding value.
265	**y-parameter failure**	The value input is outside the specified range.	Correct corresponding value.
266	**Drawing**	Your are conducting an action in draw mode with the mouse.	Observe the detailed message in this message box.
267	**Choose only time 0 .. 30 min**	The value input is outside the specified range.	Correct corresponding value.
268	**Time parameter failure**	The value input is outside the specified range.	Correct corresponding value.
269	**Time parameter ignored**	You want to use outputs 7 and/or 8 when configuring a switching object. Both of these outputs are signal relays with reduced switching power and the time parameter will therefore be ignored.	Depending on the power required at the output a power output should be selected. The technical data can be found in the description of the specific input and output board.
270	**Too many Switchobjects used**	You have selected more than 8 icons for the display.	Reduce the number of icons desired for the display.
271	**Wire file too big! Only ... byte allowed. Your file is ... byte big. Remove some wires! (1 Wire = 14 byte)**	There are too many connections used in the application.	Optimize the connections in the application.
272	**More than 120 protection parameters used**	There are too many protective functions in the application.	Remove a protective function so a maximum of 120 protective parameters are used. (Observe the upper limit of 12 protective functions with maximum 100% DSP load.)

9.4 Further information

The following subsection contains additional information on contact addresses in the event of a guarantee claim or damage. Naturally, feel free to contact your ABB sales office if you have other questions. A list of ABB sales offices can be found at the end of this section.
If the unit has been acquired from one of our licensees, please contact the licensee first in the event of any questions.

Contact in the event of malfunction

If a malfunction that cannot be corrected occurs, please contact our service department:

Note ABB Calor Emag Mittelspannung GmbH
Service department available 24 hours: 02102/121212

Contact for guarantee claims

As long as the unit is still under guarantee, contact the ABB sales office in the event of any guarantee claims.

Contact after the guarantee period

For all questions after the guarantee has expired, please also contact our service department at the number given above.

Obtaining spare parts and accessories

To obtain spare parts and accessories for your bay control and protection unit, please contact the ABB sales office.

Chapter "3.6 Overview of the technical data" on page 3-45 contains an overview of the equipment variations available.

Replacement of parts, modules or boards

For warranty reasons the ABB sales office should be consulted regarding the replacement of parts, modules or boards.
ABB personnel should carry out all replacements.

Changing the configuration

For warranty reasons the ABB sales office should be consulted regarding changes to the existing configuration. It is also worth having ABB personnel make any changes required.
However, it is principally the operator's responsibility to configure the REF542 after expiry of the guarantee period and after consultation with the ABB sales office.

Note However, because of the complexity and many functions of the unit, we strongly recommend against making arbitrary changes to the configuration!

Opening the unit

During the guarantee period only ABB personnel may open the unit. After that the operator may open the unit at the operator's risk or after consultation with the ABB sales office.

Caution **ABB Calor Emag Mittelspannung GmbH assumes no responsibility for damages resulting from improper use of REF542.**

9.4.1 ACE Center

A list of ABB Calor Emag Mittelspannung GmbH service centers can be found below.

If you do not know exactly which ABB sales office supplied your unit, contact the nearest ACE Center.

Table 53: Addresses of German Centers

Address	Telephone	Fax
ABB Calor Emag Mittelspannung GmbH Main Office Oberhauserstr. 33 D-40472 Ratingen	+49 (0) 2102 12 1230	+49 (0) 2102 12 1916
ABB Calor Emag Mittelspannung GmbH Sales East Rankestr. 35 D-01139 Dresden	+49 (0)361 2193 217	+49 (0)361 2193 218
ABB Calor Emag Mittelspannung GmbH Sales West Josef-Baumann-Str. 21 D-44805 Bochum	+49 (0)234 891 7510	+49 (0)234 891 7540
ABB Calor Emag Mittelspannung GmbH Sales South Käfertalerstr. 250 D-68167 Mannheim	+49 (0)621 386 2003	+49 (0)621 386 2765

10 Decommissioning and Storage

In this chapter you will find information

- On decommissioning the unit
- Storing the REF542 after decommissioning or before commissioning.

10.1 Storage

Please observe the following minimum requirements for optimum storage:

- Units with standard packaging or without packaging
  - Dry and well ventilated storage space, conditions in accordance with DIN VDE 0670 Part 1000/IEC 60694,
  - If packaging is used, it must be undamaged or
  - units without packaging must be well covered with protective sheets; however, ensure sufficient air circulation to prevent corrosion. Check the unit regularly for condensation.

Table 54: Technical data for storage and environmental conditions

General Data				
	Temperature Range	Operation: Storage: Transport:	-10 °C … +55 °C -20 °C … +70 °C -20 °C … +70 °C	Non-condensing humidity < 95%
	Earthquake safety	DIN IEC 60068-3-3 DIN IEC 60068-2-6 DIN IEC 60068-2-59 CEI IEC 61166 CEI IEC 60980		
	Environmental Conditions	IEC 60255-4		

10.2 Decommissioning

Please observe the following directions when decommissioning the unit:

- Isolate the bay.
- Transfer the configuration from the REF542 to the PC and save it on data media.
- Switch off the REF542 auxiliary supply voltage.
- Switch off the remaining miniature circuit breakers as well.
- If applicable, isolate all current transformers.
- Disconnect the REF542 from the measuring circuits.
- Unscrew the unit cover.
- Remove all plug connectors.
- If only the unit itself is to be replaced: Unscrew the signal converter for the analog inputs.
- Loosen the four fastening screws on the REF542.
  (On the sides and the bottom of the unit)
  ↳Chapter "6.3.2 Installation on the front panel of a substation" on page 6-4
- Remove the unit.
- Check the unit for damage.
- Tighten the four fastening screws again.
- Screw the unit cover down.
- Pack the REF542 properly; preferably in the original packaging.
- Store the unit on its side beforehand as specified.

It is not necessary to decommission the configuration program. If you wish to uninstall the configuration program, follow the relevant directions.

↳Chapter "4.6 Uninstall" on page 4-25

11 Appendices

This section contains additional and more detailed information on specific items in the documentation. The corresponding location in the text always includes a cross reference to a subsection in this appendix.

11.1 Requirements for the current transformers when implementing distance protection

Introduction

The response of distance protection units is primarily influenced by the quality of the current measuring signals. With current transformer saturations, which are generally caused by slowly d.c. component, the current measuring signals can be so strongly deformed that proper function of the distance protection unit cannot always be guaranteed. For this reason the current transformers, depending on magnitude of the fault current at the installation site, must meet certain requirements.

The design of current transformers for protection purposes to ensure fault-free functioning of the distance protection unit is discussed below. In general, the occurrence of saturation is only delayed to the extent that fast tripping is enabled. The delayed fault impedance may be strongly faulted because after the formation of the high-speed tripping, saturation of the current transformer can no longer be discounted.

Requirements

Current transformers of the type TPS, TPX or TPY, with a precision conforming to IEC 60044-6 or transducers of class 5P conforming to IEC 60185 or better, may be used. Linearized transformers of the type TPZ should not be used, because only alternating values can be transferred and no direct components. The current transformer should be selected primarily so the ratio between the maximum occurring phase fault current and the primary rated current is continuously less than 100. In addition, the dynamic range of the REF542 must be taken into account (ca. $47 \cdot I_n$). The transformation ratio of the current transformer should also be set so the minimum phase fault current that must be detected at the distance protection unit can be easily set. Because the burden for current transformers is determined by the secondary rated current, transformers with 1A secondary rated current should be preferred to the types with 5 A secondary rated current.

The REF542 distance protection unit is in principal designed to include a certain degree of insensitivity to current transformer saturation. However, the minimum design requirements for current transformers to meet protection needs must be taken into account: Reliable transmission of the maximum occurring stationary phase fault current must be possible. The stationary fault current in the immediate vicinity of where the current transformer is installed must not result in saturation. This refers to errors in both the forwards and the backwards direction.

It is best to use the knee point voltage on the secondary side of the current transformer in the design. In the event of the above minimum requirement, the minimum knee point voltage is calculated as follows:

$$E_{2min} \geq \frac{I_{Kmax} \cdot I_{Sn}}{I_{Pn}} \cdot \left(R_{CT} + R_L + \frac{0,1}{I^2_{REF\,542}} \right)$$

Where:

E_{2min}	minimum knee point voltage under symmetrical fault current condition,
I_{kmax}	maximum symmetrical fault current on the primary side,
I_{sn}	rated current of the current transformer on the secondary side,
I_{REF542}	rated current of the REF542 distance protection unit,
R_{CT}	resistance of the secondary coil of the current transformer (interior burden),
R_L	resistance of the lead and additional burdens.

Normally the maximum phase fault current occurs with a three-phase short circuit. However, in high-voltage networks with low resistance earthing in some circumstances the single-phase short circuit may supply a larger current than the three-phase short circuit. For this reason, both short-circuit calculations should always be carried out. To calculate the knee point voltage, the resistance of the phase leads in the three-phase malfunction and the resistance of the loop formed by the corresponding phase lead and the earth lead in the event of a earth fault must be used as the basis.

The REF542 distance protection unit can in principle be operated with this minimum knee point voltage. In the event of faults where the phase fault current is superimposed by a DC element, saturation of the current transformer may occur. In such a case the tripping is only formed after the decay of the DC element, after about 3 times the DC time constant. The fast tripping, which is generally 28 ms with sinusoidal measured quantities, can no longer be generated as a result of the current transformer saturation. As a result, the possibility of selectivity problems in the protected network can no longer be ruled out.

In the event of possible saturation of the current transformer, we recommend that the first impedance zone be operated by the distance protection with a first zone time of 30 ms. This setting is required to reduce the load on the current transformer as much as possible. The current transformer then only needs to transfer the transient phase fault current faultlessly in this short, specified period.

The current transformer should be designed so the short circuit location is in the middle of the set first impedance zone. Here the current transformer must be able to transfer the phase fault current faultlessly to the secondary side for a period of 25 ms, to enable the power circuit-breaker to trip after 30 ms.

This specification is the result of computer simulations.

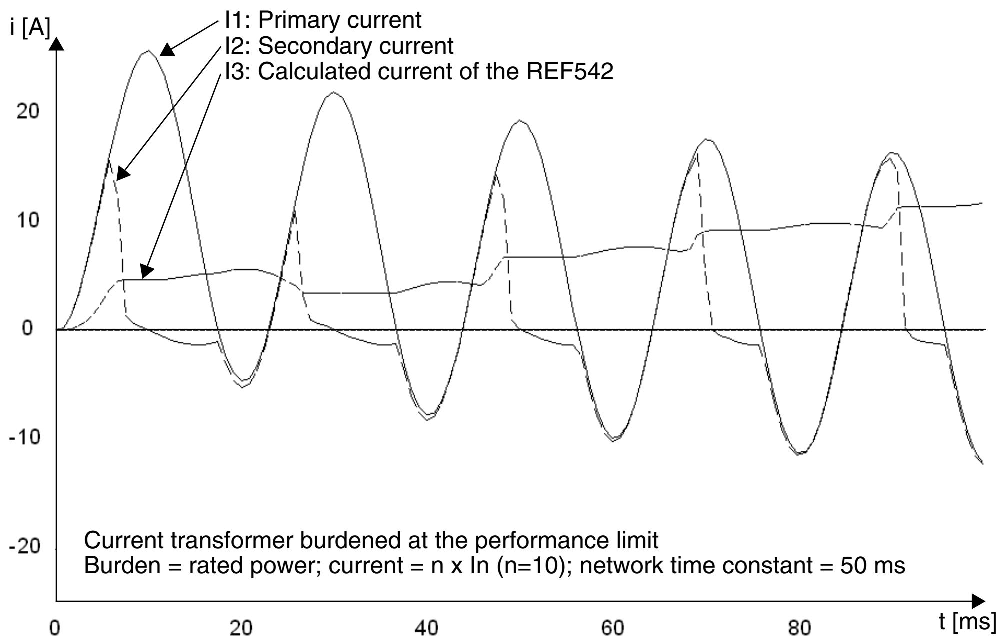


Figure 263: An example from the computer simulation

The above graph shows an example. The current transformer is burdened with the rated power and stressed with the limit overcurrent, which is set to several times the rated current in accordance with the rated overcurrent factor. The network time constant for the DC element is 50 ms. Furthermore I_1 is the primary current, I_2 is the secondary current and I_3 is the current in the REF542 calculated with the DFT, the digital Fourier transformation. As a result of the current transformer saturation, only a current with about 35% amplitude was detected in the range of the first zone time measurement – in the first 25 ms after the occurrence of the fault. As a result the fault is seen at three times the distance. Therefore, so as not to endanger the discrimination, the minimum requirement formulated above must be met.

The phase fault current calculation can be used to determine the maximum amplitude of the stationary phase fault current and the resulting DC time constant. The minimum required knee point voltage for phase fault currents with decaying DC elements can then be determined with the following equation:

$$E_{2DC} \geq \frac{I_{Kmax} \cdot I_{Sn}}{I_{Pn}} \cdot \left(R_{CT} + R_L + \frac{0,1}{I^2_{REF542}} \right) \cdot K(ct)$$

Where:

E_{2DC}: required knee point voltage with phase fault currents with DC element
I_{kmax}: maximum stationary phase fault current on the primary side,
I_{sn} rated current of the current transformer on the secondary side,
I_{REF542}: rated current of the REF542 distance protection unit,
R_{CT}: resistance of the secondary coil of the current transformer (interior burden),
R_L: resistance of the lead and additional burden,
K(ct): Factor for the design of the current transformer with phase fault currents with DC element.

The factor K(ct) is used to set the dimensions of the current transformer so saturation does not occur as a result of the corresponding DC element within the first 25 ms after the fault occurrence. The factor K(ct) can be derived from the graph below.

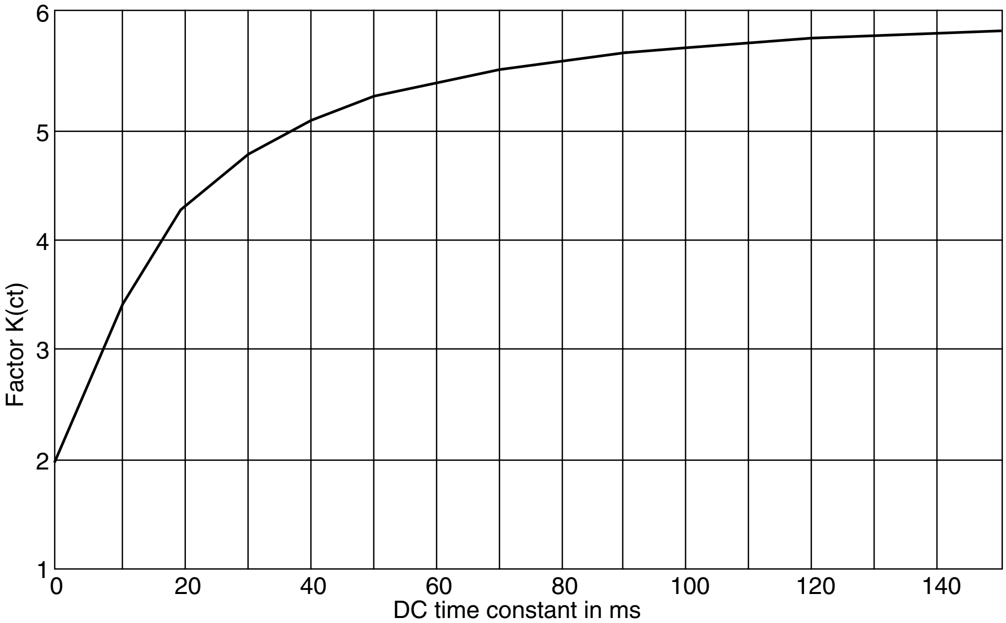


Figure 264: Factor K(ct) for setting upper dimension of the current transformer in the presence of phase fault currents with decaying DC elements

11.2 Event list of switching objects

The channel number over which the events are transmitted is set in the configuration dialog of the switching object in the `interbay bus address` input field. To enable the individual events to be sent to the higher-order control system as well, the transmission of events must be generally enabled.

Chapter "5.3.2 Global Settings" on page 5-2

The events of the individual switching objects must also be enabled. To do this, start the configuration dialog of the switching object (double-click the left mouse button on the switching object). Click the button `events` in the dialog window.

The dialog that appears lists the possible events of that switching object. Mark the adjacent checkbox so the event will be generated and sent as required. The default is no event marked.

Table 55: Event list of switching objects

Switching object 0-1		
	E0: input closed	E1: input opened
Switching object 0-2		
	E1: input opened	E2: input closed
	E4: fault position	
Switching object 0-3		
	E0: moving	
	E1: earth	E3: Line
	E2: open	E4: fault position
Switching object 1-0		
	E5: output opened	E6: output closed
	E7: end position not reached started	E8: end position not reached back
	E22: selected started	E21: selected back
	E24: by pass active	E23: by pass inactive
Switching object 1-1		
	E1: input opened	E0: input closed
	E5: output opened	E6: output closed
	E7: end position not reached incoming	E8: end position not reached outgoing
	E22: selected incoming	E21: selected outgoing
	E24: interlocking transfer active	E23: interlocking transfer inactive
Switching object 1-2		
	E0: movement	E4: fault position
	E1: input opened	E2: input closed
	E5: output opened	E6: output closed
	E7: end position not reached started	E8: end position not reached back
	E22: selected started	E21: selected back
	E24: by pass active	E23: by pass inactive

Continued next page

Table 55: Event list of switching objects

Switching object 2-1		
	E1: input opened	E0: input closed
	E5: output opened	E6: output closed
	E9: output 2 opened	E10: output 2 closed
	E7: end position not reached started	E8: end position not reached back
	E22: selected started	E21: selected back
	E24: by pass activ	E23: by pass inactive
Switching object 2-2/switching object 2-2 without power output		
	E0: moving	E4: error
	E1: input opened	E2: input closed
	E5: output opened	E6: output closed
	E9: output 2 opened	E10: output 2 closed
	E7: end position not reached started	E8: end position not reached back
	E22: selected started	E21: selected back
	E24: by pass active	E23: by pass inactive
Switching object 4-3 motor		
	E0: moving	E4: error
	E1: earth	E2: open
	E3: Line	
	E14: Earth intermediate	E13: Intermediate line
	E15: Line intermediate	E16: Intermediate earth
	E5:T o Open 1->0	E9: To Close 1->0
	E6: To Open 0->1	E10: To Close 0->1
	E8: Errorsupervision	E12: Errorsupervision
Switching object 6-5 magnet motor		
	E0: moving	E4: error
	E1: earth	E2: open
	E3: Line	
	E14: Earth intermediate	E13: Intermediat Line
	E15: Line iIntermediate	E16: Intermediate earth
	E5: To Open 1->0	E9: To Close 1->0
	E6: To Open 0->1	E10: To Close 0->1
	E17: Block magnet 1 interlocking	E18: Time out block magnet 1
	E19: Block magnet 2 interlocking	E20: Time out block magnet 2
	E8: Errorsupervision	E12: Errorsupervision
Switching object 2-2: H bridge		
	E0: moving	E4: error
	E1: input opened	E2: input closed
	E9: pulse pin left 1->0	E10: pulse pin left 0->1
	E13: pulse pin right 1->0	E14: pulse pin right 0->1
	E11: interlocking error left	E15: interlocking error right
	E12: block error	E16: block error
	E22: end position not reached started	E21: end position not reached back

Continued next page

Table 55: Event list of switching objects

Switching object 4-4: H bridge		
	E0: Line moving	E4: Line error
	E1:Line open	E2: Line close
	E5: Earth moving	E8: earth error
	E6: Earth open	E7: earth close
	E9: pulse pin left 1->0	E10: pulse pin left 0->1
	E13: pulse pin right 1->0	E14: pulse pin right 0->1
	E11: interlocking error left	E15: interlocking error right
	E12: block error	E16: block error
	E22: end position not reached started	E21: end position not reached back

11.3 Event list of protective functions

The channel number over which the events are sent is shown in the left column.

To enable specific events to be sent to the higher-order control system as well, transmission of events must first be generally enabled.

↳Chapter "5.3.2 Global Settings" on page 5-2

The events of the individual protective functions must also be enabled. To do this, start the configuration dialog of the protective function (double-click the left mouse button on the switching object). Click the button `events` in the dialog window.

The dialog that appears lists the possible events of that protective function. Mark the adjacent checkbox so the event will be generated and sent as required. The default is no event marked.

Table 56: Event list of protective functions

Inrush-Blocking					
	50	E 0	Start L1 started	E 1	Start L1 back
	50	E 2	Start L2 started	E 3	Start L2 back
	50	E 4	Start L3 started	E 5	Start L3 back
	50	E 6	trip started	E 7	Tripping back
	50	E 12	Tripp block started	E 13	Trip block started
	50	E 18	Protection block started	E 19	Protection block back
Over-Current-Directional-High-Set					
	54	E 0	Start L1 started	E 1	Start L1 Back
	54	E 2	Start L2 started	E 3	Start L2 Back
	54	E 4	Start L3 started	E 5	Start L3 Back
	54	E 6	Trip started	E 7	Trip back
	54	E 8	AR activ	E 9	AR inactive
	54	E 10	2 AR		
	54	E 11	1 AR		
	54	E 12	Trip block started	E 13	Trip block back
	54	E 18	Protection block started	E 19	Protection block back
	54	E 20	AR block started	E 21	AR block back

Continued next page

Table 56: Event list of protective functions

Overcurrent Directional Low Set					
55	E 0	Start L1 started	E 1	Start L1 back	
55	E 2	Start L2 started	E 3	Start L2 back	
55	E 4	Start L3 started	E 5	Start L3 back	
55	E 6	Trip started	E 7	Trip back	
55	E 12	Trip block started	E 13	Trip block back	
55	E 18	Protection block started	E 19	Protection block back	
Overcurrent instantaneous					
51	E 0	Start L1 started	E 1	Start L1 back	
51	E 2	Start L2 started	E 3	Start L2 back	
51	E 4	Start L3 started	E 5	Start L3 back	
51	E 6	Trip started	E 7	Trip back	
51	E 8	AR	E 9	AR inactive	
51	E 10	2 AR			
51	E 11	1AR			
51	E 12	Trip block started	E 13	Trip block back	
51	E 18	Protection block started	E 19	Protection block back	
51	E 20	AR block started	E 21	AR block back	
Overcurrent high set					
52	E 0	Start L1started	E 1	Start L1 back	
52	E 2	Start L2 started	E 3	Start L2 back	
52	E 4	Start L3 started	E 5	Start L3 back	
52	E 6	Trip started	E 7	Trip back	
52	E 8	AR active	E 9	AR inactive	
52	E 10	2 AR			
52	E 11	1AR			
52	E 12	Trip block started	E 13	Trip block back	
52	E 18	Protection block started	E 19	Protection block back	
52	E 20	AR block started	E 21	AR block back	
Overcurrent low set					
53	E 0	Start L1 started	E 1	Start L1 back	
53	E 2	Start L2 started	E 3	Start L2 back	
53	E 4	Start L3 started	E 5	Start L3back	
53	E 6	Trip started	E 7	Trip back	
53	E 12	Trip block started	E 13	Trip block back	
53	E 18	Protection block started	E 19	Protection block back	
IDMT normal inverse					
56	E 0	Start L1 started	E 1	Start L1 back	
56	E 2	Start L2 started	E 3	Start L2 back	
56	E 4	Start L3 started	E 5	Start L3 back	
56	E 6	Trip started	E 7	Trip back	
56	E 12	Trip block started	E 13	Trip block back	
56	E 18	Protection block started	E 19	Protection block back	

Continued next page

Table 56: Event list of protective functions

IDMT very inverse					
57	E 0	Start L1 started	E 1	Start L1 back
57	E 2	Start L2 started	E 3	Start L2 back
57	E 4	Start L3 started	E 5	Start L3 back
57	E 6	Trip started	E 7	Trip back
57	E 12	Trip block started	E 13	Trip block back
57	E 18	Protection block started	E 19	Protection block back
IDMT extremely inverse				
58	E 0	Start L1 started	E 1	Start L1 back
58	E 2	Start L2 started	E 3	Start L2 back
58	E 4	Start L3 started	E 5	Start L3 back
58	E 6	Trip started	E 7	Trip back
58	E 12	Trip block started	E 13	Trip block back
58	E 18	Protection block started	E 19	Protection block back
IDMT longtime inverse				
59	E 0	Start L1 started	E 1	Start L1 back
59	E 2	Start L2 started	E 3	Start L2 back
59	E 4	Start L3 started	E 5	Start L3 back
59	E 6	Trip started	E 7	Trip back
59	E 12	Trip block started	E 13	Trip block back
59	E 18	Protection block started	E 19	Protection block back
Earthfault high set				
66	E 0	Start started	E 1	Start back
66	E 6	Trip started	E 7	Trip back
66	E 8	AR active	E 9	AR inactive
66	E 10	2 AR		
66	E 11	1AR		
66	E 12	Trip block started	E 13	Trip block back
66	E 18	Protection block started	E 19	Protection block back
66	E 20	AR block started	E 21	AR block back
Earthfault low set				
67	E 0	Start started	E 1	Start back
67	E 6	Trip started	E 7	Trip back
67	E 12	Trip block started	E 13	Trip block back
67	E 18	Protection block started	E 19	Protection block back
Earthfault directional high set				
72	E 0	Start Started	E 1	Start back
72	E 6	Trip started	E 7	Trip back
72	E 8	AR active	E 9	AR inactive
72	E 10	2 AR		
72	E 11	1 AR		
72	E 12	Trip block started	E 13	Trip block back
72	E 18	Protection block started	E 19	Protection block back
72	E 20	AR block started	E 21	AR block back

Table 56: Event list of protective functions

Earthfault directinal low set					
	73	E 0	Start started	E 1	Start back
	73	E 6	Trip started	E 7	Trip back
	73	E 12	Trip block started	E 13	Trip block back
	73	E 18	Protection block started	E 19	Protection block back
Earthfault IDMT normal inverse					
	68	E 0	Start started	E 1	Start back
	68	E 6	Trip started	E 7	Trip back
	68	E 12	Trip block started	E 13	Trip block back
	68	E 18	Protection block started	E 19	Protection block back
Earthfault IDMT very inverse					
	69	E 0	Start started	E 1	Start back
	69	E 6	Trip started	E 7	Trip back
	69	E 12	Trip block started	E 13	Trip block back
	69	E 18	Protection block started	E 19	Protection block back
Earthfault IDMT extremely inverse					
	70	E 0	Start started	E 1	Start back
	70	E 6	Trip started	E 7	Trip back
	70	E 12	Trip block started	E 13	Trip block back
	70	E 18	Protection block started	E 19	Protection block back
Earthfault IDMT longtime inverse					
	71	E 0	Start started	E 1	Start back
	71	E 6	Trip started	E 7	Trip back
	71	E 12	Trip block started	E 13	Trip block back
	71	E 18	Protection block started	E 19	Protection block back
Overvoltage instantaneous					
	60	E 0	Start L1 started	E 1	Start L1 back
	60	E 2	Start L2 started	E 3	Start L2 back
	60	E 4	Start L3 started	E 5	Start L3 back
	60	E 6	Trip started	E 7	Trip back
	60	E 8	AR active	E 9	AR inactive
	60	E 10	2 AR		
	60	E 11	1 AR		
	60	E 12	Trip block started	E 13	Trip block back
	60	E 18	Protection block started	E 19	Protection block back
	60	E 20	AR block started	E 21	AR block back

Continued next page

Table 56: Event list of protective functions

Overvoltage high set					
61	E 0	Start L1 started	E 1	Start L1 back
61	E 2	Start L2 started	E 3	Start L2 back
61	E 4	Start L3 started	E 5	Start L3 back
61	E 6	Trip started	E 7	Trip back
61	E 8	AR active	E 9	AR inactive
61	E 10	2 AR		
61	E 11	1 AR		
61	E 12	Trip block started	E 13	Trip block back
61	E 18	Protection block started	E 19	Protection block back
61	E 20	AR block started	E 21	AR block back
Overvoltage low set				
62	E 0	Start L1 started	E 1	Start L1 back
62	E 2	Start L2 started	E 3	Start L2 back
62	E 4	Start L3 started	E 5	Start L3 back
62	E 6	Trip started	E 7	Trip back
62	E 12	Trip block started	E 13	Trip block back
62	E 18	Protection block started	E 19	Protection block back
Undervoltage instantaneous				
63	E 0	Start L1 started	E 1	Start L1 back
63	E 2	Start L2 started	E 3	Start L2 back
63	E 4	Start L3 started	E 5	Start L3 back
63	E 6	Tripping started	E 7	Trip back
63	E 12	Trip block started	E 13	Trip block back
63	E 18	Protection block started	E 19	Protection block back
Undervoltage high set				
64	E 0	Start L1 started	E 1	Start L1 back
64	E 2	Start L2 started	E 3	Start L2 back
64	E 4	Start L3 started	E 5	Start L3 back
64	E 6	Trip started	E 7	Trip back
64	E 8	AR active	E 9	AR inactive
64	E 10	2 AR		
64	E 11	1AR		
64	E 12	Trip block started	E 13	Trip block back
64	E 18	Protection block started	E 19	Protection block back
64	E 20	AR block started	E 21	AR block back
Undervoltage low set				
65	E 0	Start L1 started	E 1	Start L1 back
65	E 2	Start L2 started	E 3	Start L2 back
65	E 4	Start L3 started	E 5	Start L3 back
65	E 6	Trip started	E 7	Trip back
65	E 12	Trip block started	E 13	Trip block back
65	E 18	Protection block started	E 19	Protection block back

Continued next page

Table 56: Event list of protective functions

Residual overvoltage high set					
82	E 0	Start started	E 1	Start back	
82	E 6	Trip started	E 7	Trip back	
82	E 12	Trip block started	E 13	Trip block back	
82	E 18	Protection block started	E 19	Protection block back	
Residual overvoltage low set					
83	E 0	Start started	E 1	Start back	
83	E 6	Trip started	E 7	Trip back	
83	E 12	Trip block started	E 13	Trip block back	
83	E 18	Protection block started	E 19	Protection block back	
Thermal overload					
74	E 0	Start started	E 1	Start back	
74	E 6	Trip started	E 7	Trip back	
74	E 12	Trip block started	E 13	Trip block back	
74	E 14	Warning started	E 15	Warning back	
74	E 18	Protection block started	E 19	Protection block back	
Motor start protection					
80	E 0	Start started	E 1	Start back	
80	E 6	Trip started	E 7	Trip back	
80	E 12	Trip block staretd	E 13	Trip block back	
80	E16	Block signal started	E17	Block signal back	
80	E 18	Protection blocke started	E 19	Protection block back	
Blocking rotor					
86	E 0	Start L1 started	E 1	Start L1 back	
86	E 2	Start L2 started	E 3	Start L2 back	
86	E 4	Start L3 started	E 5	Start L3 back	
86	E 6	Trip started	E 7	Trip back	
86	E 12	Trip block started	E 13	Trip block back	
86	E 18	Protection block started	E 19	Protection block back	
Number of starts					
87	E 0	Start started	E 1	Start back	
87	E 6	Trip started	E 7	Trip back	
87	E 12	Trip block started	E 13	Trip block back	
87	E 14	Warning started	E 15	Warning back	
87	E 18	Protection block started	E 19	Protection block back	

Continued next page

Table 56: Event list of protective functions

Distance protection					
	81	E 0	Start L1started	E 1	Start L1 back
	81	E 2	Start L2 started	E 3	Start L2 back
	81	E 4	Start L3 started	E 5	Start L3 back
	81	E 6	Trip started	E 7	Trip back
	81	E 8	AR active	E 9	AR inactive
	81	E 10	1 AR Shot started	E 11	1 AR Shot started
	81	E 12	Trip block started	E 13	Trip block back
	81	E 14	2 AR Shot started	E 15	2 AR Shot started
	81	E 16	Z1< started	E 17	Z1< back
	81	E 18	Protection block started	E 19	Protection block back
	81	E 20	AR block started	E 21	AR block back
	81	E 22	G-Start started	E 23	G-Start back
	81	E 24	E-Start started	E 25	E-Start back
	81	E 26	CB OK started	E 27	CB OK back
	81	E 28	Signal comparison started	E 29	Signal comparison back
	81	E 30	AR block DSP started	E 31	AR block DSP back
Thermal supervision					
	78	E 0	Start incoming	E 1	Start outgoing
	78	E 6	Tripping incoming	E 7	Tripping outgoing
	78	E 12	Tripping blocked incoming	E 13	Tripping blocked outgoing
	78	E 14	Warning incoming	E 15	Warning outgoing
	78	E 18	Protection blocked incoming	E 19	Protection blocked outgoing
Unbalanced load					
	75	E 0	Start started	E 1	Start back
	75	E 6	Trip started	E 7	Trip back
	75	E 12	Trip block started	E 13	Trip block back
	75	E 18	Protection block started	E 19	Protection block back
Directional power					
	76	E 0	Start started	E 1	Start back
	76	E 6	Trip started	E 7	Trip back
	76	E 12	Trip block started	E 13	Trip block back
	76	E 18	Protection block started	E 19	Protection block back
Low load					
	77	E 0	Start started	E 1	Start back
	77	E 6	Trip started	E 7	Trip back
	77	E 12	Trip block started	E 13	Trip block back
	77	E 18	Protection block started	E 19	Protection block back
Frequency supervision					
	84	E 0	Start started	E 1	Start back
	84	E 6	Trip started	E 7	Trip back
	84	E 12	Trip block started	E 13	Trip block back
	84	E 18	Protection block started	E 19	Protection block back

Continued next page

Table 56: Event list of protective functions

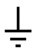
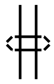
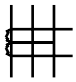
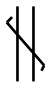
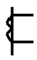
Synchron Check					
	85	E 0	Start started	E 1	Start back
	85	E 6	Trip started	E 7	Trip back
	85	E 12	Trip block started	E 13	Trip block back
	85	E 18	Protection block started	E 19	Protection block back

11.4 Typical examples of sensor or transducer connections

The following pages show examples for wiring analog inputs (measuring inputs) on the REF542 with sensors or transducers. Typical examples of usage in practice have been shown here.

The following symbols are used in the circuit diagrams:

Table 57: Symbols used in the connection diagrams of the REF542

Symbol	Label	Symbol	Label
-------	Mechanical, pneumatic or hydraulic connection		Three-phase transformer
	Earth		Voltage transformer
	Conductor in a shielded cable		Cable current transformer
	Several conductors in one cable		Power circuit-breaker
•	Conductor connection		Current sensor
	Voltage divider, not adjustable (voltage sensor here)		Cable sealing end
	Current transformer		

The following designations are also used:

- RU…/L1-L2-L3: Voltage sensor (voltage divider) in conductor L1, L2 or L3
- TI…/L1-L2-L3: Current transformer in conductor L1, L2 or L3
- TI/A: External signal converter to connect the cable current transformer to the REF542 when the sensor inputs of the -X3 terminal are used
- TI/O: Cable current transformer to detect the earth current
- TU…/L1-L2-L3: Voltage transformer in conductor L1, L2 or L3
- UI…/L1-L2-L3: Current sensor (Rogowski coil) in conductor L1, L2 or L3
- X2: Signal converter terminals on the REF542
- X3: Terminals on the REF542 for the analog inputs

Please also note the following information:

- The circuit diagrams all contain the maximum number of connections for the sample configuration in question. Various connections may be left out depending on the customer specifications.
- Current and voltage sensors have specific colors for the conductors, which are shown in the circuit diagrams: rd=red and bl=blue.
- The configuration/phase angle of conductors L1, L2 and L3 is indicated in every circuit diagram.

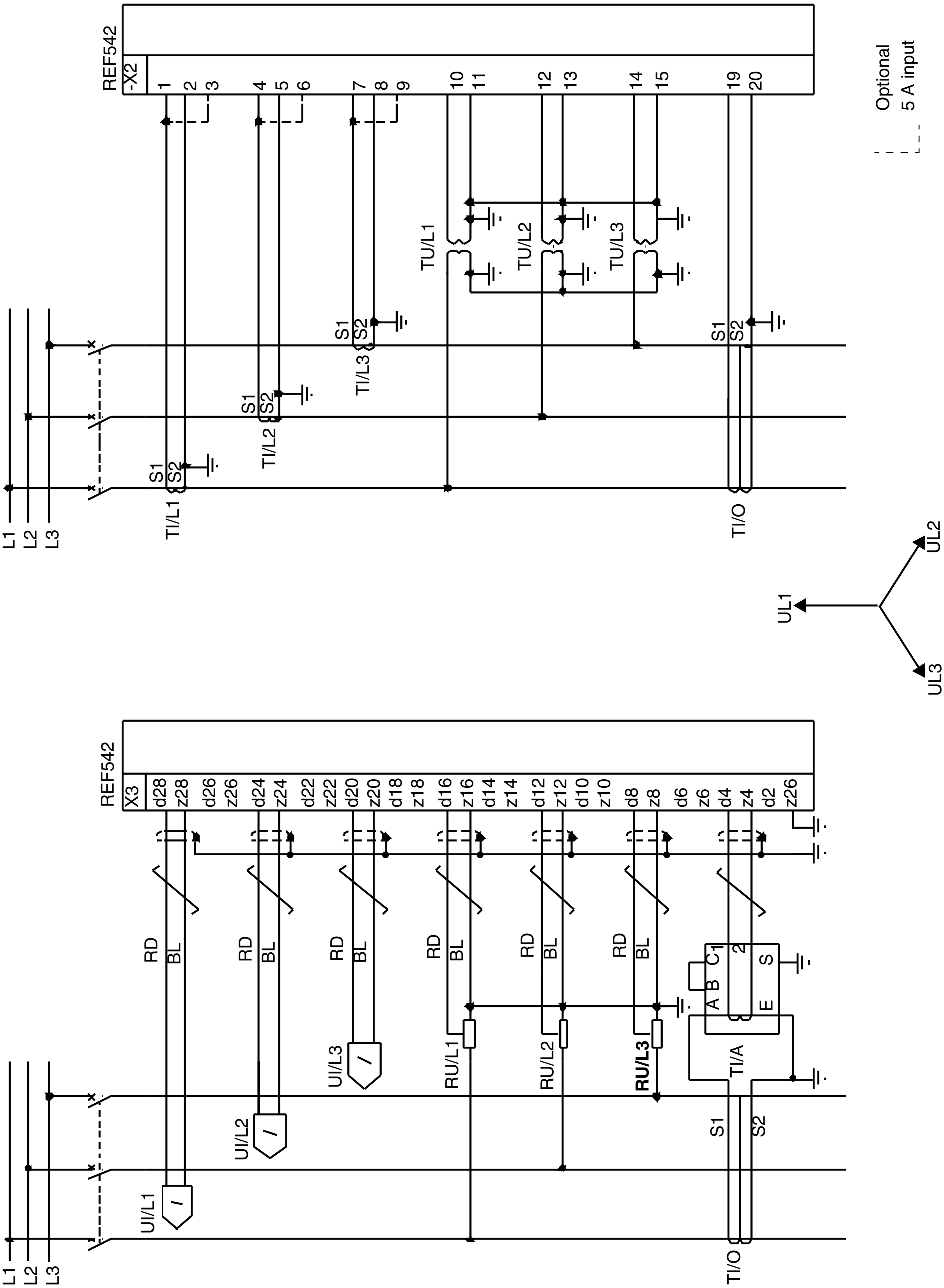


Figure 265: Typical sensor circuitry in sensors or transducers for supply or feeder bays

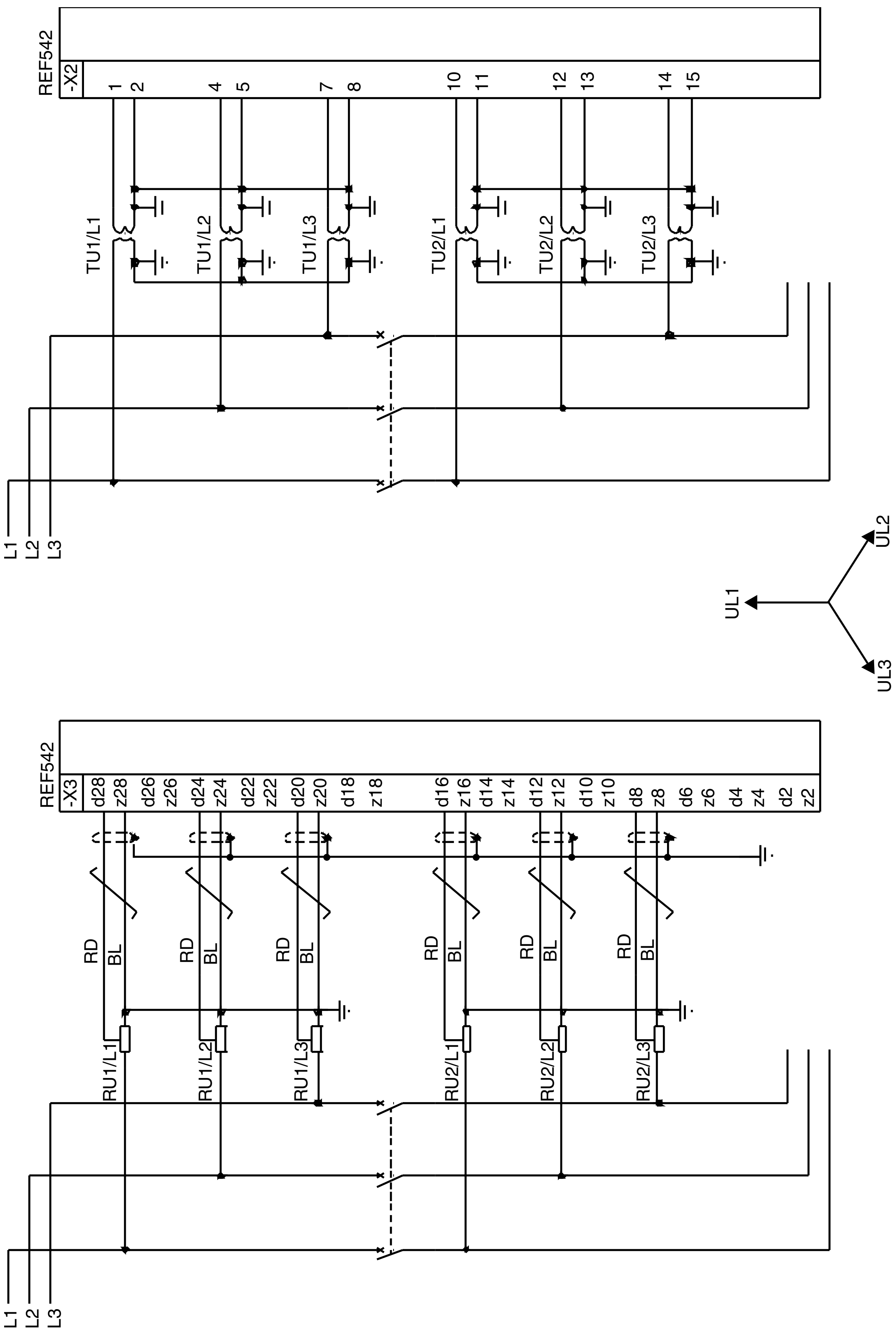


Figure 266: Typical sensor circuitry in sensors or transducers for busbar measuring

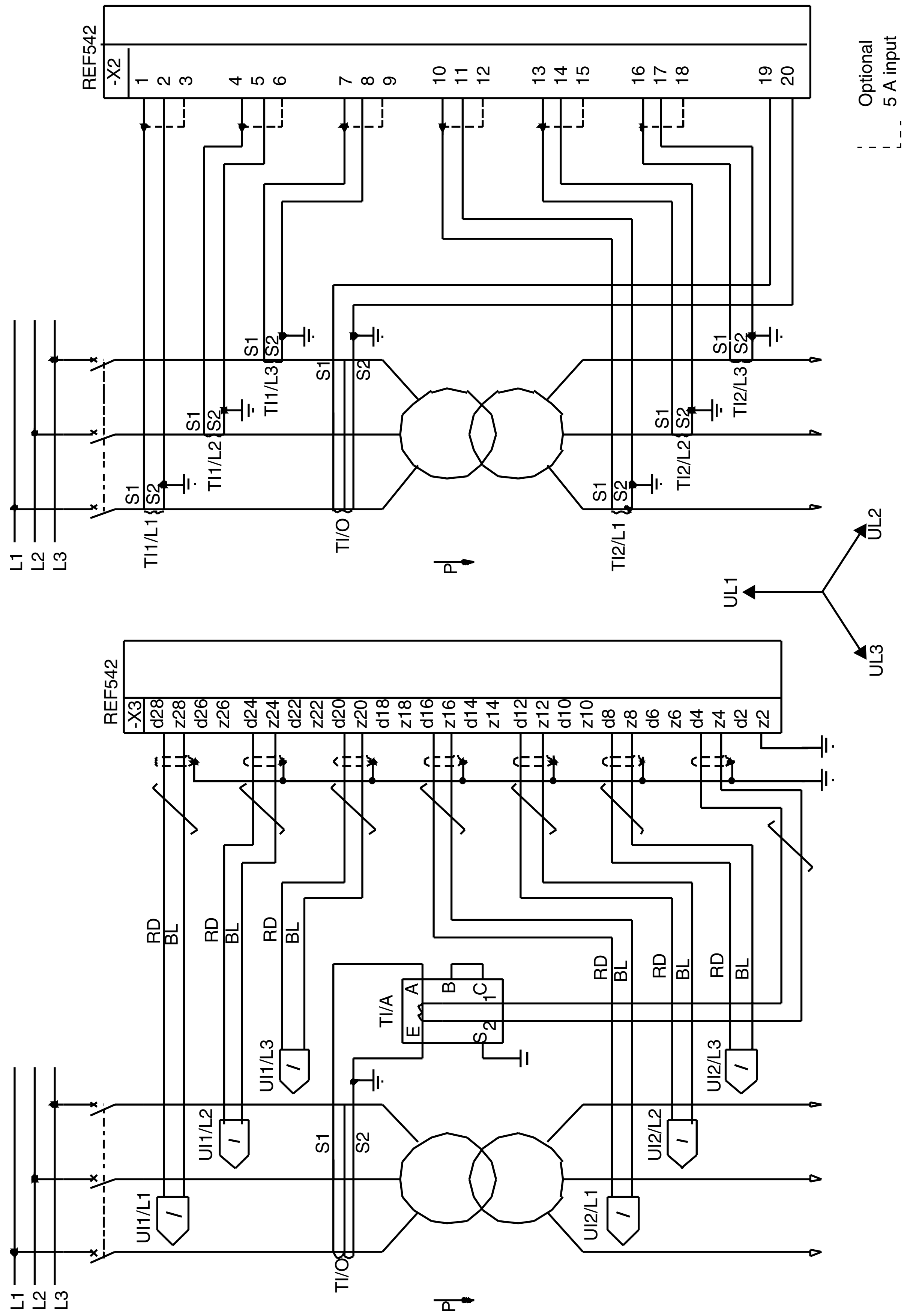


Figure 267: Typical circuitry in sensors for six current inputs

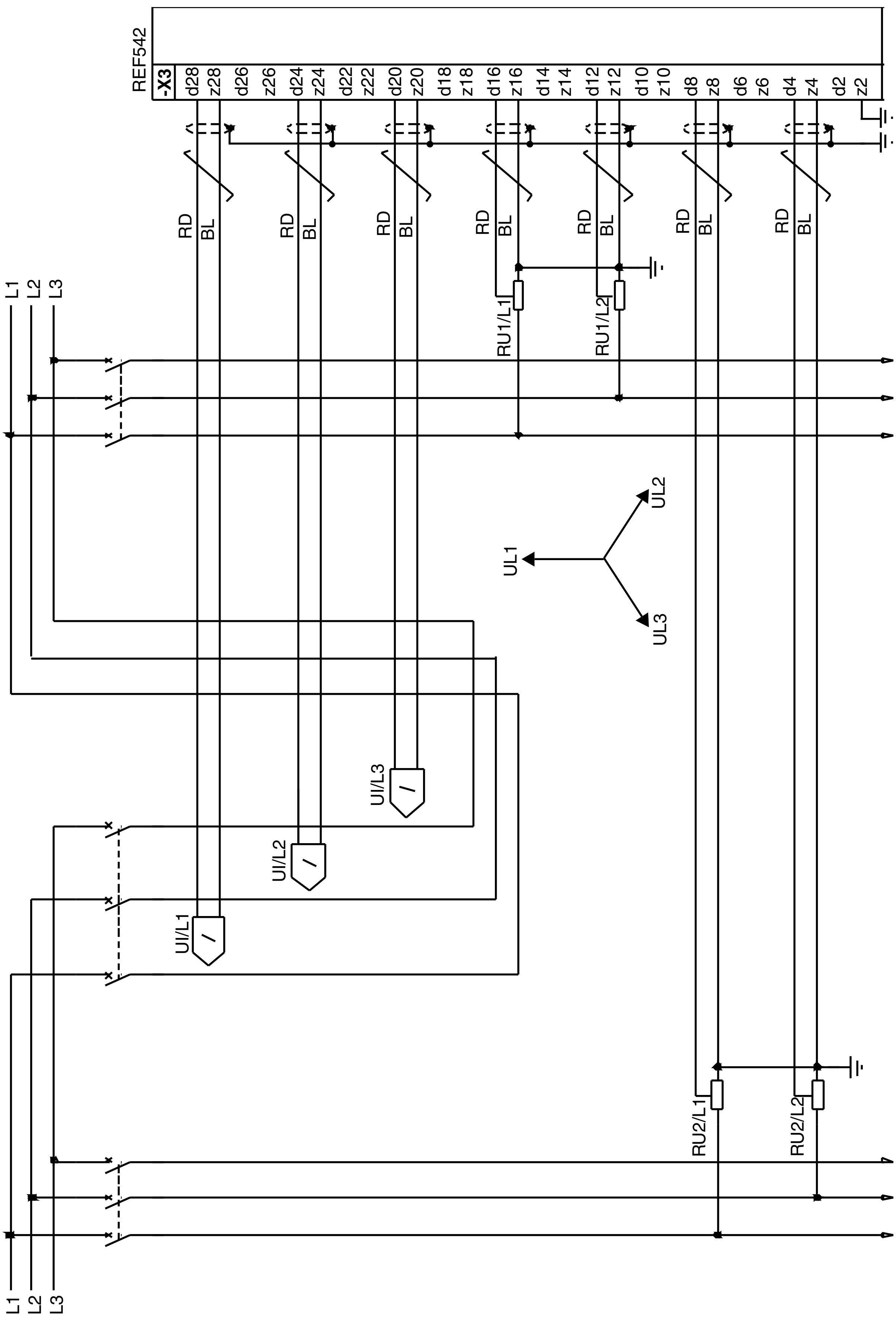


Figure 268: Typical circuitry in sensors for paralleling monitoring with measuring field

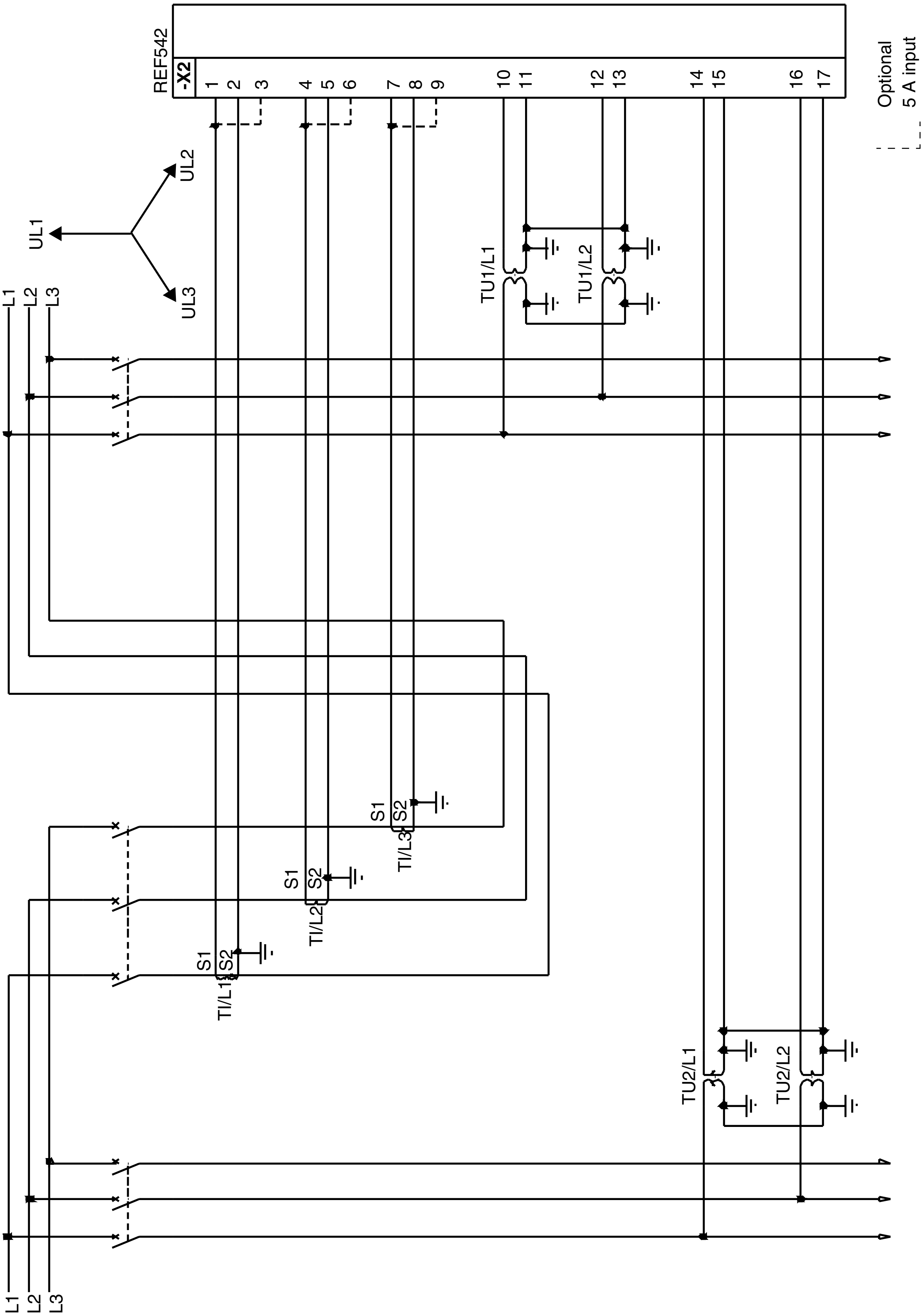


Figure 269: Typical circuitry in transducers for paralleling monitoring with measuring field

11.5 IDMT protection and earthfault IDMT protection families of curves

The four different families of curves are used for setting the protective function tripping for the IDMT protection and the earthfault IDMT protection.

↳Chapter "5.4.8.7 IDMT" on page 5-109

↳Chapter "5.4.8.12 Earthfault IDMT" on page 5-122

They indicate the connection between the start value and the period during which the start value is active. The start value is entered into the configuration dialog of the relevant protective function and is the quotient from the starting current (already converted by the transducer!) and rated current of the transducer. If the start value is reached, the protective function is started. If the start value is exceeded for at least the set delay period, the protective function will be tripped.

The period between starting and tripping depends on the fault current amount. The dependence is defined in the four families of curves, the current-time characteristics (IDMT characteristic). The start value is set there via the period between starting and tripping.

The formula for the trip time according to British Standard (BS) 142 and IEC 60255-3 is as follows::

$$t = \frac{k \cdot \beta}{I/I_{EB}{}^{\alpha} - 1} \qquad t = \frac{k}{((G/G_S)^{\alpha} - 1)}$$

BS 142 *IEC 60266-3*

t:	Time until the protective function trips under sustained overcurrent
k:	Curve parameter ($0 \leq k \leq 1$) (BS 142) or time value (IEC 60255-3)
α:	Constant according to the list below
β:	Constant according to the list below (BS 142)
I/I_{EB}:	Fault current factor
$I = G$:	Actual measured current; already converted by the transducer/sensor
$I_{EB} = G_S$:	Base current setting value: Minimum current at which the protection is activated; already converted by the transducer/sensor

The following table shows the two constants α and β of the four different current-time characteristics. To retain the specific families of curves, the formula in accordance with BS 142 is used and the k-factor of 0.1 to 1 is increased in increments of 0.1.

Current-time characteristic	α	β (BS142)	k (IEC 60255-3)
normal inverse	0.02	0.14	0.14
very inverse	1.0	13.5	13.5
extremely inverse	2.0	80.0	80.0
long time inverse	1.0	120.0	120.0

The formula for the trip curves and the selection of constants conforms to BS 142 (British Standard) and IEC 60255-3. The dependent maximum current time protection and earth fault-dependent maximum current time protection protective functions only react from the fault current factor 1.14. A corresponding limit is input in the diagrams. There is also a limit at 30 ms. This is the minimum signal processing time of the output relays.

Note: The start value and the fault current factor are different parameters. The trip time can only be determined with the fault current factor from the diagrams!

The parameters for the start value can be set in the protective function configuration dialog. It is linked to the fault current factor with the following formula:

$$\textit{Fault current factor} = \frac{I}{I_{EB}} = \frac{I}{\textit{Startvalue} \cdot I_N}$$

$$I = \textit{actually measured current (transformed)}$$

$$\textit{Start value} = \frac{I_{EB}}{I_N} = \frac{\textit{Base current setting value}}{\textit{Nominal current of transformer intermediate}}$$

Note The relay period must also be added to the trip times determined from the current-time characteristics. (Binary input/output board with transistor relays: 15 ms, and with conventional relays: 30 ms)

Example

All current values are already converted by the transducer, i.e. they are proportional to the actual currents flowing in the object that is to be protected!

The dependent maximum current time protection protective function or earth fault-dependent maximum current time protection are to be started only if the converted, measured current exceeds twice the base current setting value.

The delay period between starting and tripping should now be determined when the current-time characteristic "normal-inverse“ is based on the k-factor of 0.1. The current flowing through the object to be protected is 3 A (converted).

First the start value is calculated:

$$\textit{Start value} = \frac{I}{I_N} = \frac{2A}{1A} = 2$$

The fault current factor is calculated from the start value and the actually flowing current (converted):

$$\textit{Fault current factor} = \frac{I_>}{I} = \frac{I_>}{\textit{Start value} \cdot I_N} = \frac{3A}{2 \cdot 1A} = 1,5$$

Now, in the current-time characteristic "normal-inverse“ the curve with the k-factor 0.1 is selected (the lowest) and the time for the fault current factor of 1.5 is read.

There is a time delay of about 1.7 s between starting and tripping. Then the corresponding relay period of the binary input/output board is added. (Board with transistor relays: 15 ms, and board with conventional relays: 30 ms)

11.5.1 Current-time characteristic "normal inverse“

More information on the families of curves can also be found in Chapter "11.5 IDMT protection and earthfault IDMT protection families of curves" on page 11-20

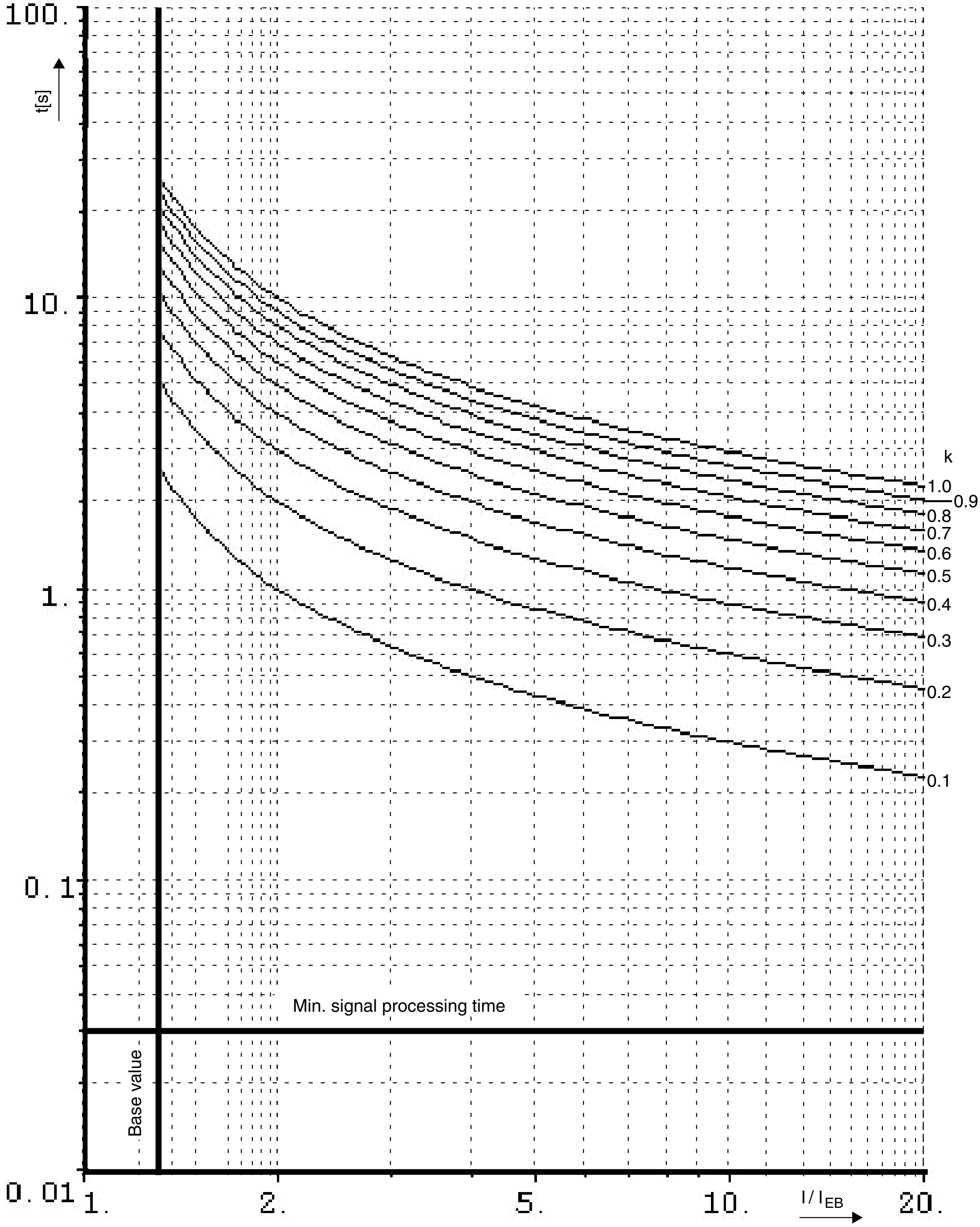


Figure 270: Current-time characteristic "normal inverse“

11.5.2 Current-time characteristic "very inverse“

More information on the families of curves can also be found in Chapter "11.5 IDMT protection and earthfault IDMT protection families of curves" on page 11-20

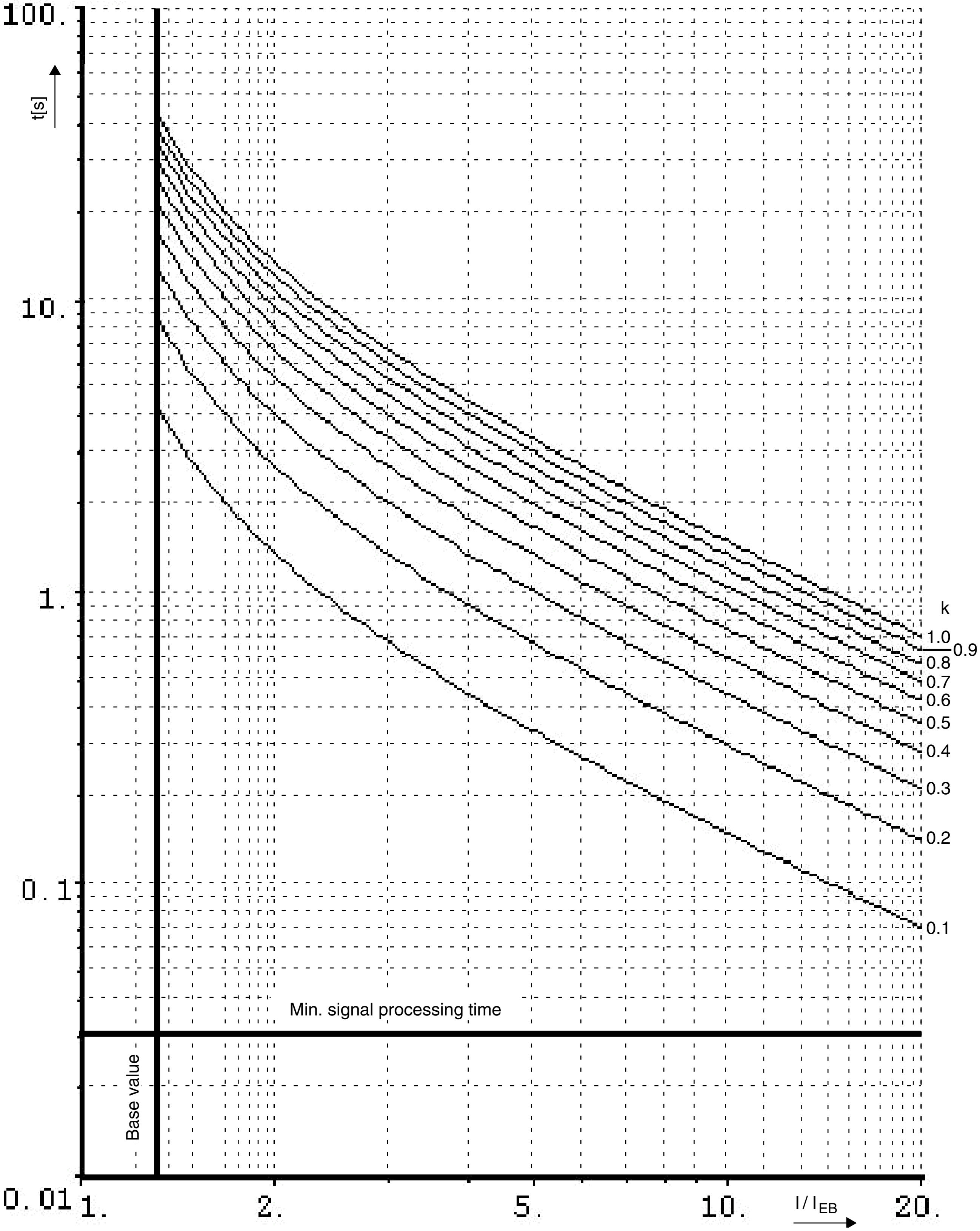


Figure 271: Current-time characteristic "very inverse“

11.5.3 Current-time characteristic "extremely inverse“

More information on the families of curves can also be found in Chapter "11.5 IDMT protection and earthfault IDMT protection families of curves" on page 11-20

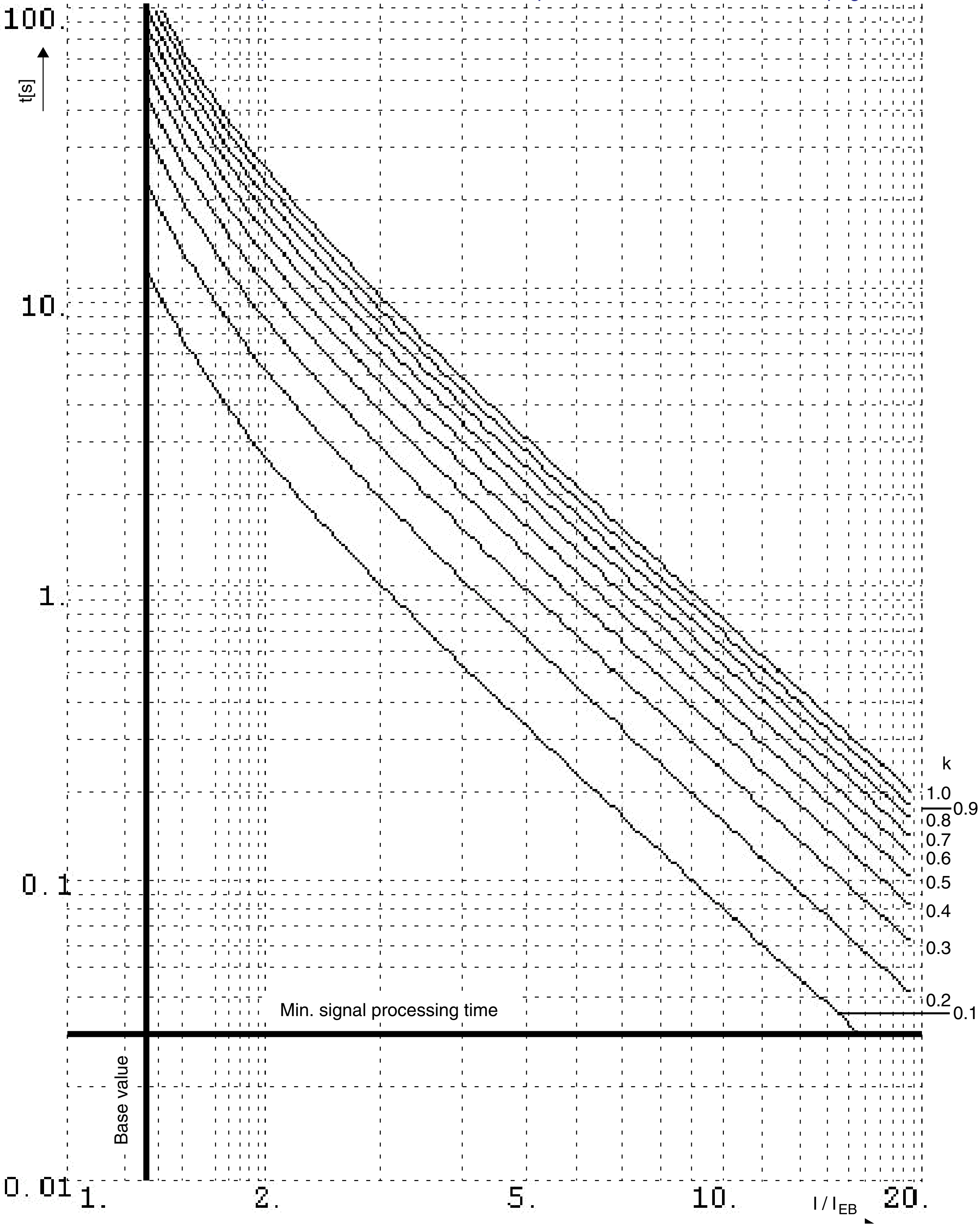


Figure 272: Current-time characteristic "extremely inverse“

11.5.4 Current-time characteristic "long time inverse“

More information on the families of curves can also be found in Chapter "11.5 IDMT protection and earthfault IDMT protection families of curves" on page 11-20

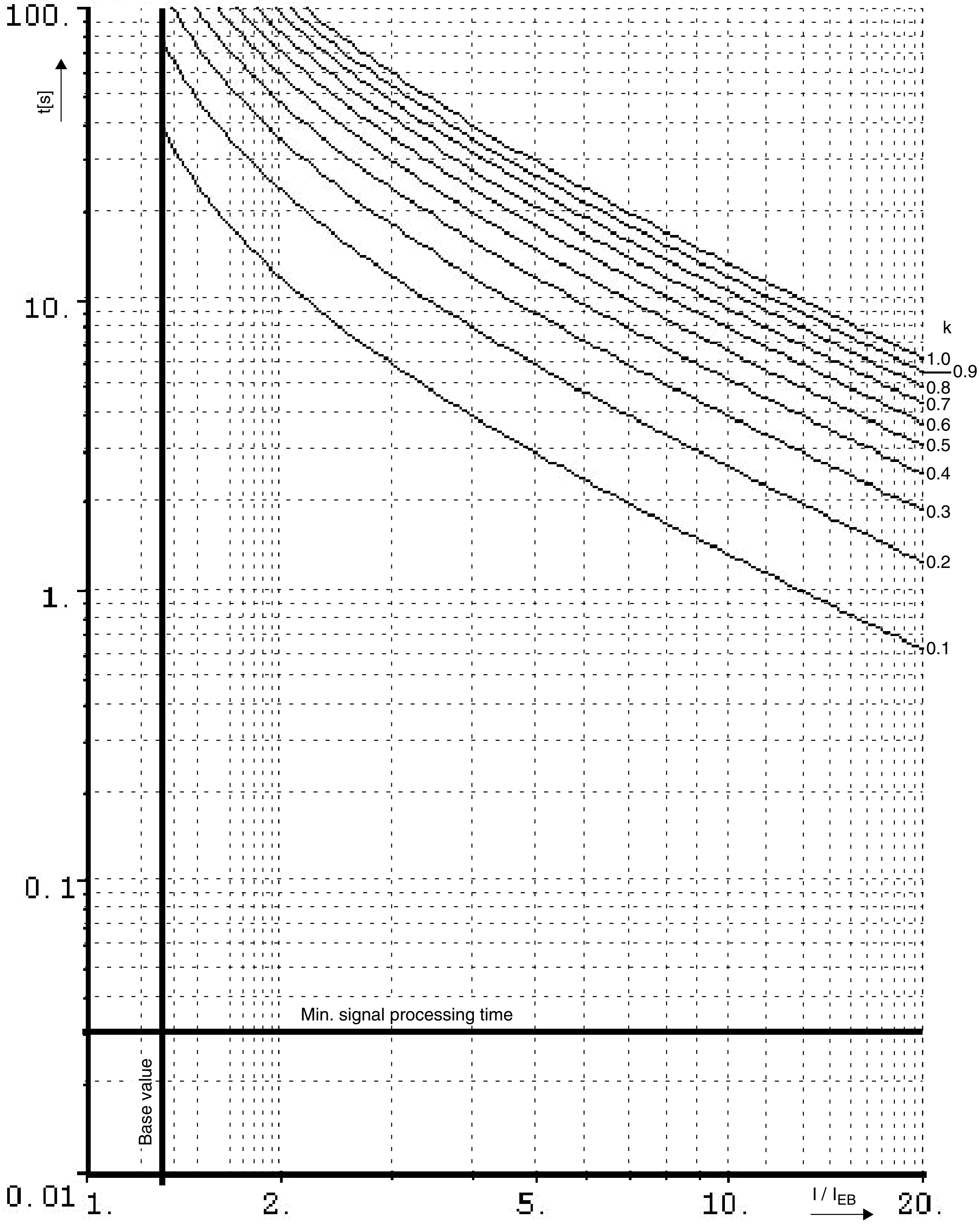


Figure 273: Current-time characteristic "long time inverse“

11.6 Tripping characteristics thermal overload protection

The following curves show the trip time depending on the relative current I / I_e and the time constant τ. I_e has a setting range of $0.3 \ldots 1.2 \cdot I_n$ (rated motor current).

All time constants are selected equally for the curves. The maximum temperature (trip temperature) corresponds to the allowable motor operating temperature.

Note The relay period and the delay period parameters (`time` parameter in the configuration dialog) must be added to the trip times derived from the curves.
(Binary input/output board with transistor relays: 15 ms, and with conventional relays: 30 ms)

11.6.1 Motor cold start

$$t(I,\tau) = -\tau \cdot \ln\left[1 - \left(\frac{I}{I_e}\right)^{-2}\right]$$

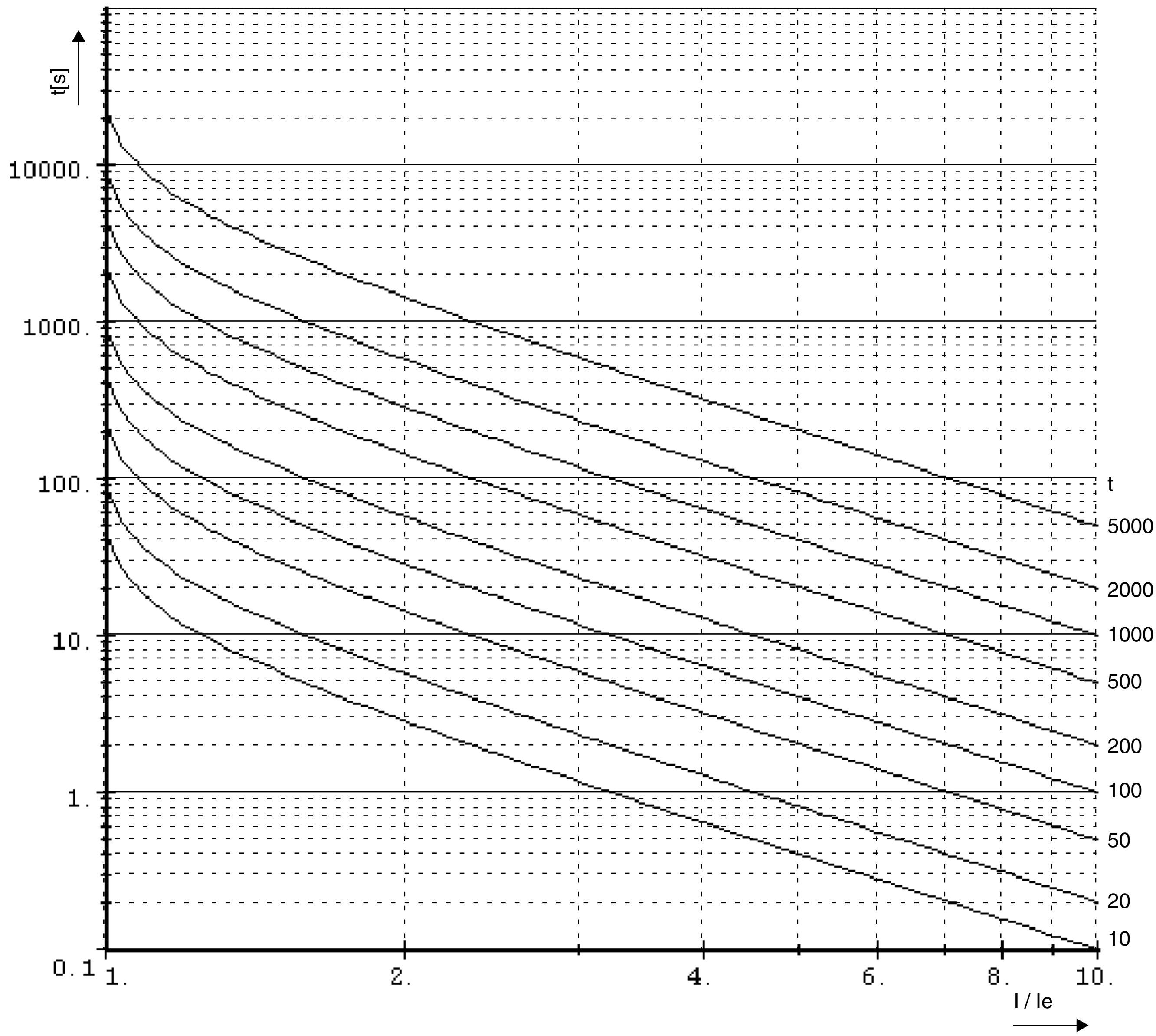


Figure 274: Trip curves of the independent thermal protection with cold start

11.6.2 Motor warm start: 20% of the operating temperature

$$t(I, \tau, x) = -\tau \cdot \ln\left(1 - \left(\frac{I}{I_e}\right)^{-2} \cdot (1 - x)\right)$$

The variable x in the equation above represents the temperature of the motor. It has been set to equal 0.2 to calculate the following trip curve. This corresponds to a motor warm start at a motor temperature of 20% of the maximum allowable temperature (operating temperature). Here $I = 0.447\ I_e$.

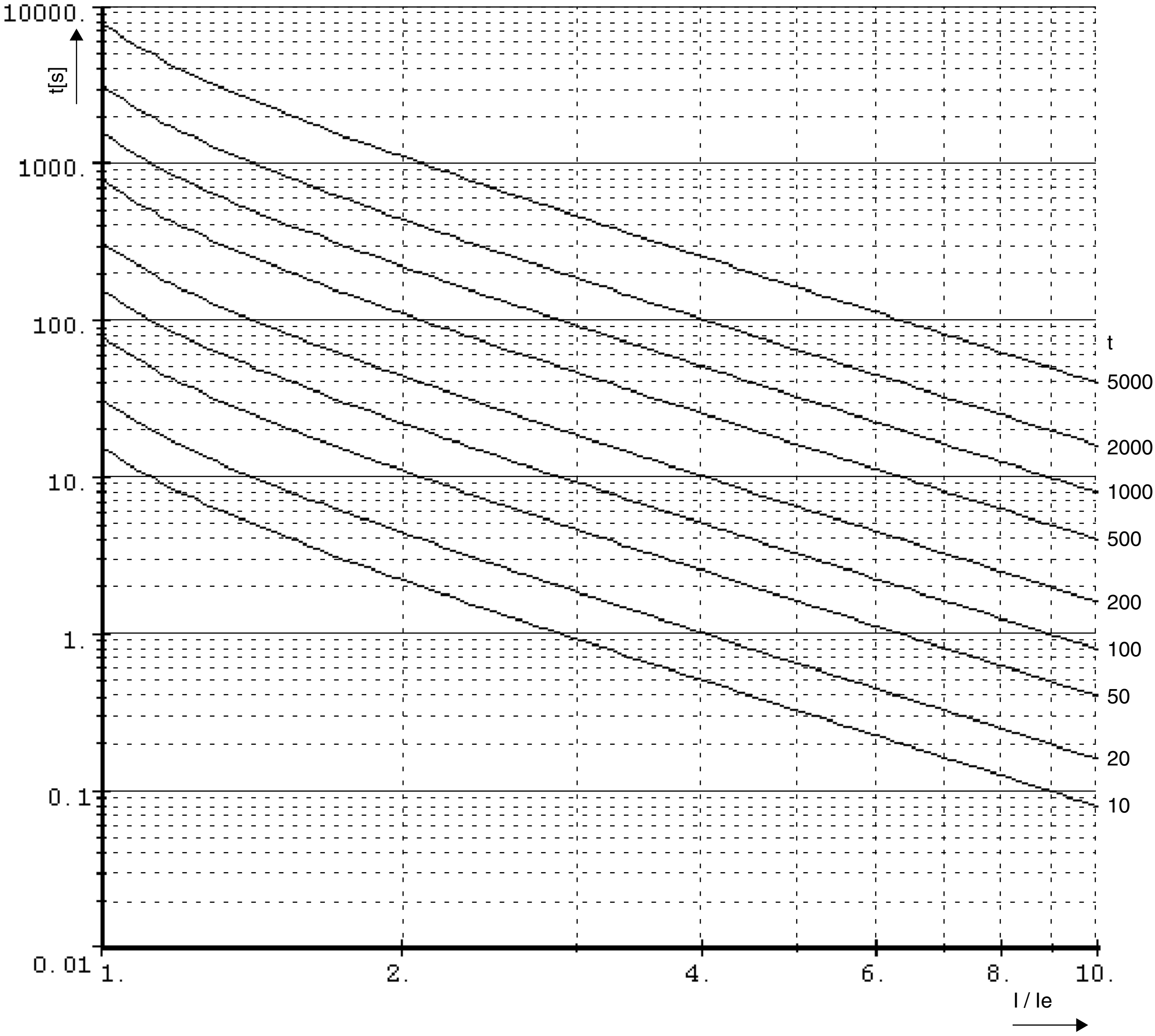


Figure 275: Trip curves of the independent thermal protection with a warm start at 20% of the operating temperature

11.6.3 Motor warm start: 50% of the operating temperature

$$t(I, \tau, x) = -\tau \cdot ln\left(1 - \left(\frac{I}{I_e}\right)^{-2} \cdot (1 - x)\right)$$

The variable x in the equation above represents the temperature of the motor. It has been set to equal 0.5 to calculate the following trip curve. This corresponds to a motor warm start at a motor temperature of 50% of the maximum allowable temperature (operating temperature). Here $I = 0.707\ I_e$.

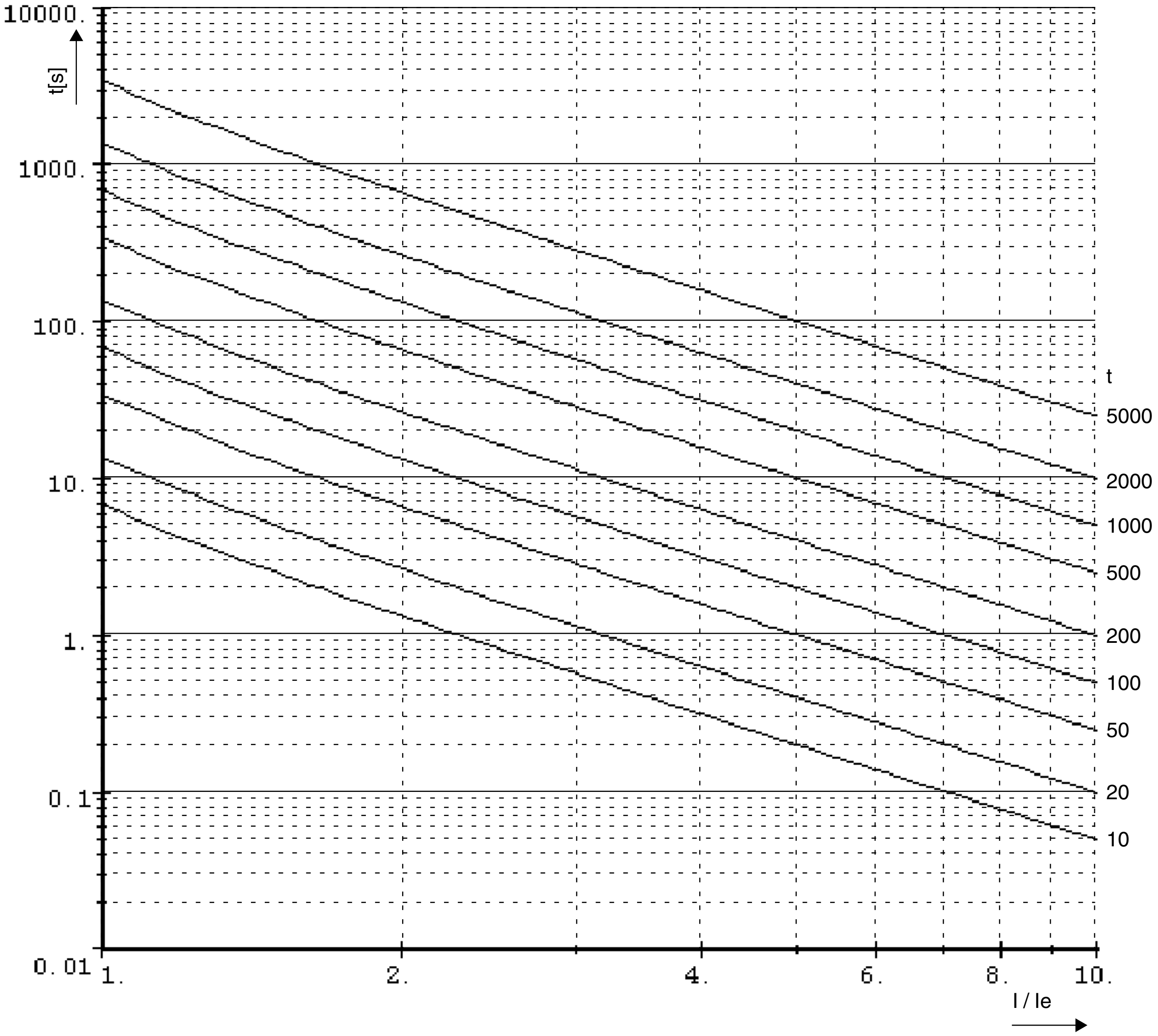


Figure 276: Trip curve of the independent thermal protection with a warm start at 50% of the operating temperature

11.7 Measuring principle of the REF542

11.7.1 Measured-value processing

The seven analog inputs are sampled at an effective frequency of 1.2 kHz for current and voltage measurement. In fact, they are oversampled at a frequency of 2.4 kHz. The period between two measurements is 1/1200[s^{-1}]=0.833 ms. At the basic frequency of 50 Hz a period duration is 1/50[s^{-1}]=20 ms. The analog inputs are sampled 20[ms]/ 0.833[ms]=24 times during one period of the system current or the system voltage.

To optimize the calculations for the REF542, only one half-wave of the input quantities is considered. This is possible without restriction because a sinusoidal curve of the currents and voltages may be assumed.

The following graph shows the frequency response of the band-pass filter at frequencies above 50 Hz. It corresponds to a band-pass filter with a frequency range of 45 Hz to 350 Hz.

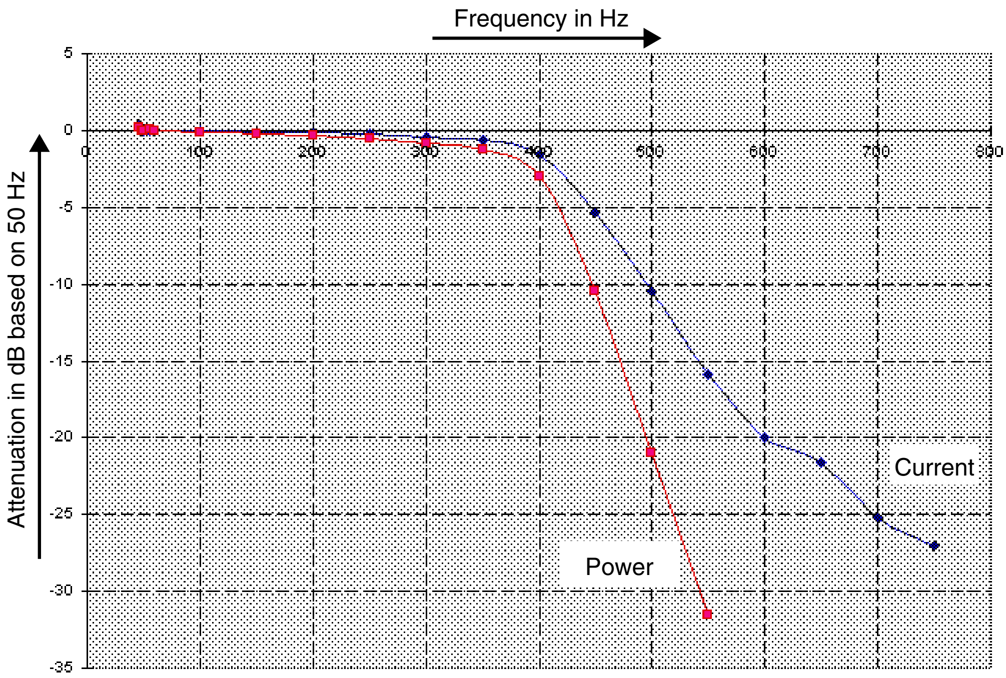


Figure 277: Frequency response of the band-pass filter at frequencies above 50 Hz

In the measurement a closed U-core transformer was used as signal converter.

Calculation of the rms value

The only measured values filtered by the band-pass filter are distributed as follows at a sinusoidal input quantity with a frequency of 50 Hz and the effective sampling rate of 1.2 kHz.

The dotted window in the following diagram shows the time range in which 12 measurements are taken. This window moves by 0.833 ms on the time axis with every newly recorded measured value.

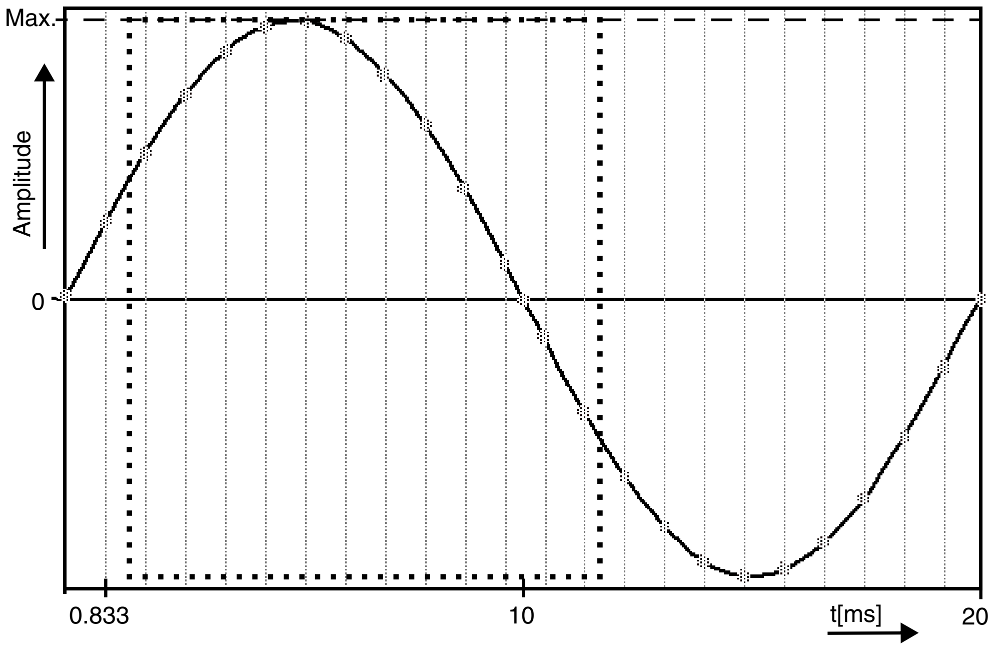


Figure 278: Distribution of the sampling values of the measured value acquisition of the REF542

The sampling value is represented by the gray dots. To calculate the rms value (rms=root mean square) the measured quantity is reduced to half of the sampling values. The calculation is then done with the following recursive formula:

$$X^2_{(n)_{RMS}} = \frac{2}{n_{tot}} \cdot \left(X^2_{(n-1)_{RMS}} \cdot \frac{n_{tot}}{2} + X^2_n - X^2_{\left(n - \frac{n_{tot}}{2}\right)} \right)$$

n_{tot}: Number of measurements in one period; here 24
RMS: Index of the rms value (root mean square)

The recursive formula calculates a new rms value from the current sampling value and the previous 23 sampling values with every new sampling value (every 0.833 ms). The resulting sequence of measured values after starting the recursive calculation can be found in the following graph. The individual measured values are represented by the gray dots.

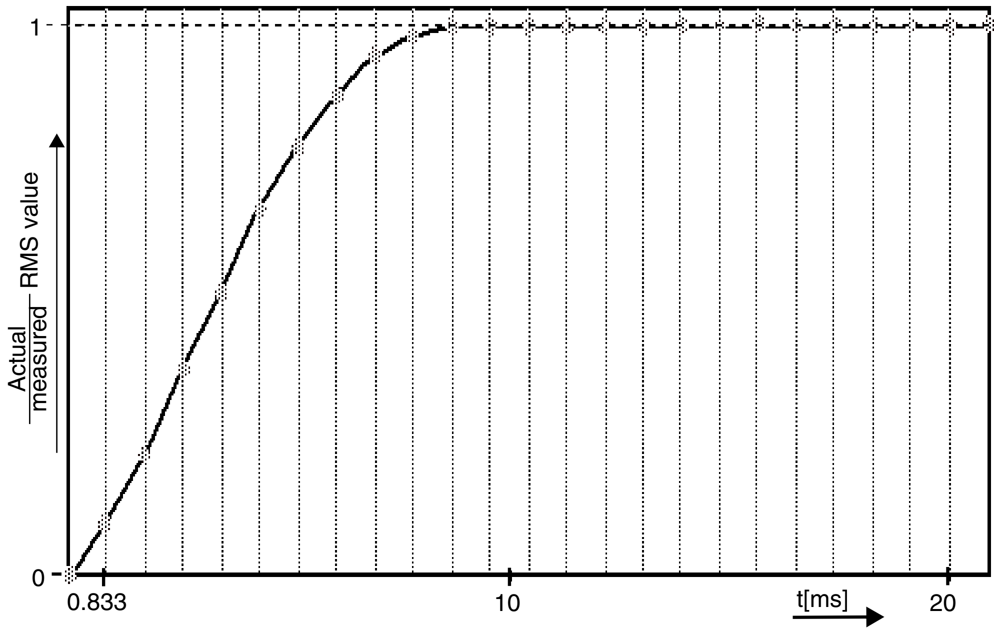


Figure 279: Approximation of the calculated rms values to the actual rms value

It can be clearly seen that a sufficiently precise result for the rms value is calculated as soon as half of the measured values have been processed. This is shown by the broken horizontal line in the graph and it corresponds to $1/\sqrt{2}$ times the maximum amplitude value from the previous graph.

Because a new measured value is received every 0.833 ms, a new rms value is also calculated in this time grid with the previously described recursive formula. Therefore, the rms value is evaluated every 0.833 ms to detect whether starting or tripping of a protective function is required.

Calculation time

The internal calculation time for calculating the rms value from the required 12 measured values is therefore about 10 ms. If the signal runtimes and the closing times of the individual relays are added, a maximum signal processing time from occurrence of the fault to the trip impulse of the REF542 is approximately 50-65 ms. The final value depends on the protective function and the type of binary input and output boards in use. The input/output board with transistor relays is always 15 ms faster.

To enable the protective functions to send the trip signal to the binary input/output board with appropriate speed, they have the option of addressing an output channel directly. The number of the output used for this purpose is entered in the input field output channel in the configuration dialog.

Measured value acquisition when using an application with distance protection

The distance protection also operates initially with the measured values described in the above section. However, for the impedance calculation the discrete Fourier transformation (DFT) is used.

↳Chapter "Determining the impedance" on page 5-162

11.7.2 Measurement or calculation of Uo, Io

If the two quantities earth current or neutral point voltage (voltage displacement) cannot be measured with their own sensors or transducers, the REF542 can calculate them internally. To enable this the various conductor quantities must be recorded as measured values. They are calculated by vectorial addition and yield amplitude and phase of the corresponding quantity:

$$3\underline{I}_0 = \underline{I}_{L1} + \underline{I}_{L2} + \underline{I}_{L3}$$

$$3\underline{U}_0 = \underline{U}_{1E} + \underline{U}_{2E} + \underline{U}_{3E}$$

Here this refers to the line currents and phase voltages in each case.

The measured quantities are referred to as earth current I_0 and as residual (zero sequence) voltage U_0. To distinguish them, the calculated quantities are referred to as neutral current I_0 and neutral voltage U_0.

Note When using a transducer to measure U_0 or I_0, a more sensitive protection setting is possible.

More information on measuring or calculation of U_0 and I_0 can be found in

Chapter "11.8 Network neutral point earthing" on page 11-35. The options for earthing the network neutral point and its effect on phase to earth fault errors are treated in detail there.

11.7.3 Calculation of the cos φ

To record cos φ, the REF542 requires the conductor-earth voltage and the line current from at least one phase. The maximum value and its time position for calculating φ are derived from each of the discrete acquired and digitalized measured values.

The REF542 calculates the angle φ from the time displacement of these two maximum values. Among other things, it is important for the protective functions with directional decision and for the power calculation.

11.7.4 Calculation of the frequency

For determining the network frequency the first configured voltage input is normally considered. If none of the analog measuring inputs is wired with a voltage sensor/ transducer, the first current input is used. The zero crossings per time unit are counted to calculate the frequency.

The frequency calculation begins from a voltage/current level of 0.35% of the rated value. However, correct values are only received from a level of 1%.

11.7.5 Power calculation

11.7.5.1 Active power calculation

In an operating and balanced loaded three-phase system is sufficient to measure the power flow in one phase. The total power is derived from three times the display. If any load cases are permissible, two or three watt-meters are required to record the power in a triple-conductor network. The calculation of the total power is explained in the following paragraphs.

Calculation according to Aron circuit – two current and three voltage sensors/transducers

This procedure can be used for any networks and is not specifically for three-phase networks. For example, a physically correct result can be derived even in disturbed three-phase systems (e.g. asymmetrical voltages, failure of one voltage). The advantage of the Aron circuit is that only two line currents are required. The following circuit diagram shows the Aron circuit. The three phase voltages are used because the REF542 measures only them and uses them to calculate the external phase-to-neutral voltages.

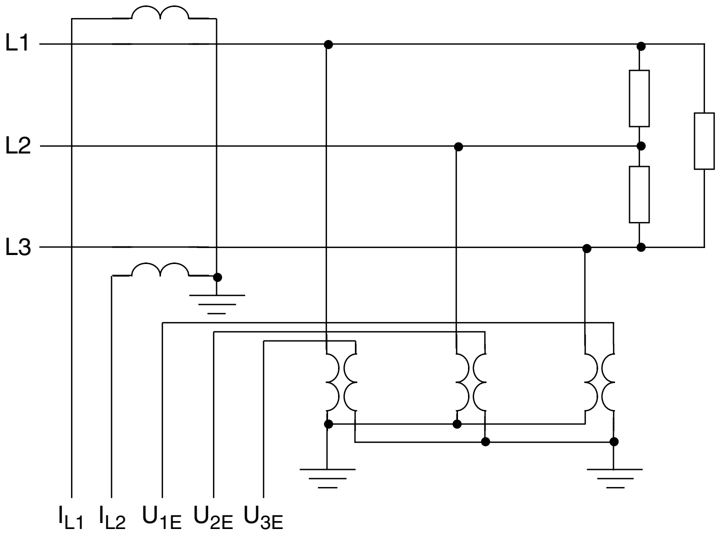


Figure 280: Aron circuit for two line currents and three phase voltages

The complex calculation is used to derive the formula. It is initially assumed that there is no neutral-point conductor (neutral conductor). The result is that the sum of the line currents is zero:

$$\underline{I}_1 + \underline{I}_2 + \underline{I}_3 = 0 \Leftrightarrow \underline{I}_3 = -(\underline{I}_1 + \underline{I}_2)$$

The line voltages can be shown by adding the phase voltages:

$$\underline{U}_{12} = \underline{U}_{1E} - \underline{U}_{2E}$$
$$\underline{U}_{23} = \underline{U}_{2E} - \underline{U}_{3E}$$
$$\underline{U}_{31} = \underline{U}_{3E} - \underline{U}_{1E}$$

For the effective power the following generally applies:

$$P = Re\{\underline{U}_{1E} \cdot \underline{I}^*_1 + \underline{U}_{2E} \cdot \underline{I}^*_2 + \underline{U}_{3E} \cdot \underline{I}^*_3\}$$

* bedeutet : konjugiert komplex

By applying the above equations to the effective power equation and then after additional conversions, the result is:

$$P = Re\{\underline{U}_{13} \cdot \underline{I}^*_1 + \underline{U}_{23} \cdot \underline{I}^*_2\}$$
$$= Re\left\{U_{13} \cdot e^{j\varphi_{1u}} \cdot I_1 \cdot e^{-j\varphi_{1i}} + U_{23} \cdot e^{j\varphi_{2u}} \cdot I_2 \cdot e^{-j\varphi_{2i}}\right\}$$
$$= Re\left\{U_{13} \cdot I_1 \cdot e^{j(\varphi_{1u} - \varphi_{1i})} + U_{23} \cdot I_2 \cdot e^{j(\varphi_{2u} - \varphi_{2i})}\right\}$$
$$= Re\{(U_{13} \cdot I_1 \cdot (cos\varphi_1 + j\,sin\varphi_1)) + (U_{23} \cdot I_2 \cdot (cos\varphi_2 + j\,sin\varphi_2))\}$$

If the real component of the complex function is formed, the following equation is eventually derived:

$$P = (U_{13} \cdot I_1 \cdot \cos\varphi_1 + U_{23} \cdot I_2 \cdot \cos\varphi_2)$$

By replacing one current with the two others the above formula for the total effective power can also be derived with the other currents and voltages.

Note The Aron circuit cannot detect power that flows to earth in the event of malfunction!

Calculation with three current and voltage sensors

As an alternative the effective power calculation for balanced or asymmetrical networks can also be done when three current and voltage sensors or transformers each are in use. The measurement recorders must measure the three line currents and the three phase voltages in that case. The total effective power is then a combination of the power in the three phases.

$$\begin{aligned} P &= P_1 + P_2 + P_3 \\ &= (U_{10} \cdot I_1 \cdot \cos\varphi_1 + U_{20} \cdot I_2 \cdot \cos\varphi_2 + U_{30} \cdot I_3 \cdot \cos\varphi_3) \end{aligned}$$

Note Because the assumption “sum of currents equals zero“ (Aron circuit) no longer applies, the power that flows to earth in the event of a malfunction will also be recorded.

11.7.5.2 Reactive power calculation

The reactive power is calculated by multiplying the effective power with the tangent of the phase difference φ:

$$Q = P \cdot \tan\varphi$$

11.8 Network neutral point earthing

Because the most common fault in distribution and transmission networks is the single-line fault with earth contact, the network neutral point handling is important in the operation of a network. The fault statistics of the association of German power suppliers (VDEW) indicate that in 70% to 90% of all cases the problem is a single-line fault with earth contact. The single-line fault is in most cases the consequence of a breakdown of the insulation (particularly in cables) or is caused by a flashover on an overhead cable. These flashovers are caused by atmospheric influences. Finally, such earth faults, particularly in cable networks, frequently cause 2 and 3-line faults by progressive destruction of the insulation.

In a network with low-resistance neutral earthing, if a single-line fault phase fault occurs, current flows back through the earth to the voltage source. In a network with high-resistance neutral point, the return path is theoretically not possible, because there is no conducting connection and therefore no closed current circuit. In practice, however, line capacitances to earth occur in the carriers, producing a current flow that is considerably smaller in amplitude than with the low-resistance earth short-circuit.

The difference between the two single-line fault types is shown even in their designation. The "single-line earth short-circuit“ in a network with low-resistance neutral earthing is distinguished from the "single-line earth fault“ in a network with high-resistance neutral point.

An earth fault in the network without neutral-point connection does not result in short-circuit currents and therefore does not need to be shut off immediately. However, the earth fault location must be found and corrected, because the current at the earth fault location and the resulting increase of the phase voltage of the intact conductor place a higher stress on the equipment insulation. The external phase-to-neutral voltages between the conductors remain unchanged, while, as stated above, the voltage of the intact conductor rises from the neutral to the delta voltage value.

Networks with the following are classified in the earth fault series:

- Isolated, coil-earthed (Petersen coil) and
- High-resistance neutral point

As previously noted, the phase fault currents are very low but the voltage increase is significant.

Networks with the following are classified in the earth fault series:

- Low-resistance neutral point

In contrast to the above, the single-line fault currents are very high and the voltage increase remains low.

The diagram below shows the circuit diagram of a carrier and the vector diagram of the currents and voltages. The following subsections use the diagram to explain the effect of earth faults in various types of earthed networks.

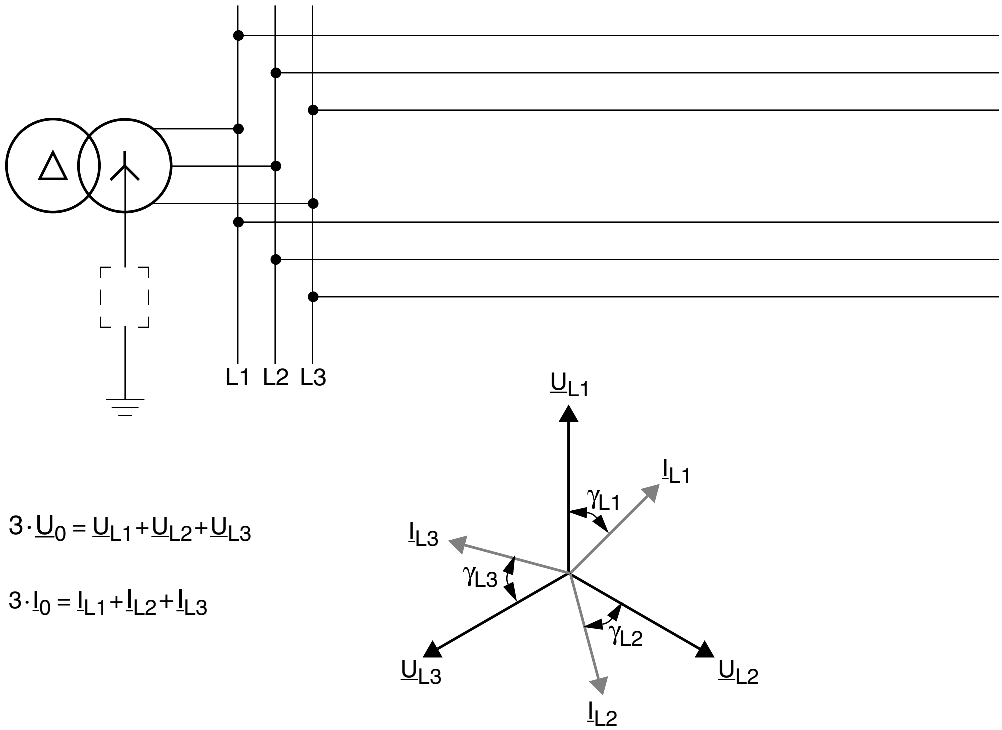


Figure 281: Equivalent circuit of a carrier or a cable

The network neutral point is still kept open and will be described in more detail in the following sections for the individual options, such as:

- Low-resistance neutral earthing,
- Resistor neutral earthing,
- Isolated neutral point,
- Neutral point with Petersen coil.

11.8.1 Low-resistance neutral earthing,

The highest zero-sequence currents occur with low-resistance neutral earthing. They are only limited and determined by the magnitude of the earth impedances $\underline{Z}_{Exx}$ and the primary equipment impedances ($\underline{Z}_Q$, $\underline{Z}_L$) between the operating voltage and the fault location. In these cases, the fault currents are of the magnitude of the multiphase fault currents, and a separate earth-fault protection is not required.

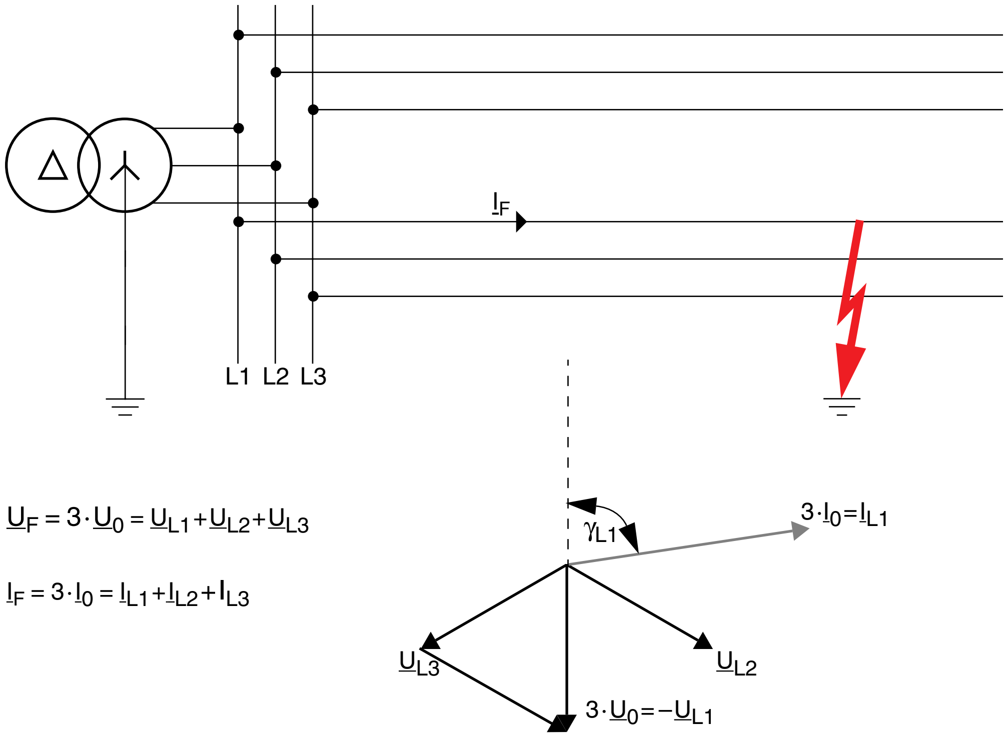


Figure 282: Single-line fault with low-resistance neutral earthing

The zero-sequence current can be measured from the summation of the current transformers in the neutral $3 \cdot \underline{I}_0 = \underline{I}_{L1} + \underline{I}_{L2} + \underline{I}_{L3}$.

If a direction-selective protection in required, the voltage displacement must be used as the measurement criterion. In the REF542 the zero-sequence voltage $3 \cdot \underline{U}_0 = \underline{U}_{L1} + \underline{U}_{L2} + \underline{U}_{L3}$ is used, which is calculated from the three measured phase voltages. The zero-sequence voltage can be taken from a separate voltage transformer in open delta circuit, which is then connected to a separate voltage measurement input on the REF542.

"Figure 286: Measuring the displacement voltage with open delta winding" on page 11-42

The network must be cleared after every earth fault in a network with low-resistance neutral earthing.

11.8.2 Resistance earthed neutral point

The network neutral point is earthed over a resistive resistor in this variation. The resistor is designed to limit the phase fault current to a desired value after incoming network phase-fault current calculation.

Low-resistance resistance earthed neutral point

There is the low-resistance resistance earthed neutral point, the ratios of the zero-sequence current values and the voltage load, which are similar to the low-resistance neutral earthing, with only the phase difference between current and voltage being different. (Refer to the vector diagram in the next figure).
The fault current limiting also limits damage incidents. An additional earth fault protec-

tion device is not required, because the fault current is always set to be greater than the maximum load current.

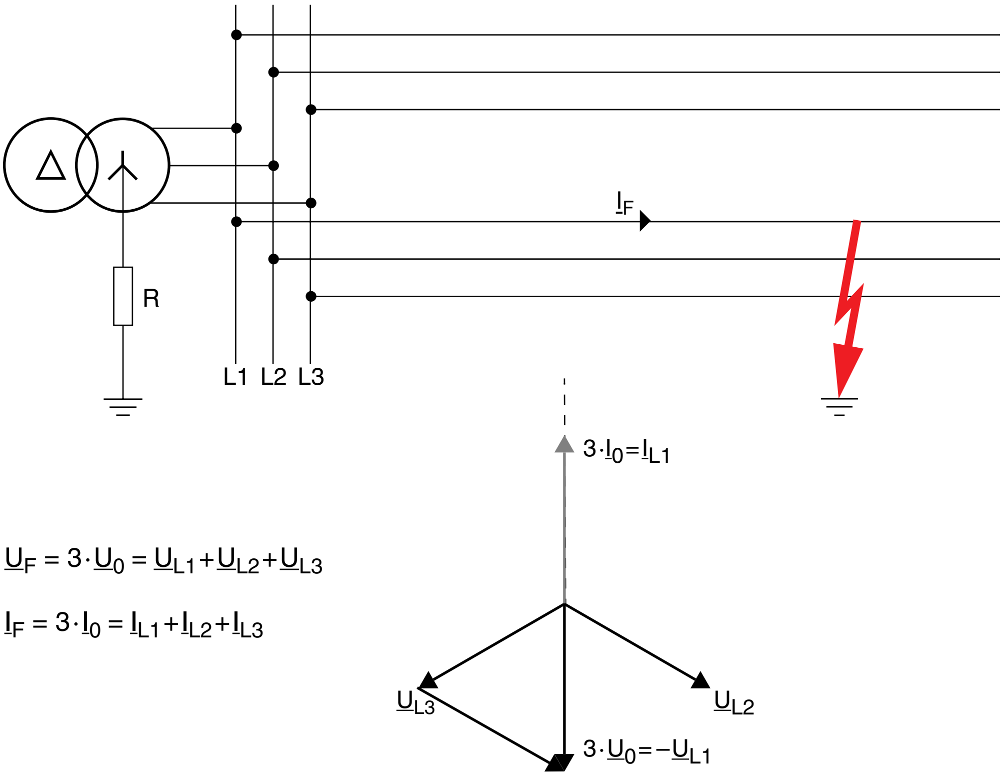


Figure 283: Single-line fault with neutral earthing over resistance

The zero-sequence current can be measured from the summation of the current transformer in the neutral path $3\cdot\underline{I}_0=\underline{I}_{L1}+\underline{I}_{L2}+\underline{I}_{L3}$. If a direction-selective protection in required, the voltage displacement must be used as the measurement criterion. In the REF542 the zero-sequence voltage $3\cdot\underline{U}_0=\underline{U}_{L1}+\underline{U}_{L2}+\underline{U}_{L3}$ is used for this. It is calculated from the three phase voltages.
The zero-sequence voltage can be derived from a separate voltage transformer in open delta circuit, which is then connected to a separate voltage measurement input on the REF542.

"Figure 286: Measuring the displacement voltage with open delta winding" on page 11-42

High resistance earthed neutral point

The second variation is the high resistance earthed neutral point, which is closer to that of the Petersen-compensated neutral point with the same advantages and disadvantages.

Chapter "11.8.4 Network with Petersen coil" on page 11-40

11.8.3 Isolated neutral point

If the network does not have a neutral connection to earth, i.e. is an isolated operation, in the event of a earth fault malfunction the capacitive current will enter via the line capacitances to earth. They will generate a capacitive fault current at the fault location, which depends on the network configuration and can be several hundred amperes.

The network may continue in operation, but the fault must be located and corrected. The fault current can cause damage and there is the danger of a two-line fault occurring in the event of a cross-country fault.

The phase voltages in the intact conductors increase by √3 times and stress the equipment insulation, thereby causing risk to life by touch voltages. The 90˚ phase displacement between fault current and voltage makes an arc extinction very difficult.

The detection of earth faults with high-resistance earthed network neutral points is made more difficult by the detection of the low earth fault currents.
Sensitive current transformers must be used for this purpose and special earth fault detection circuits with special current and voltage transformers need to be designed.

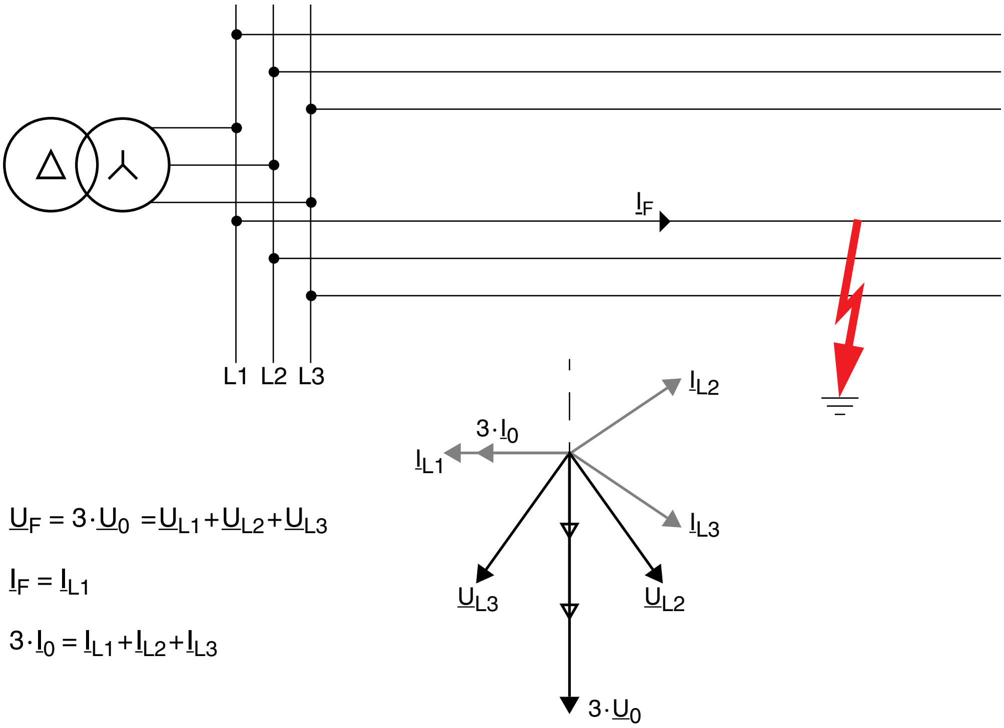


Figure 284: Single-line fault with isolated network neutral point

A sensitive residual current transformer must be used to detect the low earth fault currents. This can only be done in overhead cable networks with special and expensive current transformers.
A modified current transformer can be used with cable units, which are applied to all three conductor cables and therefore only measure the residual current
$3 \cdot \underline{I}_0 = \underline{I}_{L1} + \underline{I}_{L2} + \underline{I}_{L3}$.

The transformation ratio of the converted transformer may be set to be lower than the rated current of the feeder, because it detects the residual current only in the event of a malfunction. The lower limit of the transformation ratio of the converted transformer is set by its thermal maximum currents, because in the event of a cross-country fault it measures the high single-phase fault current at the relevant fault location of the cross-country fault.

The voltage displacement is detected as zero-sequence voltage $3 \cdot \underline{U}_0 = \underline{U}_{L1} + \underline{U}_{L2} + \underline{U}_{L3}$ and is derived from the sum of the three measured phase voltages.

A earth fault message is generated with the protection equipment.
The earth fault must be located and corrected, because in the event of a cross-country fault there will be two fault locations, which must be detected and shut off separately.

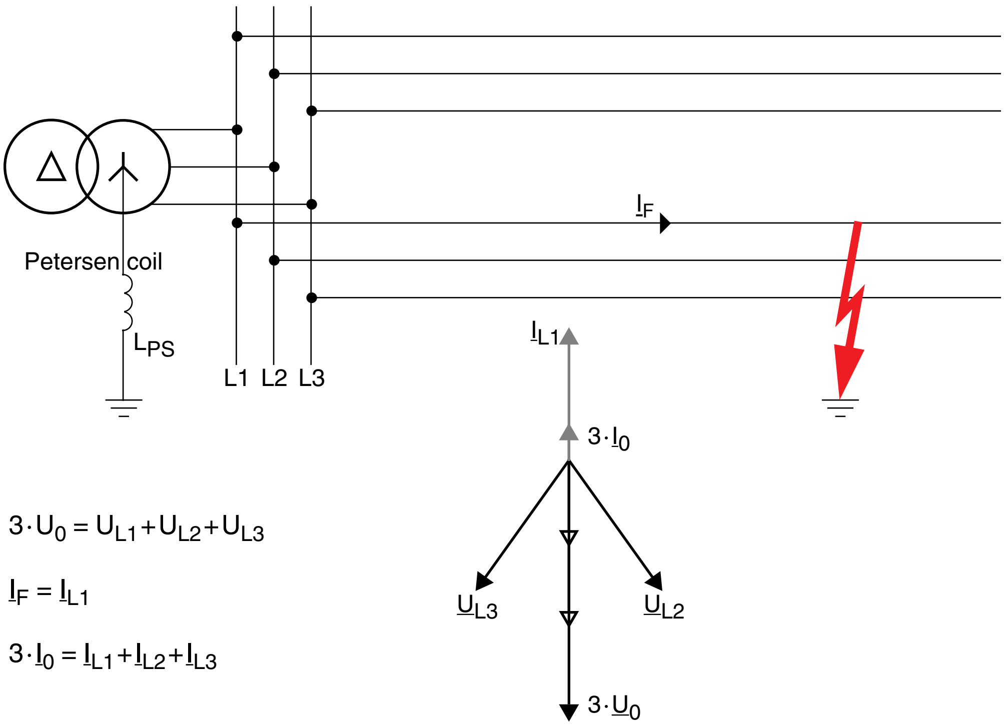
11.8.4 Network with Petersen coil

The principle of this neutral-point circuit, which was published at the beginning of the 19th century by Waldemar Petersen, is the installation of a variable reactance choke between neutral and earthing point. With the single-line earth contact the capacitive earth fault current on one hand and the inductive choke current of the Petersen coils on the other hand flows over the fault location. If the coil current is adjusted to the line capacitances to earth of the network, both currents will be of equal value but opposite in phase, i. e. the fault location has no current. In practice a very low residual effective current resulting from the real resistances of the operation and earth impedances remains. Because of the current compensation the fault location has no current. The network may continue in operation, but the earth fault must be located. In the event of a cross-country fault, a two-line fault occurs and so long as the earth fault is present the phase voltages on the intact conductor have the increased phase-to-phase values. In addition, increased transient overvoltages and oscillations occur with asymmetrical line capacitances to earth.

The low residual real current makes it more difficult to locate the earth fault. The residual real current is 2 to 3% of the total earth fault current. Sensitive current transformers must be used to detect earth faults and special earth fault detection circuits with special current and voltage transformers need to be designed.

A sensitive residual current transformer must be used to detect the low earth fault currents. This can only be done in overhead cable networks with special and expensive current transformers.

A modified current transformer can be used with cable units, which are applied to all three conductor cables and therefore only measure the residual current $3 \cdot \underline{I}_0 = \underline{I}_{L1} + \underline{I}_{L2} + \underline{I}_{L3}$. The transformation ratio of the converted transformer may be set to be lower than the rated current of the feeder, because it detects the residual current only. The lower limit of the transformation ratio of the converted transformer is set by its thermal maximum currents, because in the event of a cross-country fault it measures the high single-phase fault current at the relevant fault location of the cross-country fault.



$$3 \cdot U_0 = U_{L1} + U_{L2} + U_{L3}$$

$$\underline{I}_F = \underline{I}_{L1}$$

$$3 \cdot \underline{I}_0 = \underline{I}_{L1} + \underline{I}_{L2} + \underline{I}_{L3}$$

Figure 285: Single-line fault with coil-earthed network neutral point.

The voltage displacement is detected as zero-sequence voltage $3 \cdot \underline{U}_0 = \underline{U}_{L1} + \underline{U}_{L2} + \underline{U}_{L3}$ and is derived from the sum of the three measured phase voltages.

A earth fault message is then generated with the protection equipment.
The earth fault must be located and corrected, because in the event of a cross-country fault there will be two fault locations, which must be detected and shut off separately.

11.8.5 Earth fault signal

If a earth fault is to be detected and reported only, as is done with isolated, petersen coil earthed or high-resistance earthed network neutral points, an existing earth fault may be found by measuring the voltage displacement in the entire network. In the event of a earth fault, this neutral-point voltage displacement will occur in the entire network of this voltage level.

The neutral-point voltage displacement may be detected by three measuring methods.

The first method detects the zero-sequence voltage $3 \cdot \underline{U}_0 = \underline{U}_{L1} + \underline{U}_{L2} + \underline{U}_{L3}$ by measuring the three phase voltages calculating $3 \cdot \underline{U}_0$ in the protection device. This method is implicitly assumed in

- "Figure 282: Single-line fault with low-resistance neutral earthing" on page 11-37,
- "Figure 283: Single-line fault with neutral earthing over resistance" on page 11-38,
- "Figure 284: Single-line fault with isolated network neutral point" on page 11-39 and
- "Figure 285: Single-line fault with coil-earthed network neutral point." on page 11-40

The calculated value is then fed to a neutral point displacement measurement function in the protection device.

In the second measuring method the zero-sequence voltage $3 \cdot \underline{U}_0 = \underline{U}_{L1} + \underline{U}_{L2} + \underline{U}_{L3}$ is derived by measuring the three phase voltages with a three-phase voltage transformer set in the open delta winding, which is then connected to a single-line voltage measurement input on the protection equipment and processed by the neutral point displacement measurement function. This variation is shown in "Figure 286: Measuring the displacement voltage with open delta winding" on page 11-42.

A third method for detecting the earth fault is to measure the voltage displacement between the zero and earthing point of a power or zig-zag earthing reactor with a single-phase voltage transformer. The measured voltage is fed to the voltage measurement input on the protection equipment. This is shown in "Figure 287: Measuring the displacement voltage in the transformer neutral" on page 11-42.

Note that the measured voltage is not equivalent to the zero-sequence voltage $3 \cdot U0$ but only to one third of the zero-sequence voltage $-\underline{U}_0$, because this is the neutral-point displacement voltage of the affected conductor in the event of a malfunction, which is equal to the phase voltage.

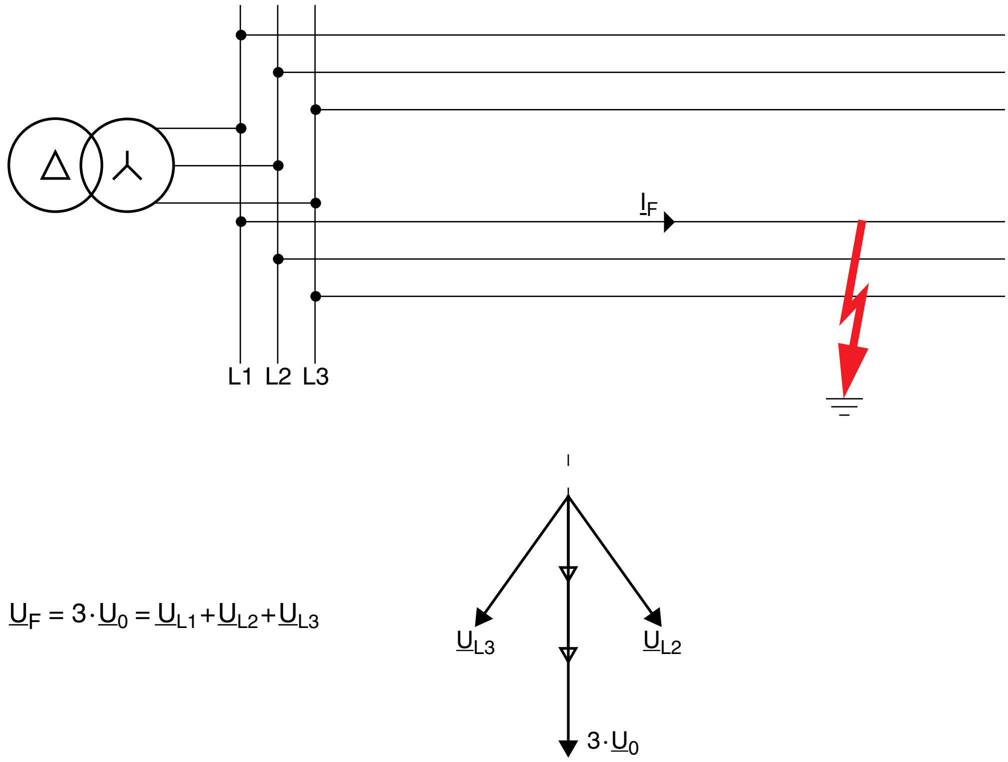


Figure 286: Measuring the displacement voltage with open delta winding

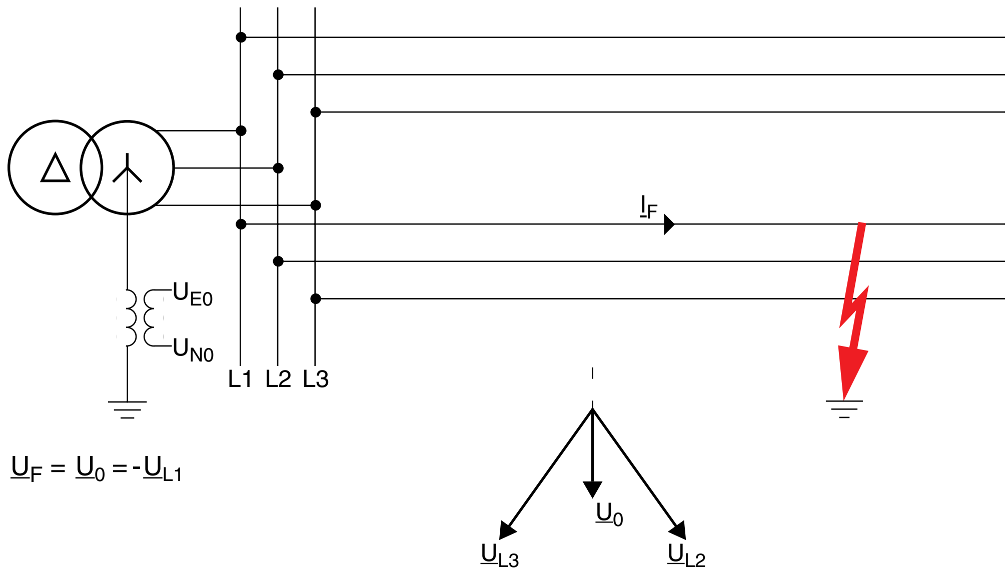


Figure 287: Measuring the displacement voltage in the transformer neutral

11.9 Setup example for motor protection

Known motor data/device data

The following values are used to calculated the straight motor protection functions.

Power P	1 700 kW
Rated motor current I_n	205 A
Ratio of motor starting current to rated motor current I_A / I_n	4.2
Maximum starting time t_E	18 s
Cooling time constant for the rotating machine t_A	30 min.
Cooling time constant for the stationary machine t_A	3 h
Rated c. t. current $I_{n,c.t.}$	250 A

The above information is generally known. All other required inputs in this example will be provided by the customer or will have to estimated.

Dependent thermal protection

↳Chapter "5.4.10.1 Thermal overload protection" on page 5-144

`T nom`	115°C	Operating temperature of the motor (value provided by customer)
`I nom`	205 A	Rated current of the motor
`T ini`	50%	Start temperature as percentage of the operating temperature (value provided by customer)
`TC Off`	3 h = 10 800 s	Cooling time constant of the stationary motor
`TC normal`	30 min = 1 800 s	Cooling time constant of the motor in standard operation
`TC error`	10 800 s	Cooling time constant of the motor while starting or malfunction (no value. This time constant is set to be equal to or greater than that of the stationary motor. This ensures that a premature trip does not occur in the event of a malfunction)
`T max`	125°C	Maximum allowable temperature of the motor (value provided by customer)
`T warn`	115°C	Motor temperature at which a warning signal should be generated (value provided by customer)
`T ambient`	30°C	Average ambient temperature at the motor installation location (value provided by customer)
`Time`	1 s	Delay period between reaching maximum temperature and tripping the protective function

Startup monitoring

↳Chapter "5.4.10.2 Motor start" on page 5-148

Motor current Ie	205 A / 250 A = 0,82	Rated motor current standardized to the rated c.t. current
Starting value	4.2	Motor starting current standardized to the rated motor current (response time)
Time	18 s = 18 000 ms	Delay period with detected motor start between reaching the start value and tripping the protective function.
Motor start IM / Ie	0.8	Standardized motor current assumed by the protective function by a starting procedure, value provided by customer

Monitoring on blocking rotor

The settings of the starting monitoring may be used. To enable fast tripping on blocking rotor it is important to monitor it with a tachogenerator or a speed switch.

Number of startups

↳Chapter "5.4.10.4 Number of starts" on page 5-155

No. of warm starts	2	Maximum allowable number of warm starts (no default. Value in accordance with IEC proposal)
No. of cold starts	3	Maximum allowable number of cold starts (no default. Value in accordance with IEC proposal)
Time	3 600 s	Reset period until the number of cold or warm starts is reduced by one and a new start attempt will be allowed.
Temperature for warm start	0.8	Standardized motor current assumed by the protective function by a starting procedure, value provided by customer

11.10 Diagrams of all function blocks

The following table shows diagrams of all function blocks. It includes references to the section (with page number) in which the function block is described.

Table 58: Diagrams of all function blocks

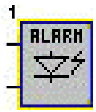
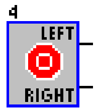
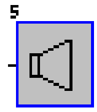
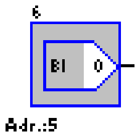
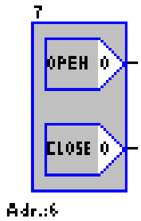
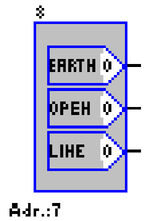
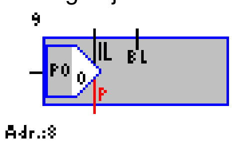
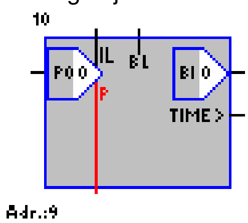
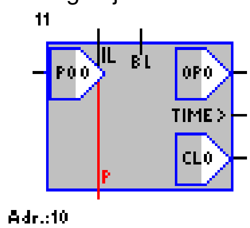
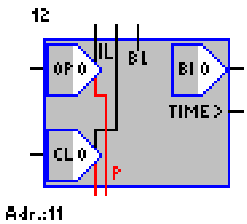
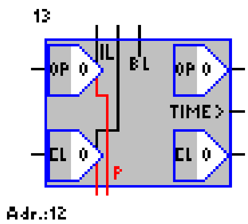
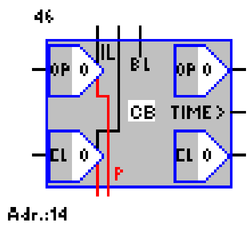
Signaling LED  Chapter 5.4.1.1 on page 5-21	Alarm LED  Chapter 5.4.1.2 on page 5-23	Alarm acknowledgement  Chapter 5.4.1.3 on page 5-24
Local-remote switchover  Chapter 5.4.1.4 on page 5-24	Danger-OFF switch  Chapter 5.4.1.5 on page 5-25	Buzzer  Chapter 5.4.1.6 on page 5-25
Switching object 0-1  Chapter 5.4.2.2 on page 5-31	Switching object 0-2  Chapter 5.4.2.3 on page 5-32	Switching object 0-3  Chapter 5.4.2.4 on page 5-34
Switching object 1-0  Chapter 5.4.2.5 on page 5-36	Switching object 1-1  Chapter 5.4.2.6 on page 5-38	Switching object 1-2  Chapter 5.4.2.7 on page 5-40
Switching object 2-1  Chapter 5.4.2.8 on page 5-43	Switching object 2-2  Chapter 5.4.2.9 on page 5-45	Switching object 2-2 as power circuit-breaker  Chapter 5.4.2.10 on page 5-48

Table 58: Diagrams of all function blocks

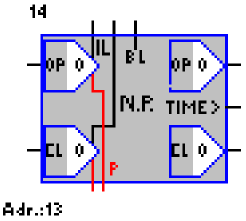
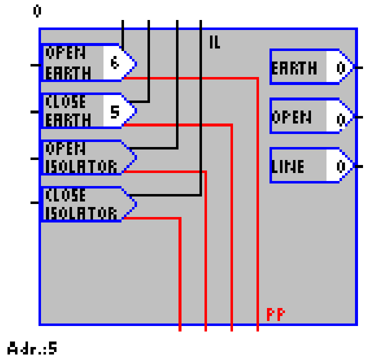
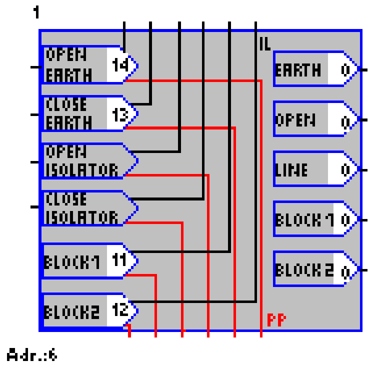
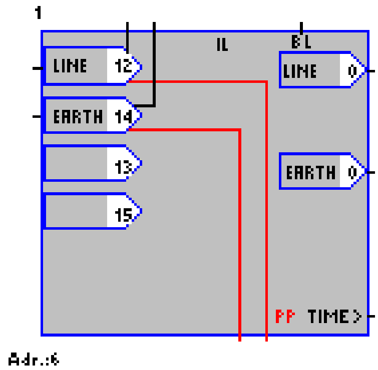
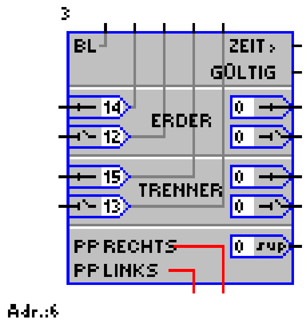
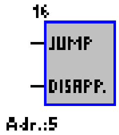
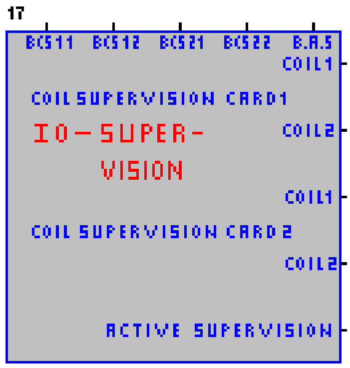
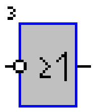
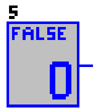
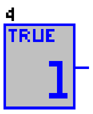
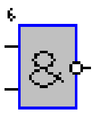
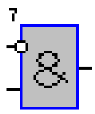
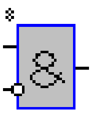
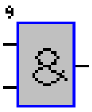
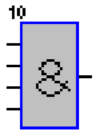
Switching object 2-2 with no power output  Chapter 5.4.2.11 on page 5-48	Switching object 4-3 motor  Chapter 5.4.2.12 on page 5-49	Switching object 6-5 magnet motor  Chapter 5.4.2.13 on page 5-52
Switching object 2-2 H bridge  Chapter 5.4.2.14 on page 5-56	Switching object 4-4 H bridge  Chapter 5.4.2.15 on page 5-59	Module for thrust  Chapter 5.4.2.16 on page 5-63
Trip circuit supervision  Chapter 5.4.2.17 on page 5-64	Inverter  Chapter 5.4.3.1 on page 5-66	Constant 0  Chapter 5.4.3.2 on page 5-66
Constant 1  Chapter 5.4.3.2 on page 5-66	AND logic gates with inverted output  Chapter 5.4.3.3 on page 5-67	AND logic gate with inverting input 1  Chapter 5.4.3.4 on page 5-67
AND logic gate with inverting input 2  Chapter 5.4.3.4 on page 5-67	AND logic gate with 2 inputs  Chapter 5.4.3.5 on page 5-68	AND logic gate with 4 inputs  Chapter 5.4.3.5 on page 5-68

Table 58: Diagrams of all function blocks

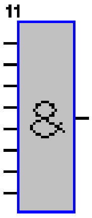
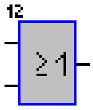
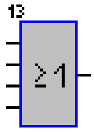
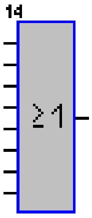
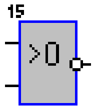
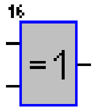
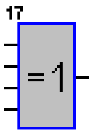
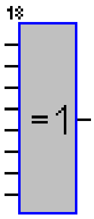
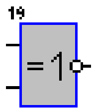
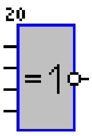
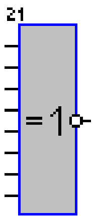
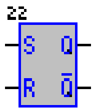
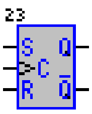
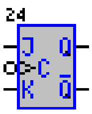
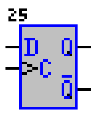
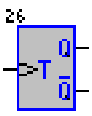
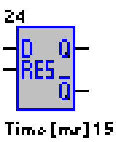
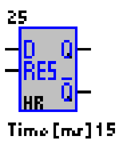
OR logic gate with 8 inputs  Chapter 5.4.3.5 on page 5-68	OR logic gate with 2 inputs  Chapter 5.4.3.6 on page 5-68	OR logic gate with 4 inputs  Chapter 5.4.3.6 on page 5-68
OR logic gate with 8 inputs  Chapter 5.4.3.6 on page 5-68	OR logic gates with inverting output  Chapter 5.4.3.7 on page 5-69	Exclusive OR logic gates with 2 inputs  Chapter 5.4.4.1 on page 5-70
Exclusive OR logic gates with 4 inputs  Chapter 5.4.4.1 on page 5-70	Exclusive OR logic gates with 8 inputs  Chapter 5.4.4.1 on page 5-70	Exclusive OR logic gate with 2 inputs and inverting output  Chapter 5.4.4.2 on page 5-70
Exclusive OR logic gate with 4 inputs and inverting output  Chapter 5.4.4.2 on page 5-70	Exclusive OR logic gate with 8 inputs and inverting output  Chapter 5.4.4.2 on page 5-70	RS flip-flop  Chapter 5.4.5.1 on page 5-72
RS flip-flop with timing input  Chapter 5.4.5.2 on page 5-73	J-K flip-flop  Chapter 5.4.5.3 on page 5-73	D flip-flop  Chapter 5.4.5.4 on page 5-74
T flip-flop  Chapter 5.4.5.5 on page 5-75	Monoflop retriggerable  Chapter 5.4.5.6 on page 5-75	Monoflop non-retriggerable  Chapter 5.4.5.7 on page 5-76

Table 58: Diagrams of all function blocks

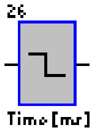
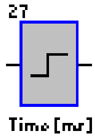
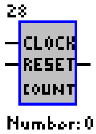
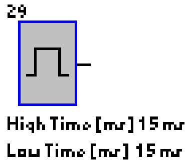
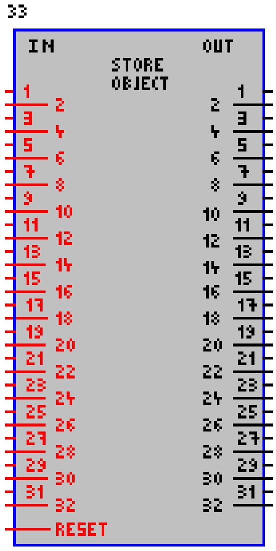
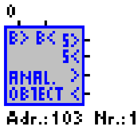
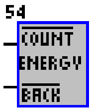
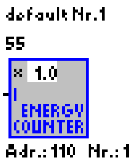
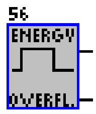
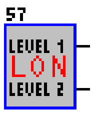
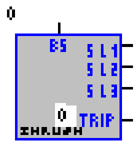
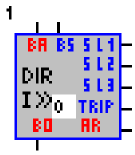
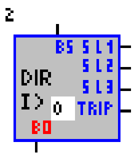
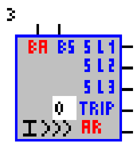
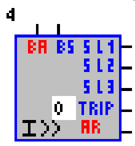
Slope delay falling  Chapter 5.4.5.8 on page 5-76	Slope delay rising  Chapter 5.4.5.8 on page 5-76	Counter  Chapter 5.4.5.9 on page 5-77
Pulse generator  Chapter 5.4.5.10 on page 5-78	Digital memory object  Chapter 5.4.5.11 on page 5-79	Threshold object  Chapter 5.4.6.1 on page 5-80
Energy management  Chapter 5.4.6.2 on page 5-82	Power counter  Chapter 5.4.6.3 on page 5-83	Energy impulse output  Chapter 5.4.6.4 on page 5-84
LON sensor  Chapter 5.4.6.5 on page 5-85	Inrush current blocking  Chapter 5.4.8.1 on page 5-91	Overcurrent directional high  Chapter 5.4.8.2 on page 5-97
Overcurrent directional low  Chapter 5.4.8.3 on page 5-100	Overcurrent instanteneous  Chapter 5.4.8.4 on page 5-102	Overcurrent high  Chapter 5.4.8.5 on page 5-105

Table 58: Diagrams of all function blocks

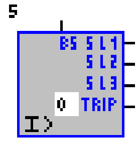
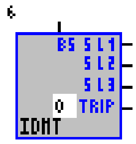
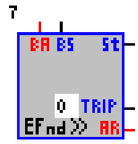
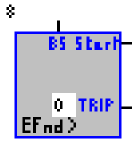
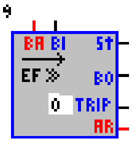
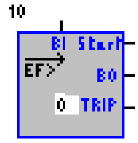
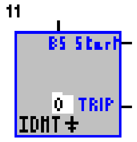
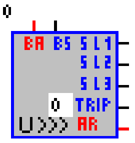
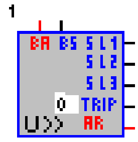
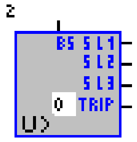
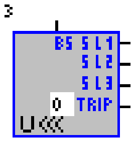
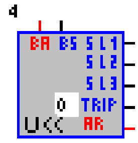
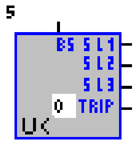
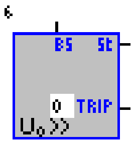
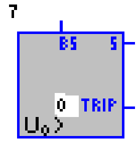
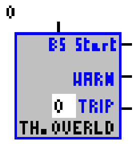
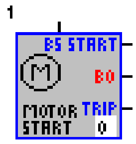
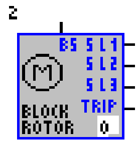
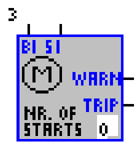
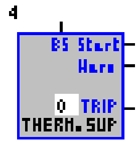
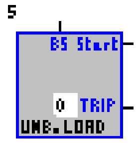
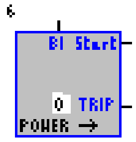
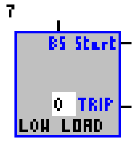
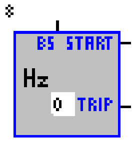
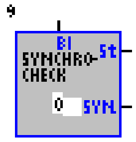
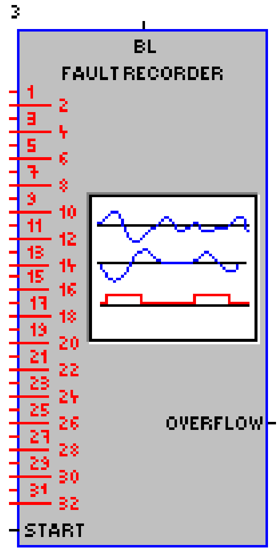
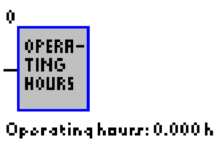
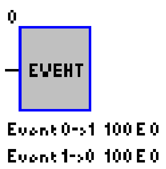
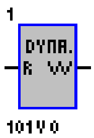
Overcurrent low  Chapter 5.4.8.6 on page 5-107	IDMT protection  Chapter 5.4.8.7 on page 5-109	Earthfault high  Chapter 5.4.8.8 on page 5-112
Earthfault low  Chapter 5.4.8.9 on page 5-114	Earthfault directional high  Chapter 5.4.8.10 on page 5-116	Earthfault directional low  Chapter 5.4.8.11 on page 5-120
Earthfault IDMT  Chapter 5.4.8.12 on page 5-122	Overvoltage instanteneous  Chapter 5.4.9.1 on page 5-126	Overvoltage high  Chapter 5.4.9.2 on page 5-128
Overvoltage low  Chapter 5.4.9.3 on page 5-130	Undervoltage instanteneous  Chapter 5.4.9.4 on page 5-132	Undervoltage high  Chapter 5.4.9.5 on page 5-135
Undervoltage low  Chapter 5.4.9.6 on page 5-137	Residual overvoltage high  Chapter 5.4.9.7 on page 5-139	Residual overvoltage low  Chapter 5.4.9.8 on page 5-141
Thermal overload  Chapter 5.4.10.1 on page 5-144	Motor start  Chapter 5.4.10.2 on page 5-148	Blocking rotor  Chapter 5.4.10.3 on page 5-152
Number of starts  Chapter 5.4.10.4 on page 5-155	Distance protection  Chapter 5.4.11 on page 5-158	Thermal supervision  Chapter 5.4.12.1 on page 5-186

Table 58: Diagrams of all function blocks

Unbalanced load  Chapter 5.4.12.2 on page 5-189	Directional power  Chapter 5.4.12.3 on page 5-192	Low load  Chapter 5.4.12.4 on page 5-194
Frequency supervision  Chapter 5.4.12.5 on page 5-197	Synchrocheck  Chapter 5.4.12.6 on page 5-199	Fault recorder  Chapter 5.4.13 on page 5-202
Operating hours counter  Chapter 5.4.14.1 on page 5-206	Message generator  Chapter 5.4.14.2 on page 5-207	Direct write-read command  Chapter 5.4.14.3 on page 5-208

11.11 SPA bus List

The following pages have the SPA bus list. It can be used to decode the data sent from the REF542.

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
						List of SPA Bus data												
T						Revision Index		J 24.11.97										
						Issued		Axel Hahn DEACE/EL										
						Checked												
						Authorised												
						Table of contents												
						" Version and project informations" on page 11-54												
						" Measurement values" on page 11-54												
						" Sensors 1,2,3" on page 11-54												
						" Sensors 4,5,6" on page 11-54												
						" Sensor 7" on page 11-54												
						" Calculated values" on page 11-55												
						" Maximum measured values" on page 11-55												
						" Synchrocheck dependent values" on page 11-55												
						" Energy pulse counter" on page 11-55												
						" Monitoring values" on page 11-55												
						" LCU" on page 11-55												
						" Binary inputs" on page 11-56												
						" Switch objects" on page 11-56												
						" Status input" on page 11-56												
						" Status output" on page 11-56												
						" Direct output write" on page 11-56												
						" Supervision" on page 11-56												
						" Event mask" on page 11-56												
						" Status object in the FUPLA" on page 11-57												
						" Resets" on page 11-57												
						" Analog objects" on page 11-57												
						" Over threshold" on page 11-57												
						" Under threshold" on page 11-57												
						" System parameters" on page 11-57												
						" Test mode" on page 11-57												
						" Interlocking" on page 11-58												
						" Sensor configuration" on page 11-58												
						" Net nominal values" on page 11-58												
						" System event mask" on page 11-58												
						" Data communication" on page 11-58												
						" Event list" on page 11-83												
						" SCU status" on page 11-83												
						" Protection function parameter" on page 11-59												
						" Current protection functions" on page 11-59												
						" Inrush blocking" on page 11-59		50										
						" Overcurrent instantaneous" on page 11-59		51										

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
						" Overcurrent definite time, high set" on page 11-60		52										
						" Overcurrent definite time, low set" on page 11-61		53										
						" Overcurrent directional, high set" on page 11-61		54										
						" Overcurrent directional, low set" on page 11-62		55										
						" Overcurrent IDMT normally inverse" on page 11-63		56										
						" Overcurrent IDMT Very inverse" on page 11-63		57										
						" Overcurrent IDMT Extremly inverse" on page 11-64		58										
						" Overcurrent IDMT Long-time inverse" on page 11-64		59										
						" Earthfault non-directional, high set" on page 11-65		66										
						" Earthfault non-directional, low set" on page 11-66		67										
						" Earthfault IDMT Normal Inverse" on page 11-66		68										
						" Earthfault IDMT Very Inverse" on page 11-66		69										
						" Earthfault IDMT Extremly Inverse" on page 11-67		70										
						" Earthfault IDMT Long time Inverse" on page 11-67		71										
						" Earthfault directional, high set" on page 11-68		72										
						" Earthfault directional, low set" on page 11-68		73										
						" Sensitive Earthfault directional" on page 11-69		88										
						" Voltage protection functions" on page 11-69												
						" Overvoltage instantaneous" on page 11-69		60										
						" Overvoltage definite time, high set" on page 11-70		61										
						" Overvoltage definite time, low set" on page 11-71		62										
						" Undervoltage instantaneous" on page 11-72		63										
						" Undervoltage definite time, high set" on page 11-72		64										
						" Undervoltage definite time, low set" on page 11-73		65										
						" Residual overvoltage definite time high" on page 11-73		82										
						" Residual overvoltage definite time low" on page 11-74		83										
						" Motor protection function" on page 11-74												
						" Thermal Overload" on page 11-74		74										
						" Motorstart protection" on page 11-75		80										
						" Blocked rotor protection" on page 11-75		86										
						" Number of Starts" on page 11-76		87										
						" Distance protection" on page 11-76												
						" Distance protection" on page 11-76		81										
						" Differential protection function" on page 11-79												
						" Differential protection function" on page 11-79		79										
						" Other protection function" on page 11-80												
						" Unbalanced load" on page 11-80		75										
						" Directional power protection" on page 11-81		76										
						" Low load protection" on page 11-81		77										
						" Thermal supervision" on page 11-81		78										
						" Frequency supervision" on page 11-82		84										
						" Synchro Check" on page 11-82		85										

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
I	2					**Version and project informations**												
D	2					Module type designation		0	F1	R	y					ISM SCU	ST	
D	2					Software version of controller		0	F2	R	y						ST	
D	2					Software version of DSP		0	F3	R	y						ST	
D	2					Software version of Fieldbus interface		0	F4	R	y						ST	
D	2					Hardware version		0	F5	R	y						ST	
D	2					Software version of config software		0	F6	R	y						ST	
D	2					Project name		0	F7	R	y						ST	
D	2					Date of configuration of protection functions		0	F8	R	y						ST	
D	2					Time of configuration of protection functions		0	F9	R	y						ST	
D	2					Date of configuration of FUPLA		0	F10	R	y						ST	
D	2					Time of configuration of FUPLA		0	F11	R	y						ST	
D	2					Name of project manager		0	F12	R	y						ST	
I	3					**Measurement values**												
I	3	1				Sensors 1,2,3												
D	3	1				Actual Current L1		1	I1	R	n				A		SL	/1000
D	3	1				Actual Current L2		1	I2	R	n				A		SL	/1000
D	3	1				Actual Current L3		1	I3	R	n				A		SL	/1000
D	3	1				Actual Voltage U1_2		1	I8	R	n				V		SL	/1000
D	3	1				Actual Voltage U2_3		1	I9	R	n				V		SL	/1000
D	3	1				Actual Voltage U3_1		1	I10	R	n				V		SL	/1000
D	3	1				Actual Voltage U1_N		1	I11	R	n				V		SL	/1000
D	3	1				Actual Voltage U2_N		1	I12	R	n				V		SL	/1000
D	3	1				Actual Voltage U3_N		1	I13	R	n				V		SL	/1000
D	3	1				Current L1, % of Inom		1	I41	R	n				%		SL	/1000
D	3	1				Current L2, % of Inom		1	I42	R	n				%		SL	/1000
D	3	1				Current L3, % of Inom		1	I43	R	n				%		SL	/1000
D	3	1				Voltage U1_2, % of Unom		1	I48	R	n				%		SL	/1000
D	3	1				Voltage U2_3, % of Unom		1	I49	R	n				%		SL	/1000
D	3	1				Voltage U3_1, % of Unom		1	I50	R	n				%		SL	/1000
D	3	1				Voltage U1_N, % of Unom		1	I51	R	n				%		SL	/1000
D	3	1				Voltage U2_N, % of Unom		1	I52	R	n				%		SL	/1000
D	3	1				Voltage U3_N, % of Unom		1	I53	R	n				%		SL	/1000
I	3	2				Sensors 4,5,6												
D	3	2				Actual Current L1		1	I4	R	n				A		SL	/1000
D	3	2				Actual Current L2		1	I5	R	n				A		SL	/1000
D	3	2				Actual Current L3		1	I6	R	n				A		SL	/1000
D	3	2				Actual Voltage U1_2		1	I15	R	n				V		SL	/1000
D	3	2				Actual Voltage U2_3		1	I16	R	n				V		SL	/1000
D	3	2				Actual Voltage U3_1		1	I17	R	n				V		SL	/1000
D	3	2				Actual Voltage U1_N		1	I18	R	n				V		SL	/1000
D	3	2				Actual Voltage U2_N		1	I19	R	n				V		SL	/1000
D	3	2				Actual Voltage U3_N		1	I20	R	n				V		SL	/1000
D	3	2				Current L1, % of Inom		1	I44	R	n				%		SL	/1000
D	3	2				Current L2, % of Inom		1	I45	R	n				%		SL	/1000
D	3	2				Current L3, % of Inom		1	I46	R	n				%		SL	/1000
D	3	2				Voltage U1_2, % of Unom		1	I55	R	n				%		SL	/1000
D	3	2				Voltage U2_3, % of Unom		1	I56	R	n				%		SL	/1000
D	3	2				Voltage U3_1, % of Unom		1	I57	R	n				%		SL	/1000
D	3	2				Voltage U1_N, % of Unom		1	I58	R	n				%		SL	/1000
D	3	2				Voltage U2_N, % of Unom		1	I59	R	n				%		SL	/1000
D	3	2				Voltage U3_N, % of Unom		1	I60	R	n				%		SL	/1000
I	3	3				Sensor 7												
D	3	3				Actual Current Io/ Voltage Uo (analog channel 7)		1	I7	R	n				V/A		SL	/1000
D	3	3				Actual Value Io_Uo, calculated, Set 1		1	I14	R	n				V/A		SL	/1000
D	3	3				Actual Value Io_Uo, calculated, Set 2		1	I21	R	n				V/A		SL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	3	3				Value Uo_Io , % of Io nom		1	I47	R	n				%		SL	/1000
D	3	3				Value Uo_Io, % of nom Set 1		1	I54	R	n				%		SL	/1000
D	3	3				Value Uo_Io, % of nom Set 2		1	I61	R	n				%		SL	/1000
I	3	4				Calculated values												
D	3	4				Frequency		1	I81	R	n				Hz		SL	/1000
D	3	4				Power factor cos(phi)		1	I82	R	n						SL	/1000
D	3	4				Active power		1	I83	R	n				kW		SL	/1000
D	3	4				Reactive Power		1	I84	R	n				kvar		SL	/1000
D	3	4				Apparent power		1	I85	R	n				kVA		SL	/1000
D	3	4				Io * sin (phi) or Io * cos(phi)		1	I86	R	n				A		SL	/1000
D	3	4				Real Energy		1	I87	R	PD				MWh		SL	/1000
D	3	4				Reactive Energy		1	I88	R	PD				Mvarh		SL	/1000
I	3	5				Maximum measured values												
D	3	5				Demand current L1		1	I89	R	n				A		SL	/1000
D	3	5				Demand current L2		1	I90	R	n				A		SL	/1000
D	3	5				Demand current L3		1	I91	R	n				A		SL	/1000
D	3	5				Maximal demand current L1		1	I92	R	PD				A		SL	/1000
D	3	5				Maximal demand current L2		1	I93	R	PD				A		SL	/1000
D	3	5				Maximal demand current L3		1	I94	R	PD				A		SL	/1000
I	3	6				Synchrocheck dependent values												
D	3	6				Delta Phase		1	I95	R	n				°		SL	/1000
D	3	6				Delta Voltage		1	I96	R	n				V		SL	/1000
D	3	6				Aktual Voltage between Sensor 3 and Sensor 7		1	I97	R	n				V		SL	/1000
D	3	6				Aktual Voltage between Sensor 6 and Sensor 7		1	I98	R	n				V		SL	/1000
I	3	7				Voltage Monitoring												
D	3	7				U1max L1-L2		1	I101	R	n				V		SL	/1000
D	3	7				U1max L2-L3		1	I102	R	n				V		SL	/1000
D	3	7				U1max L3-L1		1	I103	R	n				V		SL	/1000
D	3	7				U1min L1-L2		1	I104	R	n				V		SL	/1000
D	3	7				U1min L2-L3		1	I105	R	n				V		SL	/1000
D	3	7				U1min L3-L1		1	I106	R	n				V		SL	/1000
D	3	7				U2max L1-L2		1	I107	R	n				V		SL	/1000
D	3	7				U2max L2-L3		1	I108	R	n				V		SL	/1000
D	3	7				U2max L3-L1		1	I109	R	n				V		SL	/1000
D	3	7				U2min L1-L2		1	I110	R	n				V		SL	/1000
D	3	7				U2min L2-L3		1	I111	R	n				V		SL	/1000
D	3	7				U2min L3-L1		1	I112	R	n				V		SL	/1000
I	3	8				Energy pulse counter												
D	3	8				Actual value		110	V1..10	R/W	PD				MWh		SL	/1000
D	3	8				Energy per pulse		110	S1..10	R/W	y				kWh		SL	/1000
I	**4**					**Monitoring values**												
D	4					Circuit breaker contact wear CB		90	V100	R/W	PD					0=Reset	UL	/1000
D	4					Operating hours		90	V101	R	PD				h		UL	/1000
D	4					Added switched current of CB		90	V102	R/W	PD				A		UL	/1000
D	4					Coil continuity output 1, I/O card 1		90	V103	R	n	0	1	1		0=continuity; 1=no continuity alarm	US	
D	4					Coil continuity output 2, I/O card 1		90	V104	R	n	0	1	1		0=continuity; 1=no continuity alarm	US	
D	4					Coil continuity output 1, I/O card 2		90	V105	R	n	0	1	1		0=continuity; 1=no continuity alarm	US	
D	4					Coil continuity output 2, I/O card 2		90	V106	R	n	0	1	1		0=continuity; 1=no continuity alarm	US	
I	5					**LCU**												
D	5					Status LED 1(ALARM)	0=E7,1=E6	4	I1	R	n	0	3	1		0=black; 1=red	US	
D	5					Status LED 2 (interlocking)	2=E9,1=E8	4	I2	R	n	0	3	1		0=black; 1=red; 2=green	US	
D	5					Status LED 3..9		4	I3/9	R	n	0	3	1		0=black; 1=red; 2=green; 3=amber	US	
D	5					Status LED 10 (protection function)	0=E13,2=E10, 2=E14,3=E11, 3=E15,1=E12	4	I10	R	n	0	3	1		0=black; 1=red; 2=green; 3=amber	US	
D	5					Status of local/remote key switch	0=E29,1=E28	0	V6	R	n	0	1	1		0=local; 1=remote	US	

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	5					Status of operational/set key switch	0=E27,1=E26	0	V7	R	n	0	1	1		0=operational; 1=set	US	
I	6					**Binary inputs**												
I	6	1				Card 1												
D	6	1				Binary input status, 1 to 14, I/O card 1		2	I1/14	R	n	0	9	1		0=open status; 1=closed status; 9=not in use	US	
I	6	1				Card 2												
D	6	1				Binary input status, 15 to 28, I/O card 2		3	I1/14	R	n	0	9	1		0=open status; 1=closed status; 9=not in use	US	
I	7					**Switch objects**												
I	7	1				**Status input**												
I	7	1	1			Status 1 input												
D	7	1	1			Status of an object, 1 input	0=E1;1=E0	5..49,111...127	I4	R	n	0	1	1		0=false; 1=true	US	
I	7	1	2			Status 2 input												
D	7	1	2			Status of an object, 2 inputs	0=E0 ; 1=E2 ; 2=E1 ; 3=E4	5..49,111...127	I1	R	n	0	3	1		0=moving; 1=closed; 2=open; 3=error	US	
D	7	1	2			Closed status of an object 2 inputs		5..49,111...127	I2	R	n	0	1	1		0=not closed; 1=closed	US	
D	7	1	2			Open status of an object, 2 inputs		5..49,111...127	I3	R	n	0	1	1		0=not open; 1=open	US	
I	7	1	3			Status 3 input												
D	7	1	3			Status of an object, 3 inputs	0=E0;3=E1;2=E2; 1=E3;4=E4	5..49,111...127	I5	R	n	0	4	1		0=moving;1=on line;2=isolated;3=on earth;4=error	US	
D	7	1	3			Line status of an object, 3 inputs		5..49,111...127	I6	R	n	0	1	1		0=not on line; 1=on line	US	
D	7	1	3			Isolation/open status of an object, 3 inputs		5..49,111...127	I7	R	n	0	1	1		0=not isolated; 1=isolated	US	
D	7	1	3			Earth status of an object, 3 inputs		5..49,111...127	I8	R	n	0	1	1		0=not on earth; 1=on earth	US	
D	7	1	3			End not reached	1=E7 ; 0=E8	5..49,111...127	I9	R	n	0	1	1		0=nothing detected; 1=end not reached	US	
I	**7**	**2**				**Status output**												
D	7	2				Trip/Signal output status, output 1 of switching object		5..49,111...127	I51	R	n	0	9	1		0=open status;1=closed status; 9=not in use	US	
D	7	2				Trip/Signal output status, output 2 of switching object		5..49,111...127	I52	R	n	0	9	1		0=open status;1=closed status; 9=not in use	US	
I	7	3				**Direct output write**												
D	7	3				Write to one output object	0=E5;1=E6	5..49,111...127	O1	W	n	0	1	1		0=open it; 1=close it	US	
D	7	3				Write to two outputs object	0=E9;1=E10	5..49,111...127	O1	W	n	0	1	1		0=open it; 1=close it	US	
D	7	3				Write 4/3 or 6/5 outputs object Isolator		5..49,111...127	O2	W	n	0	1	1		0=goto earth; 1=goto line	US	
D	7	3				Write 4/3 or 6/5 outputs object Earthing switch		5..49,111...127	O3	W	n	0	1	1		0=goto line; 1=goto earth	US	
D	7	3				Direct signal output write 1 to 2		5..49,111...127	O1	W	n	0	1	1		0=not active; 1=active	US	
D	7	3				Direct signal output write 3 to 4		5..49,111...127	O1	W	n	0	1	1		0=not active; 1=active	US	
I	**7**	**3**				**Double command output write**												
D	7	3				Select	0=E21;1=E22	5..49,111...127	V1	R/W	n	0	1	1		0=is notselected;1=select it/is selected	US	
D	7	3				Write to one output object	1=E5	5..49,111...127	V2	W	n	1	1	1		1=switch it ON	US	
D	7	3				Write to one output object	1=E6	5..49,111...127	V3	W	n	1	1	1		1=switch it OFF	US	
D	7	3				Write to two output object	0=E9;1=E10	5..49,111...127	V2	W	n	1	1	1		1=close it	US	
D	7	3				Write to two output object	0=E5;1=E6	5..49,111...127	V3	W	n	1	1	1		1=open it	US	
D	7	3				Cancel select		5..49,111...127	V4	W	n	1	1	1		1=cancel select	US	
D	7	3				Interlocking Bypass (ATTENTION!! use it with great care!)	0=E23;1=E24	5..49,111...127	V7	R/W	n	0	1	1		0=is not activated;1=activate interlocking by-pass/is activated	US	
I	**7**	**4**				**Supervision**												
D	7	4				Number of cycles of switching object, SO22, CB		5..49,111...127	V100	R/W	n						US	
D	7	4				Opening time switching object SO22		5..49,111...127	V101	R	n						US	
D	7	4				Trip relays supervision, output 1 of switching object		5..49,111...127	V102	R	n	0	1	1		1=ok; 0=relay blocked alarm	US	
D	7	4				Trip relays supervision, output 2 of switching object		5..49,111...127	V103	R	n	0	1	1		1=ok; 0=relay blocked alarm	US	
D	7	4				Nr. of cycles isolator (SO43, SO65)		5..49,111...127	V104	R/W	PD						US	
D	7	4				Nr. of cycles earthing switch (SO43, SO65)		5..49,111...127	V105	R/W	PD						US	
I	**7**	**5**				**Event mask**												
D	7	5				Event 1 to 16		5..49,111...127	V21	R	y	0	65535	1			UL	/1000
D	7	5				Event 17 to 32		5..49,111...127	V22	R	y	0	65535	1			UL	/1000
I	**8**					**4-4 Switch object**												
I	**8**	**1**				**Status input**												

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data Dir	Save	Values Min	Max	Step	Unit	Single Values	Type	Factor
MicroSCADA key																		
D	8	1				Status of an object, 4 inputs		5..49,111...127	I10	R	n	0	4	1		0=moving;1=line closed;2=line open and earth open;3=earth closed;4=error	US	
D	8	1				Line status of an object, 4 inputs	0=E0;1=E1;2=E2;3=E4	5..49,111...127	I11	R	n	0	4	1		0=moving; 1= line closed; 2= line open; 3=error	US	
D	8	1				Earth status of an object, 4 inputs	0=E5;1=E6;2=E7;3=E8	5..49,111...127	I12	R	n	0	4	1		0=moving; 1= earth closed; 2= earth open; 3=error	US	
I	**8**	**2**				**Status output**												
D	8	2				Read Puls Pin Status		5..49,111...127	O4	R	n	0	4	1		0=no puls pin active; 1=puls right high2=puls pin left high	US	
D	8	2				Puls pin left 1->0	E9	5..49,111...127										
D	8	2				Puls pin left 0->1	E10	5..49,111...127										
D	8	2				Interlocking left	E11	5..49,111...127										
D	8	2				Blocking error left	E12	5..49,111...127										
D	8	2				Puls pin right 1->0	E13	5..49,111...127										
D	8	2				Puls pin right 0->1	E14	5..49,111...127										
D	8	2				Interlocking right	E15	5..49,111...127										
D	8	2				Blocking error right	E16	5..49,111...127										
D	8	2				Timeout reset	E21	5..49,111...127										
D	8	2				Timeout detected	E22	5..49,111...127										
I	8	3				**Direct output write**												
D	8	3				Write 4 outputs object Line		5..49,111...127	O2	W	n	0	1	1		0=open line; 1=close line	US	
D	8	3				Write 4 outputs object Earth		5..49,111...127	O3	W	n	0	1	1		0=open earth; 1=close earth	US	
I	8	4				**Supervision**												
D	8	4				Nr. of cycles Line		5..49,111...127	V104	R/W	n						US	
D	8	4				Nr. of cycles Earth		5..49,111...127	V105	R/W	n						US	
I	**8**	**5**				**Event mask**												
D	8	5				Event 1 to 16		5..49,111...127	V21	R	y	0	65535	1			UL	/1000
D	8	5				Event 17 to 32		5..49,111...127	V22	R	y	0	65535	1			UL	/1000
I	**9**					**Status object in the FUPLA**												
D	9					Direct write from SPABUS to FUPLA		101	O0..99	W	n	0	1	1		0=FALSE; 1=TRUE	US	
D	9					Status from FUPLA		101	I0..99	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	9					Multiple write to status object		101	V0..83	W	n	0	65535	1			US	
I	**10**					**Resets**												
D	10					Reset alarm		101	O100	W	n	1	1	0		1=reset alarm	US	
D	10					Reset maximum bar		101	O102	W	n	1	1	0		1=reset maximum bar	US	
D	10					Reset energy		101	O103	W	n	1	1	0		1=reset energy	US	
D	10					Reset switch cycles and added switch current CB		101	O104	W	n	1	1	0		1=reset CB values	US	
I	**11**					**Analog objects**												
I	11	1				Over threshold												
D	11	1				Threshold value		103..109	Sx1	R/W	y				In/Un		SL	/1000
D	11	1				Operational time		103..109	Sx2	R/W	y				s		SL	/1000
D	11	1				Block input		103..109	Ix1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	11	1				Start output		103..109	Ox1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	11	1				Trip output		103..109	Ox2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	11	2				Under threshold												
D	11	2				Threshold value		103..109	Sx3	R/W	y				In/Un		SL	/1000
D	11	2				Operational time		103..109	Sx4	R/W	y				s		SL	/1000
D	11	2				Block input		103..109	Ix2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	11	2				Start output		103..109	Ox3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	11	2				Trip output		103..109	Ox4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
						x : is the number of the analog object minus 1												
I	**12**					**System parameters**												
I	12	1				Test mode												
D	12	1				Status of test mode	0=E25;1=E24	0	V8	R	n	0	1	1		0=not in test mode; 1=in test mode	US	

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
I	12	2				Interlocking												
D	12	2				Interlocking status		0	V9	R	n	0	1	1		0=ok; 1=interlocking error	US	
I	12	3				Sensor configuration												
D	12	3				Sensor 1		0	V30	R	y	0	4	1		0=not used;1=Volt.Trans;2=Cur.Trans;3=Cur.Ro-go;4=Volt.Sen	US	
D	12	3				Sensor 2		0	V31	R	y	0	4	1		0=not used;1=Volt.Trans;2=Cur.Trans;3=Cur.Ro-go;4=Volt.Sen	US	
D	12	3				Sensor 3		0	V32	R	y	0	4	1		0=not used;1=Volt.Trans;2=Cur.Trans;3=Cur.Ro-go;4=Volt.Sen	US	
D	12	3				Sensor 4		0	V33	R	y	0	4	1		0=not used;1=Volt.Trans;2=Cur.Trans;3=Cur.Ro-go;4=Volt.Sen	US	
D	12	3				Sensor 5		0	V34	R	y	0	4	1		0=not used;1=Volt.Trans;2=Cur.Trans;3=Cur.Ro-go;4=Volt.Sen	US	
D	12	3				Sensor 6		0	V35	R	y	0	4	1		0=not used;1=Volt.Trans;2=Cur.Trans;3=Cur.Ro-go;4=Volt.Sen	US	
D	12	3				Sensor 7		0	V36	R	y	0	4	1		0=not used;1=Volt.Trans;2=Cur.Trans;3=Cur.Ro-go;4=Volt.Sen	US	
I	12	4				Net nominal values												
D	12	4				Sensor 1		0	V37	R	y	1 / 10	300k	1 / 10	A / V	not configured is replied with 0	SL	
D	12	4				Sensor 2		0	V38	R	y	1 / 10	300k	1 / 10	A / V	not configured is replied with 0	SL	
D	12	4				Sensor 3		0	V39	R	y	1 / 10	300k	1 / 10	A / V	not configured is replied with 0	SL	
						Sensor 4		0	V40	R	y	1 / 10	300k	1 / 10	A / V	not configured is replied with 0	SL	
						Sensor 5		0	V41	R	y	1 / 10	300k	1 / 10	A / V	not configured is replied with 0	SL	
						Sensor 6		0	V42	R	y	1 / 10	300k	1 / 10	A / V	not configured is replied with 0	SL	
						Sensor 7		0	V43	R	y	1 / 10	300k	1 / 10	A / V	not configured is replied with 0	SL	
D	12	4				Frequency		0	V25	R	y	50	60	10	Hz		SL	
I	12	5				System event mask												
D	12	5				Event 1 to 16		0	V21	R	y	0	65535	1			UL	/1000
D	12	5				Event 17 to 32		0	V22	R	y	0	65535	1			UL	/1000
D	12	5				Event 33 to 48		0	V23	R	y	0	65535	1			UL	/1000
D	12	5				Event 49 to 64		0	V24	R	y	0	65535	1			UL	/1000
I	12	6				Data communication												
D	12	6				Data communication address		0	V200	R/W	y	0	999	1		99=default	US	
D	12	6				Data transfer rate		0	V201	R	y	9600	9600	0		9600=fixed	UL	/1000
I	12	7				Events												
D	12	7				Reading of event registers		0	L	R	n							
D	12	7				Re-reading of event registers		0	B	R	n							
D	12	7				Event generation on/off	0=E1;1=E0	0	V52	R/W	y	0	1	1		0 = Event generation disable, 1 = Event gener. enable	US	
I	12	8				SCU mode												
D	12	8				Programm/run mode	0=E30;1=E31	0	S198	R/W	y	0	1	1		0=program mode; 1=run mode	US	
D	12	8				Data store into EEPROM	1=E32	0	V151	W	n	1	1	0		1=store and change to run mode	US	
						Faultrecorder												
						Start / end a session		0	V20	W		0	2	1		0=end session, 1=transfer uncompressed, transfer compressed		
						Read number of stored records		0	V20	R		0	9	1			US	
						Select a specific record		0	M28	W		1	9	1			US	
						Read directory info of selected record		0	M28	R								
						Read number of lines (each 64k) of selected record		0	M29	R		0	1023	1			US	

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data Dir	Save	Values Min	Max	Step	Unit	Single Values	Type	Factor
MicroSCADA key																		
						Read/Set line pointer of/to specific line to be tranfer-red next		0	M30	R/W		0	1023	1			US	
						Read one line of selected data		0	M31	R		0	1023	1		line pointer will be incremented automatically	US	
						Delete oldest record		0	V16	W		0	1	1		a sequence of 0 -> 1 is required to delete	US	
						Read recorder status		0	V16	R		0	2	1		0=recorder memory not full, ready to transfer data (if any present), 1=recorder memory full, ready to tranfer data, 2=recorder busy, rearran-ging data after delete.	US	
						Read/Set compression factor		0	V17	R/W		0	5	1	%	0=no compression, 1=1% compression, ...	US	
I	**1**					**Protection function parameter**												
I	**1**	**1**				**General protection parameter**												
D	1	1				Active parameter set	0=E3;1=E2	0	V150	R/W	y	0	1	1		0 = Set 1, 1 = Set 2	US	
D	1	1				AR general on/off	0=E5;1=E4	0	V51	R/W	y	0	1	1		0 = AR off, 1 = AR on	US	
I	**1**	**2**				**Current protection functions**												
I	**1**	**2**	**50**			**Inrush blocking**												
I	1	2	50	1		Parameter												
D	1	2	50	1		Max. current value n		50	S1	R/W	y	2	8	0.001			UL	/1000
D	1	2	50	1		Starting time		50	S2	R/W	y	0.2	100	0.001	s		UL	/1000
D	1	2	50	1		Activate value m		50	S3	R/W	y	3	4	0.001			UL	/1000
I	1	2	50	2		Measurments												
D	1	2	50	2		Value at tripping of function		50	V1	R	n						UL	/1000
D	1	2	50	2		Max. measured value		50	V2	R	n						UL	/1000
D	1	2	50	2		Number of trips		50	V3	R/W	n						UL	/1000
D	1	2	50	2		Number of startings phase L1		50	V4	R/W	n						UL	/1000
D	1	2	50	2		Number of startings phase L2		50	V5	R/W	n						UL	/1000
D	1	2	50	2		Number of startings phase L3		50	V6	R/W	n						UL	/1000
D	1	2	50	2		Duration of the latest starting situation phase L1		50	V7	R	n				ms		UL	/1000
D	1	2	50	2		Duration of the latest starting situation phase L2		50	V8	R	n				ms		UL	/1000
D	1	2	50	2		Duration of the latest starting situation phase L3		50	V9	R	n				ms		UL	/1000
I	1	2	50	3		Phases and event masks												
D	1	2	50	3		Phases used		50	V10	R	y						US	
D	1	2	50	3		Eventmask : Event 1 to 16		50	V11	R	y	0	65535	1			UL	/1000
D	1	2	50	3		Eventmask : Event 17 to 32		50	V12	R	y	0	65535	1			UL	/1000
I	1	2	50	4		Input/Output status												
D	1	2	50	4		Start output L1	0=E1;1=E0	50	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	50	4		Start output L2	0=E3;1=E2	50	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	50	4		Start output L3	0=E5;1=E4	50	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	50	4		Trip output	0=E7;1=E6	50	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	50	4		Blocked Trip	0=E13;1=E12	50	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	50	4		Block input	0=E19;1=E18	50	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	51			**Overcurrent instantaneous**												
I	1	2	51	1		Parameter												
I	1	2	51	1	2	Parameter set 1												
D	1	2	51	1	2	Overcurrent value Set 1		51	S1	R/W	y	0.1	40	0.001	In		UL	/1000
D	1	2	51	1	2	Overcurrent op. time Set 1		51	S2	R/W	y	0.02	30	0.001	s		UL	/1000
I	1	2	51	1	3	AR parameter set 1												
D	1	2	51	1	3	Number of AR shots Set 1	1=E11;2=E10	51	S3	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	2	51	1	3	Max. AR activate current Set 1 Set 1		51	S4	R/W	y	0.1	40	0.001	In		UL	/1000
D	1	2	51	1	3	AR shot starting time 1, Set 1		51	S5	R/W	y	0.02	30	0.001	s		UL	/1000
D	1	2	51	1	3	AR shot dead time 1, Set 1		51	S6	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	51	1	3	AR shot starting time 2, Set 1		51	S7	R/W	y	0.02	30	0.001	s		UL	/1000
D	1	2	51	1	3	AR shot dead time 2, Set 1		51	S8	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	51	1	3	AR reclaim time Set 1		51	S9	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	2	51	1	4	Parameter set 2												
D	1	2	51	1	4	Overcurrent value Set 2		51	S21	R/W	y	0.1	40	0.001	In		UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	2	51	1	4	Overcurrent op. time Set 2		51	S22	R/W	y	0.02	30	0.001	s		UL	/1000
I	1	2	51	1	5	AR parameter set 2												
D	1	2	51	1	5	Number of AR shots Set 2	1=E11;2=E10	51	S23	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	2	51	1	5	Max. AR activate current Set 2		51	S24	R/W	y	0.1	40	0.001	In		UL	/1000
D	1	2	51	1	5	AR shot starting time 1, Set 2		51	S25	R/W	y	0.02	30	0.001	s		UL	/1000
D	1	2	51	1	5	AR shot dead time 1, Set 2		51	S26	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	51	1	5	AR shot starting time 2, Set 2		51	S27	R/W	y	0.02	30	0.001	s		UL	/1000
D	1	2	51	1	5	AR shot dead time 2, Set 2		51	S28	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	51	1	5	AR reclaim time Set 2		51	S29	R/W	y	0.2	300	0.001	s		UL	/1000
	1	2	51	2		Measurements												
D	1	2	51	2		Value at tripping of function		51	V1	R	n						UL	/1000
D	1	2	51	2		Max. measured value		51	V2	R	n						UL	/1000
D	1	2	51	2		Number of trips		51	V3	R/W	n						UL	/1000
D	1	2	51	2		Number of startings phase L1		51	V4	R/W	n						UL	/1000
D	1	2	51	2		Number of startings phase L2		51	V5	R/W	n						UL	/1000
D	1	2	51	2		Number of startings phase L3		51	V6	R/W	n						UL	/1000
D	1	2	51	2		Duration of the latest starting situation phase L1		51	V7	R	n				ms		UL	/1000
D	1	2	51	2		Duration of the latest starting situation phase L2		51	V8	R	n				ms		UL	/1000
D	1	2	51	2		Duration of the latest starting situation phase L3		51	V9	R	n				ms		UL	/1000
	1	2	51	3		Phases and event masks												
D	1	2	51	3		Phases used		51	V10	R	y						US	
D	1	2	51	3		Eventmask : Event 1 to 16		51	V11	R	y	0	65535	1			UL	/1000
D	1	2	51	3		Eventmask : Event 17 to 32		51	V12	R	y	0	65535	1			UL	/1000
	1	2	51	4		Input/Output status												
D	1	2	51	4		Start output L1	0=E1;1=E0	51	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	51	4		Start output L2	0=E3;1=E2	51	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	51	4		Start output L3	0=E5;1=E4	51	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	51	4		Trip output	0=E7;1=E6	51	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	51	4		Blocked Trip	0=E13;1=E12	51	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	51	4		Block input	0=E19;1=E18	51	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	51	4		Block AR input	0=E21;1=E20	51	I4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	51	4		AR active	0=E9;1=E8	51	O10	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**2**	**52**			**Overcurrent definite time, high set**												
I	1	2	52	1		Parameter												
I	1	2	52	1	2	Parameter set 1												
D	1	2	52	1	2	Overcurrent value Set 1		52	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	52	1	2	Overcurrent op. time Set 1		52	S2	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	2	52	1	3	AR Parameter set 1												
D	1	2	52	1	3	Number of AR shots Set 1	1=E11;2=E10	52	S3	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	2	52	1	3	Max. AR activate current Set 1		52	S4	R/W	y	0.1	40	0.001	In		UL	/1000
D	1	2	52	1	3	AR shot starting time 1, Set 1		52	S5	R/W	y	0.05	300	0.001	s		UL	/1000
D	1	2	52	1	3	AR shot dead time 1, Set 1		52	S6	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	52	1	3	AR shot starting time 2, Set 1		52	S7	R/W	y	0.05	300	0.001	s		UL	/1000
D	1	2	52	1	3	AR shot dead time 2, Set 1		52	S8	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	52	1	3	AR reclaim time Set 1		52	S9	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	2	52	1	4	Parameter set 2												
D	1	2	52	1	4	Overcurrent value Set 2		52	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	52	1	4	Overcurrent op. time Set 2		52	S22	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	2	52	1	5	AR Parameter set 2												
D	1	2	52	1	5	Number of AR shots Set 2	1=E11;2=E10	52	S23	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	2	52	1	5	Max. AR activate current Set 2		52	S24	R/W	y	0.1	40	0.001	In		UL	/1000
D	1	2	52	1	5	AR shot starting time 1, Set 2		52	S25	R/W	y	0.05	300	0.001	s		UL	/1000
D	1	2	52	1	5	AR shot dead time 1, Set 2		52	S26	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	52	1	5	AR shot starting time 2, Set 2		52	S27	R/W	y	0.05	300	0.001	s		UL	/1000
D	1	2	52	1	5	AR shot dead time 2, Set 2		52	S28	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	52	1	5	AR reclaim time Set 2		52	S29	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	2	52	2		Measurments												

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data Dir	Save	Values Min	Max	Step	Unit	Single Values	Type	Factor
MicroSCADA key																		
D	1	2	52	2		Value at tripping of function		52	V1	R	n						UL	/1000
D	1	2	52	2		Max. measured value		52	V2	R	n						UL	/1000
D	1	2	52	2		Number of trips		52	V3	R/W	n						UL	/1000
D	1	2	52	2		Number of startings phase L1		52	V4	R/W	n						UL	/1000
D	1	2	52	2		Number of startings phase L2		52	V5	R/W	n						UL	/1000
D	1	2	52	2		Number of startings phase L3		52	V6	R/W	n						UL	/1000
D	1	2	52	2		Duration of the latest starting situation phase L1		52	V7	R	n				ms		UL	/1000
D	1	2	52	2		Duration of the latest starting situation phase L2		52	V8	R	n				ms		UL	/1000
D	1	2	52	2		Duration of the latest starting situation phase L3		52	V9	R	n				ms		UL	/1000
I	1	2	52	3		Phases and event masks												
D	1	2	52	3		Phases used		52	V10	R	y						US	
D	1	2	52	3		Eventmask : Event 1 to 16		52	V11	R	y	0	65535	1			UL	/1000
D	1	2	52	3		Eventmask : Event 17 to 32		52	V12	R	y	0	65535	1			UL	/1000
I	1	2	52	4		Input/Output status												
D	1	2	52	4		Start output L1	0=E1;1=E0	52	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	52	4		Start output L2	0=E3;1=E2	52	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	52	4		Start output L3	0=E5;1=E4	52	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	52	4		Trip output	0=E7;1=E6	52	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	52	4		Blocked Trip	0=E13;1=E12	52	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	52	4		Block input	0=E19;1=E18	52	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	52	4		Block AR input	0=E21;1=E20	52	I4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	52	4		AR active	0=E9;1=E8	52	O10	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	53			**Overcurrent definite time, low set**												
I	1	2	53	1		Parameter												
I	1	2	53	1	2	Parameter set 1												
D	1	2	53	1	2	Overcurrent value Set 1		53	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	53	1	2	Overcurrent op. time Set 1		53	S2	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	2	53	1	4	Parameter set 2												
D	1	2	53	1	4	Overcurrent value Set 2		53	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	53	1	4	Overcurrent op. time Set 2		53	S22	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	2	53	2		Measurments												
D	1	2	53	2		Value at tripping of function		53	V1	R	n						UL	/1000
D	1	2	53	2		Max. measured value		53	V2	R	n						UL	/1000
D	1	2	53	2		Number of trips		53	V3	R/W	n						UL	/1000
D	1	2	53	2		Number of startings phase L1		53	V4	R/W	n						UL	/1000
D	1	2	53	2		Number of startings phase L2		53	V5	R/W	n						UL	/1000
D	1	2	53	2		Number of startings phase L3		53	V6	R/W	n						UL	/1000
D	1	2	53	2		Duration of the latest starting situation phase L1		53	V7	R	n				ms		UL	/1000
D	1	2	53	2		Duration of the latest starting situation phase L2		53	V8	R	n				ms		UL	/1000
D	1	2	53	2		Duration of the latest starting situation phase L3		53	V9	R	n				ms		UL	/1000
I	1	2	53	3		Phases and event masks												
D	1	2	53	3		Phases used		53	V10	R	y						US	
D	1	2	53	3		Eventmask : Event 1 to 16		53	V11	R	y	0	65535	1			UL	/1000
D	1	2	53	3		Eventmask : Event 17 to 32		53	V12	R	y	0	65535	1			UL	/1000
I	1	2	53	4		Input/Output status												
D	1	2	53	4		Start output L1	0=E1;1=E0	53	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	53	4		Start output L2	0=E3;1=E2	53	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	53	4		Start output L3	0=E5;1=E4	53	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	53	4		Trip output	0=E7;1=E6	53	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	53	4		Blocked Trip	0=E13;1=E12	53	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	53	4		Block input	0=E19;1=E18	53	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	54			**Overcurrent directional, high set**												
I	1	2	54	1		Parameter												
I	1	2	54	1	2	Parameter set 1												
D	1	2	54	1	2	Overcurrent value Set 1		54	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	54	1	2	Overcurrent op. time Set 1		54	S2	R/W	y	0.02	300	0.001	s		UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
I	1	2	54	1	3	AR Parameter set 1												
D	1	2	54	1	3	Number of AR shots Set 1	1=E11;2=E10	54	S3	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	2	54	1	3	Max. AR activate current Set 1		54	S4	R/W	y	0.1	40	0.001	In		UL	/1000
D	1	2	54	1	3	AR shot starting time 1, Set 1		54	S5	R/W	y	0.05	300	0.001	s		UL	/1000
D	1	2	54	1	3	AR shot dead time 1, Set 1		54	S6	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	54	1	3	AR shot starting time 2, Set 1		54	S7	R/W	y	0.05	300	0.001	s		UL	/1000
D	1	2	54	1	3	AR shot dead time 2, Set 1		54	S8	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	54	1	3	AR reclaim time Set 1		54	S9	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	2	54	1	4	Parameter set 2												
D	1	2	54	1	4	Overcurrent value Set 2		54	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	54	1	4	Overcurrent op. time Set 2		54	S22	R/W	y	0.02	300	0.001	s		UL	/1000
D	1	2	54	1	4	Direction Set 1		54	S10	R/W	y	0	1	1		0=in front; 1=behind	UL	/1000
D	1	2	54	1	4	Direction Set 2		54	S30	R/W	y	0	1	1		0=in front; 1=behind	UL	/1000
I	1	2	54	1	5	AR Parameter set 2												
D	1	2	54	1	5	Number of AR shots Set 2	1=E11;2=E10	54	S23	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	2	54	1	5	Max. AR activate current Set 2		54	S24	R/W	y	0.1	40	0.001	In		UL	/1000
D	1	2	54	1	5	AR shot starting time 1, Set 2		54	S25	R/W	y	0.05	300	0.001	s		UL	/1000
D	1	2	54	1	5	AR shot dead time 1, Set 2		54	S26	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	54	1	5	AR shot starting time 2, Set 2		54	S27	R/W	y	0.05	300	0.001	s		UL	/1000
D	1	2	54	1	5	AR shot dead time 2, Set 2		54	S28	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	54	1	5	AR reclaim time Set 2		54	S29	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	2	54	2		Measurments												
D	1	2	54	2		Value at tripping of function		54	V1	R	n						UL	/1000
D	1	2	54	2		Max. measured value		54	V2	R	n						UL	/1000
D	1	2	54	2		Number of trips		54	V3	R/W	n						UL	/1000
D	1	2	54	2		Number of startings phase L1		54	V4	R/W	n						UL	/1000
D	1	2	54	2		Number of startings phase L2		54	V5	R/W	n						UL	/1000
D	1	2	54	2		Number of startings phase L3		54	V6	R/W	n						UL	/1000
D	1	2	54	2		Duration of the latest starting situation phase L1		54	V7	R	n				ms		UL	/1000
D	1	2	54	2		Duration of the latest starting situation phase L2		54	V8	R	n				ms		UL	/1000
D	1	2	54	2		Duration of the latest starting situation phase L3		54	V9	R	n				ms		UL	/1000
I	1	2	54	3		Phases and event masks												
D	1	2	54	3		Phases used		54	V10	R	y						US	
D	1	2	54	3		Eventmask : Event 1 to 16		54	V11	R	y	0	65535	1			UL	/1000
D	1	2	54	3		Eventmask : Event 17 to 32		54	V12	R	y	0	65535	1			UL	/1000
I	1	2	54	4		Input/Output status												
D	1	2	54	4		Start output L1	0=E1;1=E0	54	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	54	4		Start output L2	0=E3;1=E2	54	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	54	4		Start output L3	0=E5;1=E4	54	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	54	4		Trip output	0=E7;1=E6	54	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	54	4		Blocked Trip	0=E13;1=E12	54	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	54	4		Block input	0=E19;1=E18	54	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	54	4		Block AR input	0=E21;1=E20	54	I4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	54	4		AR active	0=E9;1=E8	54	O10	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	55			**Overcurrent directional, low set**												
I	1	2	55	1		Parameter												
I	1	2	55	1	2	Parameter set 1												
D	1	2	55	1	2	Overcurrent value Set 1		55	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	55	1	2	Overcurrent op. time Set 1		55	S2	R/W	y	0.02	300	0.001	s		UL	/1000
D	1	2	55	1	2	Direction Set 1		55	S3	R/W	y	0	1	1		0=in front; 1=behind	US	
I	1	2	55	1	4	Parameter set 2												
D	1	2	55	1	4	Overcurrent value Set 2		55	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	55	1	4	Overcurrent op. time Set 2		55	S22	R/W	y	0.02	300	0.001	s		UL	/1000
D	1	2	55	1	4	Direction Set 2		55	S23	R/W	y	0	1	1		0=in front; 1=behind	US	
I	1	2	55	2		Measurments												
D	1	2	55	2		Value at tripping of function		55	V1	R	n						UL	/1000
D	1	2	55	2		Max. measured value		55	V2	R	n						UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	2	55	2		Number of trips		55	V3	R/W	n						UL	/1000
D	1	2	55	2		Number of startings phase L1		55	V4	R/W	n						UL	/1000
D	1	2	55	2		Number of startings phase L2		55	V5	R/W	n						UL	/1000
D	1	2	55	2		Number of startings phase L3		55	V6	R/W	n						UL	/1000
D	1	2	55	2		Duration of the latest starting situation phase L1		55	V7	R	n				ms		UL	/1000
D	1	2	55	2		Duration of the latest starting situation phase L2		55	V8	R	n				ms		UL	/1000
D	1	2	55	2		Duration of the latest starting situation phase L3		55	V9	R	n				ms		UL	/1000
I	1	2	55	3		Phases and event masks												
D	1	2	55	3		Phases used		55	V10	R	y						US	
D	1	2	55	3		Eventmask : Event 1 to 16		55	V11	R	y	0	65535	1			UL	/1000
D	1	2	55	3		Eventmask : Event 17 to 32		55	V12	R	y	0	65535	1			UL	/1000
I	1	2	55	4		Input/Output status												
D	1	2	55	4		Start output L1	0=E1;1=E0	55	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	55	4		Start output L2	0=E3;1=E2	55	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	55	4		Start output L3	0=E5;1=E4	55	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	55	4		Trip output	0=E7;1=E6	55	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	55	4		Blocked Trip	0=E13;1=E12	55	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	55	4		Block input	0=E19;1=E18	55	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	56			**Overcurrent IDMT normally inverse**												
I	1	2	56	1		Parameter												
I	1	2	56	1	2	Parameter set 1												
D	1	2	56	1	2	Overcurrent value Set 1		56	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	56	1	2	Time multiplier Set 1		56	S2	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	56	1	4	Parameter set 1												
D	1	2	56	1	4	Overcurrent value Set 2		56	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	56	1	4	Time multiplier Set 2		56	S22	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	56	2		Measurments												
D	1	2	56	2		Value at tripping of function		56	V1	R	n						UL	/1000
D	1	2	56	2		Max. measured value		56	V2	R	n						UL	/1000
D	1	2	56	2		Number of trips		56	V3	R/W	n						UL	/1000
D	1	2	56	2		Number of startings phase L1		56	V4	R/W	n						UL	/1000
D	1	2	56	2		Number of startings phase L2		56	V5	R/W	n						UL	/1000
D	1	2	56	2		Number of startings phase L3		56	V6	R/W	n						UL	/1000
D	1	2	56	2		Duration of the latest starting situation phase L1		56	V7	R	n				ms		UL	/1000
D	1	2	56	2		Duration of the latest starting situation phase L2		56	V8	R	n				ms		UL	/1000
D	1	2	56	2		Duration of the latest starting situation phase L3		56	V9	R	n				ms		UL	/1000
I	1	2	56	3		Phases and event masks												
D	1	2	56	3		Phases used		56	V10	R	y						US	
D	1	2	56	3		Eventmask : Event 1 to 16		56	V11	R	y	0	65535	1			UL	/1000
D	1	2	56	3		Eventmask : Event 17 to 32		56	V12	R	y	0	65535	1			UL	/1000
I	1	2	56	4		Input/Output status												
D	1	2	56	4		Start output L1	0=E1;1=E0	56	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	56	4		Start output L2	0=E3;1=E2	56	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	56	4		Start output L3	0=E5;1=E4	56	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	56	4		Trip output	0=E7;1=E6	56	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	56	4		Blocked Trip	0=E13;1=E12	56	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	56	4		Block input	0=E19;1=E18	56	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	57			**Overcurrent IDMT Very inverse**												
I	1	2	57	1		Parameter												
I	1	2	57	1	2	Parameter set 1												
D	1	2	57	1	2	Overcurrent value Set 1		57	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	57	1	2	Time multiplier Set 1		57	S2	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	57	1	4	Parameter set 2												
D	1	2	57	1	4	Overcurrent value Set 2		57	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	57	1	4	Time multiplier Set 2		57	S22	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	57	2		Measurments												

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	2	57	2		Value at tripping of function		57	V1	R	n						UL	/1000
D	1	2	57	2		Max. measured value		57	V2	R	n						UL	/1000
D	1	2	57	2		Number of trips		57	V3	R/W	n						UL	/1000
D	1	2	57	2		Number of startings phase L1		57	V4	R/W	n						UL	/1000
D	1	2	57	2		Number of startings phase L2		57	V5	R/W	n						UL	/1000
D	1	2	57	2		Number of startings phase L3		57	V6	R/W	n						UL	/1000
D	1	2	57	2		Duration of the latest starting situation phase L1		57	V7	R	n				ms		UL	/1000
D	1	2	57	2		Duration of the latest starting situation phase L2		57	V8	R	n				ms		UL	/1000
D	1	2	57	2		Duration of the latest starting situation phase L3		57	V9	R	n				ms		UL	/1000
I	1	2	57	3		Phases and event masks												
D	1	2	57	3		Phases used		57	V10	R	y						US	
D	1	2	57	3		Eventmask : Event 1 to 16		57	V11	R	y	0	65535	1			UL	/1000
D	1	2	57	3		Eventmask : Event 17 to 32		57	V12	R	y	0	65535	1			UL	/1000
I	1	2	57	4		Input/Output status												
D	1	2	57	4		Start output L1	0=E1;1=E0	57	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	57	4		Start output L2	0=E3;1=E2	57	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	57	4		Start output L3	0=E5;1=E4	57	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	57	4		Trip output	0=E7;1=E6	57	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	57	4		Blocked Trip	0=E13;1=E12	57	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	57	4		Block input	0=E19;1=E18	57	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	58			**Overcurrent IDMT Extremly inverse**												
I	1	2	58	1		Parameter												
I	1	2	58	1	2	Parameter set 1												
D	1	2	58	1	2	Overcurrent value Set 1		58	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	58	1	2	Time multiplier Set 1		58	S2	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	58	1	4	Parameter set 2												
D	1	2	58	1	4	Overcurrent value Set 2		58	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	58	1	4	Time multiplier Set 2		58	S22	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	58	2		Measurments												
D	1	2	58	2		Value at tripping of function		58	V1	R	n						UL	/1000
D	1	2	58	2		Max. measured value		58	V2	R	n						UL	/1000
D	1	2	58	2		Number of trips		58	V3	R/W	n						UL	/1000
D	1	2	58	2		Number of startings phase L1		58	V4	R/W	n						UL	/1000
D	1	2	58	2		Number of startings phase L2		58	V5	R/W	n						UL	/1000
D	1	2	58	2		Number of startings phase L3		58	V6	R/W	n						UL	/1000
D	1	2	58	2		Duration of the latest starting situation phase L1		58	V7	R	n				ms		UL	/1000
D	1	2	58	2		Duration of the latest starting situation phase L2		58	V8	R	n				ms		UL	/1000
D	1	2	58	2		Duration of the latest starting situation phase L3		58	V9	R	n				ms		UL	/1000
I	1	2	58	3		Phases and event masks												
D	1	2	58	3		Phases used		58	V10	R	y						US	
D	1	2	58	3		Eventmask : Event 1 to 16		58	V11	R	y	0	65535	1			UL	/1000
D	1	2	58	3		Eventmask : Event 17 to 32		58	V12	R	y	0	65535	1			UL	/1000
I	1	2	58	4		Input/Output status												
D	1	2	58	4		Start output L1	0=E1;1=E0	58	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	58	4		Start output L2	0=E3;1=E2	58	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	58	4		Start output L3	0=E5;1=E4	58	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	58	4		Trip output	0=E7;1=E6	58	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	58	4		Blocked Trip	0=E13;1=E12	58	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	58	4		Block input	0=E19;1=E18	58	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	59			**Overcurrent IDMT Long-time inverse**												
I	1	2	59	1		Parameter												
I	1	2	59	1	2	Parameter set 1												
D	1	2	59	1	2	Overcurrent value Set 1		59	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	59	1	2	Time multiplier Set 1		59	S2	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	59	1	4	Parameter set 2												
D	1	2	59	1	4	Overcurrent value Set 2		59	S21	R/W	y	0.05	40	0.001	In		UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data Dir	Save	Values Min	Max	Step	Unit	Single Values	Type	Factor
MicroSCADA key																		
D	1	2	59	1	4	Time multiplier Set 2		59	S22	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	59	2		Measurments												
D	1	2	59	2		Value at tripping of function		59	V1	R	n						UL	/1000
D	1	2	59	2		Max. measured value		59	V2	R	n						UL	/1000
D	1	2	59	2		Number of trips		59	V3	R/W	n						UL	/1000
D	1	2	59	2		Number of startings phase L1		59	V4	R/W	n						UL	/1000
D	1	2	59	2		Number of startings phase L2		59	V5	R/W	n						UL	/1000
D	1	2	59	2		Number of startings phase L3		59	V6	R/W	n						UL	/1000
D	1	2	59	2		Duration of the latest starting situation phase L1		59	V7	R	n				ms		UL	/1000
D	1	2	59	2		Duration of the latest starting situation phase L2		59	V8	R	n				ms		UL	/1000
D	1	2	59	2		Duration of the latest starting situation phase L3		59	V9	R	n				ms		UL	/1000
I	1	2	59	3		Phases and event masks												
D	1	2	59	3		Phases used		59	V10	R	y						US	
D	1	2	59	3		Eventmask : Event 1 to 16		59	V11	R	y	0	65535	1			UL	/1000
D	1	2	59	3		Eventmask : Event 17 to 32		59	V12	R	y	0	65535	1			UL	/1000
I	1	2	59	4		Input/Output status												
D	1	2	59	4		Start output L1	0=E1;1=E0	59	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	59	4		Start output L2	0=E3;1=E2	59	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	59	4		Start output L3	0=E5;1=E4	59	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	59	4		Trip output	0=E7;1=E6	59	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	59	4		Blocked Trip	0=E13;1=E12	59	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	59	4		Block input	0=E19;1=E18	59	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	66			**Earthfault non-directional, high set**												
I	1	2	66	1		Parameter												
I	1	2	66	1	2	Parameter set 1												
D	1	2	66	1	2	Earthfault current value Set 1		66	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	66	1	2	Earthfault op. time Set 1		66	S2	R/W	y	0.05	100	0.001	s		UL	/1000
I	1	2	66	1	3	AR Parameter set 1												
D	1	2	66	1	3	Number of AR shots Set 1	1=E11;2=E10	66	S3	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	2	66	1	3	Max. AR activate current Set 1		66	S4	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	66	1	3	AR shot starting time 1, Set 1		66	S5	R/W	y	0.1	100	0.001	s		UL	/1000
D	1	2	66	1	3	AR shot dead time 1, Set 1		66	S6	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	66	1	3	AR shot starting time 2, Set 1		66	S7	R/W	y	0.1	100	0.001	s		UL	/1000
D	1	2	66	1	3	AR shot dead time 2, Set 1		66	S8	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	66	1	3	AR reclaim time Set 1		66	S9	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	2	66	1	4	Parameter set 2												
D	1	2	66	1	4	Earthfault current value Set 2		66	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	66	1	4	Earthfault op. time Set 2		66	S22	R/W	y	0.05	100	0.001	s		UL	/1000
I	1	2	66	1	5	AR Parameter set 2												
D	1	2	66	1	5	Number of AR shots Set 2	1=E11;2=E10	66	S23	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	2	66	1	5	Max. AR activate current Set 2		66	S24	R/W	y	0.05	40	0.01	In		UL	/1000
D	1	2	66	1	5	AR shot starting time 1, Set 2		66	S25	R/W	y	0.1	100	0.001	s		UL	/1000
D	1	2	66	1	5	AR shot dead time 1, Set 2		66	S26	R/W	y	0.2	300	0.01	s		UL	/1000
D	1	2	66	1	5	AR shot starting time 2, Set 2		66	S27	R/W	y	0.1	100	0.001	s		UL	/1000
D	1	2	66	1	5	AR shot dead time 2, Set 2		66	S28	R/W	y	0.2	300	0.01	s		UL	/1000
D	1	2	66	1	5	AR reclaim time Set 2		66	S29	R/W	y	0.2	300	0.01	s		UL	/1000
I	1	2	66	2		Measurments												
D	1	2	66	2		Value at tripping of function		66	V1	R	n						UL	/1000
D	1	2	66	2		Max. measured value		66	V2	R	n						UL	/1000
D	1	2	66	2		Number of trips		66	V3	R/W	n						UL	/1000
D	1	2	66	2		Number of startings phase		66	V4	R/W	n						UL	/1000
D	1	2	66	2		Duration of the latest starting situation		66	V7	R	n				ms		UL	/1000
I	1	2	66	3		Phases and event masks												
D	1	2	66	3		Phases used		66	V10	R	y						US	
D	1	2	66	3		Eventmask : Event 1 to 16		66	V11	R	y	0	65535	1			UL	/1000
D	1	2	66	3		Eventmask : Event 17 to 32		66	V12	R	y	0	65535	1			UL	/1000
I	1	2	66	4		Input/Output status												

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	2	66	4		Start output	0=E1;1=E0	66	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	66	4		Trip output	0=E7;1=E6	66	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	66	4		Blocked Trip	0=E13;1=E12	66	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	66	4		Block input	0=E19;1=E18	66	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	66	4		Block AR input	0=E21;1=E20	66	I4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	66	4		AR active	0=E9;1=E8	66	O10	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	67			**Earthfault non-directional, low set**												
I	1	2	67	1		Parameter												
I	1	2	67	1	2	Parameter set 1												
D	1	2	67	1	2	Earthfault current value Set 1		67	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	67	1	2	Earthfault op. time Set 1		67	S2	R/W	y	0.05	100	0.001	s		UL	/1000
I	1	2	67	1	4	Parameter set 2												
D	1	2	67	1	4	Earthfault current value Set 2		67	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	67	1	4	Earthfault op. time Set 2		67	S22	R/W	y	0.05	100	0.001	s		UL	/1000
I	1	2	67	2		Measurments												
D	1	2	67	2		Value at tripping of function		67	V1	R	n						UL	/1000
D	1	2	67	2		Max. measured value		67	V2	R	n						UL	/1000
D	1	2	67	2		Number of trips		67	V3	R/W	n						UL	/1000
D	1	2	67	2		Number of startings phase		67	V4	R/W	n						UL	/1000
D	1	2	67	2		Duration of the latest starting situation		67	V7	R	n				ms		UL	/1000
I	1	2	67	3		Phases and event masks												
D	1	2	67	3		Phases used		67	V10	R	y						US	
D	1	2	67	3		Eventmask : Event 1 to 16		67	V11	R	y	0	65535	1			UL	/1000
D	1	2	67	3		Eventmask : Event 17 to 32		67	V12	R	y	0	65535	1			UL	/1000
I	1	2	67	4		Input/Output status												
D	1	2	67	4		Start output	0=E1;1=E0	67	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	67	4		Trip output	0=E7;1=E6	67	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	67	4		Blocked Trip	0=E13;1=E12	67	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	67	4		Block input	0=E19;1=E18	67	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	68			**Earthfault IDMT Normal Inverse**												
I	1	2	68	1		Parameter												
I	1	2	68	1	2	Parameter set 1												
D	1	2	68	1	2	Earthfault current value Set 1		68	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	68	1	2	Time multiplier Set 1		68	S2	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	68	1	4	Parameter set 2												
D	1	2	68	1	4	Earthfault current value Set 2		68	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	68	1	4	Time multiplier Set 2		68	S22	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	68	2		Measurments												
D	1	2	68	2		Value at tripping of function		68	V1	R	n						UL	/1000
D	1	2	68	2		Max. measured value		68	V2	R	n						UL	/1000
D	1	2	68	2		Number of trips		68	V3	R/W	n						UL	/1000
D	1	2	68	2		Number of startings phase		68	V4	R/W	n						UL	/1000
D	1	2	68	2		Duration of the latest starting situation		68	V7	R	n				ms		UL	/1000
I	1	2	68	3		Phases and event masks												
D	1	2	68	3		Phases used		68	V10	R	y						US	
D	1	2	68	3		Eventmask : Event 1 to 16		68	V11	R	y	0	65535	1			UL	/1000
D	1	2	68	3		Eventmask : Event 17 to 32		68	V12	R	y	0	65535	1			UL	/1000
I	1	2	68	4		Input/Output status												
D	1	2	68	4		Start output	0=E1;1=E0	68	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	68	4		Trip output	0=E7;1=E6	68	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	68	4		Blocked Trip	0=E13;1=E12	68	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	68	4		Block input	0=E19;1=E18	68	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	69			**Earthfault IDMT Very Inverse**												
I	1	2	69	1		Parameter												
I	1	2	69	1	2	Parameter set 1												
D	1	2	69	1	2	Earthfault current value Set 1		69	S1	R/W	y	0.05	40	0.001	In		UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	2	69	1	2	Time multiplier Set 1		69	S2	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	69	1	4	Parameter set 2												
D	1	2	69	1	4	Earthfault current value Set 2		69	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	69	1	4	Time multiplier Set 2		69	S22	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	69	2		Measurments												
D	1	2	69	2		Value at tripping of function		69	V1	R	n						UL	/1000
D	1	2	69	2		Max. measured value		69	V2	R	n						UL	/1000
D	1	2	69	2		Number of trips		69	V3	R/W	n						UL	/1000
D	1	2	69	2		Number of startings phase		69	V4	R/W	n						UL	/1000
D	1	2	69	2		Duration of the latest starting situation		69	V7	R	n				ms		UL	/1000
I	1	2	69	3		Phases and event masks												
D	1	2	69	3		Phases used		69	V10	R	y						US	
D	1	2	69	3		Eventmask : Event 1 to 16		69	V11	R	y	0	65535	1			UL	/1000
D	1	2	69	3		Eventmask : Event 17 to 32		69	V12	R	y	0	65535	1			UL	/1000
I	1	2	69	4		Input/Output status												
D	1	2	69	4		Start output	0=E1;1=E0	69	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	69	4		Trip output	0=E7;1=E6	69	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	69	4		Blocked Trip	0=E13;1=E12	69	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	69	4		Block input	0=E19;1=E18	69	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	70			**Earthfault IDMT Extremly Inverse**												
I	1	2	70	1		Parameter												
I	1	2	70	1	2	Parameter set 1												
D	1	2	70	1	2	Earthfault current value Set 1		70	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	70	1	2	Time multiplier Set 1		70	S2	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	70	1	4	Parameter set 2												
D	1	2	70	1	4	Earthfault current value Set 2		70	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	70	1	4	Time multiplier Set 2		70	S22	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	70	2		Measurments												
D	1	2	70	2		Value at tripping of function		70	V1	R	n						UL	/1000
D	1	2	70	2		Max. measured value		70	V2	R	n						UL	/1000
D	1	2	70	2		Number of trips		70	V3	R/W	n						UL	/1000
D	1	2	70	2		Number of startings phase		70	V4	R/W	n						UL	/1000
D	1	2	70	2		Duration of the latest starting situation		70	V7	R	n				ms		UL	/1000
I	1	2	70	3		Phases and event masks												
D	1	2	70	3		Phases used		70	V10	R	y						US	
D	1	2	70	3		Eventmask : Event 1 to 16		70	V11	R	y	0	65535	1			UL	/1000
D	1	2	70	3		Eventmask : Event 17 to 32		70	V12	R	y	0	65535	1			UL	/1000
I	1	2	70	4		Input/Output status												
D	1	2	70	4		Start output	0=E1;1=E0	70	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	70	4		Trip output	0=E7;1=E6	70	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	70	4		Blocked Trip	0=E13;1=E12	70	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	70	4		Block input	0=E19;1=E18	70	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	71			**Earthfault IDMT Long time Inverse**												
I	1	2	71	1		Parameter												
I	1	2	71	1	2	Parameter set 1												
D	1	2	71	1	2	Earthfault current value Set 1		71	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	71	1	2	Time multiplier Set 1		71	S2	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	71	1	4	Parameter set 2												
D	1	2	71	1	4	Earthfault current value Set 2		71	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	71	1	4	Time multiplier Set 2		71	S22	R/W	y	0.05	1	0.001	s		UL	/1000
I	1	2	71	2		Measurments												
D	1	2	71	2		Value at tripping of function		71	V1	R	n						UL	/1000
D	1	2	71	2		Max. measured value		71	V2	R	n						UL	/1000
D	1	2	71	2		Number of trips		71	V3	R/W	n						UL	/1000
D	1	2	71	2		Number of startings phase		71	V4	R/W	n						UL	/1000
D	1	2	71	2		Duration of the latest starting situation		71	V7	R	n				ms		UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
I	1	2	71	3		Phases and event masks												
D	1	2	71	3		Phases used		71	V10	R	y						US	
D	1	2	71	3		Eventmask : Event 1 to 16		71	V11	R	y	0	65535	1			UL	/1000
D	1	2	71	3		Eventmask : Event 17 to 32		71	V12	R	y	0	65535	1			UL	/1000
I	1	2	71	4		Input/Output status												
D	1	2	71	4		Start output	0=E1;1=E0	71	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	71	4		Trip output	0=E7;1=E6	71	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	71	4		Blocked Trip	0=E13;1=E12	71	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	71	4		Block input	0=E19;1=E18	71	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	2	72			**Earthfault directional, high set**												
I	1	2	72	1		Parameter												
I	1	2	72	1	1	general Parameter												
D	1	2	72	1	1	Net-earthtype		72	S11	R/W	y	0	1	1		0=sin phi (isolated); 1=cos phi (earthed)	US	
I	1	2	72	1	2	Parameter set 1												
D	1	2	72	1	2	Earthfault current value Set 1		72	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	72	1	2	Earthfault op. time Set 1		72	S2	R/W	y	0.05	100	0.001	s		UL	/1000
D	1	2	72	1	2	Direction Set 1		72	S10	R/W	y	0	1	1		0=in front; 1=behind	US	
I	1	2	72	1	3	AR Parameter set 1												
D	1	2	72	1	3	Number of AR shots Set 1	1=E11;2=E10	72	S3	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	2	72	1	3	Max. AR activate current Set 1		72	S4	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	72	1	3	AR shot starting time 1, Set 1		72	S5	R/W	y	0.1	100	0.001	s		UL	/1000
D	1	2	72	1	3	AR shot dead time 1, Set 1		72	S6	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	72	1	3	AR shot starting time 2, Set 1		72	S7	R/W	y	0.1	100	0.001	s		UL	/1000
D	1	2	72	1	3	AR shot dead time 2, Set 1		72	S8	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	72	1	3	AR reclaim time Set 1		72	S9	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	2	72	1	4	Parameter set 2												
D	1	2	72	1	4	Earthfault current value Set 2		72	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	72	1	4	Earthfault op. time Set 2		72	S22	R/W	y	0.05	100	0.001	s		UL	/1000
D	1	2	72	1	4	Direction Set 2		72	S30	R/W	y	0	1	1		0=in front; 1=behind	US	
I	1	2	72	1	5	AR Parameter set 2												
D	1	2	72	1	5	Number of AR shots Set 2	1=E11;2=E10	72	S23	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	2	72	1	5	Max. AR activate current Set 2		72	S24	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	72	1	5	AR shot starting time 1, Set 2		72	S25	R/W	y	0.1	100	0.001	s		UL	/1000
D	1	2	72	1	5	AR shot dead time 1, Set 2		72	S26	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	72	1	5	AR shot starting time 2, Set 2		72	S27	R/W	y	0.1	100	0.001	s		UL	/1000
D	1	2	72	1	5	AR shot dead time 2, Set 2		72	S28	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	2	72	1	5	AR reclaim time Set 2		72	S29	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	2	72	2		Measurments												
D	1	2	72	2		Value at tripping of function		72	V1	R	n						UL	/1000
D	1	2	72	2		Max. measured value		72	V2	R	n						UL	/1000
D	1	2	72	2		Number of trips		72	V3	R/W	n						UL	/1000
D	1	2	72	2		Number of startings phase		72	V4	R/W	n						UL	/1000
D	1	2	72	2		Duration of the latest starting situation		72	V7	R	n				ms		UL	/1000
I	1	2	72	3		Phases and event masks												
D	1	2	72	3		Phases used		72	V10	R	y						US	
D	1	2	72	3		Eventmask : Event 1 to 16		72	V11	R	y	0	65535	1			UL	/1000
D	1	2	72	3		Eventmask : Event 17 to 32		72	V12	R	y	0	65535	1			UL	/1000
I	1	2	72	4		Input/Output status												
D	1	2	72	4		Start output	0=E1;1=E0	72	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	72	4		Trip output	0=E7;1=E6	72	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	72	4		Blocked Trip	0=E13;1=E12	72	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	72	4		Block input	0=E19;1=E18	72	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	72	4		Block AR input	0=E21;1=E20	72	I4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	72	4		AR active	0=E9;1=E8	72	O10	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**2**	**73**			**Earthfault directional, low set**												
I	1	2	73	1		Parameter												

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
I	1	2	73	1	2	Parameter set 1												
D	1	2	73	1	2	Earthfault current value Set 1		73	S1	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	73	1	2	Earthfault op. time Set 1		73	S2	R/W	y	0.05	100	0.001	s		UL	/1000
D	1	2	73	1	2	Direction Set 1		73	S3	R/W	y	0	1	1		0=sin phi (isolated); 1=cos phi (earthed)	US	
D	1	2	73	1	2	Net-earthtype Set 1		73	S4	R/W	y	0	1	1		0=in front; 1=behind	US	
	1	2	73	1	4	Parameter set 2												
D	1	2	73	1	4	Earthfault current value Set 2		73	S21	R/W	y	0.05	40	0.001	In		UL	/1000
D	1	2	73	1	4	Earthfault op. time Set 2		73	S22	R/W	y	0.05	100	0.001	s		UL	/1000
D	1	2	73	1	4	Direction Set 2		73	S23	R/W	y	0	1	1		0=sin phi (isolated); 1=cos phi (earthed)	US	
D	1	2	73	1	4	Net-earthtype Set 2		73	S24	R/W	y	0	1	1		0=in front; 1=behind	US	
I	1	2	73	2		Measurments												
D	1	2	73	2		Value at tripping of function		73	V1	R	n						UL	/1000
D	1	2	73	2		Max. measured value		73	V2	R	n						UL	/1000
D	1	2	73	2		Number of trips		73	V3	R/W	n						UL	/1000
D	1	2	73	2		Number of startings phase		73	V4	R/W	n						UL	/1000
D	1	2	73	2		Duration of the latest starting situation		73	V7	R	n				ms		UL	/1000
I	1	2	73	3		Phases and event masks												
D	1	2	73	3		Phases used		73	V10	R	y						US	
D	1	2	73	3		Eventmask : Event 1 to 16		73	V11	R	y	0	65535	1			UL	/1000
D	1	2	73	3		Eventmask : Event 17 to 32		73	V12	R	y	0	65535	1			UL	/1000
I	1	2	73	4		Input/Output status												
D	1	2	73	4		Start output	0=E1;1=E0	73	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	73	4		Trip output	0=E7;1=E6	73	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	73	4		Blocked Trip	0=E13;1=E12	73	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	73	4		Block input	0=E19;1=E18	73	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**2**	**88**			**Sensitive Earthfault directional**												
I	1	2	88	1		Parameter												
I	1	2	88	1	2	Parameter set 1												
D	1	2	88	1	2	Earthfault current value Set 1		88	S1	R/W	y	0.05	2	0.001	In0		UL	/1000
D	1	2	88	1	2	Earthfault op. time Set 1		88	S2	R/W	y	0.1	10	0.001	s		UL	/1000
D	1	2	88	1	2	Opening angle alpha		88	S3	R/W	y	0	20	0.001	°		UL	/1000
D	1	2	88	1	2	Residual Voltage		88	S4	R/W	y	0.1	0.7	0.001	Un		UL	/1000
D	1	2	88	1	2	Nettype/Direction/Phasecorrection		88	S5	R/W	y	-180	180	0.01	°		SL	/1000
	1	2	88	1	4	Parameter set 2		88										
D	1	2	88	1	4	Earthfault current value Set 1		88	S21	R/W	y	0.05	2	0.001	In0		UL	/1000
D	1	2	88	1	4	Earthfault op. time Set 1		88	S22	R/W	y	0.1	10	0.001	s		UL	/1000
D	1	2	88	1	4	Opening angle alpha		88	S23	R/W	y	0	20	0.001	°		UL	/1000
D	1	2	88	1	4	Residual Voltage		88	S24	R/W	y	0.1	0.7	0.001	Un		UL	/1000
D	1	2	88	1	4	Nettype/Direction/Phasecorrection		88	S25	R/W	y	-180	180	0.01	°		SL	/1000
I	1	2	88	2		Parameter set 2		88										
D	1	2	88	2		Value at tripping of function		88	V1	R	n				In0		UL	/1000
D	1	2	88	2		Max. measured value		88	V2	R	n				In0		UL	/1000
D	1	2	88	2		Number of trips		88	V3	R/W	n						UL	/1000
D	1	2	88	2		Number of startings phase		88	V4	R/W	n						UL	/1000
D	1	2	88	2		Duration of the latest starting situation		88	V7	R	n				ms		UL	/1000
I	1	2	88	3		Phases and event masks		88										
D	1	2	88	3		Phases used		88	V10	R	y						US	
I	1	2	88	4		Input/Output status		88										
D	1	2	88	4		Start output	0=E1;1=E0	88	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	88	4		Trip output	0=E7;1=E6	88	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	88	4		Blocked Trip	0=E13;1=E12	88	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	2	88	4		Block input	0=E19;1=E18	88	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**3**				**Voltage protection functions**												
I	**1**	**3**	**60**			**Overvoltage instantaneous**												
I	1	3	60	1		Parameter												
I	1	3	60	1	2	Parameter set 1												

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	3	60	1	2	Overvoltage value Set 1		60	S1	R/W	y	0.8	2	0.001	Un		UL	/1000
D	1	3	60	1	2	Overvoltage op. time Set 1		60	S2	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	3	60	1	3	AR Parameter set 1												
D	1	3	60	1	3	Number of AR shots Set 1	1=E11;2=E10	60	S3	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	3	60	1	3	Max. AR activate current Set 1		60	S4	R/W	y	0.8	2	0.001	Un		UL	/1000
D	1	3	60	1	3	AR shot starting time 1, Set 1		60	S5	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	60	1	3	AR shot dead time 1, Set 1		60	S6	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	3	60	1	3	AR shot starting time 2, Set 1		60	S7	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	60	1	3	AR shot dead time 2, Set 1		60	S8	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	3	60	1	3	AR reclaim time Set 1		60	S9	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	3	60	1	4	Parameter set 2												
D	1	3	60	1	4	Overvoltage value Set 2		60	S21	R/W	y	0.8	2	0.001	Un		UL	/1000
D	1	3	60	1	4	Overvoltage op. time Set 2		60	S22	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	3	60	1	5	AR Parameter set 2												
D	1	3	60	1	5	Number of AR shots Set 2	1=E11;2=E10	60	S23	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	3	60	1	5	Max. AR activate current Set 2		60	S24	R/W	y	0.8	2	0.001	Un		UL	/1000
D	1	3	60	1	5	AR shot starting time 1, Set 2		60	S25	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	60	1	5	AR shot dead time 1, Set 2		60	S26	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	3	60	1	5	AR shot starting time 2, Set 2		60	S27	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	60	1	5	AR shot dead time 2, Set 2		60	S28	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	3	60	1	5	AR reclaim time Set 2		60	S29	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	3	60	2		Measurments												
D	1	3	60	2		Value at tripping of function		60	V1	R	n						UL	/1000
D	1	3	60	2		Max. measured value		60	V2	R	n						UL	/1000
D	1	3	60	2		Number of trips		60	V3	R/W	n						UL	/1000
D	1	3	60	2		Number of startings phase L1		60	V4	R/W	n						UL	/1000
D	1	3	60	2		Number of startings phase L2		60	V5	R/W	n						UL	/1000
D	1	3	60	2		Number of startings phase L3		60	V6	R/W	n						UL	/1000
D	1	3	60	2		Duration of the latest starting situation phase L1		60	V7	R	n				ms		UL	/1000
D	1	3	60	2		Duration of the latest starting situation phase L2		60	V8	R	n				ms		UL	/1000
D	1	3	60	2		Duration of the latest starting situation phase L3		60	V9	R	n				ms		UL	/1000
I	1	3	60	3		Phases and event masks												
D	1	3	60	3		Phases used		60	V10	R	y						US	
D	1	3	60	3		Eventmask : Event 1 to 16		60	V11	R	y	0	65535	1			UL	/1000
D	1	3	60	3		Eventmask : Event 17 to 32		60	V12	R	y	0	65535	1			UL	/1000
I	1	3	60	4		Input/Output status												
D	1	3	60	4		Start output L1	0=E1;1=E0	60	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	60	4		Start output L2	0=E3;1=E2	60	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	60	4		Start output L3	0=E5;1=E4	60	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	60	4		Trip output	0=E7;1=E6	60	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	60	4		Blocked Trip	0=E13;1=E12	60	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	60	4		Block input	0=E19;1=E18	60	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	60	4		Block AR input	0=E21;1=E20	60	I4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	60	4		AR active	0=E9;1=E8	60	O10	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**3**	**61**			**Overvoltage definite time, high set**												
I	1	3	61	1		Parameter												
I	1	3	61	1	2	Parameter set 1												
D	1	3	61	1	2	Overvoltage value Set 1		61	S1	R/W	y	0.8	2	0.001	Un		UL	/1000
D	1	3	61	1	2	Overvoltage op. time Set 1		61	S2	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	3	61	1	3	AR Parameter set 1												
D	1	3	61	1	3	Number of AR shots Set 1	1=E11;2=E10	61	S3	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	3	61	1	3	Max. AR activate current Set 1		61	S4	R/W	y	0.8	2	0.001	Un		UL	/1000
D	1	3	61	1	3	AR shot starting time 1, Set 1		61	S5	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	61	1	3	AR shot dead time 1, Set 1		61	S6	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	3	61	1	3	AR shot starting time 2, Set 1		61	S7	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	61	1	3	AR shot dead time 2, Set 1		61	S8	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	3	61	1	3	AR reclaim time Set 1		61	S9	R/W	y	0.2	300	0.001	s		UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
I	1	3	61	1	4	Parameter set 2												
D	1	3	61	1	4	Overvoltage value Set 2		61	S21	R/W	y	0.8	2	0.001	Un		UL	/1000
D	1	3	61	1	4	Overvoltage op. time Set 2		61	S22	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	3	61	1	5	AR Parameter set 2												
D	1	3	61	1	5	Number of AR shots Set 2	1=E11;2=E10	61	S23	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	3	61	1	5	Max. AR activate current Set 2		61	S24	R/W	y	0.8	2	0.001	Un		UL	/1000
D	1	3	61	1	5	AR shot starting time 1, Set 2		61	S25	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	61	1	5	AR shot dead time 1, Set 2		61	S26	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	3	61	1	5	AR shot starting time 2, Set 2		61	S27	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	61	1	5	AR shot dead time 2, Set 2		61	S28	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	3	61	1	5	AR reclaim time Set 2		61	S29	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	3	61	2		Measurments												
D	1	3	61	2		Value at tripping of function		61	V1	R	n						UL	/1000
D	1	3	61	2		Max. measured value		61	V2	R	n						UL	/1000
D	1	3	61	2		Number of trips		61	V3	R/W	n						UL	/1000
D	1	3	61	2		Number of startings phase L1		61	V4	R/W	n						UL	/1000
D	1	3	61	2		Number of startings phase L2		61	V5	R/W	n						UL	/1000
D	1	3	61	2		Number of startings phase L3		61	V6	R/W	n						UL	/1000
D	1	3	61	2		Duration of the latest starting situation phase L1		61	V7	R	n				ms		UL	/1000
D	1	3	61	2		Duration of the latest starting situation phase L2		61	V8	R	n				ms		UL	/1000
D	1	3	61	2		Duration of the latest starting situation phase L3		61	V9	R	n				ms		UL	/1000
I	1	3	61	3		Phases and event masks												
D	1	3	61	3		Phases used		61	V10	R	y						US	
D	1	3	61	3		Eventmask : Event 1 to 16		61	V11	R	y	0	65535	1			UL	/1000
D	1	3	61	3		Eventmask : Event 17 to 32		61	V12	R	y	0	65535	1			UL	/1000
I	1	3	61	4		Input/Output status												
D	1	3	61	4		Start output L1	0=E1;1=E0	61	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	61	4		Start output L2	0=E3;1=E2	61	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	61	4		Start output L3	0=E5;1=E4	61	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	61	4		Trip output	0=E7;1=E6	61	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	61	4		Blocked Trip	0=E13;1=E12	61	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	61	4		Block input	0=E19;1=E18	61	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	61	4		Block AR input	0=E21;1=E20	61	I4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	61	4		AR active	0=E9;1=E8	61	O10	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**3**	**62**			**Overvoltage definite time, low set**												
I	1	3	62	1		Parameter												
I	1	3	62	1	2	Parameter set 1												
D	1	3	62	1	2	Overvoltage value Set 1		62	S1	R/W	y	0.8	2	0.001	Un		UL	/1000
D	1	3	62	1	2	Overvoltage op. time Set 1		62	S2	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	3	62	1	4	Parameter set 2												
D	1	3	62	1	4	Overvoltage value Set 2		62	S21	R/W	y	0.8	2	0.001	Un		UL	/1000
D	1	3	62	1	4	Overvoltage op. time Set 2		62	S22	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	3	62	2		Measurments												
D	1	3	62	2		Value at tripping of function		62	V1	R	n						UL	/1000
D	1	3	62	2		Max. measured value		62	V2	R	n						UL	/1000
D	1	3	62	2		Number of trips		62	V3	R/W	n						UL	/1000
D	1	3	62	2		Number of startings phase L1		62	V4	R/W	n						UL	/1000
D	1	3	62	2		Number of startings phase L2		62	V5	R/W	n						UL	/1000
D	1	3	62	2		Number of startings phase L3		62	V6	R/W	n						UL	/1000
D	1	3	62	2		Duration of the latest starting situation phase L1		62	V7	R	n				ms		UL	/1000
D	1	3	62	2		Duration of the latest starting situation phase L2		62	V8	R	n				ms		UL	/1000
D	1	3	62	2		Duration of the latest starting situation phase L3		62	V9	R	n				ms		UL	/1000
I	1	3	62	3		Phases and event masks												
D	1	3	62	3		Phases used		62	V10	R	y						US	
D	1	3	62	3		Eventmask : Event 1 to 16		62	V11	R	y	0	65535	1			UL	/1000
D	1	3	62	3		Eventmask : Event 17 to 32		62	V12	R	y	0	65535	1			UL	/1000
I	1	3	62	4		Input/Output status												

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	3	62	4		Start output L1	0=E1;1=E0	62	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	62	4		Start output L2	0=E3;1=E2	62	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	62	4		Start output L3	0=E5;1=E4	62	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	62	4		Trip output	0=E7;1=E6	62	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	62	4		Blocked Trip	0=E13;1=E12	62	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	62	4		Block input	0=E19;1=E18	62	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**3**	**63**			**Undervoltage instantaneous**												
I	1	3	63	1		Parameter												
I	1	3	63	1	2	Parameter set 1												
D	1	3	63	1	2	Undervoltage value Set 1		63	S1	R/W	y	0.2	1.2	0.001	Un		UL	/1000
D	1	3	63	1	2	Undervoltage op. time Set 1		63	S2	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	3	63	1	4	Parameter set 2												
D	1	3	63	1	4	Undervoltage value Set 2		63	S21	R/W	y	0.2	1.2	0.001	Un		UL	/1000
D	1	3	63	1	4	Undervoltage op. time Set 2		63	S22	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	3	63	2		Measurments												
D	1	3	63	2		Value at tripping of function		63	V1	R	n						UL	/1000
D	1	3	63	2		Max. measured value		63	V2	R	n						UL	/1000
D	1	3	63	2		Number of trips		63	V3	R/W	n						UL	/1000
D	1	3	63	2		Number of startings phase L1		63	V4	R/W	n						UL	/1000
D	1	3	63	2		Number of startings phase L2		63	V5	R/W	n						UL	/1000
D	1	3	63	2		Number of startings phase L3		63	V6	R/W	n						UL	/1000
D	1	3	63	2		Duration of the latest starting situation phase L1		63	V7	R	n				ms		UL	/1000
D	1	3	63	2		Duration of the latest starting situation phase L2		63	V8	R	n				ms		UL	/1000
D	1	3	63	2		Duration of the latest starting situation phase L3		63	V9	R	n				ms		UL	/1000
I	1	3	63	3		Phases and event masks												
D	1	3	63	3		Phases used		63	V10	R	y						US	
D	1	3	63	3		Eventmask : Event 1 to 16		63	V11	R	y	0	65535	1			UL	/1000
D	1	3	63	3		Eventmask : Event 17 to 32		63	V12	R	y	0	65535	1			UL	/1000
I	1	3	63	4		Input/Output status												
D	1	3	63	4		Start output L1	0=E1;1=E0	63	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	63	4		Start output L2	0=E3;1=E2	63	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	63	4		Start output L3	0=E5;1=E4	63	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	63	4		Trip output	0=E7;1=E6	63	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	63	4		Blocked Trip	0=E13;1=E12	63	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	63	4		Block input	0=E19;1=E18	63	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**3**	**64**			**Undervoltage definite time, high set**												
I	1	3	64	1		Parameter												
I	1	3	64	1	2	Parameter set 1												
D	1	3	64	1	2	Undervoltage value Set 1		64	S1	R/W	y	0.2	1.2	0.001	Un		UL	/1000
D	1	3	64	1	2	Undervoltage op. time Set 1		64	S2	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	3	64	1	3	AR Parameter set 1												
D	1	3	64	1	3	Number of AR shots Set 1	1=E11;2=E10	64	S3	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	3	64	1	3	Max. AR activate current Set 1		64	S4	R/W	y	0.4	1.2	0.001	Un		UL	/1000
D	1	3	64	1	3	AR shot starting time 1, Set 1		64	S5	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	64	1	3	AR shot dead time 1, Set 1		64	S6	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	3	64	1	3	AR shot starting time 2, Set 1		64	S7	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	64	1	3	AR shot dead time 2, Set 1		64	S8	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	3	64	1	3	AR reclaim time Set 1		64	S9	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	3	64	1	4	Parameter set 2												
D	1	3	64	1	4	Undervoltage value Set 2		64	S21	R/W	y	0.2	1.2	0.001	Un		UL	/1000
D	1	3	64	1	4	Undervoltage op. time Set 2		64	S22	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	3	64	1	5	AR Parameter set 2												
D	1	3	64	1	5	Number of AR shots Set 2	1=E11;2=E10	64	S23	R/W	y	0	2	1		0=no shot;1=one shot;2=two shots	US	
D	1	3	64	1	5	Max. AR activate current Set 2		64	S24	R/W	y	0.4	1.2	0.001	Un		UL	/1000
D	1	3	64	1	5	AR shot starting time 1, Set 2		64	S25	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	64	1	5	AR shot dead time 1, Set 2		64	S26	R/W	y	0.2	300	0.001	s		UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	3	64	1	5	AR shot starting time 2, Set 2		64	S27	R/W	y	0.03	300	0.001	s		UL	/1000
D	1	3	64	1	5	AR shot dead time 2, Set 2		64	S28	R/W	y	0.2	300	0.001	s		UL	/1000
D	1	3	64	1	5	AR reclaim time Set 2		64	S29	R/W	y	0.2	300	0.001	s		UL	/1000
I	1	3	64	2		Measurments												
D	1	3	64	2		Value at tripping of function		64	V1	R	n						UL	/1000
D	1	3	64	2		Max. measured value		64	V2	R	n						UL	/1000
D	1	3	64	2		Number of trips		64	V3	R/W	n						UL	/1000
D	1	3	64	2		Number of startings phase L1		64	V4	R/W	n						UL	/1000
D	1	3	64	2		Number of startings phase L2		64	V5	R/W	n						UL	/1000
D	1	3	64	2		Number of startings phase L3		64	V6	R/W	n						UL	/1000
D	1	3	64	2		Duration of the latest starting situation phase L1		64	V7	R	n				ms		UL	/1000
D	1	3	64	2		Duration of the latest starting situation phase L2		64	V8	R	n				ms		UL	/1000
D	1	3	64	2		Duration of the latest starting situation phase L3		64	V9	R	n				ms		UL	/1000
I	1	3	64	3		Phases and event masks												
D	1	3	64	3		Phases used		64	V10	R	y						US	
D	1	3	64	3		Eventmask : Event 1 to 16		64	V11	R	y	0	65535	1			UL	/1000
D	1	3	64	3		Eventmask : Event 17 to 32		64	V12	R	y	0	65535	1			UL	/1000
I	1	3	64	4		Input/Output status												
D	1	3	64	4		Start output L1	0=E1;1=E0	64	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	64	4		Start output L2	0=E3;1=E2	64	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	64	4		Start output L3	0=E5;1=E4	64	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	64	4		Trip output	0=E7;1=E6	64	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	64	4		Blocked Trip	0=E13;1=E12	64	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	64	4		Block input	0=E19;1=E18	64	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	64	4		Block AR input	0=E21;1=E20	64	I4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	64	4		AR active	0=E9;1=E8	64	O10	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**3**	**65**			**Undervoltage definite time, low set**												
I	1	3	65	1		Parameter												
I	1	3	65	1	2	Parameter set 1												
D	1	3	65	1	2	Undervoltage value Set 1		65	S1	R/W	y	0.4	1.2	0.001	Un		UL	/1000
D	1	3	65	1	2	Undervoltage op. time Set 1		65	S2	R/W	y	0.05	300	0.001	s		UL	/1000
I	1	3	65	1	4	Parameter set 2												
D	1	3	65	1	4	Undervoltage value Set 2		65	S21	R/W	y	0.4	1.2	0.001	Un		UL	/1000
D	1	3	65	1	4	Undervoltage op. time Set 2		65	S22	R/W	y	0.05	300	0.001	s		UL	/1000
I	1	3	65	2		Measurments												
D	1	3	65	2		Value at tripping of function		65	V1	R	n						UL	/1000
D	1	3	65	2		Max. measured value		65	V2	R	n						UL	/1000
D	1	3	65	2		Number of trips		65	V3	R/W	n						UL	/1000
D	1	3	65	2		Number of startings phase L1		65	V4	R/W	n						UL	/1000
D	1	3	65	2		Number of startings phase L2		65	V5	R/W	n						UL	/1000
D	1	3	65	2		Number of startings phase L3		65	V6	R/W	n						UL	/1000
D	1	3	65	2		Duration of the latest starting situation phase L1		65	V7	R	n				ms		UL	/1000
D	1	3	65	2		Duration of the latest starting situation phase L2		65	V8	R	n				ms		UL	/1000
D	1	3	65	2		Duration of the latest starting situation phase L3		65	V9	R	n				ms		UL	/1000
I	1	3	65	3		Phases and event masks												
D	1	3	65	3		Phases used		65	V10	R	y						US	
D	1	3	65	3		Eventmask : Event 1 to 16		65	V11	R	y	0	65535	1			UL	/1000
D	1	3	65	3		Eventmask : Event 17 to 32		65	V12	R	y	0	65535	1			UL	/1000
I	1	3	65	4		Input/Output status												
D	1	3	65	4		Start output L1	0=E1;1=E0	65	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	65	4		Start output L2	0=E3;1=E2	65	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	65	4		Start output L3	0=E5;1=E4	65	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	65	4		Trip output	0=E7;1=E6	65	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	65	4		Blocked Trip	0=E13;1=E12	65	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	65	4		Block input	0=E19;1=E18	65	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**3**	**82**			**Residual overvoltage definite time high**												

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
I	1	3	82	1		Parameter												
I	1	3	82	1	2	Parameter set 1												
D	1	3	82	1	2	Voltage Set 1		82	S1	R/W	y	0.05	3	0.001	Un		UL	/1000
D	1	3	82	1	2	Time Set 1		82	S2	R/W	y	0.04	300	0.001	s		UL	/1000
I	1	3	82	1	4	Parameter set 2												
D	1	3	82	1	4	Voltage Set 2		82	S21	R/W	y	0.05	3	0.001	Un		UL	/1000
D	1	3	82	1	4	Time Set 2		82	S22	R/W	y	0.04	300	0.001	s		UL	/1000
I	1	3	82	2		Measurments												
D	1	3	82	2		Value at tripping of function		82	V1	R	n						UL	/1000
D	1	3	82	2		Max. measured value		82	V2	R	n						UL	/1000
D	1	3	82	2		Number of trips		82	V3	R/W	n						UL	/1000
D	1	3	82	2		Number of startings phase		82	V4	R/W	n						UL	/1000
D	1	3	82	2		Duration of the latest starting situation		82	V7	R	n				ms		UL	/1000
I	1	3	82	3		Phases and event masks												
D	1	3	82	3		Phases used		82	V10	R	y						US	
D	1	3	82	3		Eventmask : Event 1 to 16		82	V11	R	y	0	65535	1			UL	/1000
D	1	3	82	3		Eventmask : Event 17 to 32		82	V12	R	y	0	65535	1			UL	/1000
I	1	3	82	4		Input/Output status												
D	1	3	82	4		Start output	0=E1;1=E0	82	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	82	4		Trip output	0=E7;1=E6	82	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	82	4		Blocked Trip	0=E13;1=E12	82	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	82	4		Block input	0=E19;1=E18	82	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	3	83			**Residual overvoltage definite time low**												
I	1	3	83	1		Parameter												
I	1	3	83	1	2	Parameter set 1												
D	1	3	83	1	2	Voltage Set 1		83	S1	R/W	y	0.05	3	0.001	Un		UL	/1000
D	1	3	83	1	2	Time Set 1		83	S2	R/W	y	0.04	300	0.001	s		UL	/1000
I	1	3	83	1	4	Parameter set 2												
D	1	3	83	1	4	Voltage Set 2		83	S21	R/W	y	0.05	3	0.001	Un		UL	/1000
D	1	3	83	1	4	Time Set 2		83	S22	R/W	y	0.04	300	0.001	s		UL	/1000
I	1	3	83	2		Measurments												
D	1	3	83	2		Value at tripping of function		83	V1	R	n						UL	/1000
D	1	3	83	2		Max. measured value		83	V2	R	n						UL	/1000
D	1	3	83	2		Number of trips		83	V3	R/W	n						UL	/1000
D	1	3	83	2		Number of startings phase		83	V4	R/W	n						UL	/1000
D	1	3	83	2		Duration of the latest starting situation		83	V7	R	n				ms		UL	/1000
I	1	3	83	3		Phases and event masks												
D	1	3	83	3		Phases used		83	V10	R	y						US	
D	1	3	83	3		Eventmask : Event 1 to 16		83	V11	R	y	0	65535	1			UL	/1000
D	1	3	83	3		Eventmask : Event 17 to 32		83	V12	R	y	0	65535	1			UL	/1000
I	1	3	83	4		Input/Output status												
D	1	3	83	4		Start output	0=E1;1=E0	83	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	83	4		Trip output	0=E7;1=E6	83	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	83	4		Blocked Trip	0=E13;1=E12	83	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	3	83	4		Block input	0=E19;1=E18	83	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**4**				**Motor protection function**												
I	**1**	**4**	**74**			**Thermal Overload**												
I	1	4	74	1		Parameter												
D	1	4	74	1		Maximum temperature		74	S1	R/W	y	20	400	0.001	C		UL	/1000
D	1	4	74	1		Operating time		74	S2	R/W	y	1	1000	0.001	s		UL	/1000
D	1	4	74	1		Nominal temperature		74	S3	R/W	y	50	400	0.001	C		UL	/1000
D	1	4	74	1		Nominal current		74	S4	R/W	y	1	65535	0.001	A		UL	/1000
D	1	4	74	1		Initial temperature		74	S5	R/W	y	50	120	0.001	%		UL	/1000
D	1	4	74	1		Fundamental time constant for motor OFF		74	S6	R/W	y	10	5000	0.001	s		UL	/1000
D	1	4	74	1		Fundamental time constant for normal work		74	S7	R/W	y	10	5000	0.001	s		UL	/1000
D	1	4	74	1		Fundamental time constant for fault		74	S8	R/W	y	10	5000	0.001	s		UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data Dir	Save	Values Min	Max	Step	Unit	Single Values	Type	Factor
MicroSCADA key																		
D	1	4	74	1		Warning temperature		74	S9	R/W	y	20	400	0.001	C		UL	/1000
I	1	4	74	2		Measurments												
D	1	4	74	2		Value at tripping of function		74	V1	R	n						UL	/1000
D	1	4	74	2		Max. measured value		74	V2	R	n						UL	/1000
D	1	4	74	2		Number of trips		74	V3	R/W	n						UL	/1000
D	1	4	74	2		Number of startings phase		74	V4	R/W	n						UL	/1000
D	1	4	74	2		Duration of the latest starting situation		74	V7	R	n				ms		UL	/1000
D	1	4	74	2		Actual temperature		74	V8	R	n				C		SL	/1000
D	1	4	74	2		Time to start		74	V9	R	n				min		UL	/1000
I	1	4	74	3		Phases and event masks												
D	1	4	74	3		Phases used		74	V10	R	y						US	
D	1	4	74	3		Eventmask : Event 1 to 16		74	V11	R	y	0	65535	1			UL	/1000
D	1	4	74	3		Eventmask : Event 17 to 32		74	V12	R	y	0	65535	1			UL	/1000
I	1	4	74	4		Input/Output status												
D	1	4	74	4		Start output	0=E1;1=E0	74	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	74	4		Trip output	0=E7;1=E6	74	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	74	4		Blocked Trip	0=E13;1=E12	74	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	74	4		Warning	0=E15;1=E14	74	O6	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	74	4		Block input	0=E19;1=E18	74	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**4**	**80**			**Motorstart protection**												
I	1	4	80	1		Parameter												
I	1	4	80	1	2	Parameter set 1												
D	1	4	80	1	2	Starting current value Set 1		80	S1	R/W	y	1	20	0.001	In		UL	/1000
D	1	4	80	1	2	Starting current op. time Set 1		80	S2	R/W	y	0.02	300	0.001	s		UL	/1000
D	1	4	80	1	2	Start Threshold Set 1		80	S3	R/W	y	0.3	1.2	0.001	In		UL	/1000
I	1	4	80	1	4	Parameter set 2												
D	1	4	80	1	4	Starting current value Set 2		80	S21	R/W	y	1	20	0.001	In		UL	/1000
D	1	4	80	1	4	Starting current op. time Set 2		80	S22	R/W	y	0.02	300	0.001	s		UL	/1000
D	1	4	80	1	4	Start Threshold Set 2		80	S23	R/W	y	0.3	1.2	0.001	In		UL	/1000
I	1	4	80	2		Measurments												
D	1	4	80	2		Value at tripping of function		80	V1	R	n						UL	/1000
D	1	4	80	2		Max. measured value		80	V2	R	n						UL	/1000
D	1	4	80	2		Number of trips		80	V3	R/W	n						UL	/1000
D	1	4	80	2		Number of startings phase		80	V4	R/W	n						UL	/1000
D	1	4	80	2		Duration of the latest starting situation		80	V7	R	n				ms		UL	/1000
I	1	4	80	3		Phases and event masks												
D	1	4	80	3		Phases used		80	V10	R	y						US	
D	1	4	80	3		Eventmask : Event 1 to 16		80	V11	R	y	0	65535	1			UL	/1000
D	1	4	80	3		Eventmask : Event 17 to 32		80	V12	R	y	0	65535	1			UL	/1000
I	1	4	80	4		Input/Output status												
D	1	4	80	4		Start output	0=E1;1=E0	80	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	80	4		Trip output	0=E7;1=E6	80	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	80	4		Blocked Trip	0=E13;1=E12	80	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	80	4		Block Out	0=E17;1=E16	80	O9	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	80	4		Block input	0=E19;1=E18	80	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**4**	**86**			**Blocked rotor protection**												
I	1	4	86	1		Parameter												
I	1	4	86	1	2	Parameter set 1												
D	1	4	86	1	2	Overcurrent value Set 1		86	S1	R/W	y	1	20	0.001	In		UL	/1000
D	1	4	86	1	2	Overcurrent op. time Set 1		86	S2	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	4	86	1	4	Parameter set 2												
D	1	4	86	1	4	Overcurrent value Set 2		86	S21	R/W	y	1	20	0.001	In		UL	/1000
D	1	4	86	1	4	Overcurrent op. time Set 2		86	S22	R/W	y	0.02	300	0.001	s		UL	/1000
I	1	4	86	2		Measurments												
D	1	4	86	2		Value at tripping of function		86	V1	R	n						UL	/1000
D	1	4	86	2		Max. measured value		86	V2	R	n						UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	4	86	2		Number of trips		86	V3	R/W	n						UL	/1000
D	1	4	86	2		Number of startings phase L1		86	V4	R/W	n						UL	/1000
D	1	4	86	2		Number of startings phase L2		86	V5	R/W	n						UL	/1000
D	1	4	86	2		Number of startings phase L3		86	V6	R/W	n						UL	/1000
D	1	4	86	2		Duration of the latest starting situation phase L1		86	V7	R	n				ms		UL	/1000
D	1	4	86	2		Duration of the latest starting situation phase L2		86	V8	R	n				ms		UL	/1000
D	1	4	86	2		Duration of the latest starting situation phase L3		86	V9	R	n				ms		UL	/1000
I	1	4	86	3		Phases and event masks												
D	1	4	86	3		Phases used		86	V10	R	y						US	
D	1	4	86	3		Eventmask : Event 1 to 16		86	V11	R	y	0	65535	1			UL	/1000
D	1	4	86	3		Eventmask : Event 17 to 32		86	V12	R	y	0	65535	1			UL	/1000
I	1	4	86	4		Input/Output status												
D	1	4	86	4		Start output L1	0=E1;1=E0	86	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	86	4		Start output L2	0=E3;1=E2	86	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	86	4		Start output L3	0=E5;1=E4	86	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	86	4		Trip output	0=E7;1=E6	86	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	86	4		Blocked Trip	0=E13;1=E12	86	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	86	4		Block input	0=E19;1=E18	86	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**4**	**87**			**Number of Starts**												
I	1	4	87	1		Parameter												
I	1	4	87	1	2	Parameter set 1												
D	1	4	87	1	2	Counter warm Set 1		87	S1	R/W	y	1	10	1			UL	/1000
D	1	4	87	1	2	Counter cold Set 1		87	S2	R/W	y	1	10	1			UL	/1000
D	1	4	87	1	2	Operating time Set 1		87	S3	R/W	y	1	120	0.001	s		UL	/1000
D	1	4	87	1	2	Temperatur threshold cold->warm Set 1		87	S4	R/W	y	20	400	0.001	C		UL	/1000
I	1	4	87	1	4	Parameter set 2												
D	1	4	87	1	4	Counter warm Set 2		87	S21	R/W	y	1	10	1			UL	/1000
D	1	4	87	1	4	Counter cold Set 2		87	S22	R/W	y	1	10	1			UL	/1000
D	1	4	87	1	4	Operating time Set 2		87	S23	R/W	y	1	120	0.001	s		UL	/1000
D	1	4	87	1	4	Temperatur threshold cold->warm Set 2		87	S24	R/W	y	20	400	0.001	C		UL	/1000
I	1	4	87	2		Measurments												
D	1	4	87	2		Value at tripping of function		87	V1	R	n						UL	/1000
D	1	4	87	2		Number of warnings		87	V2	R/W	n						UL	/1000
D	1	4	87	2		Number of trips		87	V3	R/W	n						UL	/1000
D	1	4	87	2		Number of cold starts		87	V4	R	n						UL	/1000
D	1	4	87	2		Number of warm starts		87	V5	R	n						UL	/1000
I	1	4	87	3		Phases and event masks												
D	1	4	87	3		Phases used		87	V10	R	y						US	
D	1	4	87	3		Eventmask : Event 1 to 16		87	V11	R	y	0	65535	1			UL	/1000
D	1	4	87	3		Eventmask : Event 17 to 32		87	V12	R	y	0	65535	1			UL	/1000
I	1	4	87	4		Input/Output status												
D	1	4	87	4		Trip output	0=E1;1=E0	87	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	87	4		Blocked Trip	0=E13;1=E12	87	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	87	4		Warning output		87	O6	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	87	4		Block input		87	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	87	4		Start motor input		87	I3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**5**				**Distance protection**												
I	**1**	**4**	**81**			**Distance protection**												
I	1	4	81	1		Parameter												
D	1	4	81	1		Net Type		81	S9	R/W	y	0	1	1		0=HighOhmic;1=LowOhmic	US	
D	1	4	81	1		E-Start or G-Start		81	S10	R/W	y	0	1	1		0=GStartOrEStart;1=GStart	US	
D	1	4	81	1		Transfer Ground Side		81	S11	R/W	y	0	1	1		0=Lineside;1=Busbarside	US	
D	1	4	81	1		Switch On Fault		81	S12	R/W	y	0	2	1		0=normal;1=Overreach;2=TripAfterGStart	US	
D	1	4	81	1		Mixed Cable/Cverhead		81	S13	R/W	y	0	1	1		0=mixed; 1=homogenous	US	
D	1	4	81	1		Cable before Overhead		81	S14	R/W	y	0	1	1		0=OverheadFirst;1=CableFirst	US	
D	1	4	81	1		Z boarder Cable/Overhead Zb		81	S15	R/W	y	0.05	120	0.01	Ohm		SL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	4	81	1		Cable impedance Zc		81	S16	R/W	y	0.05	120	0.01	Ohm	0=NoCable	SL	/1000
D	1	4	81	1		Overhead impedance Zo		81	S17	R/W	y	0.05	120	0.01	Ohm	0=NoOverhead	SL	/1000
I	1	4	81	1	2	Parameter set 1												
D	1	4	81	1	2	Current threshold I>		81	S1	R/W	y	0.05	4	0.01	In		UL	/1000
D	1	4	81	1	2	Earth current threshold Io>		81	S2	R/W	y	0.05	4	0.01	In		UL	/1000
D	1	4	81	1	2	Current fault threshold If>		81	S3	R/W	y	0.05	4	0.01	In		UL	/1000
D	1	4	81	1	2	Undervoltage threshold Uf<		81	S4	R/W	y	0.05	0.9	0.01	Un		UL	/1000
D	1	4	81	1	2	Phase selection		81	S5	R/W	y	0	3	1		0=NAc312;1=NAc1231;2=IAc132;3=IAc1231	US	
D	1	4	81	1	2	Earthfactor Real		81	S6	R/W	y						SL	/1000
D	1	4	81	1	2	Earthfactor Imag		81	S7	R/W	y						SL	/1000
D	1	4	81	1	2	Signal Comparison Time		81	S8	R/W	y	0.01	1	0.01	s		UL	/1000
I	1	4	81	1	4	Parameter set 2												
D	1	4	81	1	4	Current threshold I>		81	S21	R/W	y	0.05	4	0.01	In		UL	/1000
D	1	4	81	1	4	Earth current threshold Io>		81	S22	R/W	y	0.05	4	0.01	In		UL	/1000
D	1	4	81	1	4	Current fault threshold If>		81	S23	R/W	y	0.05	4	0.01	In		UL	/1000
D	1	4	81	1	4	Undervoltage threshold Uf<		81	S24	R/W	y	0.05	0.9	0.01	Un		UL	/1000
D	1	4	81	1	4	Phase selection		81	S25	R/W	y	0	3	1		0=NAc312;1=NAc1231;2=IAc132;3=IAc1231	US	
D	1	4	81	1	4	Earthfactor Real		81	S26	R/W	y						SL	/1000
D	1	4	81	1	4	Earthfactor Imag		81	S27	R/W	y						SL	/1000
D	1	4	81	1	4	Signal Comparison Time		81	S28	R/W	y	0.01	1	0.01	s		UL	/1000
I	1	4	81	2		Zone 1												
I	1	4	81	1	2	Parameter set 1												
D	1	4	81	1	2	R		81	S41	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	X		81	S42	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	Delta1		81	S43	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S44	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Time		81	S45	R/W	y	0	10	0.01	s		UL	/1000
D	1	4	81	1	2	Direction		81	S46	R/W	y	0	1	1		0=InFront;1=Behind	US	
I	1	4	81	1	4	Parameter set 2												
D	1	4	81	1	2	R		81	S51	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	X		81	S52	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	Delta1		81	S53	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S54	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Time		81	S55	R/W	y	0	10	0.01	s		UL	/1000
D	1	4	81	1	2	Direction		81	S56	R/W	y	0	1	1		0=InFront;1=Behind	US	
I	1	4	81	2		Overreach Zone												
I	1	4	81	1	2	Parameter set 1												
D	1	4	81	1	2	R		81	S61	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	X		81	S62	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	Delta1		81	S63	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S64	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Time		81	S65	R/W	y	0	10	0.01	s		UL	/1000
D	1	4	81	1	2	Direction		81	S66	R/W	y	0	1	1		0=InFront;1=Behind	US	
I	1	4	81	1	4	Parameter set 2												
D	1	4	81	1	2	R		81	S71	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	X		81	S72	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	Delta1		81	S73	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S74	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Time		81	S75	R/W	y	0	10	0.01	s		UL	/1000
D	1	4	81	1	2	Direction		81	S76	R/W	y	0	1	1		0=InFront;1=Behind	US	
I	1	4	81	2		Block AR Zone												
I	1	4	81	1	2	Parameter set 1												
D	1	4	81	1	2	R		81	S81	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	X		81	S82	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	Delta1		81	S83	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S84	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Direction		81	S86	R/W	y	0	1	1		0=InFront;1=Behind	US	

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
I	1	4	81	1	4	Parameter set 2												
D	1	4	81	1	2	R		81	S91	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	X		81	S92	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	Delta1		81	S93	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S94	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Direction		81	S96	R/W	y	0	1	1		0=InFront;1=Behind	US	
I	1	4	81	2		Zone 2												
I	1	4	81	1	2	Parameter set 1												
D	1	4	81	1	2	R		81	S101	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	X		81	S102	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	Delta1		81	S103	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S104	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Time		81	S105	R/W	y	0	10	0.01	s		UL	/1000
D	1	4	81	1	2	Direction		81	S106	R/W	y	0	1	1		0=InFront;1=Behind	US	
I	1	4	81	1	4	Parameter set 2												
D	1	4	81	1	2	R		81	S111	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	X		81	S112	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	Delta1		81	S113	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S114	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Time		81	S115	R/W	y	0	10	0.01	s		UL	/1000
D	1	4	81	1	2	Direction		81	S116	R/W	y	0	1	1		0=InFront;1=Behind	US	
I	1	4	81	2		Zone 3												
I	1	4	81	1	2	Parameter set 1												
D	1	4	81	1	2	R		81	S121	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	X		81	S122	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	Delta1		81	S123	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S124	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Time		81	S125	R/W	y	0	10	0.01	s		UL	/1000
D	1	4	81	1	2	Direction		81	S126	R/W	y	0	1	1		0=InFront;1=Behind	US	
I	1	4	81	1	4	Parameter set 2												
D	1	4	81	1	2	R		81	S131	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	X		81	S132	R/W	y	0.05	120	0.01	Ohm		UL	/1000
D	1	4	81	1	2	Delta1		81	S133	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S134	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Time		81	S135	R/W	y	0	10	0.01	s		UL	/1000
D	1	4	81	1	2	Direction		81	S136	R/W	y	0	1	1		0=InFront;1=Behind	US	
I	1	4	81	2		Directional Backup												
I	1	4	81	1	2	Parameter set 1												
D	1	4	81	1	2	Delta1		81	S143	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S144	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Time		81	S145	R/W	y	0	10	0.01	s		UL	/1000
D	1	4	81	1	2	Direction		81	S146	R/W	y	0	1	1		0=InFront;1=Behind	US	
I	1	4	81	1	4	Parameter set 2												
D	1	4	81	1	2	Delta1		81	S153	R/W	y	-45	0	1	Grad		SL	/1000
D	1	4	81	1	2	Delta2		81	S154	R/W	y	90	135	1	Grad		SL	/1000
D	1	4	81	1	2	Time		81	S155	R/W	y	0	10	0.01	s		UL	/1000
D	1	4	81	1	2	Direction		81	S156	R/W	y	0	1	1		0=InFront;1=Behind	US	
I	1	4	81	2		Non Directional Backup												
I	1	4	81	1	2	Parameter set 1												
D	1	4	81	1	2	Time		81	S165	R/W	y	0	10	0.01	s		UL	/1000
I	1	4	81	1	4	Parameter set 2												
D	1	4	81	1	2	Time		81	S175	R/W	y	0	10	0.01	s		UL	/1000
I	1	4	81	2		Measurments												
D	1	4	81	2		E-Start duration		81	V1	R	n				ms		UL	/1000
D	1	4	81	2		G-Start duration		81	V2	R	n				ms		UL	/1000
D	1	4	81	2		Number of trips		81	V3	R/W	n						UL	/1000
D	1	4	81	2		Number of starts L1		81	V4	R/W	n						UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	4	81	2		Number of starts L2		81	V5	R/W	n						UL	/1000
D	1	4	81	2		Number of starts L3		81	V6	R/W	n						UL	/1000
D	1	4	81	2		Duration of the latest starting situation phase L1		81	V7	R	n				ms		UL	/1000
D	1	4	81	2		Duration of the latest starting situation phase L2		81	V8	R	n				ms		UL	/1000
D	1	4	81	2		Duration of the latest starting situation phase L3		81	V9	R	n				ms		UL	/1000
D	1	4	81	2		Number of starts earth fault		81	V13	R/W	n						UL	/1000
D	1	4	81	2		Number of starts general start		81	V14	R/W	n						UL	/1000
D	1	4	81	2		Number of starts of <Z1		81	V15	R/W	n						UL	/1000
D	1	4	81	2		Impedance IZI		81	V16	R	n				Ohm		SL	/1000
D	1	4	81	2		Angle phi(Z)		81	V17	R	n				Grad		SL	/1000
D	1	4	81	2		Resistance R		81	V18	R	n				Ohm		SL	/1000
D	1	4	81	2		Reactance X		81	V19	R	n				Ohm		SL	/1000
D	1	4	81	2		Zone		81	V20	R	n						SL	/1000
D	1	4	81	2		Distance of the fault		81	V21	R	n				km		SL	/1000
D	1	4	81	2		Duration of the latest starting of <Z1		81	V22	R	n				ms		UL	/1000
I	1	4	81	3		Phases and event masks												
I	1	4	81	4		Input/Output status												
D	1	4	81	4		Start output L1	0=E1;1=E0	81	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		Start output L2	0=E3;1=E2	81	O2	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		Start output L3	0=E5;1=E4	81	O3	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		Trip output	0=E7;1=E6	81	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		Blocked Trip	0=E13;1=E12	81	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		Earth Start	0=E25;1=E24	81	O6	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		General Start	0=E23;1=E22	81	O7	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		Overreach Zone AR		81	O8	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		Overreach Zone Switch on Fault		81	O9	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		AR active	0=E9;1=E8	81	O10	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		<Z1	0=E17;1=E16	81	O11	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		1. AR shot	0=E11;1=E10	81	O12	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		2.AR shot	0=E15;1=E14	81	O13	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		Block input	0=E19;1=E18	81	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		Block AR	0=E21;1=E20	81	I4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		CB OK	0=E27;1=E26	81	I5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		Signal Comp.	0=E29;1=E28	81	I6	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	4	81	4		Block AR from DSP	0=E31;1=E30	81	I7	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**5**				**Differential protection function**												
I	**1**	**5**	**79**			**Unbalanced load**												
I	1	5	79	1		Parameter												
I	1	5	79	1	2	Parameter set 2												
D	1	5	79	1	2	Primary Winding Nominal Current		79	S1	R/W	y	0	100	0.1	A		UL	/1000
D	1	5	79	1	2	Secondary Winding Nominal Current		79	S2	R/W	y	0	100	0.2	A		UL	/1000
D	1	5	79	1	2	Transformer Group		79	S3	R/W	y	0	11	1			UL	/1000
D	1	5	79	1	2	Primary side earthing		79	S4	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	2	Secondary side earthing		79	S5	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	2	Primary current triplet		79	S6	R/W	y	0	1	1		0=(1,2,3); 1=(4,5,6)	UL	/1000
D	1	5	79	1	2	Threshold current		79	S7	R/W	y	0.1	0.5	0.01	In		UL	/1000
D	1	5	79	1	2	Unbiased region limit		79	S8	R/W	y	0.5	5	0.01	In		UL	/1000
D	1	5	79	1	2	Slightly biased region threshold		79	S9	R/W	y	0.2	2	0.01	In		UL	/1000
D	1	5	79	1	2	Slightly biased region limit		79	S10	R/W	y	1	10	0.01	In		UL	/1000
D	1	5	79	1	2	Heavily biased behaviour slope		79	S11	R/W	y	0.4	1.0	0.01			UL	/1000
D	1	5	79	1	2	Second harmonic threshold vs. Idiff		79	S12	R/W	y	0.1	0.3	0.01			UL	/1000
D	1	5	79	1	2	Third harmonic threshold vs. Idiff		79	S13	R/W	y	0.1	0.3	0.01			UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data Dir	Save	Values Min	Max	Step	Unit	Single Values	Type	Factor
MicroSCADA key																		
D	1	5	79	1	2	Fifth harmonic threshold vs. Idiff		79	S14	R/W	y	0.1	0.3	0.01			UL	/1000
D	1	5	79	1	2	Second harmonic block enable		79	S15	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	2	Third harmonic block enable		79	S16	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	2	Fifth harmonic block enable		79	S17	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	2	Second harmonic block at start-up only		79	S18	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	2	CTs' saturation current limit for 3rd harmonic block		79	S19	R/W	y	5	40	0.01	In		UL	/1000
D	1	5	79	1	2	Operating Time		79	S20	R/W	y	0.02	0.1	0.001	s		UL	/1000
I	1	5	79	1	4	Parameter set 2												
D	1	5	79	1	4	Primary Winding Nominal Current		79	S21	R/W	y	0	100	0.1	A		UL	/1000
D	1	5	79	1	4	Secondary Winding Nominal Current		79	S22	R/W	y	0	100	0.2	A		UL	/1000
D	1	5	79	1	4	Transformer Group		79	S23	R/W	y	0	11	1			UL	/1000
D	1	5	79	1	4	Primary side earthing		79	S24	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	4	Secondary side earthing		79	S25	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	4	Primary current triplet		79	S26	R/W	y	0	1	1		0=(1,2,3); 1=(4,5,6)	UL	/1000
D	1	5	79	1	4	Threshold current		79	S27	R/W	y	0.1	0.5	0.01	In		UL	/1000
D	1	5	79	1	4	Unbiased region limit		79	S28	R/W	y	0.5	5	0.01	In		UL	/1000
D	1	5	79	1	4	Slightly biased region threshold		79	S29	R/W	y	0.2	2	0.01	In		UL	/1000
D	1	5	79	1	4	Slightly biased region limit		79	S30	R/W	y	1	10	0.01	In		UL	/1000
D	1	5	79	1	4	Heavily biased behaviour slope		79	S31	R/W	y	0.4	1.0	0.01			UL	/1000
D	1	5	79	1	4	Second harmonic threshold vs. Idiff		79	S32	R/W	y	0.1	0.3	0.01			UL	/1000
D	1	5	79	1	4	Third harmonic threshold vs. Idiff		79	S33	R/W	y	0.1	0.3	0.01			UL	/1000
D	1	5	79	1	4	Fifth harmonic threshold vs. Idiff		79	S34	R/W	y	0.1	0.3	0.01			UL	/1000
D	1	5	79	1	4	Second harmonic block enable		79	S35	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	4	Third harmonic block enable		79	S36	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	4	Fifth harmonic block enable		79	S37	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	4	Second harmonic block at start-up only		79	S38	R/W	y	0	1	1		0=FALSE; 1=TRUE	UL	/1000
D	1	5	79	1	4	CTs' saturation current limit for 3rd harmonic block		79	S39	R/W	y	5	40	0.01	In		UL	/1000
D	1	5	79	1	4	Operating Time		79	S40	R/W	y	0.02	0.1	0.001	s		UL	/1000
I	1	5	79	2		Measurments												
D	1	5	79	2		Number of trips		79	V3	R/W	n						UL	/1000
D	1	5	79	2		Number of startings phase		79	V4	R/W	n						UL	/1000
D	1	5	79	2		Duration of the latest starting situation phase		79	V7	R	n				ms		UL	/1000
I	1	5	79	4		Input/Output status												
I	1	5	79	4		Start output	0=E1;1=E0	79	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	5	79	4		Trip output	0=E7;1=E6	79	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	/1000
I	1	5	79	4		Blocked Trip	0=E13;1=E12	79	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	5	79	4		Block 2nd Harmonic	0=E21;1=E20	79	O6	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	5	79	4		Block 3rd Harmonic	0=E23;1=E22	79	O7	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	5	79	4		Block 5th Harmonic	0=E25;1=E24	79	O8	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	5	79	4		General Block	0=E27;1=E26	79	O9	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	1	5	79	4		Block input	0=E19;1=E18	79	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**6**				**Other protection function**												
I	**1**	**6**	**75**			**Unbalanced load**												
I	1	6	75	1		Parameter												
D	1	6	75	1		Minimum active current		75	S1	R/W	y	5	100	0.001	%		UL	/1000
D	1	6	75	1		Operating time		75	S2	R/W	y	1	1000	0.001	s		UL	/1000
D	1	6	75	1		Maximum unbalanced		75	S3	R/W	y	5	80	0.001	%		UL	/1000
I	1	6	75	2		Measurments												
D	1	6	75	2		Value at tripping of function		75	V1	R	n						UL	/1000
D	1	6	75	2		Max. measured value		75	V2	R	n						UL	/1000
D	1	6	75	2		Number of trips		75	V3	R/W	n						UL	/1000
D	1	6	75	2		Number of startings phase		75	V4	R/W	n						UL	/1000
D	1	6	75	2		Duration of the latest starting situation		75	V7	R	n				ms		UL	/1000
I	1	6	75	3		Phases and event masks												
D	1	6	75	3		Phases used		75	V10	R	y						US	
D	1	6	75	3		Eventmask : Event 1 to 16		75	V11	R	y	0	65535	1			UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	6	75	3		Eventmask : Event 17 to 32		75	V12	R	y	0	65535	1			UL	/1000
I	1	6	75	4		Input/Output status												
D	1	6	75	4		Start output	0=E1;1=E0	75	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	75	4		Trip output	0=E7;1=E6	75	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	75	4		Blocked Trip	0=E13;1=E12	75	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	75	4		Block input	0=E19;1=E18	75	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**6**	**76**			**Directional power protection**												
I	1	6	76	1		Parameter												
D	1	6	76	1		Maximum reverse load		76	S1	R/W	y	1	50	0.001	%		UL	/1000
D	1	6	76	1		Operating time		76	S2	R/W	y	1	1000	0.001	s		UL	/1000
D	1	6	76	1		Nominal real power		76	S3	R/W	y	0.05	1000	0.001	MW		UL	/1000
D	1	6	76	1		Direction		76	S4	R/W	y	0	1	1		0=in front; 1=behind	US	
I	1	6	76	2		Measurments												
D	1	6	76	2		Value at tripping of function		76	V1	R	n						UL	/1000
D	1	6	76	2		Max. measured value		76	V2	R	n						UL	/1000
D	1	6	76	2		Number of trips		76	V3	R/W	n						UL	/1000
D	1	6	76	2		Number of startings phase		76	V4	R/W	n						UL	/1000
D	1	6	76	2		Duration of the latest starting situation		76	V7	R	n				ms		UL	/1000
I	1	6	76	3		Phases and event masks												
D	1	6	76	3		Phases used		76	V10	R	y						US	
D	1	6	76	3		Eventmask : Event 1 to 16		76	V11	R	y	0	65535	1			UL	/1000
D	1	6	76	3		Eventmask : Event 17 to 32		76	V12	R	y	0	65535	1			UL	/1000
I	1	6	76	4		Input/Output status												
D	1	6	76	4		Start output	0=E1;1=E0	76	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	76	4		Trip output	0=E7;1=E6	76	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	76	4		Blocked Trip	0=E13;1=E12	76	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	76	4		Block input	0=E19;1=E18	76	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**6**	**77**			**Low load protection**												
I	1	6	77	1		Parameter												
D	1	6	77	1		Minimum load		77	S1	R/W	y	5	100	0.001	%		UL	/1000
D	1	6	77	1		Operating time		77	S2	R/W	y	1	1000	0.001	s		UL	/1000
D	1	6	77	1		Nominal real power		77	S3	R/W	y	0.05	1000	0.001	MW		UL	/1000
D	1	6	77	1		Minimum operating current		77	S4	R/W	y	2	20	0.001	%		UL	/1000
I	1	6	77	2		Measurments												
D	1	6	77	2		Value at tripping of function		77	V1	R	n						UL	/1000
D	1	6	77	2		Max. measured value		77	V2	R	n						UL	/1000
D	1	6	77	2		Number of trips		77	V3	R/W	n						UL	/1000
D	1	6	77	2		Number of startings phase		77	V4	R/W	n						UL	/1000
D	1	6	77	2		Duration of the latest starting situation		77	V7	R	n				ms		UL	/1000
I	1	6	77	3		Phases and event masks												
D	1	6	77	3		Phases used		77	V10	R	y						US	
D	1	6	77	3		Eventmask : Event 1 to 16		77	V11	R	y	0	65535	1			UL	/1000
D	1	6	77	3		Eventmask : Event 17 to 32		77	V12	R	y	0	65535	1			UL	/1000
	1	6	77	4		Input/Output status												
D	1	6	77	4		Start output	0=E1;1=E0	77	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	77	4		Trip output	0=E7;1=E6	77	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	77	4		Blocked Trip	0=E13;1=E12	77	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	77	4		Block input	0=E19;1=E18	77	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**6**	**78**			**Thermal supervision**												
I	1	6	78	1		Parameter												
D	1	6	78	1		Maximum temperature		78	S1	R/W	y	50	400	0.001	C		UL	/1000
D	1	6	78	1		Operating time		78	S2	R/W	y	1	1000	0.001	s		UL	/1000
D	1	6	78	1		Warning temperature		78	S3	R/W	y	50	400	0.001	C		UL	/1000
I	1	6	78	2		Measurments												
D	1	6	78	2		Value at tripping of function		78	V1	R	n						UL	/1000
D	1	6	78	2		Max. measured value		78	V2	R	n						UL	/1000

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
D	1	6	78	2		Number of trips		78	V3	R/W	n						UL	/1000
D	1	6	78	2		Number of startings phase		78	V4	R/W	n						UL	/1000
D	1	6	78	2		Duration of the latest starting situation		78	V7	R	n				ms		UL	/1000
I	1	6	78	3		Phases and event masks												
D	1	6	78	3		Phases used		78	V10	R	y						US	
D	1	6	78	3		Eventmask : Event 1 to 16		78	V11	R	y	0	65535	1			UL	/1000
D	1	6	78	3		Eventmask : Event 17 to 32		78	V12	R	y	0	65535	1			UL	/1000
I	1	6	78	4		Input/Output status												
D	1	6	78	4		Start output	0=E1;1=E0	78	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	78	4		Trip output	0=E7;1=E6	78	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	78	4		Blocked Trip	0=E13;1=E12	78	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	78	4		Warning	0=E15;1=E14	78	O6	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	78	4		Block input	0=E19;1=E18	78	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**6**	**84**			**Frequency supervision**												
I	1	6	84	1		Parameter												
I	1	6	84	1	2	Parameter set 1												
D	1	6	84	1	2	Frequency Set 1		84	S1	R/W	y	0.0	0.5	0.001	fn		UL	/1000
D	1	6	84	1	2	Time Set 1		84	S2	R/W	y	10	1000	0.001	s		UL	/1000
I	1	6	84	1	4	Parameter set 2												
D	1	6	84	1	4	Frequency Set 2		84	S21	R/W	y	0.0	0.5	0.001	fn		UL	/1000
D	1	6	84	1	4	Time Set 2		84	S22	R/W	y	10	1000	0.001	s		UL	/1000
I	1	6	84	2		Measurments												
D	1	6	84	2		Value at tripping of function		84	V1	R	n						UL	/1000
D	1	6	84	2		Max. measured value		84	V2	R	n						UL	/1000
D	1	6	84	2		Number of trips		84	V3	R/W	n						UL	/1000
D	1	6	84	2		Number of startings phase		84	V4	R/W	n						UL	/1000
D	1	6	84	2		Duration of the latest starting situation		84	V7	R	n				ms		UL	/1000
I	1	6	84	3		Phases and event masks												
D	1	6	84	3		Phases used		84	V10	R	y						US	
D	1	6	84	3		Eventmask : Event 1 to 16		84	V11	R	y	0	65535	1			UL	/1000
D	1	6	84	3		Eventmask : Event 17 to 32		84	V12	R	y	0	65535	1			UL	/1000
I	1	6	84	4		Input/Output status												
D	1	6	84	4		Start output	0=E1;1=E0	84	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	84	4		Trip output	0=E7;1=E6	84	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	84	4		Blocked Trip	0=E13;1=E12	84	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	84	4		Block input	0=E19;1=E18	84	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
I	**1**	**6**	**85**			**Synchro Check**												
I	1	6	85	1		Parameter												
D	1	6	85	1		Delta Voltage Set 1		85	S1	R/W	y	0.02	0.4	0.001	Un		UL	/1000
D	1	6	85	1		Time Set 1		85	S2	R/W	y	1	1000	0.001	s		UL	/1000
D	1	6	85	1		Delta Phase Set 1		85	S3	R/W	y	0.005	0.05	0.001	°		UL	/1000
D	1	6	85	1		Delta Voltage Set 2		85	S21	R/W	y	0.02	0.4	0.001	Un		UL	/1000
D	1	6	85	1		Time Set 2		85	S22	R/W	y	1	1000	0.001	s		UL	/1000
D	1	6	85	1		Delta Phase Set 2		85	S23	R/W	y	0.005	0.05	0.001	°		UL	/1000
I	1	6	85	3		Phases and event masks												
D	1	6	85	3		Phases used		85	V10	R	y						US	
D	1	6	85	3		Eventmask : Event 1 to 16		85	V11	R	y	0	65535	1			UL	/1000
D	1	6	85	3		Eventmask : Event 17 to 32		85	V12	R	y	0	65535	1			UL	/1000
I	1	6	85	4		Input/Output status												
D	1	6	85	4		Start output	0=E1;1=E0	85	O1	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	85	4		Synchronous	0=E7;1=E6	85	O4	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	85	4		Blocked synchronous	0=E13;1=E12	85	O5	R	n	0	1	1		0=FALSE; 1=TRUE	US	
D	1	6	85	4		Block input	0=E19;1=E18	85	I1	R	n	0	1	1		0=FALSE; 1=TRUE	US	

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
						R : read W : write PD : saved during power down y : saved after download or leaving program mode with saving datga n : not saved US : unsigned short X{X{X{X}}} UL : unsigned long X{X{X{X}}}.X{X{X}} SL : signed long {+}I-X{X{X{X}}}.X{X{X}} ST : string of maximal 21 characters												
						Event list												
						Monitoring values												
						Coil continuity output 1, I/O card 1	0=E17;1=E16	0										
						Coil continuity output 2, I/O card 1	0=E19;1=E18	0										
						Coil continuity output 1, I/O card 2	0=E21;1=E20	0										
						Coil continuity output 2, I/O card 2	0=E23;1=E22	0										
						SCU status												
E						Down load PC -> SCU	1=E33	0										
E						Up load PC <- SCU	1=E34	0										
E						Power down	1=E35	0										
E						Power up (controller resetted)	1=E36	0										
E						Watchdog	1=E37	0										
E						DSP reset	1=E38	0										
E						Acknowledge Display	1=E39	0										
E						Energy Owerflow	1=E40	0										
E						SCU restarting	1=E50	0										
E						Overflow of event register	1=E51	0										
E						Temporary disturbance in data communication	1=E52	0								not in the SCU generated (MSU, SRIO ..)		
E						No response from the SCU	1=E53	0								not in the SCU generated (MSU, SRIO ..)		
E						The SCU responds again	1=E54	0								not in the SCU generated (MSU, SRIO ..)		
						Systemerrors												
						operating system definition of errors												
E						ENQ_ERROR	1=E0	102										
						driver EEPROM definition of errors												
E						MemFullError	1=E1	102										
E						ReadyError	1=E2	102										
E						WritingByteError	1=E3	102										
E						VppLowError	1=E4	102										
E						BlockError	1=E5	102										
E						SuspendedError	1=E6	102										
E						StatusRegError	1=E7	102										
E						EraseAdrBlockError	1=E8	102										
E						NOT_IDENT_EEPROMDATA	1=E9	102										
E						EEPROM_DATA_DISRUPTED	1=E10	102										
E						WRONG_BLOCK	1=E11	102										
						HOST INTERFACE: definition errors												
E						WRITE_HOST_ERROR	1=E20	102										
E						CONFIG_DSP_ERROR	1=E21	102										
E						CALIBRATION_DSP_FAULT	1=E22	102										
						COMMUNICATION: PC <->SCU definition errors												
E						TIMEOUT_ERROR	1=E30	102										
						PROTECTION FUNCTION: definition errors												
E						AUTORECL_ERROR	1=E40	102										
E						CONFIG_ERROR	1=E41	102										

Table 59: List of SPA Bus data

k1	k2	k3	k4	k5	k6	Data	Events	Channel	Code	Data	Save	Values				Single Values	Type	Factor
MicroSCADA key										Dir		Min	Max	Step	Unit			
E						UNDEFINED_PROT_ERROR	1=E42	102										
						CONFIGURATION errors:												
E						WRONG_CONFIGURATION	1=E43	102										
						LON: definition of errors												
E						CONFIG_LON_ERROR	1=E48	102										

11.12 Feedback form

Dear user

We are continuously improving the quality of our Handbook. This is why your opinion is important to us.

The following pages are provided for your wishes, suggestions and criticisms.

Please take advantage of this opportunity to let us know what you think. If you do not use the form provided, please include the document number and the release information (date and reference). Both can be found in the footer of the Handbook.

Thank you

ABB Calor Emag Mittelspannung GmbH
Abteilung: DECMS/S
Oberhausener Str. 33
D-40472 Ratingen/Germany

Phone +49 (0)2102 12 1230
Fax +49 (0)2102 12 1916

Have you found an error in the Handbook?
Please describe the error.

Do you consider the Handbook complete, comprehensible and well structured? If possible, please provide suggestions for improvement.

Do the Handbook include sufficient information on:

- The technical data
- The functioning of the unit
- Using the configuration program
- Using the unit itself

Customer: ______________________ Date: ______________

Address: ______________________________________

Contact: ______________________________________

Tel.: ______________________ Fax: ______________

Processing (to be completed by ABB)

Received by: ______________________ Date: ______________

Answered by: ______________________ Date: ______________

Problem solved? ☐ Yes ☐ No

Name: ______________________ Date: ______________

Action taken to solve problem:

Follow-up (e.g. for project development or documentation)

Subject Index

G

H

I

J

L

M

T

U

V

W

12 New REF542 Version V2C04

Version V2C04 of the software replaced the previous Version V2C02 in August 1998. The interim Version V2C03 was intended solely for internal ABB test purposes. With this new version the REF542 bay control and protection unit (SCU) has the following components:

Configuration Program	V2C04
Microcontroller:	V2C04 or V2C04B
DSP:	V2C04
SPA bus:	V3.01
MVB bus:	V2.0
LON interbay bus:	V9.01

In the configuration program you can read the current versions of the REF542 micro-controllers (MC) and the configuration program.

↳Chapter " Version" on page 4-18

Version V2C04 has improvements in the system response of certain functions compared to the prior Version V2C02. Some new functions have also been implemented. The current operating instructions for Version V2C02 are valid in their entirety.

The following description of the new or improved functions is a supplement to the above-mentioned operating instructions.

Note: Version V2C04 is backwards compatible to the earlier Versions V2C02, V2C01 and V2C00. Applications made with this earlier version can be used.

12.1 Changes and supplements

Note: The Handbook für Version V2C02 (only in german available) is further valid. It is corrected and supplemented with this chapter.

In the following subsections you find changes and supplements. After a reference to the concerned chapter you find the description of the new or changed function.

12.1.1 Print setup

↳**Supplement to:** Chapter "4.5.2.1 Main Menu/File" on page 4-16

In this version the configuration program has a function for setting up a printer. When the configuration program is installed, the default printer is activated initially. If required, another printer can be directly selected and defined as the default printer.

12.1.2 Add connection/Number of connections

↳ **Changes to:** Chapter "4.5.1.7 Add or move connection" on page 4-7

Connecting function blocks

- Position the mouse cursor over a connection point on a function block. The mouse cursor will change to the shape of a soldering iron.
- To make a connection hold the right mouse button down and drag the mouse to another connection point. The mouse curser looks again like a soldering iron.
- Release the right mouse button.

The number of connections is increased from 512 to 560. However, the numbers 11 to 512 are used for designation of the connection.

Changes to: Chapter "4.5.2.8 Drawing menu/Edit" on page 4-21

The menu item Mode is not longer available.

Changes to: Chapter "4.5.2.6 Main menu/Help" on page 4-20 **and** Chapter "4.5.2.13 Drawing menu/Help" on page 4-24

The Function Keys F3 and F4 are not longer in use. You can now switch directly between connection mode and drawing mode.

12.1.3 Blocking the protective funktions

Supplement to: Chapter "5.4.7 General Information on the protective functions" on page 5-87

In this version, when a protective function is blocked (connection pin `BI` or `BS`), the messages, such as start, are also fully blocked, except for the trip. Messages are no longer generated for the station control system.

However, if the block is lifted during a continuing power system fault, the active messages will be released immediately. If the appropriate condition is met, for example start and expiry of the delay period, the trip may be initiated, if applicable. In this case - if available in the station control system - timestamping or time marking will be correctly set to the beginning of the fault.

12.1.4 Shorter trip time: Overcurrent instantaneous, I>>>

Changes to: Chapter "5.4.8.4 Overcurrent instantaneous" on page 5-102

The trip time of this function is shorter with Version V2C04. The shortest trip time is now (**0 ms**+t_{relay}) and not longer (20 ms + t_{relay}). The actual setting range is shown below:

Setting range: [**0** ms + t_{relay}] … 300 000 ms (increment: 10)

The relaytime is 15 ms for solid-state relays and 30 ms for conventional relays.

12.1.5 New Protection function: Earthfault directional sensitive (Io>dir., sensitive)

Supplement to: Chapter "5.4.8 Current protective functions" on page 5-90

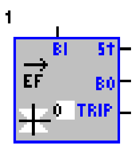


Figure 288: Function block Earthfault directional sensitive (Io>dir., sensitive)

Function

In Version V2C04B the function of earthfault directional sensitive has a new implementation. This function is primarily for ground fault detection in medium-voltage networks with ground fault compensation or with isolated neutral point, particularly if the network has strong harmonic or is subject to significant disturbance variables at a frequency of 16 2/3 Hz from the railway power system.

The difference from the prior functions is how the measured quantities are processed and the configuration of the transducers or sensors. Initially, the base harmonic is determined from the measured quantities in the neutral system, i.e. from the neutral point ground voltage and the ground current, with the DFT algorithm (DFT = digital Fourier transformation). Then a directional determination is made. Because medium-voltage networks with ground fault compensation are generally only found in European countries, this function is accordingly provided for networks with a 50 Hz rated frequency.

The neutral point ground voltage is calculated directly from the sum of the 3 conductor-ground voltages. As a result, the connection to zero-voltage transformers or open delta winding in the voltage transformer set is not required. The ground current must be obtained by a cable current transformer, whose rated current should be as low as possible. The measured quantities from the cable current transformer must always be to the 7th input.

In networks with ground fault compensation, the effective power proportion of the neutral system (cos j circuit) is generally calculated and evaluated for directional decision. In contrast, the reactive power proportion (sin j circuit) in networks with isolated neutral point of the neutral system must be used.

Chapter "11.8 Network neutral point earthing" on page 11-35

If the ground current response time and the setting value of the neutral ground voltage are exceeded, the protective function is started. The setting of the neutral ground voltage is based on the neutral voltage, which is derived from the sum of the 3 conductor-ground voltages. If the starting and a decision in the forwards direction is present, the protective function generates a "trip" signal after expiry of the time delay, which can be adjusted. If the decision is in the backwards direction, a "BO" signal (= Blocking Output) is generated. In this case, the function does not wait for the time delay to expire!

Note

The message ground fault in backwards direction is sent to the BO output immediately. In this case, the function does not wait for the time delay to expire. The BO signal may be used for signal comparison protection if required.

With the real power measurement (cos φ) the response characteristic for the forward direction is set by a straight line drawn parallel to the horizontal axis. The following diagram shows the directional definition. The distance to the horizontal axis is specified by the setting value of the ground current in the opposite phase to the neutral ground voltage.

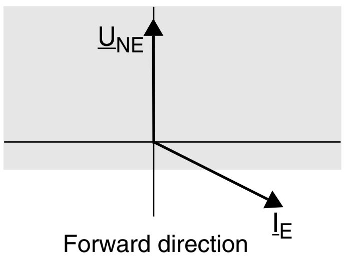


Figure 289: Vector diagram of the earthfault directional sensitive for networks with ground fault compensation.

With the reactive power measurement (sin φ circuit) the response characteristic for the forward direction should be set by a straight line drawn parallel to the vertical axis. The following diagram shows the directional definition. The distance to the vertical axis is specified by the setting value of the lagging ground current (inductive) at 90° to the neutral ground voltage.

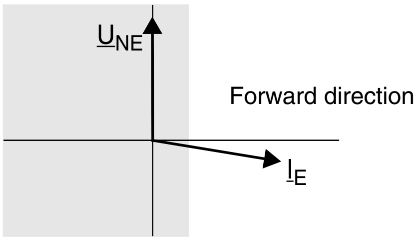


Figure 290: Vector diagram of the earthfault directional sensitive for networks with isolated neutral point.

To ensure the required sensitivity and discrimination for the ground fault detection, in its implementation in the REF542 bay control and protection unit (SCU) the response characteristic is formed with additional adjustability. The following diagram shows the shape of the response characteristic.

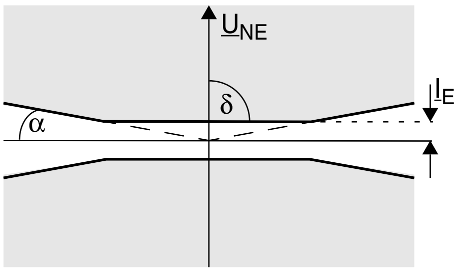


Figure 291: Response characteristic of the earthfault directional sensitive for networks with ground fault compensation (cos φ circuit).

The parameter d initially offers the option of variable settings for the angle between the current and the voltage-proportional measured quantities in the range of –180° to 180°. The provides the option of compensating for a possible phase error in the representation of measured quantities from the network. For example, if it can be assumed that the phase errors in representation can be disregarded, in networks with ground fault compensation (cos φ circuit) the angle d will have to be set to equal 180°. In contrast to that, in networks with isolated neutral point (sin j circuit) an angle of 90° (inductive) will have to be set. If the phase error is not to be disregarded, the setting will have to be corrected.

The other parameter a is used to improve the discrimination of the directional decision. This opening angle can suppress a possible faulty response of the directional decision. This means that only directional ground-fault protection functions, which are in the immediate vicinity of the ground fault location, should respond.

The response time I_E gives the parallel displacement of the response characteristic from the axis. In the above diagram the response characteristic for networks with ground fault compensation (cos φ circuit) is shown with d equal to 180°. The displacement from the horizontal axis is set by the response time I_E. The response characteristic for forwards or backwards direction is formed to be balanced. When making settings for networks with isolated neutral point (sin j circuit), the response characteristic must be displaced parallel to the vertical axis.

Note

There is a failure in the definition for the angle δ in networks with ground fault compensation (cos φ circuit). You must adjust the angle δ=0° instead of δ=180°. For networks with isolated neutral point (sin φ circuit) the angle δ=90° is correct.

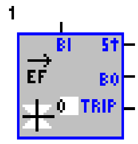


Figure 292: Function block Earthfault directional sensitive (Io>dir., sensitive)

Connections

`BI` input: A logical 1 signal at this input suppresses the protective function trip signal. The funcion is still dispayed on the tripping page.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`BO` output: If the protective function detects a starting in the opposite direction to the set tripping direction, a logical 1 signal will be sent to this output. In this case, the function does not wait for the time delay to expire.

`Trip` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip threshold for the set period.

Configuration

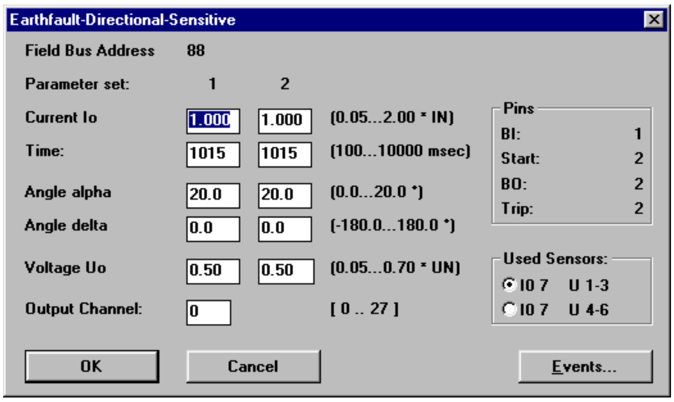


Figure 293: Configuration dialog function block earthfault directional sensitive

Information field `interbay bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `current Io` (once per parameter set): Input of the multiplier for I_N to specify the response time for the ground current I_E of the protective function.
Setting range: 0.050 … 2.000 (increment: 0.001)
Default: 1.000

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value (response time) remains exceeded and the tripping direction conforms to the parameter setting.
Setting range: 100 ms … 10 000 ms (increment: 1)
Default: 1015

Input field `angle alpha` (once per parameter set): Angular setting for increasing the opening angle of the response characteristic to retain clear directional decisions.
Setting range: 0.0 … 20.0 ° (increment: 0.1)
Default: 20 °

Input field `angle delta` (once per parameter set): Angular setting for definition of the network neutral point handling.
Setting range: -180.0 … 180.0 ° (increment: 0.1)
Default: 0 °

Input field `voltage Uo` (once per parameter set): Input of the multiplier for U_N to specify the response time for the ground current I_E of the protective function. This refers to the reference quantity of the neutral voltage!
Setting range: 0.05 … 0.70 (increment: 0.01)
Default: 0.5

Input field `output channel:` Input of the number of the binary output for the direct output signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of direct tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Information field `pins:` List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Option field `used sensors`: Selects the analog measuring inputs to which the transducers/sensors are connected and to whose values the protective function should react.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

↳Chapter "5.3.2 Global Settings" on page 5-2

Table 60: Event list of Earthfault directional sensitive (Io>dir., sensitive)

Earthfault directional sensitive (Io>dir., sensitive)					
	88	E 0	Start started	E 1	Start back
	88	E 6	Trip started	E 7	Trip back
	88	E 12	Trip block started	E 13	Trip block back
	88	E 18	Protection block started	E 19	Protection block back

12.1.6 Revised protection function: Synchrocheck

↳**Changes to:** Chapter "5.4.12.6 Synchrocheck" on page 5-199

To enable this function to be combined with other protective functions without problems, for example with the distance protection, it has been revised in this version. Input 7 of the active sensors is provided for measuring the external phase-to-neutral voltage U_{2L12} of the 2nd network.

The function and the settings are described in detail once again below.

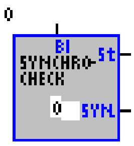


Figure 294: Function block Synchrocheck

Function

The paralleling monitoring checks the voltage quantities of two networks and only generates a closing command if the difference of the voltage amplitudes, the phase difference and the frequency vary within the set allowable limits for a specific period.

For this purpose the paralleling monitoring initially uses two conductor-ground voltages from the 1st network, i.e. the voltage U_{1L1E} from the phase L1 and voltage U_{1L2E} from the phase L2. Then the external phase-to-neutral voltage U_{1L12} is calculated from the above. Therefore, to implement the paralleling monitoring, the external phase-to-neutral voltage U_{2L12} from the 2nd network between the phases L1 and L2 is required.

To implement the paralleling monitoring function a differential voltage ΔU is initially determined from the two external phase-to-neutral voltages as an auxiliary quantity. This auxiliary quantity is used to check the synchronicity of the two networks with respect to their phase angle and amplitude, in that the differential voltage in amplitude and phase must remain within the set time limits.

If the values of the differential voltage and the phase difference are within the set limit, first the protective function is started (St). If the valuesremain within these limits for at least the set time, both networks are equalized in their frequencies to that extent. The signal (SYN) for parallel switching by both networks is formed. Two parameter sets may be configured for the paralleling monitoring.

Setting

The setting of the paralleling monitoring function is shown by examples below. If two networks must be switched in parallel, the voltage amplitudes in both networks must first be nearly equal and should approximate the value of the rated voltage. So long as the frequencies in the networks are different, the two voltages will naturally not be synchronous. A phase displacement occurs between the two voltages that need to be equalized. As a result a differential voltage dependent on the time occurs. This differential voltage can be used to determine whether the two networks can be parallel switched. The voltage ratios are shown in an example in the following diagram.

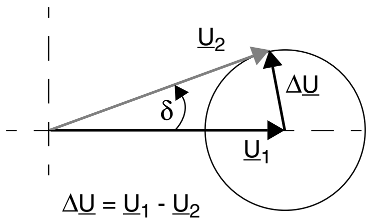


Figure 295: Vector diagram of the voltage quantities with unequal frequencies.

As shown in the diagram, the phase difference that needs to be set depends on the setting of the differential voltage as follows:

$$\Delta\delta = arctan\left(\frac{\Delta U}{U}\right)$$

$\Delta\delta$: Setting the phase difference
ΔU: Setting the differential voltage as start value
U: Rated voltage of a network as reference quantity

After transposing the above equation the required voltage difference can be calculated:

$$\Delta U = U \cdot tan\Delta\delta$$

A time window as follows can be used:to check the frequency variation

$$t = \frac{2 \cdot T_n \cdot \Delta\delta}{360°} \cdot \frac{f_n}{\Delta f}$$

t: Time window to check frequency
T_n: Period duration at rated frequency
f_n: Rated frequency
Δf: Frequency difference

So long as the frequency difference remains within an allowable limit, the set time can run out. This enables the signal "SYN" to be formed for parallel switching of both networks.

Connections

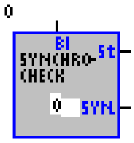


Figure 296: Function block Synchrocheck

`BI` input: A logical 1 at this input will suppress the protective function trip signal. The function on the tripping side will still be displayed.

`Start` output: A logical 1 signal can be tapped here so long as the protective function is started.

`Syn` output: Becomes logical 1 as soon as one of the three monitored voltages exceeds the trip treshhold for the set period. The switching operation for coupling the separate systems can be released with this signal.

Application

A paralleling monitoring is required for coupling two networks. The paralleling monitoring can also be used before the reswitching after a three-line autoreclosure.

↳"Table 40: Use of the protective functions depending on the configuration of the analog measuring inputs" on page 5-89

Configuration

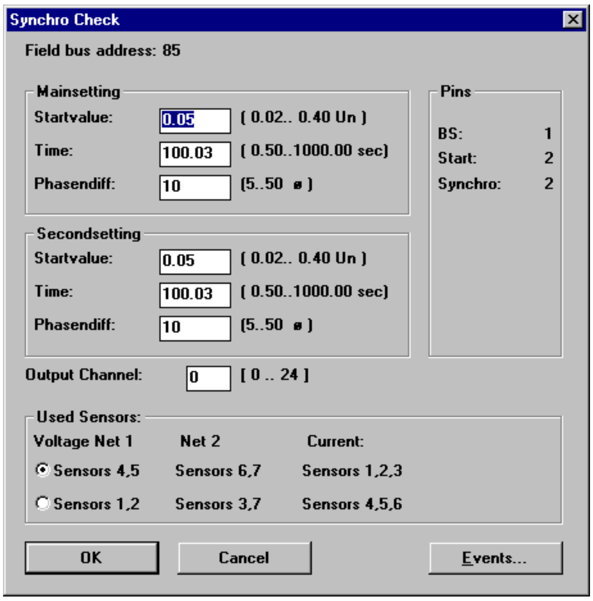


Figure 297: Configuration dialog function block synchrocheck

Information field `interbay bus address`: Set for every protective function and used to address the function block for interbay bus commands.

Input field `start value` (once per parameter set/setting): Input of the multiplier for U_n to specify the response time of the protective function. The amplitude of the allowable differential voltage is set here.
Setting range: 0.02 … 0.40 (increment: 0.01)
Default: 0.05

Input field `time` (once per parameter set/setting): Delay period in ms after which the protective function trips if the start value and the phase difference remains exceeded.
Setting range: 0.50 … 1000.00 s (increment: 0.01)
Default: 100

Input field `(phasendiff.) phase difference` (once per parameter set/setting): Input of the maximum phase difference between the networks that are to be coupled or the maximum phase difference of the differential voltage.
Setting range: 5 … 50° (increment: 1)
Default: 10°

Input field `output channel:` Indicates the number of the binary output affected by the direct trip signal. For safety and documentation the output must also be made via a switching object in the function chart. Input of the value 0 suppresses the option of faster tripping. The number of the selected binary output is also shown in the FUPLA. It is underlined in white in the relevant function block.
Setting range: 0 … [number of binary outputs] (increment: 1)
Default: 0

Information field `pins`: List of connections on the function block with adjacent connection number. The connection numbers 1 (on one input) and 2 (on one output) appear if the function block still has no connections made.

Option field `active sensors`: Selects the analog measuring inputs to which the transducers/sensors to whose values the protective function reacts are connected.

Button `OK`: All settings are saved in the configuration program. The dialog window is closed.

Button `Cancel`: Settings are not saved in the configuration program. The dialog window is closed.

Button `events`: A configuration dialog is opened. Mark (activate) the events that should be sent to the station control system over the interbay bus. The button can only be selected when the events function has been activated in the REF542 basic settings.

✎Chapter "5.3.2 Global Settings" on page 5-2

✎Chapter "11.3 Event list of protective functions" on page 11-6

12.1.7 Changed recording: Fault recorder

✎**Supplement to:** Chapter "5.4.13 Faultrecorder" on page 5-202

Recording changes in the start- and trip-signals in the fault recorder is no longer set by the FUPLA cycle time with the introduction of this version. These signals are now recorded at a default sampling rate of approximately 800 Hz. This enables changes in the start- and trip-signals to be detected with a precision of about 1.2 ms. A maximum time error of 2 ms can therefore be ensured. This required the corresponding signals to be directly linked to the inputs of the fault recorder.

The sampling rate of the other signals depends, as before, on the FUPLA cycle time.

It should be noted that in this robust fault recorder function the digital filter times set in the configuration software no longer need to be taken into account.

The analog signals of the instrument transformers or measuring sensors are recorded as before at a sampling rate of 1200 Hz.

Note The load on the DSP has also increased in this version. Once it has been activated, the fault recorder takes up 35% of the available DSP calculation capacity.

12.1.8 Changed measured value display

↳**Changes to:** Chapter "8.1.4.3 Retrieving measured and calculated values" on page 8-5

Because of unavoidable electromagnetic influences at the installation site of the REF542 bay control and protection unit (SCU), in some cases it may occur that a very small current value is displayed in the phases in spite of the deactivated power circuit-breaker. Therefore, with the introduction of Version V2C04 the measured value display is equipped with a neutral suppression. The value zero is shown on the LC display if the measured values are less than 1 % of the rated value.

The measured value response time has also been implemented. This is to ensure that measured values are only sent to the station control system after a time delay dependent on the size of the change. The equation for the time delay is as follows:

$$t = \frac{6}{\Delta A}\left[\frac{\% \cdot s}{\%}\right]$$

Where

t: The resulting time delay
ΔA: On the change based on the current measured value

If the load current of 200 A changes to 206 A in the network, for example after switchover actions have been conducted, according to the above definition $\Delta A = 3$ %. According to the above equation this change will only be sent to the control system 2 s later if the current remains constant at 206 A.

The frequency display has been expanded to ± 5 Hz. At 50 Hz rated frequency the display range is 45 Hz to 55 Hz. This requires the corresponding measured quantities, voltage or current, to be present in sufficient quantity to enable the frequency to be determined with the required precision. If the frequency cannot be determined, no display is visible.

↳Chapter "11.7.4 Calculation of the frequency" on page 11-33

ABB Calor Emag Mittelspannung GmbH

Oberhausener Str. 33
D-40472 Ratingen

Phone +49 (0)2102 12 1230
Fax +49 (0)2102 12 1916
e-mail: calor.info@de.abb.com
Internet: www.abb-calor-emag.de

ABB Sécheron SA

Rue des Sablières 4-6
CH-1211 Genève 2

+41 (0)1 318 3300
+41 (0)1 318 1188

ABB SACE T.M.S. S.p.A.

Via Friuli 4
I-24044 Dalmine (BG)

+39 (0)35 395 111
+39 (0)35 395 874