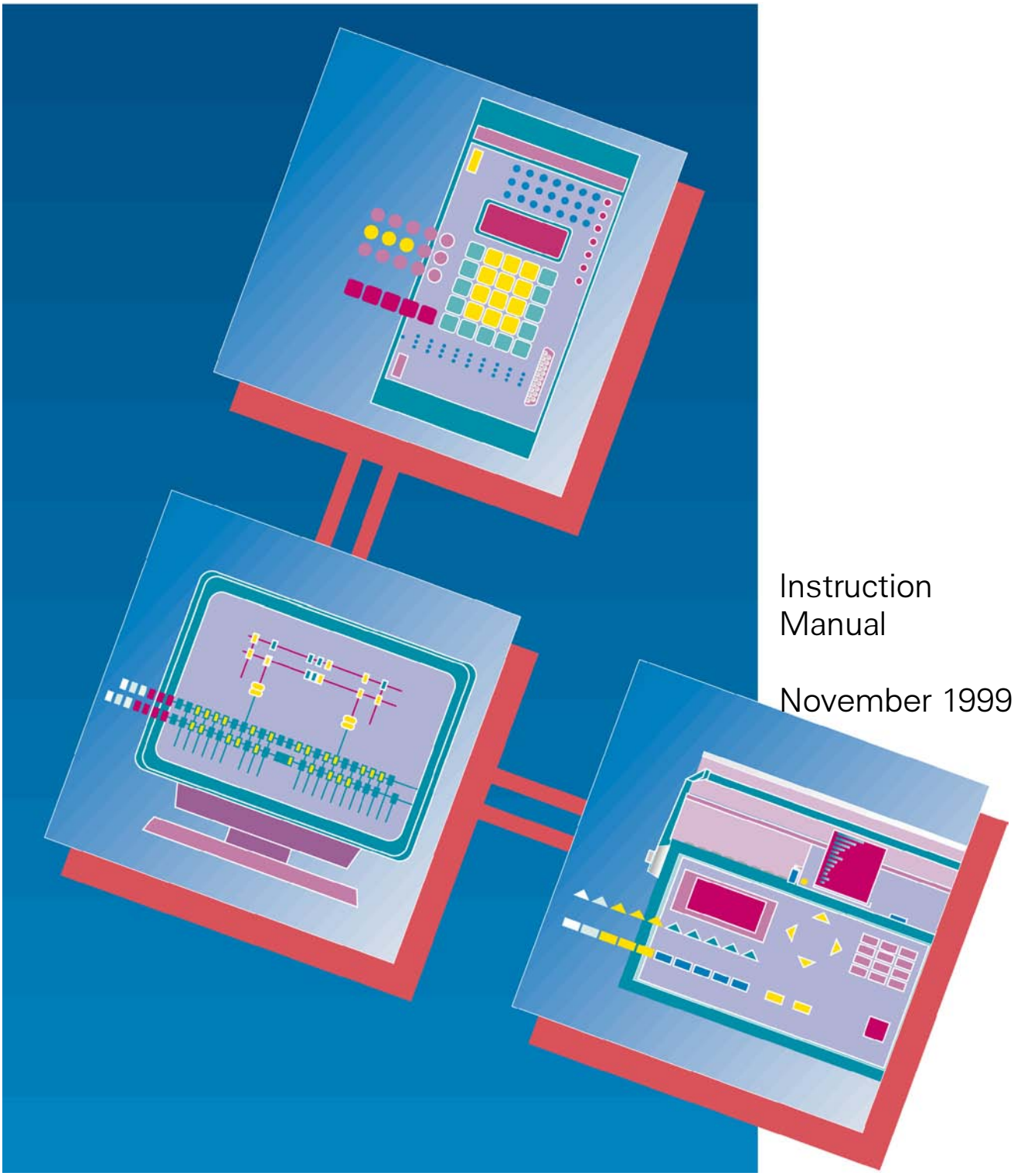
SIEMENS

Numerical Overhead Contact-Line Protection 7SA518/519 V3.2



Instruction Manual

November 1999

SIEMENS

Numerical Overhead Contact-Line Protection 7SA518/519 V3.2

Instruction Manual Order No.: C53000-G1176-C108-3

Edition November 1999

The table below does not represent a complete list of all the safety measures needed to operate the device or module, since specific operating conditions may make further measures necessary.

Warning

During operation of electrical equipment, some parts always carry a dangerous voltage. This means that if you do not act correctly, severe injury or serious damage to property may result.

- Before making any connections, ground the equipment at the protective earth terminal.
- Dangerous voltages may be connected in all the circuits connected to the voltage supply.
- Dangerous voltages can still be present in the device even after the supply voltage has been separated (capacitor).
- Equipment with current transformer circuits may not be run open.
- The limit values stated in the manual or in the operating instructions may not be exceeded; this also applies at testing and commissioning.
- Only qualified personnel are allowed to work on this equipment. Faultless and safe operation of the equipment is conditional on correct transportation, storage, set-up and assembly as well as careful operation and corrective maintenance.

For reasons of clarity, this manual does not contain all the details of all product types and cannot take into account all possible set-up, operation and corrective maintenance options.

If you need more information or have special problems that are not gone into in enough detail in the operating instructions, ask your local Siemens distributor.

Qualified personnel are considered to be persons who are familiar with setting up, assembling, commissioning and operating the product and who have qualifications appropriate to their activities.

- Trained, instructed or authorized to commission, ground and mark circuits and equipment in accordance with recognized safety standards
- Trained or instructed in accordance with recognized safety standards in the care and use of appropriate safety equipment
- Trained in first aid

Information about CE Conformity

The product complies with the specifications of the guideline of the European Council on the Coordination of the Legislation of the member countries with regard to electromagnetic compatibility (EMC Guideline 89/336/EU).

This conformity is the result of a test that SIEMENS AG carried out in accordance with Article 10 of the guideline in conjunction with basic specifications EN 50081-2.

The device was developed and manufactured for industrial applications in accordance with the EMC standard.

The product conforms to international standards of series IEC 255 and to German standard DIN 57435, Part 303.

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Numerical Overhead Contact-Line Protection 7SA518/519 V 3.2 — Instruction Manual Order No. C53000-G1176-C108-3

1 Introduction

This manual describes the most important characteristics of the Numerical Overhead Contact-Line Protection System, 7SA518/519, and how to handle it. Before commissioning the device, read the manual completely. Each chapter contains a description of an important feature of the protection device and of its use.

1.1 Chapter Overview

Chapter 1: Introduction
This chapter provides an overview of the contents of this manual and is complemented by information on selection and ordering data.

Chapter 2: Product Description
Chapter 2 provides an outline of the area of application, the most important characteristics and the scope of features of the digital overhead contact-line protection system, 7SA518/519. This chapter also contains descriptions of the designs, dimensions and constructions of the devices.

Chapter 3: Method of Operation
This chapter describes all the functions of the digital overhead contact-line protection system, 7SA518/519.

Chapter 4: Instructions for Preparation
Chapter 4 provides information about transportation, adaptation, assembly and connection of the protection device.

Chapter 5: Operating Instructions
This chapter describes in detail how you operate, test and commission the digital overhead contact-line protection system, 7SA518/519.

Chapter 6: Maintenance and Troubleshooting
The options for troubleshooting and replacing parts of the device are contained in this chapter.

Chapter 7: Corrective Maintenance
This chapter contains information about corrective maintenance of the digital overhead contact-line protection system, 7SA518/519.

Chapter 8: Storage
This chapter contains information about storage of the digital overhead contact-line protection system, 7SA518/519.

Reference Section:
The reference section contains all the relevant technical data as well as standards and guidelines. This section is complemented by plans and tables to adapt and connect the digital overhead contact-line protection system, 7SA518/519.

Appendix:
The appendix consists of various overview and characteristic tables.

1 Introduction

1.2 Selection and Ordering Data

Table 1.1 gives an overview of available variants of the 7SA518/519 Digital Overhead Contact-Line Protection System and their order numbers. To complement this, the available documentation on this topic is listed together with order numbers.

Table 1.1 Selection and Ordering Data

Numerical Overhead Contact-Line Protection System 7SA518/519	Order No. **7SA51 □ □ - □ □ A □ 0 - □ □ A 0**
Scope of functions	
Without external temperature processing, without instantaneous tripping unit.	**8**
With external temperature processing and instantaneous tripping unit.	**9**
Rated current at 50/60 Hz AC	
1 A	**1**
5 A	**5**
Rated auxiliary voltage	
24, 48 V DC	**2**
60, 110, 125 V DC	**4**
220, 250 V DC	**5**
Mechanical Design	
Panel surface mounting	**B**
Panel flush mounting	**C**
Cubicle installation (without glass front)	**E**
Instantaneous tripping unit, rated voltage	
Without (7SA518)	**0**
60 V (7SA519)	**1**
110/220 V (7SA519)	**2**
Automatic reclosing, AR, (including Therm AR) and Reverse impedance settings Z1 REV, Z2 REV	
without AR, without Z1 REV, Z2 REV	**1**
with AR, without Z1 REV, Z2 REV	**2**
without AR, with Z1 REV, Z2 REV	**3**
with AR, with Z1 REV, Z2 REV	**4**
System interface to the substation control and protection system	
Without	**A**
Integrated 820-nm OWG connection	**C**

Documentation	
Catalogue sheet LSA 2.1.14: Line protection 7SA518/519 (V3) for traction overhead contact-lines	**E50001-K5712-A241-A1**
Instruction manual: 7SA518/519 (V3) Digital overhead contact-line connection	**C53000-G1176-C108-3**
Instruction manual: ATE 7SW400	

2 Product Description

This chapter provides an outline of the area of application, the most important characteristics and the scope of features of the digital overhead contact-line protection system, 7SA518/519. It also contains descriptions of the designs, dimensions and constructions of the devices

2.1 Application

The numerical overhead contact-line protection system, 7SA518/519, is a selective and rapid protection system for single-end- and multi-end-fed overhead lines in meshed networks of any configuration.

The device contains all the functions that are normally needed to protect an overhead line section. This makes it suitable for universal applications.

The basic function is recognition of the short-circuit distance by means of **distance measurement**.

Depending on the selected variant, this is complemented by a range of other protection functions:

- Overcurrent high-speed protection I>>>
- Thermal-protection function
- Fault location
- Auto-reclosing (AR)
- Thermo-protection reclosing (Thermal AR)

2.2 Characteristics

The numerical overhead contact-line protection system, 7SA518/519, is characterized by the following features:

- A device in a sturdy, steel housing that is ready to connect;
- Variants are available for mounting on control panels as well as installing in control panels and relay cubicles;
- Complete galvanic and noise-free separation of the internal processing circuits from the measuring, control and supply circuits of the system by means of screened measured value transformers, binary input and output modules and dc-dc voltage transducers;
- A powerful 16-bit microprocessor system;
- Complete digital measured value processing and control ranging from sampling and digitizing the measured quantities to making the trip and close decisions for the circuit breaker;
- Easy operation by means of the integrated operation and display panel or using a connected personal computer with operator guidance;
- Communication possible with the substation control and protection system via a serial interface, connection by means of optical fibre.

2.3 Range of Functions

The numerical overhead contact-line protection system, 7SA518/519 offers a complete range of functions relevant to the task of protecting a line branch:

Distance Protection

- Two distance zones, either in the operative direction or non-directional; two additional extended zones for the AR;
- Three time stages;
- Circular tripping characteristic with separate setting of the range (impedance amount Z) and the angle;
- Directional specification with voltage memory, thus allowing unlimited directional sensitivity;
- Instantaneous tripping in the case of manual switch-on a bold fault.

Fault Location

- Triggering due to fall-back of the distance protection starting, to a triggering command or to an external command;
- Calculation of the fault impedance and the fault distance, even for non-homogenous lines with up to five sections
- Display of the fault location in Ohms, kilometers or percent of the line length.

Auto-Reclose (AR)

- Rapid auto-reclose (RAR) and multiple delayed auto-reclose (DAR) (up to nine cycles);
- Current-controlled AR;
- Control of the internal AR functions by means of an external protection system;
- Range control using two special extended zones, Z1B and Z1L, of the distance protection system;
- Additional functionality, e.g. test-RAR and circuit breaker monitoring.

Thermal Auto-Reclose (Thermo-AR)

- Up to nine cycles;
- Close command is issued when the overhead line temperature falls below the limit value.

High-Speed Overcurrent I>>>

- High-speed closing if a parametrizable threshold value is exceeded for the handling of short-circuits at the station level.

Emergency Function

- With independent current/time characteristic;
- Effective when the current converter circuit breaker trips;
- Effective with a measuring voltage failure (e.g. due to a fuse).

Thermal Protection

- Thermal replica of the overhead contact-line taking into account the loading and the external temperature;
- Three alternative characteristics.

Breaker Failure Protection

- Starting by means of an internal trip command, Starting by means of a binary input (external), Internal or external starting;
- Two-stage design.

The range of functions also includes

- Four **user-definable annunciations** with time stages to implement logical operations, delays and message processing of any external signals;
- Constant **monitoring** of the current and voltage inputcircuits, the internal measuring circuits and the hardware and software, which leads to increased availability;

- **Operational measurement** in normal load operation:
  Measurement of the load current and the operating voltage, measurement of the frequency and the load angle, measurement of the load impedance;
- **Message storage** for fault event logs of the last twelve network faults with real-time assignment; the system stores all the messages that are not directly associated with a fault in the operating message buffer;
- **Data storage and transfer** for fault recording, which leads to fast fault analysis and detailed fault logging;
- **Counting the tripping and closing commands** as well as logging the short-circuit data and accumulation of the cleared short-circuit currents;
- **Commissioning aids**, e.g. direction checks, circuit-breaker checking and test reclosing.
- **Parameter changeover** (up to 4 different parameter sets)
  Changeover by binary inputs, telegrams (system interface) or integrated operator panel.

2.4 Designs

The 7SA518 protection system comprises three modules with the 7SA519 system consisting of four. These modules are mounted in a 7XP20 housing. In this connection, three of the modules are combined in a subrack to form one basic module. Two housing designs are available.

2.4.1 7SA518/519*-*BA**-00 for panel surface mounting

In the case of the panel surface mounting variant, the 7SA518 and 7SA519 devices are supplied in housing types 7XP2030-1 and 7XP2040-1 respectively.

The housing has full sheet metal covers as well as a removable front cover with transparent plastic window for panel mounting.

Plastic guide rails are built in for the support of plug-in modules. Next to the guide rail at the bottom on the left hand side of each module, a contact area which is electrically connected to the housing is installed to mate with the earthing spring of the module. Connection to earth is made before the plugs make contact. Earthing screws have been provided on the left hand side of the housing.

The high-current connectors automatically short-circuit the current converter circuit when you remove the modules.

All the signals, including the auxiliary voltage, are routed on two-tier screw terminals that are arranged on the top and bottom of the device. In the case of version 7SA518, the device has 60 of these terminals. With version 7SA519, by contrast, the device has 100 two-tier screw terminals. On each tier, the terminals are numbered consecutively from left to right. Two F-SMA connections are mounted on the bottom of the device to provide the optical waveguide interface to the station.

Refer to Figures 2.1 and 2.2 for the dimensions of the housing.

2.4.2 7SA518/519*-*CA**-00 for panel flush mounting or for cubicle installation

In the case of the panel flush mounting variant, the 7SA518 and 7SA519 devices are supplied in housing types 7XP2030-2 and 7XP2040-2 respectively.

The housing has full sheet metal covers as well as a removable front cover with transparent plastic window for panel mounting.

Plastic guide rails are built in for the support of plug in modules. Next to the guide rail at the bottom on the left hand side of each module, a contact area which is electrically connected to the housing is installed to mate with the earthing spring of the module. Connection to earth is made before the plugs make contact. Earthing screws have been provided on the rear wall of the housing.

The high-current connectors automatically short-circuit the current converter circuit when you remove the modules.

All the signals, including the auxiliary voltage, are routed on connection modules that are arranged on the back panel. In this context, one screw terminal, and parallel with it, one plug-in terminal per electrical connection are available for system wiring; with command circuit 1, there is a screw terminal only. There are two F-SMA connections on a module to provide the optical waveguide interface to the station.

The connector modules are labelled according to a coordinate system that matches their installation locations. Viewed from the back, the individual terminals within a module are numbered from left to right, e.g. 1C1 and 1B4 (see also Figures R.8/3 and R.8/4 in Chapter R.6 of the Reference Section).

Refer to Figures 2.3 and 2.4 for the dimensions of the housing.

2.5 Dimensions

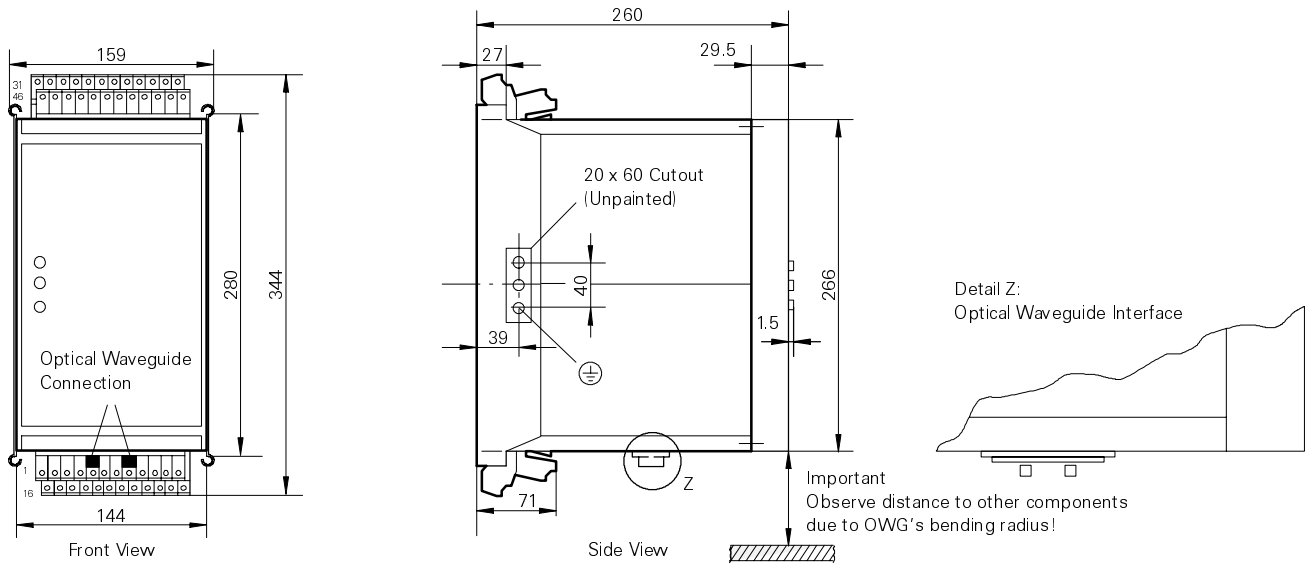


Figure 2.1 Dimensional Drawing of 7XP2030-1 for Panel Surface Mounting, Device Version 7SA518 (all dimensions in mm)

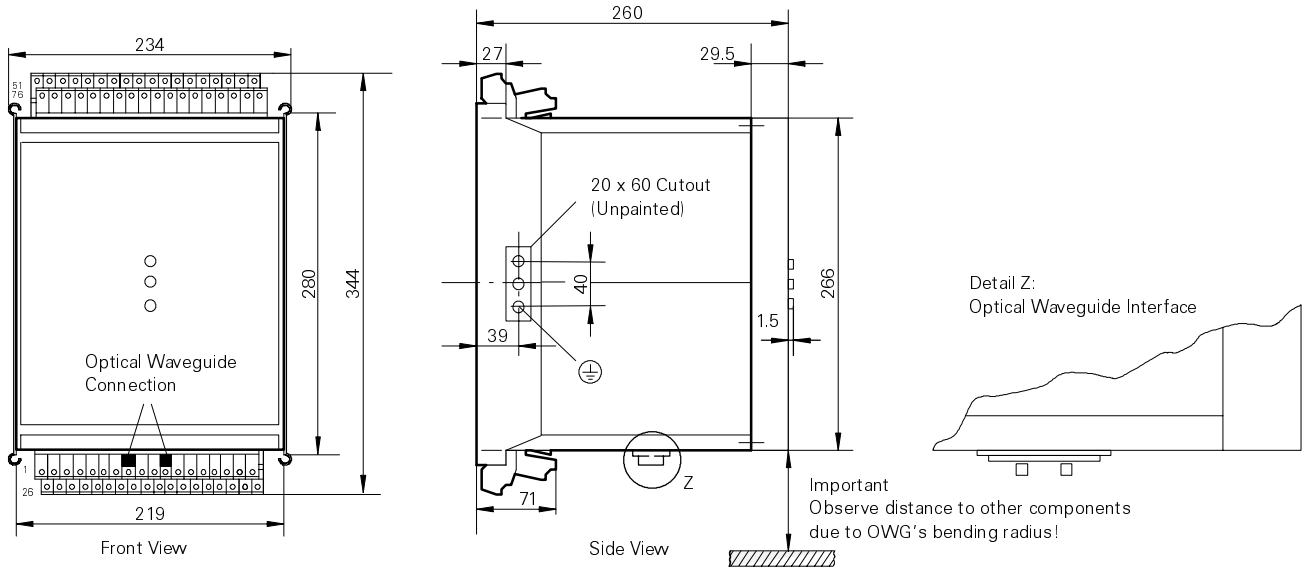


Figure 2.2 Dimensional Drawing of 7XP2040-1 for Panel Surface Mounting, Device Version 7SA519 (all dimensions in mm)

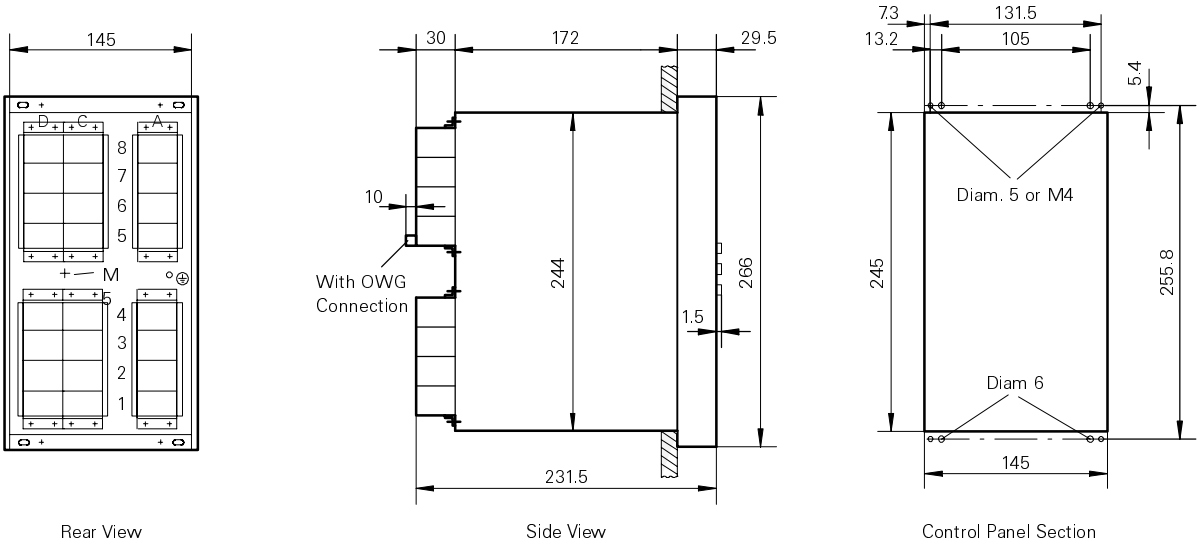


Figure 2.3 Dimensional Drawing of 7XP2030-2 for Panel Flush Mounting or for Cubicle Installation, Device Version 7SA518 (all dimensions in mm)

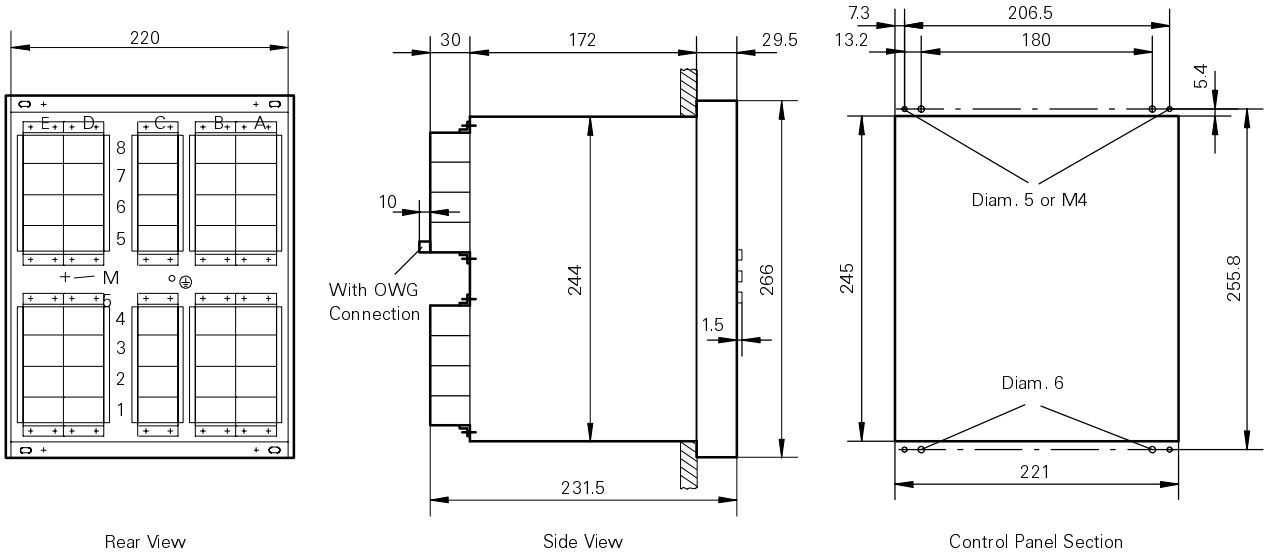


Figure 2.4 Dimensional Drawing of 7XP2040-2 for Panel Flush Mounting or for Cubicle Installation, Device Version 7SA519 (all dimensions in mm)

Table 2.1 Overview of Device Connections

Variant	Device	Current Connections	Voltage Connections	OWG Connections
Mounting on Control Panel	7SA518	60 terminals with the following connection cross-sections: maximum of 4 mm^2 for finely stranded conductors maximum of 7 mm^2 for solid conductors		Integrated F-SMA plug-in connector for OWG connection, e.g. 62.5-/125-µm glass-fibre
	7SA519	100 terminals with the following connection cross-sections: maximum of 4 mm^2 for finely stranded conductors maximum of 7 mm^2 for solid conductors		Integrated F-SMA plug-in connector for OWG connection, e.g. 62.5-/125-µm glass-fibre
Installation in Control Panel or Cabinet	7SA518/ 7SA519	Screw terminal, max. of 4 mm^2 Parallel to this, double flat spring crimp contact for a max. of 2.5 mm^2	Screw terminal, max. of 1.5 mm^2 Parallel to this, double flat spring crimp contact for a max. of 1.5 mm^2 (command circuit 1, screw terminal only)	Integrated F-SMA plug-in connector for OWG connection, e.g. 62.5-/125-µm glass-fibre

2.6 Construction

Binary inputs and outputs from and to the processor are routed via the input/output modules. The processor gets information here from the plant (e.g. remote reset) or from other devices (e.g. blocking commands). The most important outputs are the command to the circuit-breaker, the messages for remote signalling of important events and optical displays (LEDs) and an alphanumeric display field on the front.

Communication with the device is possible by means of an integrated membrane keyboard in conjunction with the alphanumeric LCD display field that is also integrated. Using this unit, you can enter or call all the data necessary for processing, e.g. setting values, plant data (see Chapter 5.2) or read out data that is relevant to a disturbance (see Chapter 5.3).

Manual operating units and PCs can communicate via the serial port on the front.

An optical waveguide is used to transfer fault data to a central analysis unit. In normal operation, the system also transfers measured values here, e.g. the current at the protection unit's place of installation.

The described function units are fed by a power supply with the appropriate power at the various voltage levels. A voltage of +18 V is available to the relay outputs. The analog input needs ±15 V, whereas the processor and its immediate peripherals are fed with +5 V.

A dc voltage store buffers brief voltage dips lasting up to 50 ms that occur in the case of short-circuits in the plant's dc supply system at rated voltages of 110 V, see table R.8.1 in Chapter R.1 of the Reference Section).

3 Method of Operation

In addition to the central functions and monitoring functions of the 7SA518/519 digital overhead contact-line protection system, this chapter describes in detail the user functions of the system. This section of the manual also contains descriptions of how to handle messages, disturbance and measured values.

3.1 Central Functions

The 7SA518/519 numerical overhead contact-line protection system is fitted with a powerful 16-bit microprocessor. This is used to digitally process all tasks ranging from the acquisition of measured variables to the issuing of commands to the circuit breaker.

The measuring inputs transform the currents and voltages coming from the measuring transducers and adapt them to the device's internal processing level. In addition to the complete galvanic separation due to the transformer, filters are provided to suppress disturbances; the bandwidth and processing speed of these filters are optimized for measured value processing.

The system routes the adapted analog variables to the analog input. Functionally speaking, this unit consists of an input amplifier, sample and hold elements, a multiplexer, analog/digital converters and memory chips for the transfer of data to the microprocessor bus.

In the system core, the measured variables are controlled and monitored and the system carries out the actual protection functions. In particular, these include:

- Filtering and conditioning the measured variables;
- Continuously calculating the values relevant to the response of the protective device;
- Polling limit values and time sequences;
- Controlling of signals and sequences for zone setting, evaluation of the thermal protection, etc.
- Deciding on the trip command;
- Storing and outputting messages and fault event data for fault analysis.

3.2 Monitoring Functions

The numerical overhead contact-line protection system 7SA518/519 provides a large number of functions for monitoring the device hardware and software.

In addition, the system continually checks the plausibility of measuring variables. Due to this measure, the current and voltage transformer circuits are also included in monitoring.

3.2.1 Hardware Monitoring

The system monitors the device from the measuring inputs to the command relay. The monitoring circuits and the processor check the hardware for errors and illegal conditions. In detail, the following are checked:

- **Auxiliary and Reference Voltages**
  The processor monitors the offset and reference voltages of the analog-to-digital converter (ADC). If there are illegal deviations, protection is blocked; the system reports permanent faults.

  If the power supply fails or is switched off, the device is taken out of service; the system issues a message via a normally closed contact. Brief voltage dips of less than 50 ms do not affect the device's readiness.

- **Measured Value Recording**
  By means of plausibility checks of the measuring values, the system constantly monitors the chain of analog input circuits from the input converters to digitization.

- **Command Circuits**
  The command relays that are used to trigger the circuit breaker's trip coil are controlled via two command channels and an additional enable channel. While no fault detection is pending, the processor cyclically checks that each channel is functioning correctly. If there is a fault in the channel that is just being checked, or there is a fault in the command relay coil, the system immediately blocks the issuing of commands and an alarm is issued.

- **Memory Chips**
  The system periodically checks memory chips (RAM, EPROM, EEPROM) for errors.

3.2.2 Software Monitoring

A watchdog is provided for continuous monitoring of program execution. If the processor fails or a program gets out of step, the watchdog runs and triggers resetting of the processor. Further internal plausibility checks in program execution ensure that the system detects faults during processing of the programs; these checks also trigger resetting of the processor with a restart. Resetting the processor (restarting) results in the ready for operation relay dropping for the duration of the restart and reporting Device Error with its normally closed contact.

If one of these errors cannot be cleared by the restart, the system tries to restart again. After three unsuccessful attempts to restart, the protection deactivates itself automatically by entering the monitor program (shown on the display). The red Blocked LED lights up. As a result, the ready for operation relay drops permanently and reports a Device Error with its normally closed contact.

3.2.3 Monitoring the External Converter Circuits

The system detects a measuring voltage failure if, at the same time, a minimum current flows across the protected line. This condition is necessary, since the voltage is also zero when the line is switched off. The system detects a voltage failure after a delay time **(Addr. 2902)**, which you can set, when the voltage falls below a parameterizable limit **(Addr. 2901)** and a minimum current of 0.06 $\bullet I_N$ flows at the same time.

When a voltage failure has been detected, the system blocks distance protection; an emergency O/C function is possible. Message Failure Umeas **(FNo. 168)** is generated. Configuration of the individual functions is described in Chapter 5.2.

3.3 User-Defined Functions

The sections below describe functions that users can manipulate by setting parameters. These include all the protection functions, user-defined annunciations and additional test-triggering functions.

To reinforce the written description of these functions, diagrams are used to illustrate the relationships in each case between the input and output functions and signals. Figure 3.1 shows a legend for the symbols used to make it easier to understand the diagrams.

The following always applies: with all binary input functions, the system also generates the corresponding binary output messages.

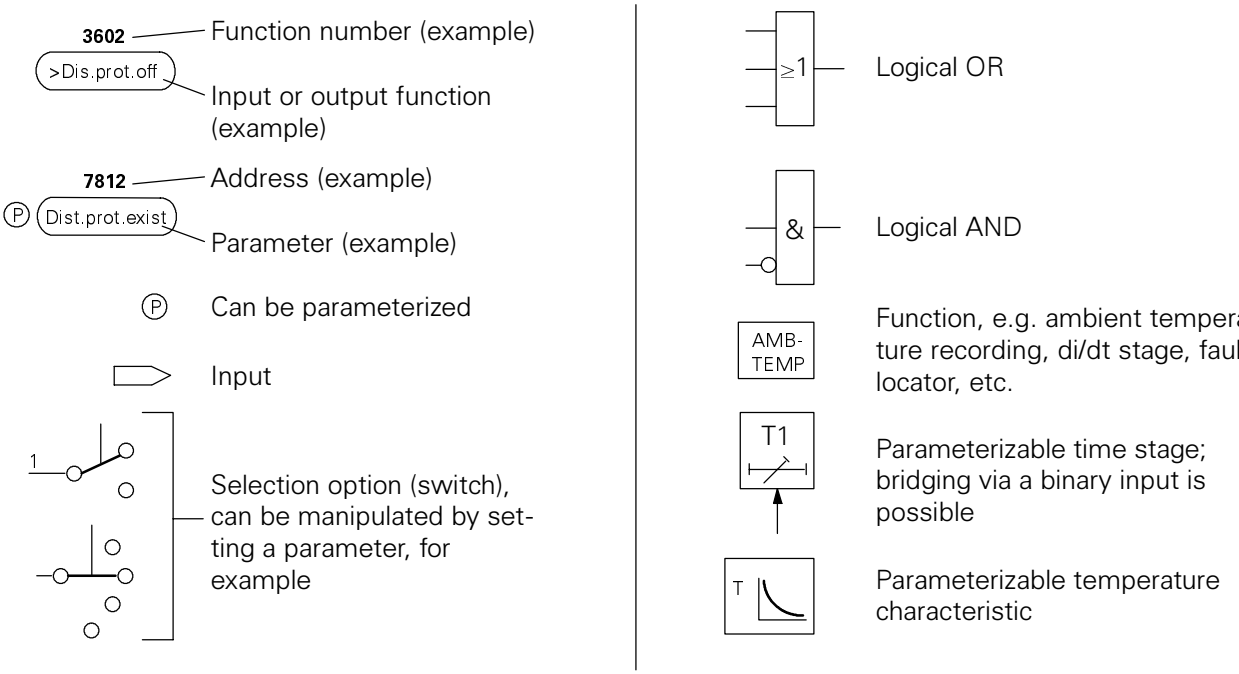


Figure 3.1 Legend for Further Diagrams

3.3.1 Distance Protection

Distance protection is the main function of the 7SA518/519 overhead contact-line protection system. It is characterized by its high degree of measuring precision and the wide range of adaptation options to the existing power system conditions. It is complemented by a range of additional functions.

3.3.1.1 Enable for Distance Measurement

After numerical filtering, the system monitors the amount of the line current for exceeding of a parameterizable limit value I> **(Addr. 1212)**. The distance stages above this limit value are enabled. The system continuously calculates the line impedance and compares it with the set characteristics.

3.3.1.2 Direction Determination

Direction determination is carried out in a similar way to distance measurement. However, if the measured voltage is below a minimum value, the system uses the stored voltage for direction determination. This guarantees that the protection will trip in the case of all faults, including a complete collapse of the short-circuit voltage. In this context, the stored voltage (with a storage depth of three periods) is only significant if the measured voltage is insufficient for correct direction determination.

3.3.1.3 Determining the Short-Circuit Impedance

The system continuously calculates the impedance of the short-circuit loop from the measured variables while the enable criterion is being fulfilled. The calculation algorithm is based on digital filtering of the current and the voltage.

The algorithm's optimum filter properties make possible determination of components R and X=ωL of the conductor loop, regardless of the set trip characteristic.

The calculated reactance, X=ωL, corresponds to conductor reactance, X_L, up to the short-circuit position. It is decisive for fault distance. In this context, you must take into account a line heterogenity that may be present. By contrast, the resistance, R, may contain a fault resistance, R_F, in addition to the conductor resistance R_L.

3.3.1.4 Tripping Characteristics

The 7SA518/519 digital overhead contact-line protection system's tripping areas are of circular form. They comprise one arc (the range) and two angular limitations. You can set the angle and the ranges for both zones separately and independently of each other.

As shown in Figure 3.2, the protection has the following characteristic that you can set independently:

- Zone Z1 with setting parameters

Z1	**(Addr. 1204)**	Zone Z1: Impedance (range)
Zone Z1: angle α	**(Addr. 1213)**	Zone Z1: Angular limitation, bottom
Zone Z1: angle β	**(Addr. 1214)**	Zone Z1: Angular limitation, top
Z1 REV	**(Addr. 1205)**	Impedance reverse (range) Zone Z1

- Zone Z2 with setting parameters

Z2	**(Addr. 1210)**	Zone Z2: Impedance (range)
Angle Z2α	**(Addr. 1219)**	Zone Z2: Angular limitation, bottom
Angle Z2β	**(Addr. 1220)**	Zone Z2: Angular limitation, top
Z2 REV	**(Addr. 1211)**	Impedance reverse (range) Zone Z2

Optionally, all the zones can be effective in the forwards direction or non-directionally:

Direc. Z1	**(Addr. 1227)**	Zone Z1: Direction
Direc. Z2	**(Addr. 1228)**	Zone Z2: Direction

The parameters for the reverse impedances of the two zones (Z1 REV and Z2 REV) are only available in one particular version of the protection device ordering data.

They can be set in that version independently of the parameters Z1 and Z2.

When setting the angles for each characteristic, care must be taken with non-directional characteristics to avoid overlaps of the forward and reverse characteristics. The corresponding formula is

$$\textbf{Angle Z1}\beta\textbf{(Z2}\beta\textbf{) – Angle Z1}\alpha\textbf{(Z2}\alpha\textbf{)} \leqq \textbf{180°}$$

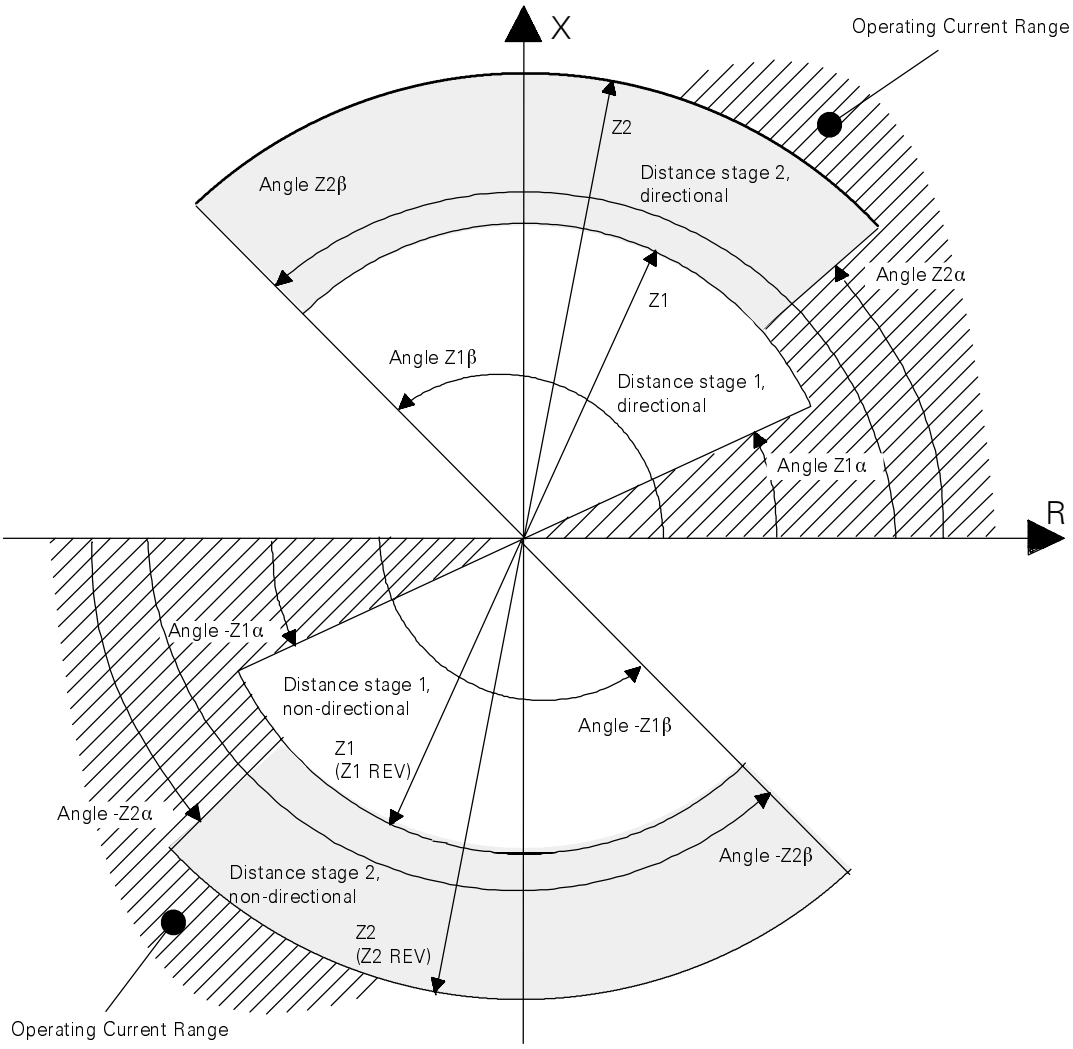


Figure 3.2 Tripping Characteristics

In the same way, it is possible to route the information about the current directions of zones Z1 and Z2 to signal relays or LEDs. The following outputs are used for this:

DisZ1 forw	**(FNo. 3920)**	Zone Z1 forwards direction
DisZ2 forw	**(FNo. 3921)**	Zone Z2 forwards direction

Figure 3.2 does not contain zones Z1B and Z1L, which are in the range between Z1 und Z2. They are always active unless you configure auto-reclose (AR) as EXISTENT. If this is the case, zone Z1B is active during rapid auto-recloses; whereas, with delayed auto-recloses, zone Z1L is active. The other parameters are assigned to the individual zones in a similar way as with zones Z1 and Z2.

Z1B	**(Addr. 1206)**	Zone Z1B: Impedance (range)
Z1B REV	**(Addr. 1207)**	Zone Z1B REV: Impedance reverse (range)
Z1L	**(Addr. 1208)**	Zone Z1L: Impedance (range)
Z1L REV	**(Addr. 1209)**	Zone Z1L: Impedance reverse (range)

Angular limitation zones Z1B and Z1L are identical with zone Z1. This also applies to the directions of these zones.

The parameters with addresses 1202 and 1203 make it possible to activate and deactivate zones Z1B or Z1L respectively. This is conditional on your having configured AR as being EXISTENT.

3.3.1.5 Tripping Logic

After enabling distance measurement (see Chapter 3.3.1.1), the system compares the components of the impedance to the limit values of the set zones. Tripping is carried out if the impedance is in its zone when the corresponding time stage expires.

Tripping relays of appropriate power are available to output the trip command to the circuit breaker. The command relays drop when the fault detection drops and the current has been switched off (the minimum current was fallen short of).

3.3.1.5.1 Instantaneous Release Unit for 7SA519

The instantaneous release unit quickly triggers the circuit breaker but cannot bear the load for a long period of time. For this reason, the slower contact of the command relay takes the current for the trip coil. The instantaneous tripping unit is reset after approximately 20 ms independently of the command relay. Due to charging procedures, the instantaneous release unit is not ready for operation again until at least 100 ms after tripping.

3.3.1.5.2 Functions of the di/dt Stage

In the case of long and highly loaded sections, the operating currents at the end of the Z2 range can be the same as or even greater than the possible short-circuit currents. The **di/dt stage** has the job of differentiating high operating currents from the short-circuit currents. The limits for zones 2K and 2L are identical; their zone times, on the other hand, are different. To decide whether there is a power system fault (⇒ zone 2K) or an overload (⇒ zone 2L), the system compares the r.m.s value of the currently measured current with the r.m.s value of the current from two periods ago. In this connection, the system uses the fact that this difference is considerably less in the case of an overload than it is when a short-circuit occurs.
Parameter dI/dT **(Addr. 1229)** specifies the difference between the two currents relative to the rated current.
As soon as there is a fault in Z2, the system analyzes the rate of current rise (the current difference). If it establishes at least once that the fault is in Z2K (i.e. the difference is greater than parameter dI/dT), this is retained until the fault leaves zone 2. The system clears the identifier Fault in Z2L as soon as the fault is in Z2K. While the criterion for Z2K is not fulfilled, Z2L is automatically detected.

Set parameter dI/dT according to the formula below:

$$\text{"dI/dT"} = k\,(I_{kmin} - I_N)$$

Where
k = safety factor, e.g. 0.5
I_{kmin}: = minimum short-circuit current at end of zone 2

In dependence on the zone in which the fault is located, Z1, Z2K or Z2L, the system starts the corresponding delay time T1 **(Addr. 1221)**, T2K **(Addr. 1224)** or T2L **(Addr. 1225)** respectively.

Figure 3.3 shows the logic diagram of the distance protection including the associated binary input and output functions. Configuration of the functions is described in Chapter 5.2.

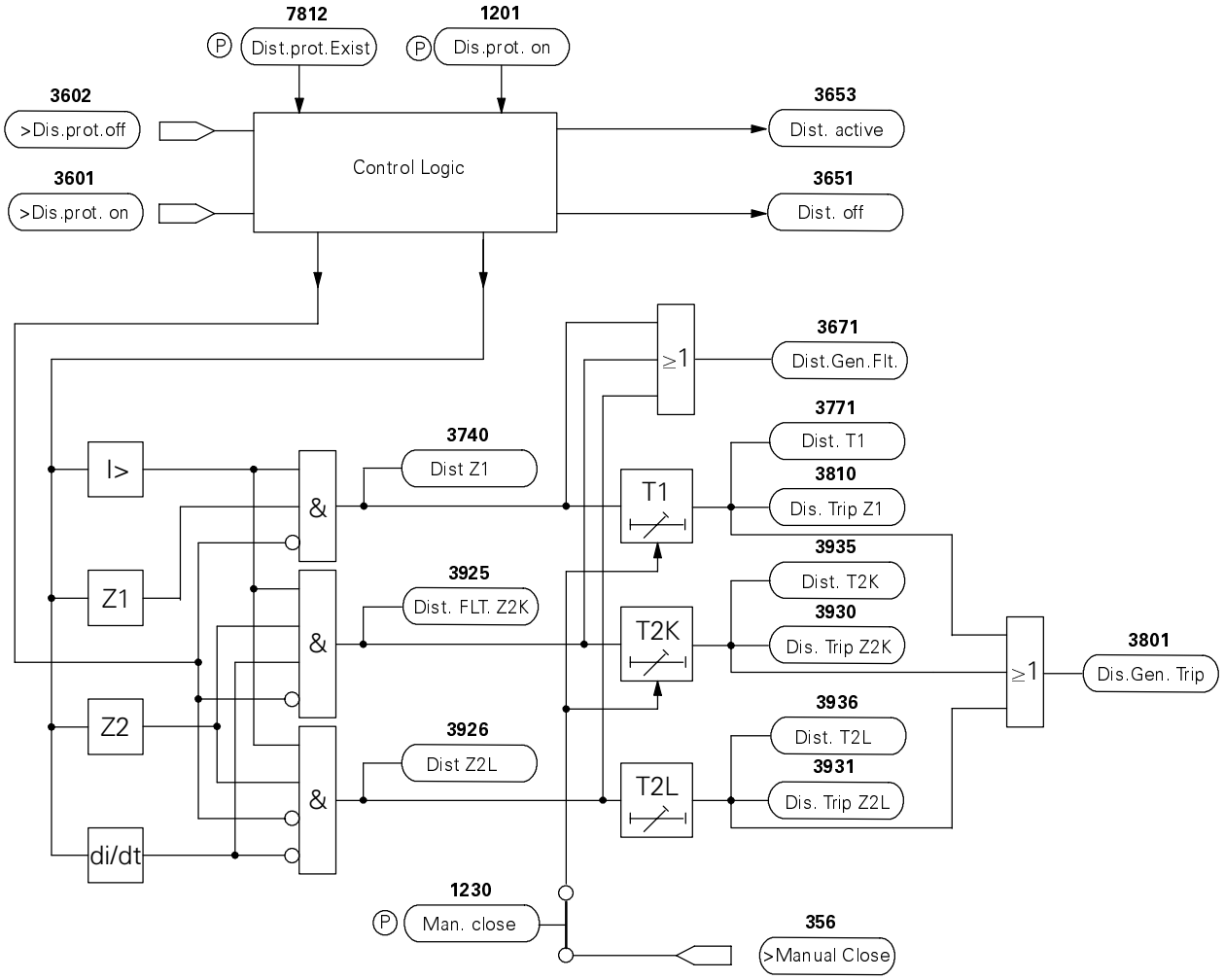


Figure 3.3 Logic Diagram of Distance Protection

3.3.1.6 Protection on Switching to a Short-Circuit

If you switch a deenergized line that is short-circuited to a live busbar, it is generally desirable to disconnect this line again without delay. With faults close to both line ends, undelayed disconnection just by means of the distance protection is not always possible: in the case of faults at the protection's place of installation, the necessary measuring voltage for correct direction determination is missing. If the voltage transformer is installed towards the line, no stored voltage is available. Every time a fault occurs close to the remote line end, the distance protection will not be able to switch off until a delayed stage.

With local faults, the overhead contact-line protection system automatically detects to FORWARD if there is a missing voltage after switching the line. This makes tripping possible in the first stage.

The following criterion applies to non-directional tripping of directed zone 1 on switching to a short-circuit: voltage U_{vor} before switching and voltage U_k after switching must both be less than or equal to 1 V.

3.3.1.7 Overcurrent Stage Effect

To make possible undelayed tripping on switching of a faulty line, the control-discrepancy switch can use a binary input to issue the manual close command to the overhead contact-line protection system. The associated input function is >Manual Close **(FNo. 356)**.

The protection then switches for a minimum of 300 ms to undelayed tripping after fault detection in zones Z1 (Z1 stroke) and Z2 (Z2 stroke). If desired, this Manual Close function can be deactivated. To do this, use parameter MAN. CLOSE **(Addr. 1230)**.

3.3.1.8 Overcurrent Protection and Emergency Mode

You can also use the 7SA518/519 digital overhead contact-line protection system as an independent overcurrent protection system (O/C protection).

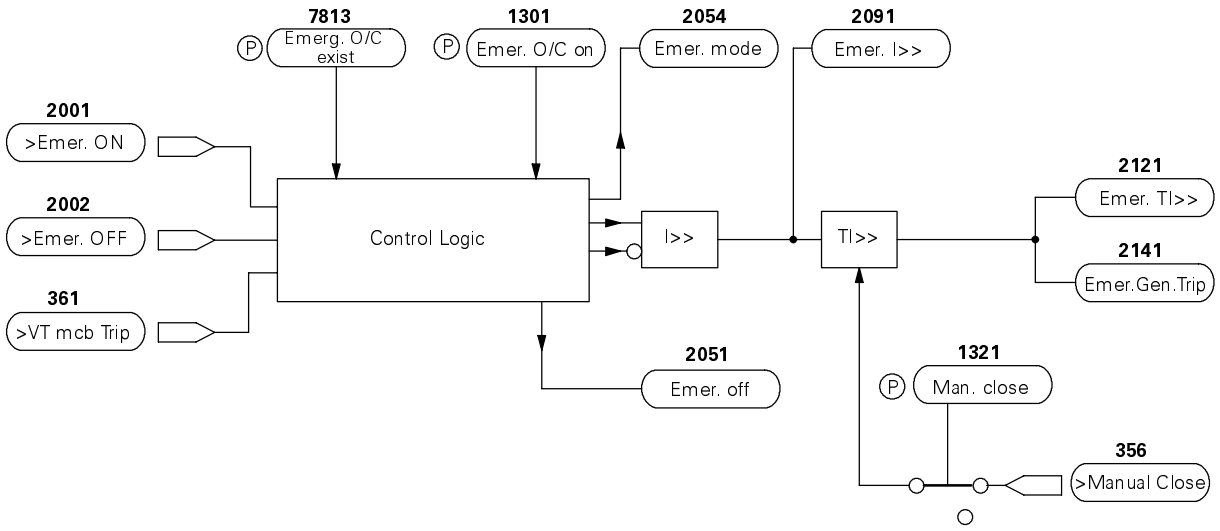


Figure 3.4 Logic Diagram of the Emergency Overcurrent Protection System

The system automatically activates emergency overcurrent protection when one of the following events occurs:

- The internal voltage monitoring responds due to a short circuit or an interruption in the voltage transformer circuit (see Chapter 3.2.3);
- Input of signal U Line side VT MCB tripped **(FNo. 361)** via a binary input: the measuring voltage failure is detected;
- Distance protection is configured as NON-EXIST **(Addr. 7812)** or is off **(Addr. 1201 or FNo. 3602)**.

If one of these events happens, the system blocks distance protection and it is possible to switch over to O/C emergency mode (parameters with **addresses 7813 and 1301**) or to switch on via a binary input **(FNo. 2001)**.

In this mode, selectivity is only possible by means of delay; this is the case with all overcurrent time protection circuits.

As soon as the device detects that the measuring voltage is available again, the system automatically switches back to distance protection.

The O/C emergency mode function has the following setting values:

I>>	**(Addr. 1302)**	Overcurrent threshold
TI>>	**(Addr. 1303)**	Delay time for I>>

In the case of manual closing, rapid (undelayed) tripping with I>> is also possible in O/C emergency mode. To do this, use parameter MAN. CLOSE I>> UNDELAYED **(Addr. 1321)**.

Figure 3.4 shows the logic diagram of the emergency O/C protection including the associated binary input and output functions. Configuration of the functions is described in Chapter 5.2.

3.3.2 High-Speed Overcurrent Protection I>>>

Very high short-circuit currents occur in the case of faults at the station level. After limit value I>>> has been exceeded, the high-speed overcurrent protection system causes very fast non-direction-dependent tripping at the time TI>>> (non-directional emergency overcurrent protection).

I>>>	**(Addr. 1402)**	Highest o/c threshold
TI>>>	**(Addr. 1403)**	Delay time for I>>>

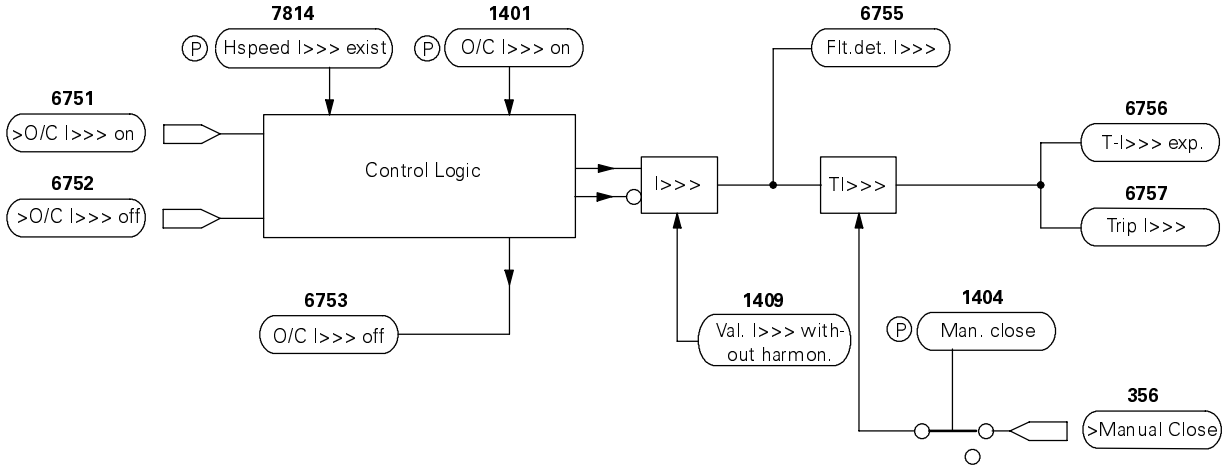


Figure 3.5 Logic Diagram of High-Speed Overcurrent Protection I>>>

The high-speed overcurrent protection system can work with measured values with and without harmonics **(Addr. 1409)**. In the first case, the system analyzes instantaneous values (sample values). In the second case, the system forms the r.m.s value using measured values within a specified time window.

Tripping on the basis of measured values with harmonics (that takes about 6 ms with the 7SA519) is carried out faster than triggering on the basis of measured values without harmonics (approximately 24 ms). You can achieve higher trip precision by using measured values without harmonics.

In the case of manual closing, undelayed tripping with I>>> is also possible when operating with high-speed overcurrent protection. To do this, use parameter MAN. CLOSE I>>> UNDELAYED **(Addr. 1404)**.

Figure 3.5 shows the logic diagram of the high-speed overcurrent protection including the associated binary input and output functions. Configuration of the functions is described in Chapter 5.2.

3.3.3 Thermal Protection

Thermal protection works on the principle of the thermal replica of the overhead line based on the current load and the ambient temperature. With both the 7SA518 and the 7SA519 versions of the device, you can specify the ambient temperature as a fixed reference value. In addition, device version 7SA519 offers the option of ambient temperature sensing.

3.3.3.1 Ambient Temperature Sensing

Figure 3.6 shows in schematic form ambient temperature sensing (ATS) for device version 7SA519.

The system senses the ambient temperature T_{ATS} only once per station in a special (7SW4000) device that has its own galvanically isolated power supply and its own housing. A Pt100 sensor is used for this. At the output, this device supplies an injected current (4.9-20 mA interface) that can be looped via an isolation amplifier through up to 12 connected 7SA519s.

The system senses the ambient temperature T_{ATS} in the range -30 °C to +55 °C or -55 °C to +55 °C (depending on parameter 7817).

The system detects an ATS failure **(FNo. 158)**, e.g., due to a cable break to the Pt100 sensor or a voltage failure), in the main protection equipment by means of defined current values in the current loop.

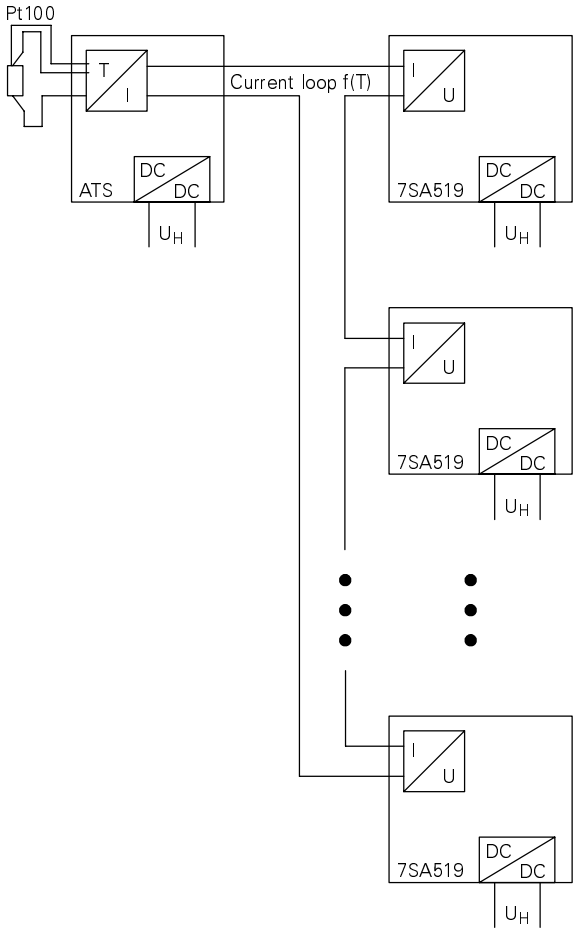


Figure 3.6 Ambient Temperature Sensing

Every time that the ATS has been updated, the system checks whether the current is in the allowed working range. If this is not the case, the system blocks ambient temperature sensing and retains the last valid ambient temperature value. In addition, the message Fail TEMPSENS **(FNo. 158)** is issued.

If ATS is disturbed when the protection is switched on, the system assumes an ambient temperature of 15° C for the calculation and also issues the message Fail TEMPSENS.

3.3.3.2 Thermal Protection Function

If the calculated contact line temperature T_{ltg} exceeds the set operating temperature, T_{End}, the system trips the main circuit breaker. When the set temperature, $T_{Warn,}$ is exceeded, the system generates an alarm message to prevent overtemperature of the contact line. The overtemperature is proportional to the square of the contact line currents. If the parameterized current, I_{NENN}, is flowing, this results in the parameterized overtemperature, $T_{Ü}$. Another parameter (the time constant) influences the transient response of the temperature replica. This follows the characteristic of a decaying exponential function.

The change in the overtemperature between instants t_1 and t_2 is described by the following formula:

$$T_{Ü2} = T_{Ü1} + [T_{Ü} (\frac{i}{i_{NENN}\ KW})^2 - T_{Ü1}] [1 - e^{-(t_2 - t_1)/\tau}]$$

Parameters:

$T_{Ü}$	**(Addr. 1504)**	Temperature-rise limit when current I_N flows
I_{NENN}	**(Addr. 1503)**	Current value that leads to temperature-rise limit $T_{Ü}$.
KW	**(Addr. 1508, Addr. 1509)**	Parameter 'Catenary' that is used to modify the characteristic
τ	**(Addr. 1502)**	Parameterized time constant of the contact line
T_{End}	**(Addr. 1505)**	Maximum permissible final temperature
T_{Warn}	**(Addr. 1506)**	Limit value for alarm message

Measured Values:

i	Current that flows during the time interval between t_1 and t_2
T_{ATE}	Measured outdoor temperature

Calculated Variables:

$T_{Ü1} = T_1 - T_{ATE}$	Overtemperature at instant t_1
$T_{Ü2} = T_2 - T_{ATE}$	Overtemperature at instant t_2
T_1	Line temperature at instant t_1
T_2	Line temperature at instant t_2

Tripping is carried out when:

$$T_{ATE} + T_{Ü2} \geq T_{End}$$

The system issues the message Thermal protection warning indication when:

$$T_{ATE} + T_{Ü2} \geq T_{Warn}$$

The trip time, t_{Aus}, of the thermal protection function is calculated according to the following formula:

$$T_{AUS} = \tau \ln \frac{T_{Ü} (\frac{i}{i_{NENN}\ KW})^2 - (T_0 - T_{ATE})}{T_{Ü} (\frac{i}{i_{NENN}\ KW})^2 - (T_{END} - T_{ATE})}$$

Where T_0: Line temperature at instant t = 0

You can permanently set the ambient temperature, **(Addr. 1510)**, for test purposes or if no ATS is present.

Variable KW symbolizes the value of the catenary that was set by means of a binary input or a telegram from the control system. Variables KW1, KW2 and KW3 exist. The binary functions in the table below are available for setting:

>Cat.1 active	**(FNo. 6605)** Activate catenary 1
>Cat.2 active	**(FNo. 6604)** Activate catenary 2
>Cat.3 active	**(FNo. 6603)** Activate catenary 3

Cat1 is always equal to 1; Cat2 and Cat3 are always entered as parameters relative to Cat1:

Cat 2	**(Addr. 1508)**	Correction factor for 2nd catenary
Cat3	**(Addr. 1509)**	Correction factor for 3rd catenary

If the thermal protection trips, you can use message Close-lockout **(FNo. 6614)** to prevent reclosing until the contact line has cooled down again. The system also calculates the temperature during cooling according to the formula above. If the line temperature falls below temperature T_{Ein}, the system withdraws the message.

The value for T_{Ein} results from multiplying T_{End} by a parameterizable cooling factor **(Addr. 1507)**.

When checking the thermal protection function, it is possible to reduce the stored temperature to the value of the ambient temperature. To do this, use parameter CAL.TMP.CAT **(Addr. 4101)**.

Figure 3.7 shows the logic diagram of the thermal protection including the associated binary input and output functions. Configuration of the functions is described in Chapter 5.2.

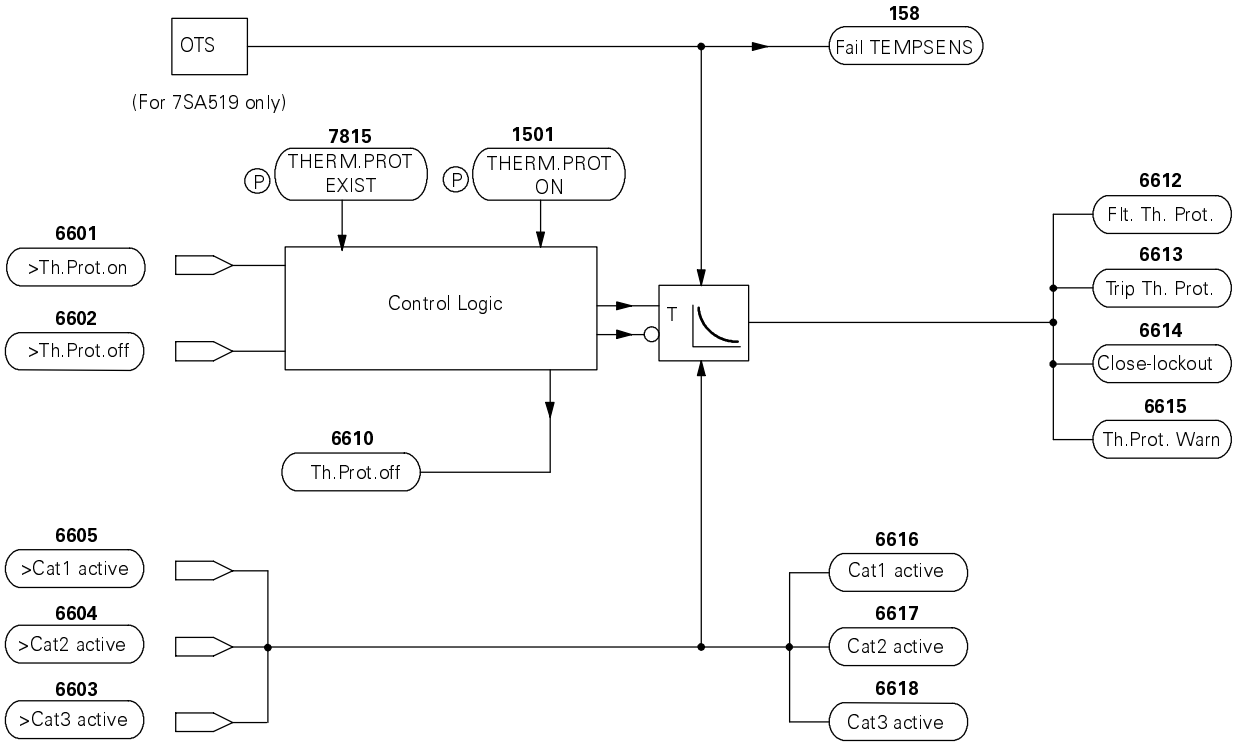


Figure 3.7 Logic Diagram of the Thermal Protection

3.3.4 Breaker Failure Protection

To monitor correct switch off of the associated circuit breaker, the system checks whether no more current is flowing after a trip command has been issued.

The following criteria must be fulfilled for the breaker failure protection to respond:

- the minimum current threshold I> **(Addr. 1212)** must be exceeded;
- the function must be activated **(Addr. 3901)**, either by
  - an On, internal (Trip command of own protection must be issued) or
  - an On, external (Trip command of an external protection must be pending at own protection via binary input) or
  - an On, int. or ext. (logical ORing of the two other options mentioned above).

In the main protection, two-stage time monitoring of the short-circuit current is implemented. You can parameterize two delay times for this:

T_{HR}	**(Addr. 3903)**	Delay time for back-up circuit breaker
T_{HSV}	**(Addr. 3905)**	Delay time for the higher level protection relay

1st Stage Times t_{HR} and t_{HSV} are started at the same time as the trip command to the main coil. If the current does not fall below value I> within time t_{HR}, the system issues another trip command to the back-up coil. In addition, message B/F off **(FNo. 1471)** is generated.

2nd Stage If the first stage does not lead to an interruption of the short-circuit current either, the system triggers tripping of the adjacent circuit breaker after time t_{HSV}. At the same time, message B/Fs.ordProt **(FNo. 1484)** is issued.

Figure 3.8 shows the logic diagram of the breaker failure protection including the associated binary input and output functions. Configuration of the functions is described in Chapter 5.2.

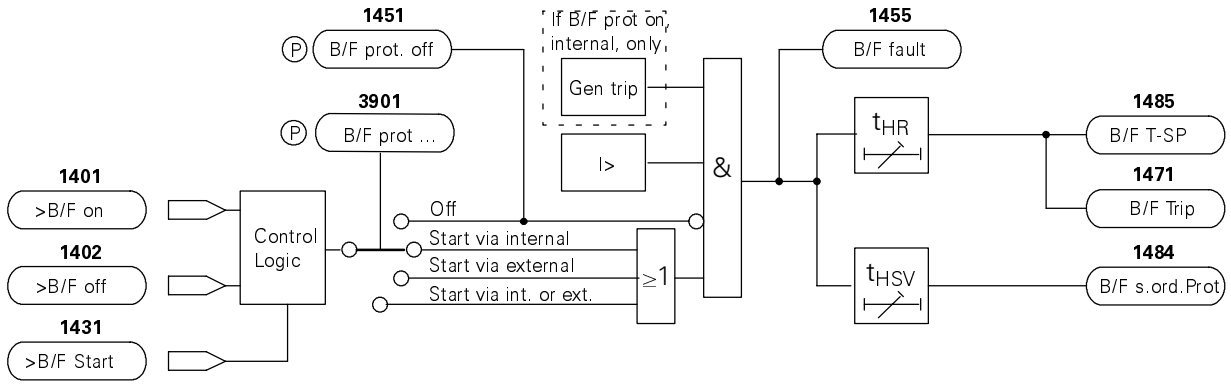


Figure 3.8 Logic Diagram of Breaker Circuit Protection

3.3.5 Fault Location

Using the Fault location function, you can find the exact location of the short-circuit after a fault event. For this, the system derives the line reactance from the fault event data. This is the basis for calculating the distance of the short-circuit location as a percentage of the line length or in kilometers.

3.3.5.1 Activating and Blocking a Fault Location Calculation

There are several different ways of activating a fault location calculation:

- by the protection's trip command **(Addr. 3802 trip command)**;
- by drop-off or trip of fault detection **(Addr. 3802 drop-off or trip)**;
- by an external binary input **(FNo. 1106)**.

In all cases, the current threshold,I>, **(Addr. 1212)** must be exceeded. The following conditions lead to blocking of the fault location calculation:

- responding of the internal measured value monitoring on failure of the measuring voltage **(FNo. 168)**;
- appearance or drop-off of the thermal protection function **(FNo. 6612, 6613)**;
- input of signal U line side VT MCB tripped **(FNo. 361)** via a binary input;
- blocking of distance protection.

3.3.5.2 Procedures for Fault Location Calculation

For the Fault location function, you can define up to five line sections with different quantities per unit length (see Figure 3.9). This makes fault location calculation possible even with non-homogenous lines. Several physical variables are used to calculate the fault location:

- the line voltage,
- the line current,
- the line or the short circuit reactance,
- the reactance per unit length of line section n,
- the length of the individual sections.

The line voltage and current are determined from the sample values. The system calculates the short-circuit reactance from the line voltage and the line current. You must parameterize the reactance quantities per unit length of the individual line sections, n.

Fault location calculation also works properly when there is a transformer (transformer booster with a reactance of X_T) on the line section (see Figure 3.9).

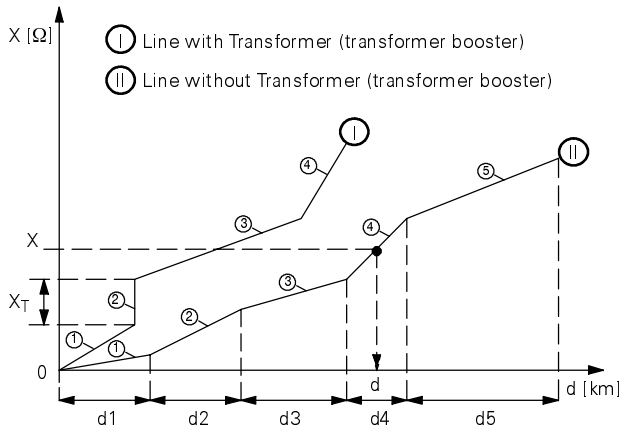


Figure 3.9 Dividing a Non-Homogenous Line into Several Sections

In the context of fault location calculation, the system may issue the messages/measured values listed below:

R_{pri}	**(FNo. 1114)**	Calculated primary fault resistance in Ω
X_{pri}	**(FNo. 1115)**	Calculated primary fault reactance in Ω
R_{sec}	**(FNo. 1117)**	Calculated secondary fault resistance in Ω
X_{sec}	**(FNo. 1118)**	Calculated secondary fault reactance in Ω
d =	**(FNo. 1119)**	Calculated fault distance in km
d% =	**(FNo. 1120)**	Calculated fault distance in percent of the line length
Fault section	**(FNo. 1121)**	Faulty section of the line

FltLoc imposs (FNo. 1129) Measured reactance is negative; fault location-calculation is not possible.

Flt dist > (FNo. 1130) Fault is outside the configured section

The messages with **function numbers 1114, 1115, 1117 and 1118** cannot be issued while message Flt dist. > is pending. This also applies to the messages with **function numbers 1119, 1120 and 1121**, while message FltLoc imposs. is pending.

Figure 3.10 shows the logic diagram of fault location including the associated binary input and output functions. Configuration of the functions is described in Chapter 5.2.

3.3.5.3 Remote Transmission of Fault Location

Using the optical system interface, the 7SA518/519 can be connected to the complementary devices 7SM70 (analog output) and 7SM71 (BCD output) for transmission of the fault location, e.g. via telecontrol centers.

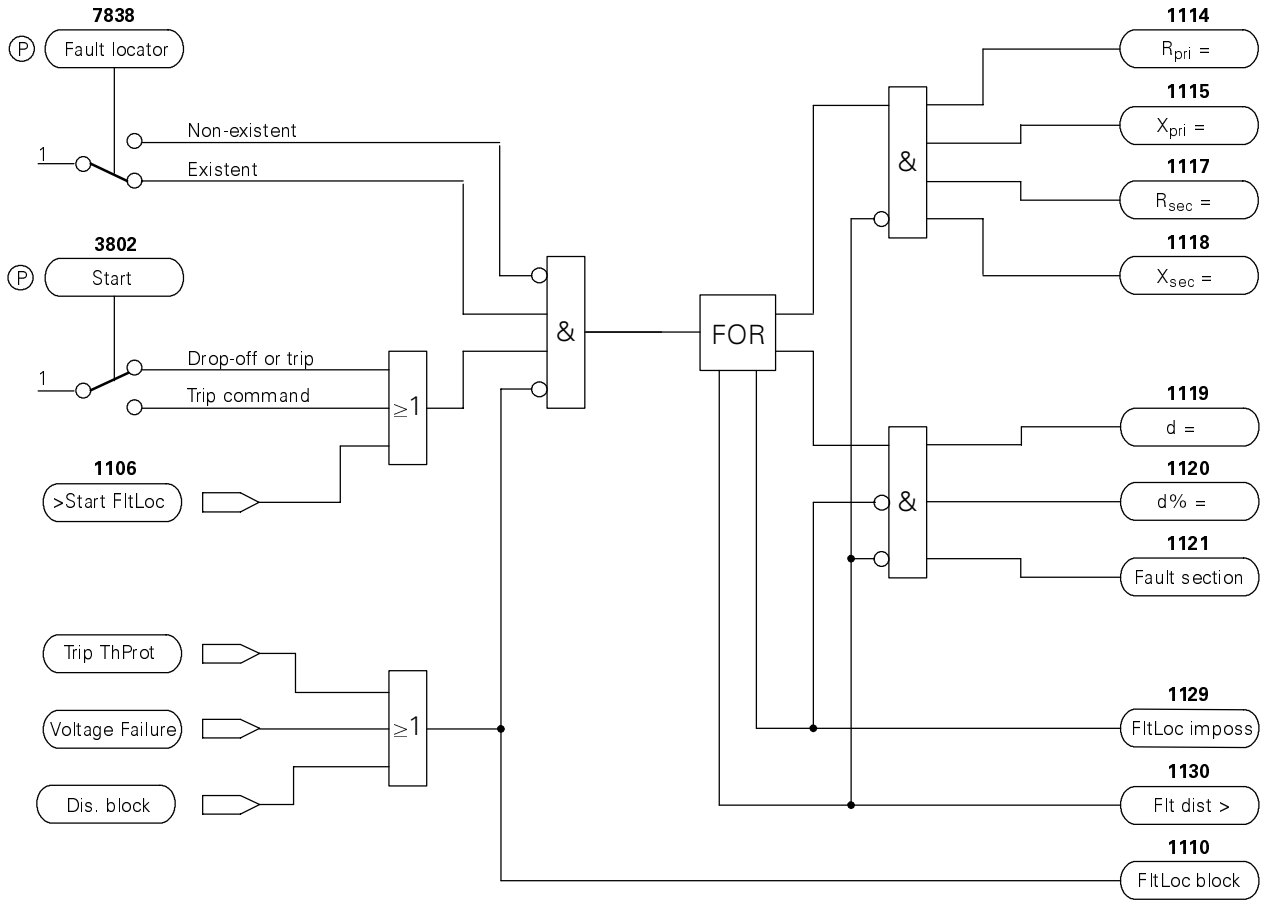


Figure 3.10 Binary Inputs and Outputs of Fault Location

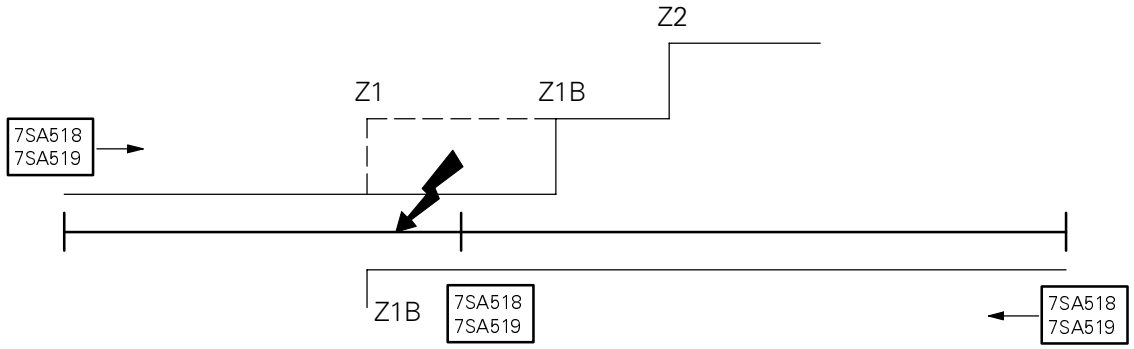
3.3.6 Auto-Reclose (AR)

AR is an optional sub-function of the 7SA518/519 digital overhead contact-line protection system. It makes possible a parameterizable number of attempts at reclosing following drop-off of the circuit breaker.

Experience has shown that extinction of approximately 85% of all short-circuits to arc takes place automatically after the protection disconnects. This means that the line can be connected again. AR carries out connection. In this context, a rapid auto-reclose cycle (RAR) is followed by a delayed auto-reclose cycle (DAR) (see Chapter 3.3.6.1).

For the rapid auto-reclose cycle to be carried out successfully, the system should be able to disconnect a faulty line at both ends within the same time period, which should be as short as possible. This means that, in general, it is desirable to instantaneously trip the short-circuit protection before the AR connects. To do this, the short-circuit protection, which can start the rapid auto-close cycle, has an RAR stage. While setting up the device configuration, you can specify for each of the short-circuit functions whether it is to work in conjunction with the AR (see Chapter 3.3.6.3).

a) Zone range to the end of the first RAR dead time (Z1B enabled)



b) Zone range after the first RAR dead time

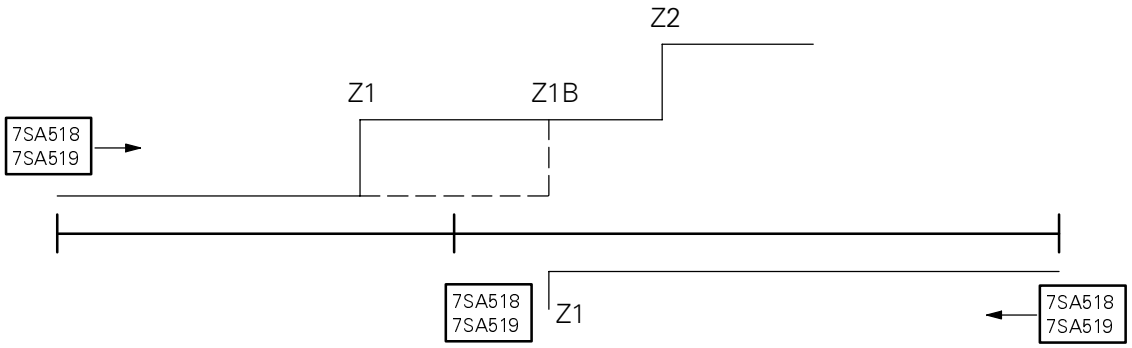


Figure 3.11 Range Control By the Auto-Reclose Function

In the case of distance protection, extended zone Z1B (Z1B REV) can be active for the first auto-reclose cycle (rapid auto-reclose):

Z1B	**(Addr. 1206)**	Impedance (range) zone Z1B
Z1B REV	**(Addr. 1207)**	Impedance reverse (range) zone Z1B
T1B	**(Addr. 1222)**	Delay time T1B of zone Z1B

For DAR, a separate range Z1L (Z1L stroke) with its own delay time is available with distance protection:

Z1L	**(Addr. 1208)**	Impedance (range) zone Z1L
Z1L REV	**(Addr. 1209)**	Impedance reverse (range) zone Z1L
T1L	**(Addr. 1223)**	Delay time T1B of zone Z1L

The angular limitations of zones Z1B and Z1L correspond to parameters α and β for zone Z1 **(Addr. 1213, 1214)**. The normal stages of distance protection Z1 and Z2 as well as normal staggering of the other short-circuit functions are not dependent on the auto-reclose function. You should bear this in mind if a fault is to be disconnected with a delay for reasons of selectivity, assuming that reclosing is not to be carried out. This means that it is not realistic to set a shorter delay for normal stages than for Z1B.

Zone Z1B (Z1B REV) (see Chapter 3.3.6.2) is enabled to the end of the first RAR dead time (see Figure 3.11a). In the case of a short-circuit close to a line end, the system first disconnects all the surrounding lines, since they can detect the fault in their extended zone Z1B (Z1B REV).

If auto-reclose is not expected (e.g. the circuit breaker is not ready for closing), the normal selective time interval must apply to ensure that selectivity is complied with. Thus, the system only carries out instantaneous tripping in the case of faults within zone Z1 (see Figure 3.11 b).

The parameters with **addresses 1202 and 1203** make it possible to enable zone Z1B (Z1B REV) or to disable zone Z1L (Z1L REV).

3.3.6.1 Auto-Reclose Cycles

The auto-recloses are broken down into individual cycles:

- **Cycle 1:**
  In the first cycle, there is exactly one rapid auto-reclose. During this cycle, there is a choice of zone Z1B or Z1B stroke being active. This means that there must be a fault detection in one of these zones.
- **Cycles 2 to n:**
  Within these cycles, there is one delayed auto-reclose. You can parameterize the number n-1 of these cycles **(Addr. 3443)**. During this cycle, there is a choice of zone Z1L or Z1L stroke being active. This means that there must be a fault detection in one of these zones.
- **Cycle n+1:**
  If the fault is still present when all the previous cycles have been run through, the system definitively switches off in cycle n+1. During this cycle, there is a choice of zone Z1 or Z1 stroke being active.

3.3.6.2 Programs and Time Terms

The individual cycles are characterized by different programs:

- **Rapid Auto-Reclose (RAR)**
  A rapid auto-reclose is only carried out in the first cycle. You parameterize the rapid auto-reclose with its own dead time **(Addr. 3426)**.
- **Delayed Auto-Reclose (DAR)**
  A delayed auto-reclose can be carried out between the second and the last cycles. You parameterize one common dead time for all the delayed auto-recloses **(Addr. 3446)**.

To make it easier to understand the time course of the individual cycles, we shall first define a few terms (see also Figures 3.12 and 3.13):

- **Action Time**
  The action time is started by the general fault detection in each cycle. The trip command can only trigger the Auto-reclose function within the action time. AR is interrupted if the trip command is not issued until after the action time has expired. The action time is ended when the trip command drops off. The RAR and DAR action times can be different **(Addr. 3424 and 3445 respectively)**.
- **Dead Time**
  The dead time is started after the trip command has dropped off. It is the time during which the circuit breaker is open. You can parameterize different dead times for rapid auto-recloses and delayed auto-recloses **(Addr. 3426 and 3446 respectively)**.
- **Maximum Close Command Duration**
  The maximum close command duration **(Addr. 1135)** is started after the dead time has expired. It is the time limitation of the close command. You can parameterize the close command duration to match the requirements of the circuit breaker.
- **Reclaim Time**
  The reclaim time **(Addr. 3405)** is started at the same time as the "maximum close command duration" after the dead time has expired. The system evaluates a fault that occurred during the reclaim time as belonging to the current AR cycle. Depending on the parameterization, this results in a new cycle or a final trip. By contrast, the system evaluates a fault that did not occur until the reclaim time had expired as a new power system fault. A successful AR cycle is not detected until the reclaim time has expired. This means that you should parameterize a higher value for this time than for the maximum close command duration.

3.3.6.3 Connection with Protection Functions

AR can be started by several different functions:

- Distance protection **(Addr. 7904)**,
- High-speed overcurrent I>>> **(Addr. 7905)**,
- Emergency overcurrent protection I>> **(Addr. 7906)**,
- External trip via binary input **(Addr. 7907)**.

AR is given the information below for every protection function:

- Fault detection of the protection function,
- Enabling or disabling of the AR by the protection function, and
- Trip command of the protection function.

In return, AR provides via an interface the protection functions with information about their readiness and auto-reclose cycles.

A special option is provided by the connection of the AR to the high-speed overcurrent protection. Using parameter PRG I>>> AR **(Addr. 3420)**, you can choose whether high-speed overcurrent protection is to have the effect of starting AR for one RAR cycle only or, additionally, for one DAR cycle.

3.3.6.4 Binary Input and Output Functions of AR

The following **binary input functions** of AR can be marshalled:

>CB ready	**(FNo. 2730)**	Circuit breaker is ready for AR
>AR block	**(FNo. 2703)**	External blocking of AR
>DAR block	**(FNo. 2709)**	External blocking of DAR cycle
>ext.Start AR	**(FNo. 2711)**	External start for internal AR
>ext. Trip AR	**(FNo. 2712)**	External trip for internal AR
>AR on	**(FNo. 2701)**	External switch-on of AR
>AR off	**(FNo. 2702)**	External switch-off of AR

AR provides the following **output functions** (annunciations) that can be marshalled:

AR off **(FNo. 2781)** AR is switched-off

AR not ready **(FNo. 2784)** AR is not ready at the moment

This is a common annunciation for an AR logic that is not ready (AR blocked and reclaim time after the last reclose has expired)

CB not ready **(FNo. 2787)** Circuit breaker is not ready

To be able to carry out reclosing, the circuit breaker must be ready before starting of the AR. If signal CB ready is not marshalled to a binary input, the AR is also started even when the circuit breaker has not been interrogated.

AR in prog. **(FNo. 2801)** AR has been started

The system sets this message when the AR is started and is retained until an AR drop-off.

RAR T-act.run **(FNo. 2812)** AR: RAR action time is running

The RAR action time is still running that was started by a coming fault detection in the first reclose cycle.

DAR T-act.run **(FNo. 2832)** AR: DAR action time is running

The DAR action time is still running that was started by a coming fault detection in the second to the last reclose cycles.

RAR Tdead run **(FNo. 2813)** AR: RAR dead time is running

The dead time is still running that was started after the trip command for the RAR cycle.

DAR Tdead run **(FNo. 2833)** AR: DAR dead time is running

The dead time is still running that was started after the trip command for the DAR cycle.

AR T-Recl.run **(FNo. 2861)** AR: Reclaim time is running

The reclaim time is running that was started with the Maximum close command duration.

AR successful **(FNo. 2862)** AR successful

The completed reclose cycle was successful, i.e. the reclaim time was able to expire without a new fault event occurring.

Definit.Trip **(FNo. 2863)** AR: definitive trip

The system carries out a definitive trip if the AR is blocked during a dead time or if a trip command is issued with the AR blocked at the same time. After a definitive trip, there is no further reclose cycle.

CB Alarm Supp **(FNo. 563)** CB drop-off alarm suppression

This message is issued to suppress, within reclose cycle, a signal of the circuit breaker's auxiliary contact.

AR Close Cmd. **(FNo. 2851)** AR: Close command

After a dead time expired, a reclose command was issued.

RAR Zone Rel. **(FNo. 2817)** Release signal for RAR stage

This message is issued when the AR is ready to carry out a rapid auto-reclose.

DAR Zone Rel. **(FNo. 2837)** Release signal for DAR stage

This message is issued when the AR is ready to carry out a delayed auto-reclose.

3.3.6.5 Execution of AR

If starting permission has been issued, action time RAR T-ACT for rapid auto-reclose starts at the same time as fault detection. If the system issues a TRIP command before the action time has expired, dead time RAR T-DEAD of rapid auto-reclose is started on a departing trip. This is dependent on no blocking being present (see Chapter 3.3.6.6). If function >CB ready is routed to a binary input, the signal must be active on this input.

If no blocking occurs before the dead time expires, automatic reclosing, AR, issues a close command. When this command is issued, the reclaim time, T-RECLAIM is started. At the same time, the system cancels the enable for rapid auto-reclose (Zone Z1B for distance protection) and enables delayed auto-reclose (Zone Z1L for distance protection).
If another fault does not occur (i.e. no fault detection) before the reclaim time expires, the cycle is considered to have been completed successfully. The system outputs the message AR successful and all the functions are zeroed. The system evaluates a fault that occurs after the reclaim time as a new power system disturbance.

Figure 3.12 shows the execution of an unsuccessful AR - an existing fault was not removed. After output of the close command, another trip appears, before the reclaim time has expired, with delay time T1L of zone Z1L that is active at this time. At the same time, the system cancels the ongoing reclaim time, $T_{Reclaim}$. Depending on the parameterization, the system carries out a reclose. In Figure 3.12, only one DAR cycle is parameterized for the sequence shown.

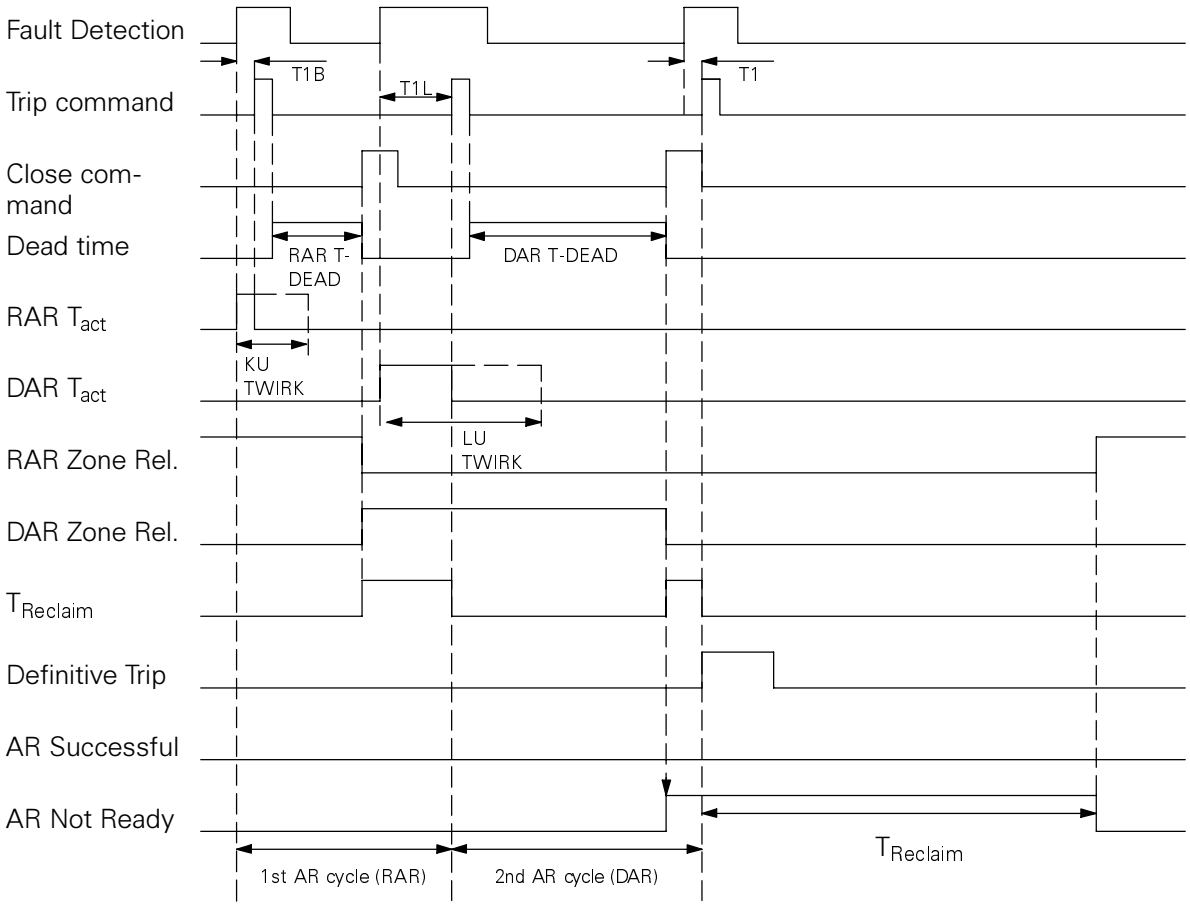


Figure 3.12 Unsuccessful Execution of AR (RAR and one DAR)

If a trip command appears before the action time, DAR T_{act}, of the delayed auto-reclose has expired, the system starts dead time DAR T-DEAD of the delayed auto-reclose. After this time has expired, a close command is issued. Since only one DAR cycle is parameterized in the described case, the enable for the delayed auto-reclose is cancelled.

Since an existing fault was not removed and no further DAR cycles were parameterized, the fault

detection and the definitive trip appear after time T1 of zone Z1. The Definitive trip message is pending for 500 ms. The reclaim time that was started with fault detection is cancelled by the trip. The system generates the AR not ready at the same time as the reclaim time starts. It is retained until the parameterized reclaim time has expired.

Figure 3.13 shows successful execution of AR; the fault is removed during the dead time of the rapid auto-reclose.

In this case, there is no fault detection after the close command, since the fault was removed during the dead time of the rapid auto-reclose, RAR T-DEAD. After reclaim time $T_{reclaim}$ has expired, the message AR successful appears for 500 ms. The system then releases the RAR zone and all the AR functions are zeroed.

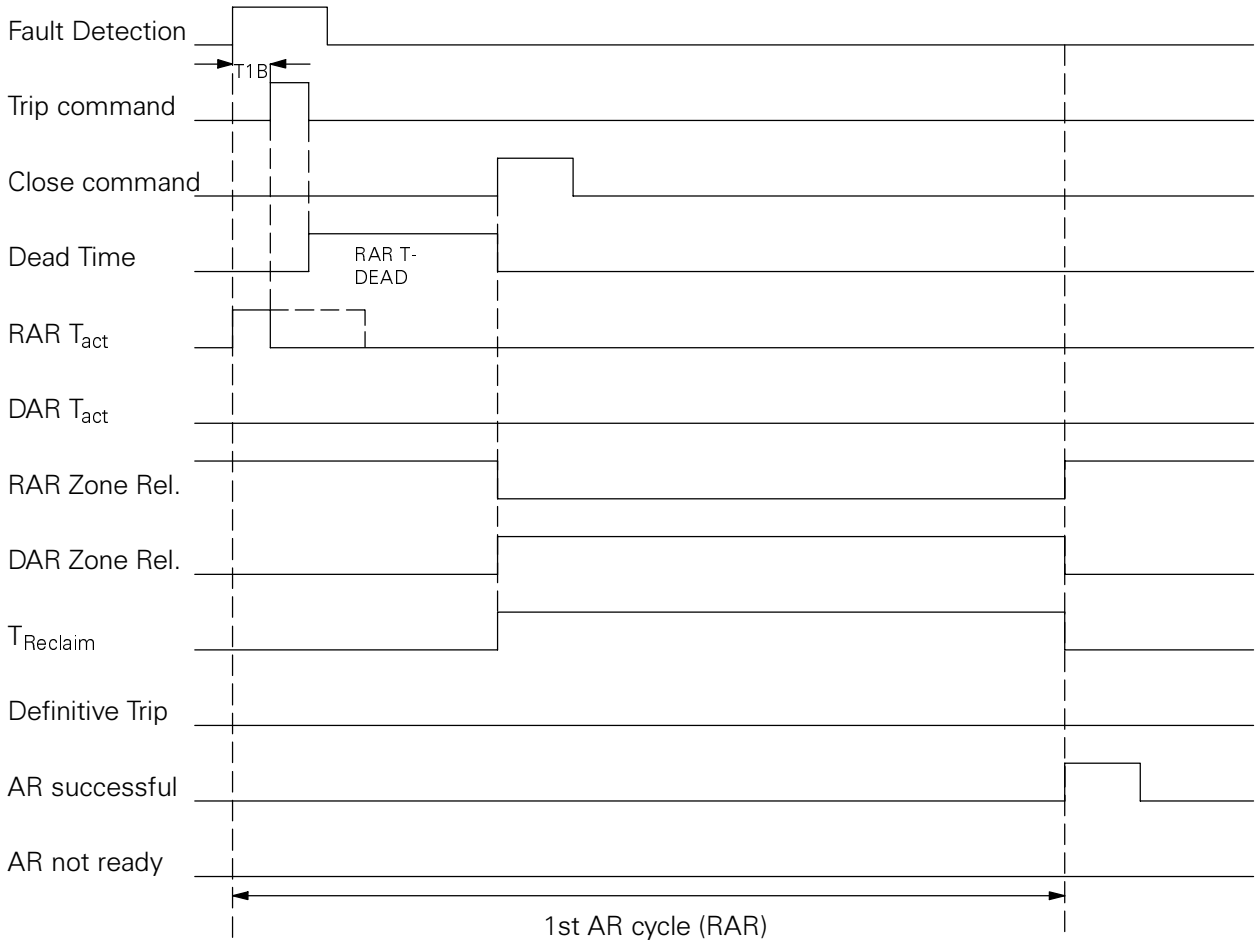


Figure 3.13 Successful Execution of AR (RAR)

3.3.6.6 Blocking AR

Blocking is used to prevent starting of AR or to terminate an active cycle. The following options lead to blocking of the AR:

- Function AR is switched off by an internal or an external signal or an external signal blocking is pending at the binary input.
- Thermo-protection trips.

- Using parameter I LIMIT AR **(Addr. 3404)** it is possible to block AR in dependence on the current. If the current threshold for blocking is exceeded at fault detection, there is a definitive trip (no further AR cycles). You can disable this function by setting parameter I LIMIT AR to ∞.
- In the case of manual closing, you can block the AR for the parameterized time T-BLOCK MC **(Addr. 3407)** that is set using parameter MC BLOCK" **(Addr. 3403)**.

  If function >Manual Close **(FNo. 356)** is routed to a binary input, the signal must be active on this input.
- The last one of all the parameterized cycles was unsuccessful.
- If the protective logic tells the AR that the reverse protection has tripped, you can use parameter AR REV BLO **(Addr. 3402)** to block the AR. However, this is only possible if distance protection is set to the directional zone.

3.3.7 Thermal Protection Auto-Reclose (Thermal AR)

After a brief overload, the thermal protection may trip. In this case, the Thermal AR has the job of auto-reclosing once or several times.

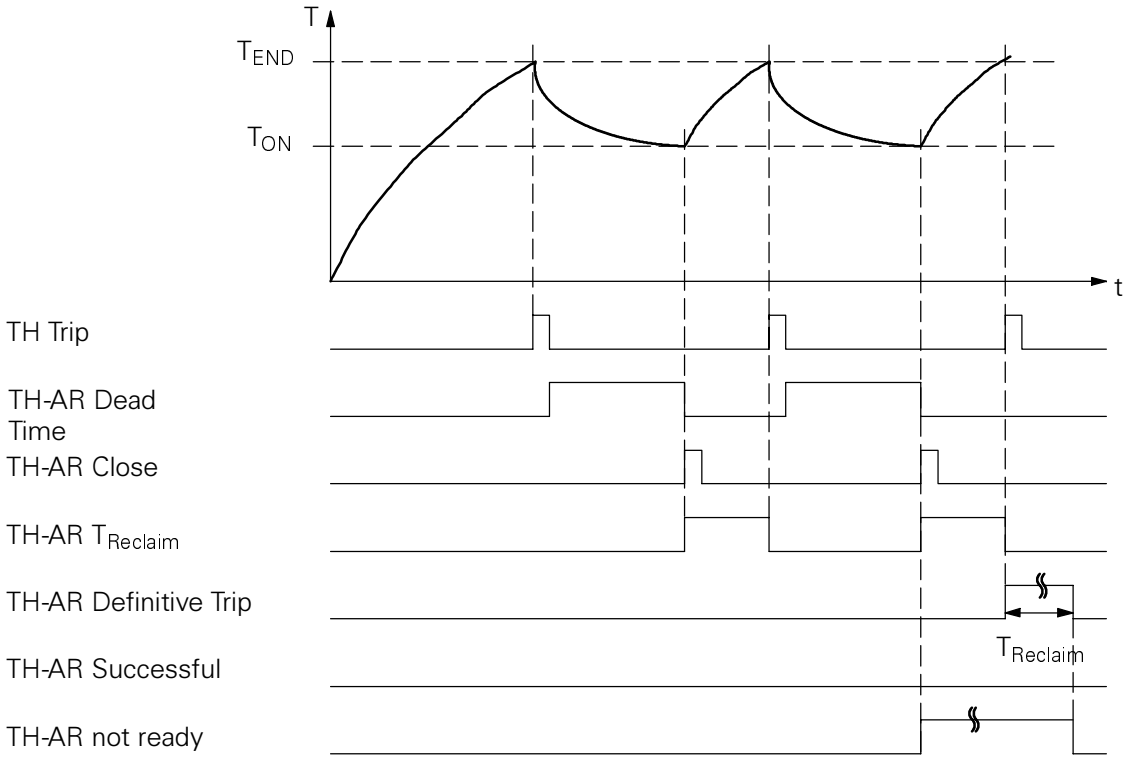


Figure 3.14 Unsuccessful Execution of Thermal AR (two Cycles)

If Thermal AR **(Addr. 7835)** is parameterized, this function is initially zeroed after you switch on the device. The system releases the Thermal AR in dependence on the setting of parameter THERM. AR **(Addr. 3501)** and the status of binary input function >CB ready **(FNo. 2730)**. Figure 3.14 shows unsuccessful execution of auto-reclosing with two cycles.

After triggering by thermal protection, the system starts Thermal AR. The dead time, TH-AR dead time, is a dynamic variable rather than a parameterizable time stage. If the contact line exceeds the threshold temperature, T_{End} **(Addr. 1505)** of the thermal protection trip, it is started by a departing trip command, TH TRIP of the thermal protection. It expires as soon as the temperature falls below the threshold, T_{On}. The value of T_{On} results from multiplying T_{End} by a parametrizable cooling factor **(Addr. 1507)**.

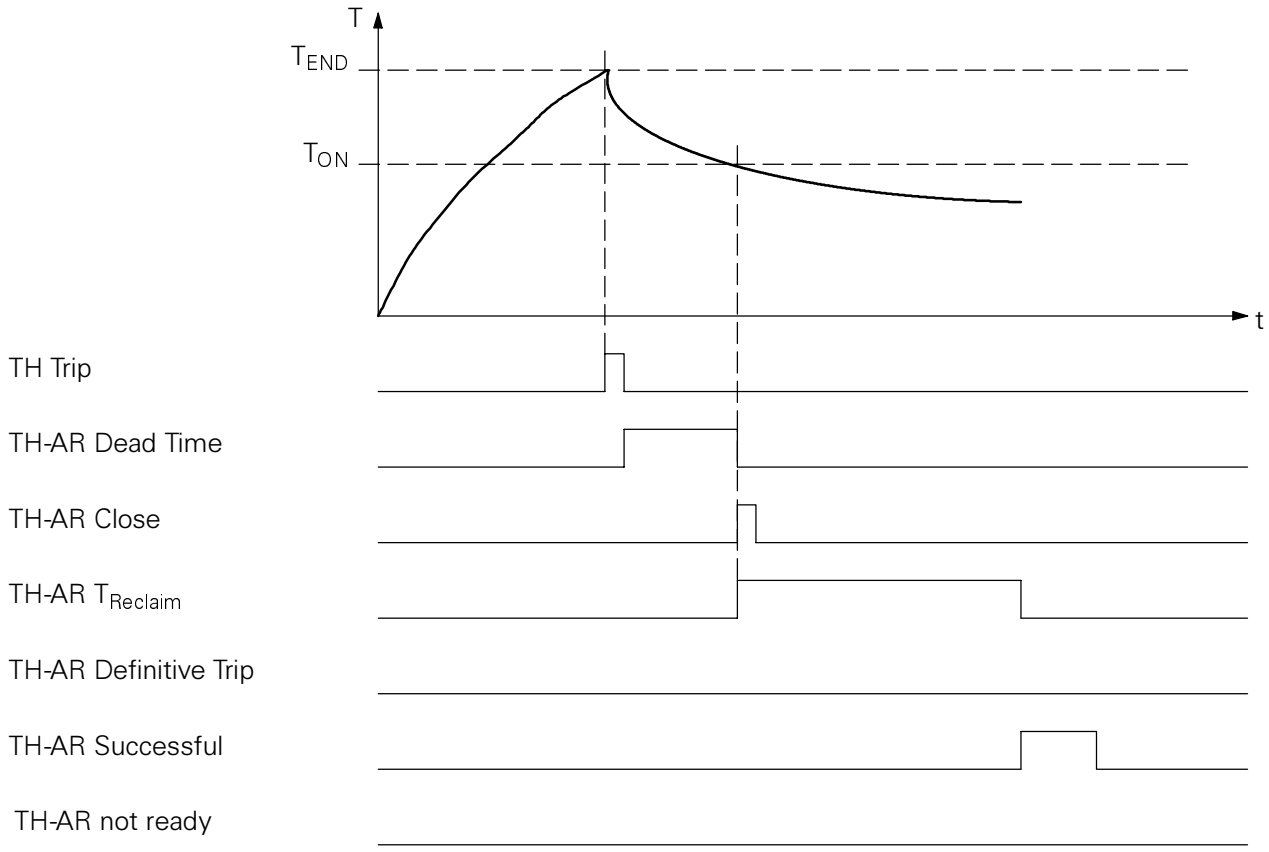


Figure 3.15 Successful Execution of Thermal AR

If there is no blocking of Thermal AR during the dead time, the system generates a close command lasting T-CLOSE **(Addr. 1135)**. At the same time, the reclaim time, T-RECLAIM-TH **(Addr. 3503)** is started. If the thermal protection trips again during the reclaim time, another reclose cycle is triggered.

This procedure is repeated in accordance with the number of cycles parameterized in TH-AR No **(Addr. 3502)**. During the last parameterized cycle, the Thermal AR is internally blocked. The subsequent trip by thermal protection is a definitive trip.

If, after the reclaim time has expired, the contact line temperature is not below the threshold of the closing lock-out temperature, T_{On}, the subsequent trip by the thermal protection is a definitive trip. There are no further reclosing cycles. For this reason, the setting of TH AR Treclaim must be greater than the time that is needed to fall below the threshold temperature, T_{On}.

Figure 3.15 shows successful execution of reclosing. In this case, the reclaim time expires without thermal protection being tripped again. After the reclaim time has expired, the contact wire temperature is below the threshold temperature of the closing lock-out T_{On}.

Thermal AR is reported as being successful by Th-AR success.

You should note that if the thermal protection carries out tripping, the auto-reclose function, AR, which is described in Chapter 3.3.6, is blocked for all the other protection stages. In this case, only the Thermal AR can carry out an auto-reclose. In the event of a fault detection, the thermal AR itself is immediately blocked by a protective function.

The binary input and output functions correspond to those of the AR (see Chapter 3.3.6.4).

3.4 Additional Functions

3.4.1 User-Defined Annunciations

The 7SA518/519 numerical overhead contact-line protection system has four user-defined annunciations; each of them has a time stage assigned to it. Each of these four time stages can be started via a separate binary input **(FNo. 011, 012, 013, 014)**. You set the delay time, T_{ANNUNC}, separately for each time stage **(Addr. 2801, 2802, 2803, 2804)**.

Triggering a time stage via a binary input leads to output of an annunciation after the delay time, T_{ANNUNC}, has expired. You can define the annunciations yourself and marshal them on annunciator relays, LEDs and trip relays.

The described functionality makes it possible, for example, to integrate the annunciations of protective devices that do not have any interfaces that are externally available.

3.4.2 Triggering Check Functions

The 7SA518/519 numerical overhead contact-line protection system makes it possible to easily check the tripping circuits and the circuit breaker. There are two different check procedures:

- Circuit breaker checking by definitive trip: this procedure is suitable for every device.
- Circuit breaker checking by a TRIP-CLOSE cycle: this procedure is suitable for devices that have the auto-reclose function (parameter block 4300).

The following conditions must be met for both checking procedures:

- No fault detection of any protective function of the device may be present.
- The circuit breaker must be closed before switching off. This can only be required if the auxiliary contact of the circuit breaker informs the device of its position via a binary input.

For checking by a TRIP-CLOSE cycle, the conditions for reclosing must also be met:

- The circuit breaker must be open before closing. This can only be required if the auxiliary contact of the circuit breaker informs the device of its position via a binary input.
- The AR must be activated.
- The AR may not be blocked.

With both checking procedures, you can choose which coil is to be checked, i.e. the main coil, the back-up coil or both.

After you enter the codeword, checking is triggered via the integrated operator panel or the front operating interface. With activation via a binary input, which is also possible, you do not need to enter a codeword. Depending on the status conditions, the protection provides the appropriate return information.

3.5 Handling Annunciations, Faults and Measured Values

3.5.1 Signal Processing

After a disturbance in the power system, it is important to have information about the response of the protection device and the measuring variables to be able to exactly analyze the course of the disturbance. For this, the device has a signal processing facility that functions in three ways.

3.5.1.1 Displays and Binary Outputs (Signal Relays)

The system indicates important events and status conditions by means of LEDs on the front panels. In addition, the modules contain signal relays for remote signalling. Most of the annunciations and displays can be marshalled, i.e. assigned differently to the ex-works default settings. Chapter 4.5 contains a detailed description of the delivery condition and the marshalling options.

The signal relays are not stored and fall back after the criterion to be signalled no longer applies. You can parameterize whether the LEDs are to operate stored or not.

The LED memories are battery-buffered in case the auxiliary supply fails and are reset

- locally by pressing the reset button on the device;
- remotely by energizing the reset relay;
- automatically at the start of every general fault detection.

Some displays and relays indicate status conditions: they should not be stored. It is also not possible to reset them until the criterion to be signalled has been cancelled. This applies in particular to status messages such as Auxiliary supply missing, Emer. OFF, etc.

A green LED (Service) shows that the unit is ready for use. It cannot be reset and lights up when the microprocessor is operating properly and there is no device fault. The LED goes out if the microprocessor's automatic control detects a disturbance or if the auxiliary supply is missing.

If there is an auxiliary supply and an internal device fault, the red LED (Blocked) lights up and blocks the device.

3.5.1.2 Information via Display Field or Operator Panel

You can read off events and status conditions on the display field on the device's front panel. It is also possible to connect a PC to the front operating interface to which the system can transfer the information.

In the idle state, i.e. while no power system disturbance is present, each of the two lines of the display field show one selectable piece of operating information (generally an operational measured value). In the event of a power system disturbance, the system displays instead information about the fault, e.g. the time from fault detection to tripping, which you can also select. After acknowledging these fault annunciations, the system displays the idle information again. Acknowledgement is the same as resetting saved LED displays.

In addition, the device has several event buffers, e.g. for operational annunciations, switching statistics and fault annunciations (see Chapter 5.3.1). A battery prevents data loss in the event of an auxiliary supply failure. You can display these annunciations and all the available operational measured values at any time on

the integrated operator panel; you can also transfer them to a PC across the serial interface.

Following a power system disturbance, you can read out important information, e.g. fault detection and tripping, about the course of the disturbance. The system timestamps the start of the disturbance with the real-time clock time. The course of the disturbance is given a time relative to the instant of fault detection. This means that it is possible to detect the duration to tripping and to fall back of the trip command. The time information has a resolution of 1 ms. It is also possible to use a PC and the DIGSI® operating and evaluation software to output the events. You have the option of logging the data on the connected printer or saving it to floppy disk for later evaluation.

The protection device saves the annunciation logs of the last twelve power system disturbances. If a thirteenth fault occurs, the oldest event in the fault memory is cleared. A power system fault starts when the system detects the fault due to pick/up of any protection and ends when the excitation of the last fault falls back.

3.5.1.3 Information via the Serial Interface

You can additionally transfer stored information via the system interface to the substation control and protection system, e.g. the SIEMENS LSA 678. Data is transferred using a DIN 19244-standard protocol or you can parameterize the VDEW/ZVEI-standard protocol.

3.5.2 Fault Recording

The system records the instantaneous values of measured variables **u** and **i** at 20 sampling values per power system period and stores them in a circulating buffer. In the event of a fault, the system stores the data for a period that you can set, but which may be a maximum of five seconds long. Up to eight fault events can be stored in this area. If a new fault occurs, the fault memory is updated automatically thus making acknowledgement unnecessary.

A PC can read out the data via the operating interface and then process it using the DIGSI® operating and evaluation software. The voltage and the current are referred to their maximum values, standardized to the rated value and prepared for display in graphic form. In addition, signals are logged as binary traces (markers), e.g. Fault detection and Tripping.

It is also possible to upload fault data via the serial system interface to a central unit. Appropriate programs in the central unit evaluate the data. In this connection, the currents are referred to their maximum values, standardized to the rated value and prepared for display in graphic form. In addition, signals are logged as binary traces (markers), e.g. Fault detection and Tripping.

When uploading to a central device, polling can be carried out automatically with the option of polling after every pick-up of the protection or only after tripping. In this context, the following applies:

- The protection signals the fact that fault data are ready to be polled.
- The system keeps the data ready for polling until the memory is overwritten by new faults.
- The central unit can prematurely cancel ongoing disposal (polling).

3.5.3 Operational Measurement and Measurement Transforming

The r.m.s. values of the values listed below are available for local polling or data transfer:

- primary contact line current in amperes as well as in percent of the rated device current;
- primary contact line voltage in kilovolt as well as in percent of the rated device voltage;
- calculated frequency in Hz;
- temperature of contact line in degrees C;
- ambient temperature in degrees C;
- operating resistance and reactance in Ω;
- operating phase angle in degrees.

While no fault detection is pending, the system constantly updates these values.

4 Preparatory Measures

Warning

The successful and safe operation of this device is dependent on proper handling and installation by qualified personnel under observance of all warnings and hints contained in this manual.

In particular the general erection and safety regulations (e.g. IEC, DIN, VDE, or national standards) regarding the correct use of hoisting gear must be observed. Non–observance can result in death, personal injury or substantial property damage.

4.1 Unpacking and Repacking the Device

When dispatched from the factory, the equipment is packed in accordance with the guidelines laid down in IEC 255–21, which specifies the impact resistance of packaging.

This packing shall be removed with care, without force and without the use of inappropriate tools. The equipment should be visually checked to ensure that there are no external traces of damage.

The transport packing can be re–used for further transport when applied in the same way. If alternative packing is used, this must also provide the same degree of protection against mechanical shock, as laid down in IEC 255–21–1 class 2 and IEC 255–21–2 class 1.

4.2 Preparing for Operation

The operating conditions must accord with VDE 0100/5.73 and VDE 0105 part 1/7.83, or corresponding national standards for electrical power installations.

Caution

The modules of digital relays contain CMOS circuits. These shall not be withdrawn or inserted under live conditions! The modules must be so handled that any possibility of damage due to static electrical charges is excluded. During any necessary handling of individual modules the recommendations relating to the handling of electrostatically endangered components (EEC) must be observed. In installed conditions, the modules are in no danger.

4.2.1 Mounting and Connection

4.2.1.1 Version 7SA518/519*-*B*** for Panel Flush Mounting or for Cubicle Installation

- Secure the unit with four screws to the panel. For dimensions refer to Chapter 2.5.
- Make a solid low–ohmic and low–inductive operational earth connection between the earthing surface at the side of the unit using at least one standard screw M4, and the earthing continuity system of the panel; recommended grounding strap DIN 72333 form A.
- Make connections via screwed terminals.

4.2.1.2 Version 7SA518/519*-*C*** for Installation in Control Board or Switching Cabinet

- Lift up both labelling strips on the lid of the unit and remove cover to gain access to four holes for the fixing screws.
- Insert the unit into the panel cut–out and secure it with the fixing screws. For dimensions refer to Chapter 2.5.
- Connect earthing screw on the rear of the unit to the protective earth of the panel or cubicle.
- Make a solid low–ohmic and low–inductive operational earth connection between the earthing, surface at the rear of the unit using at least one standard screw M4, and the earthing continuity system of the panel or cubicle; recommended grounding strap DIN 72333 form A.
- Make connections via the screwed or snap–in terminals of the sockets of the housing. Observe labelling of the individual connector modules to ensure correct location.

4.2.2 Checking the Rated Data

The rated data of the unit must be checked against the plant data. This applies in particular to the auxiliary voltage and the rated current of the current transformers (7SA519 only).

4.2.3 Adapting the Control Voltage for the Binary Inputs

As delivered, the binary inputs are set such that it is possible to use as the control variable direct voltages in the entire working range between 19 V and 288 V. With higher rated system-side voltages (110 V- and above), it may be sensible to give the binary inputs a higher operating threshold to increase the static signal-to-noise ratio.

To fit a binary input with the increased operating threshold of approximately 65 V, you must open one soldered jumper (W1 to W6) on basic module EPS-2 in each case.

Increasing the operating threshold of the binary inputs on module MEA-1 is done by moving jumper plugs X61 to X66 from position 2-3 to position 1-2.

The layout of soldered jumpers and jumper plugs on the individual modules is shown in Chapter R.5 of the Reference Section.

4.2.4 Checking the Connections

General and connection diagrams are shown in chapter R.6. The marshalling possibilities of the binary inputs and outputs are described in Chapter 4.5.

Warning

Some of the following test steps are carried out in presence of hazardous voltages. They shall be performed by qualified personnel only which is thoroughly familiar with all safety regulations and precautionary measures and pay due attention to them. Non–observance can result in severe personal injury.

- Switch off the circuit breakers for the dc supply and the voltage transformer circuits!
- Check the continuity of all the current and voltage transformer circuits against the plant and connection diagrams:
  - Are the current transformers correctly earthed?
  - Is the phase relationship of the current transformers correct?
  - Are the voltage transformers correctly earthed?
  - Is the phase relationship of the voltage transformers correct?
- Ensure that the miniature slide switch on the front plate is in the "OFF" position (see Figures 5.1 and 5.2).
- Fit a dc ammeter in the auxiliary power circuit; range approx. 1.5 A to 3 A.
- Close the battery supply circuit breaker; check polarity and magnitude of voltage at the terminals of the unit or at the connector module.
- The measured current consumption should be insignificant. Transient movement of the ammeter pointer only indicates the charging current of the storage capacitors.
- Put the miniature slide switch of the front plate in the "ON" position. The unit starts up and, on completion of the run–up period, the green LED on the front comes on at most 0.5 sec the red LED gets off after at most 5 sec.
- Close the voltage transformer m.c.b. (secondary circuit).
- Remove dc ammeter; reconnect the auxiliary voltage leads.
- Check through the tripping circuits to the circuit breaker.
- Check through the control wiring to and from other devices.
- Check the signal circuits.
- Reclose the protective m.c.b.'s.

4.2.5 Checking the Data Connection to the Substation Control System

If you use the serial interface in accordance with the VDEW protocol to connect to a control centre, you must check the data connection. It is important to visually check the assignments of the send and receive channels. Since each connection is specified for one direction of transfer, one device's send connection must be linked to the other device's receive connection and vice versa. Data transfer over optical waveguides is particularly resistant to disturbances and provides an inherent guaranteed galvanic isolation of the connection. The send connection is marked with an arrow pointing away from a dot; with the receive connection being shown by an arrow pointing towards a dot.

The default setting of the neutral position for the optical waveguide connection is Light off. If you want to change the neutral position, use jumper X91. It is accessible once you remove the basic module and is located in the middle of the basic module (EPS-2) towards the back on the component side between the connection modules (see Figure R.8/3).

Table 4.1 Jumper X91

Position	Neutral position
90-91	Light off
91-92	Light on

4.3 Configuring Operator Functions

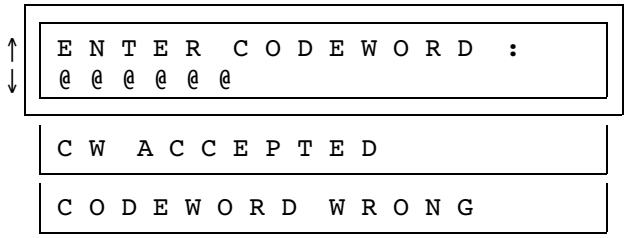
4.3.1 Conditions for Operation

For most operational functions. the input of a codeword is necessary. This applies for all entries via the membrane keyboard or front interface which concern the operation on the relay, for example

- configuration parameters for configuration of the interfaces and the device functions,
- allocation or marshalling of annunciation signals, binary inputs, optical indications, and trip relays,
- setting of functional parameters (thresholds, functions),.
- initiation of test procedures.

The codeword is not required for the read–out of annunciations, operating data or fault data, or for the read–out of setting parameters.

To indicate authorized operator use, press key CW, enter the six figure code 6 6 6 6 6 6 and confirm with E. Codeword entry can also be made retrospectively after paging or direct addressing to any setting address.



The entered characters do not appear in the display, instead only a symbol @ appears. After confirmation of the correct input with E the display responds with ← **CW ACCEPTED**. Press the entry key **E** again.

← If the codeword is not correct the display shows **CODEWORD WRONG**. Pressing the **CW** key allows another attempt at codeword entry.

4.3.2 Setting Operational Parameters

You can set operational parameters in block 70. This block makes it possible, for example, to change the operating language, to adapt the transfer rate for operation on a PC and to specify the operational and spontaneous messages shown in the display on the front panel. A codeword must be entered for this.

The simplest way of arriving at the beginning of this configuration blocks is to use key **DA**, followed by the address number **7 0 0 0** and ENTER, key **E**. The address 7 0 0 0 appears. Use the key ↑ to find the next address.

The display shows the four dit1it address number, i.e. block and sequence number. The title of the requested parameter appears behind the bar (see below). The second line of the display shows the text applicable to the parameter. The present text can be rejected by the "No"–key **N**. The next text choice then appears, as shown in the boxes below. The chosen alternative must be confirmed with enter key E!

On delivery, the device is set up to display information and designations in English.

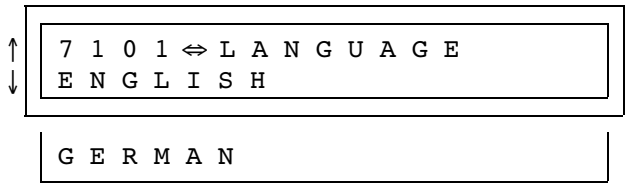
The setting procedure can be ended at any time by the key combination **F E**, i.e. depressing the function key F followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS?". Confirm with the "Yes"–key Y that the new settings shall become valid now. If you press the "No"–key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.

If one tries to leave the setting range for the configuration blocks (i.e. address blocks 60 to 79) with keys

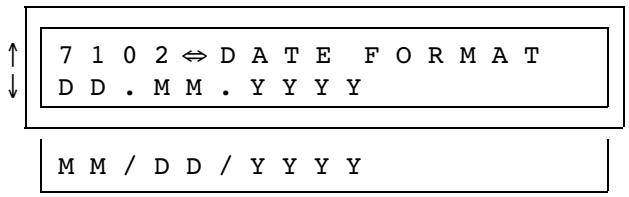
⇑⇓. the display shows the question "END OF CODEWORD OPERATION ?". Press the "No"–key **N** to continue configuration. If you press the "Yes"–key **J/Y** instead, another question appears: "SAVE NEW SETTINGS 7". Now you can confirm with **J/Y** or abort with **N**, as above.

When one exits the setting program, the altered parameters, which until then have been stored in buffer stores, are permanently secured in EEPROMs and protected against power outage. If configuration parameters have been changed the processor system will reset and re–start. During re–start the device is not operational.

Beginning of the block "Integrated operation"

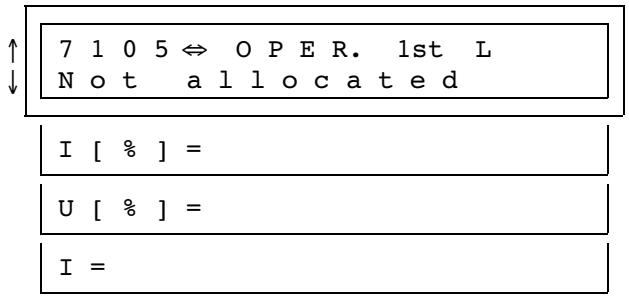


You can display the available languages by repeatedly pressing the No key, **N**; the information is shown in the appropriate language in each case. You choose the desired language by pressing the enter key, **E**.

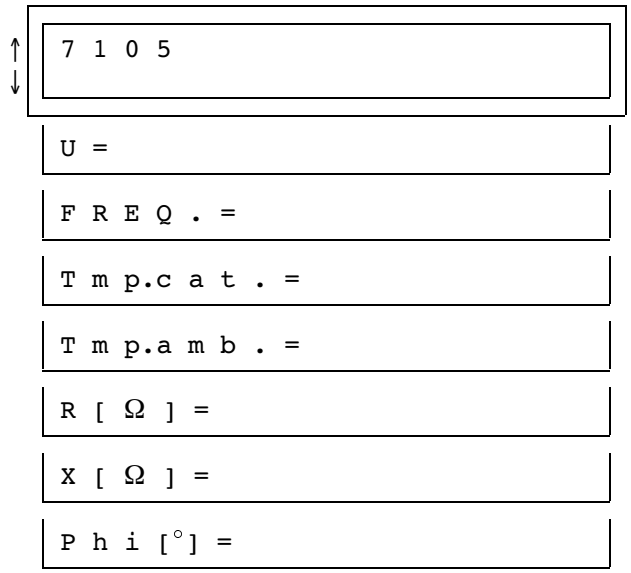


The date in the display is preset to the European format Day.Month.Year. Switch–over to the American format Month/Day/Year is achieved by depressing the "No"–key **N**; then confirm with the entry key **E**.

DD	two figures for the day
MM	two figures for the month
YYYY	four figures for the year (incl. century)

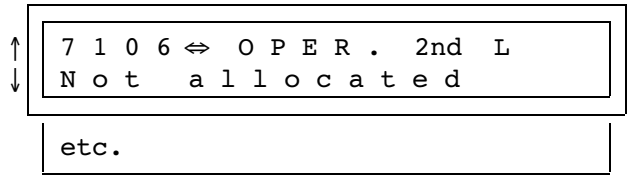


Operational message for the first display line. You can choose all the operational measured values by repeatedly pressing the No key, **N**; confirm the desired one by pressing the enter key, **E**. The system continuously shows the measured value you choose here on the **first** line of the display while the device is in the idle state.

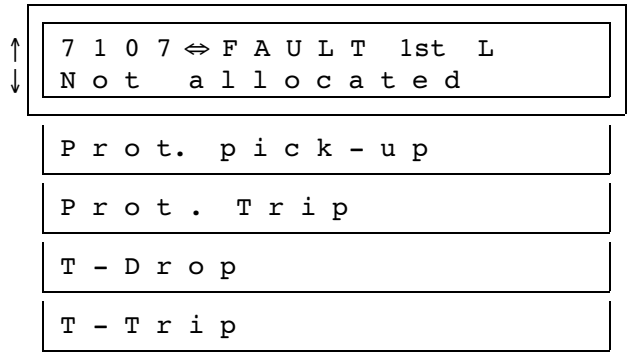


CONTINUED

Fault event annunciations can be displayed after a fault on the front. These can be chosen under addresses 7107 and 7108. The possible messages can be selected by repeatedly pressing the "No"–key **N**. The desired message is confirmed with the enter key **E**. These spontaneous messages are acknowledged during operation with the RESET key or via the remote reset input of the device or via the system interface (if fitted). After acknowledgement, the operational messages of the quiescent state will be displayed again as chosen under **addresses 7105 and 7106**.



Operational message for the second display line. The system continuously shows the measured value you choose here on the **second** line of the display while the device is in the idle state.



After a fault event, the **first** line of the display shows:
← Nothing

← protection function which has picked up,

← protection function, which has tripped,

← the elapsed time from pick–up to drop–off,

← the elapsed time from pick–up to trip command.

CONTINUED

7 1 0 7	
R p r i	← The primary fault resistance in ohms
X p r i	← The primary fault reactance in ohms
R s e c	← The secondary fault resistance in ohms
X s e c	← The secondary fault reactance in ohms
d =	← The distance to the fault in kilometers
d [%] =	← The distance to the fault in percent
F a u l t s e c t i o n	← The section containing the fault

7 1 0 8 ⇔ F A U L T 2nd L N o t a l l o c a t e d	After a fault event, the **second** line of the display shows: the possibilities are the same as under address 7107.
etc.	

7 1 1 0 ⇔ F A U L T I N D I C . w i t h f a u l t d e t e c	Stored LED indications and the fault event messages in the display can be displayed either with each fault detection or only after trip command is given. This mode can be changed by depressing the "No"–key **N** and confirmed with the enter–key **E**.
w i t h t r i p c o m m a n d	

4.3.2.1 Changing Codewords

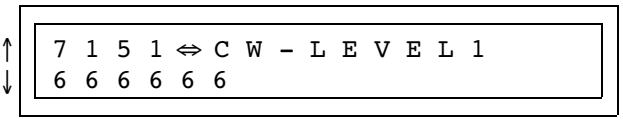
Addresses 7151 to 7154 can be used to change the codewords of all four available codeword levels. These levels allow to allocate different operator access permissions.

The four addresses can only be viewed and edited if code word level 4 (maximum permission level) is activated. To do so, the codeword for level 4 must be entered.

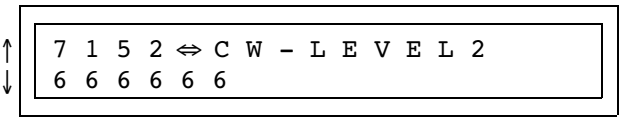
On each level, the access permission for that level includes access permissions for all lower levels.

Codewords may be reduced to less than six digits. If this is done, they must be entered with exactly the number of digits used.

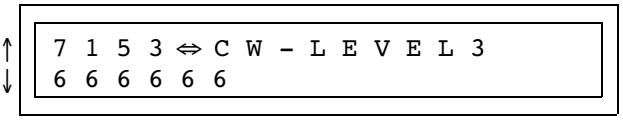
If the user does not change the codewords, the defaults settings remain valid. These are for all four codeword levels: "666666".



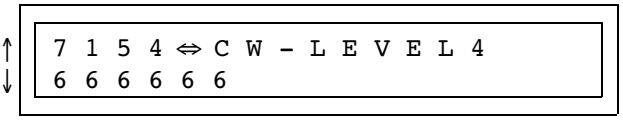
Codeword level 1: This permission level is for actions during normal operation (Control/Switching, Start fault recording, Set the real time clock, Select active parameter set).
Smallest permissible number: **0**
Largest permissible number: . . . **999999**



Codeword level 2: This permission level is for actions of special significance: Functional parameters (address blocks 11 to 39), Testing (block 44), Reset memory (block 82) and Parameter changeover (block 85).
Smallest permissible number: **0**
Largest permissible number: . . . **999999**



Codeword level 3: This permission level is for setting the system parameters; Marshalling (address blocks 61 to 64), Interfaces (blocks 71 to 72), Fault recording (block 74), Scope of functions (block 78).
Smallest permissible number: **0**
Largest permissible number: . . . **999999**



Codeword level 4: This is the highest permission level for users. It allows to change code words (addresses 7151 to 7154).

Smallest permissible number: **0**
Largest permissible number: . . . **999999**

4.3.3 Configuration of the Serial Interfaces - Block 72

The device provides one or two serial interfaces: one PC interface in the front for operation by means of a personal computer and - dependent of the ordered model - a further system interface for connection of a central control and storage unit, e.g. Siemens LSA 678. Communication via these interfaces requires some data prearrangements: identification of the relay, transmission format, transmission speed.

These data are entered to the relay in address block 72. Codeword input is necessary (see Chapter 4.3.1).

The data must be coordinated with the connected devices.

All annunciations which can be processed by the LSA are stored within the device in a separate table. This is listed in Appendix A.1.

Addresses 7211 to 7216 are valid for the operating (PC) interface on the front of the relay.

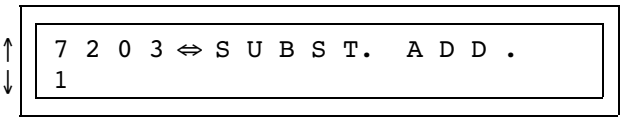
Note: for operator panel 7XR5, the PC-interface format **(Addr. 7211)** must be ASCII, the PC Baud-rate **(Addr. 7215)** must be 1200 BAUD, the PC parity **(Addr. 7216)** must be NO 2 STOP.

Beginning of the block "Interfaces for personal computer and central computer system"

Identification number of the relay within the substation: valid for both the interfaces (operating and system interface). The number can be chosen at liberty, but must be used only once within the plant system
Smallest permissible number: **1**
Largest permissible number: **254**

Number of the feeder within the substation; valid for both the interfaces (operating and system interface)

Smallest permissible number: **1**
Largest permissible number: **254**

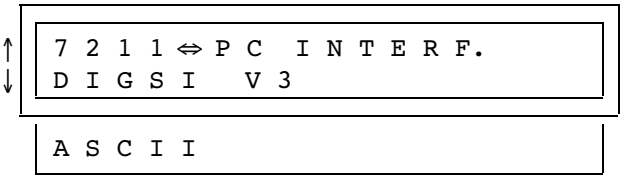


Identification number of the substation, in case more than one substation can be connected to a central device

Smallest permissible number: **1**
Largest permissible number: **254**

Function type in accordance with VDEW/ZVEI; for distance protection no. 226. This address is mainly for information, it should not be changed.

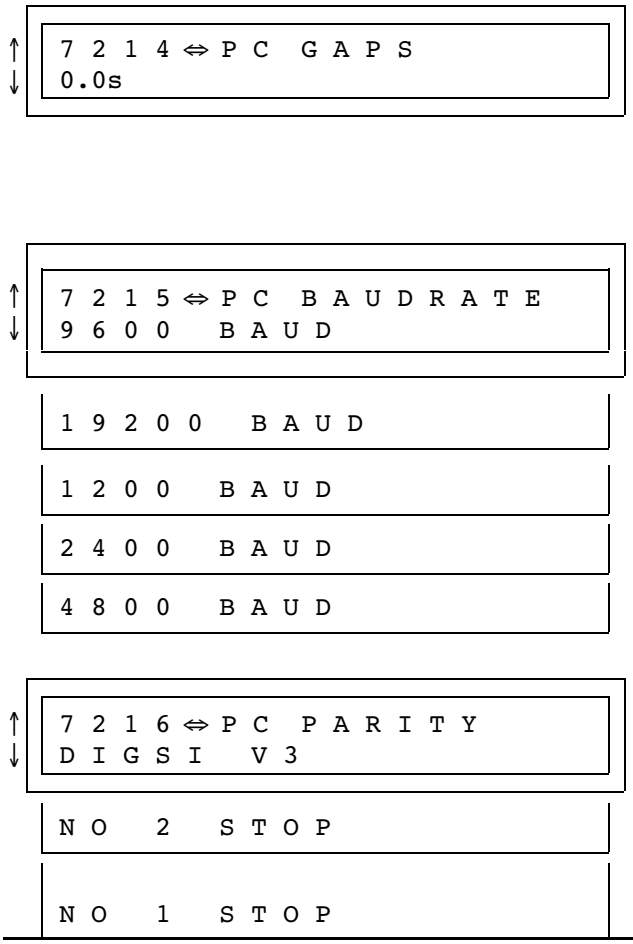
Device type for identification of the device in Siemens LSA 678 and program *DIGSI*®. For 7SA518/519 no. 20. This address is only for information, it cannot be changed.



Data format for the PC (operating) interface:

format for Siemens protection data processing program *DIGSI*® Version V3

ASCII format



Maximum permissible gaps within telegrams for modem transmission via the PC interface.

Smallest setting value: **0.0s**
Largest setting value: **5.0s**

The transmission Baud–rate for communication via the PC (operating) interface at the front can be adapted to the operator's communication interface, e.g. personal computer, if necessary. The available possibilities can be displayed by repeatedly depression of the "No"–key **N**. Confirm the desired Baud–rate with the entry key **E**.

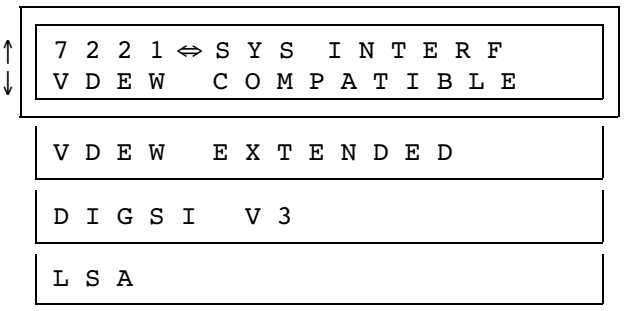
Parity and stop–bits for the PC (operating) interface:

← format for Siemens protection data processing program *DIGSI*® Version V3 with even parity and 1 stop–bit

← transmission with *NO* parity and 2 *STOP*–bits

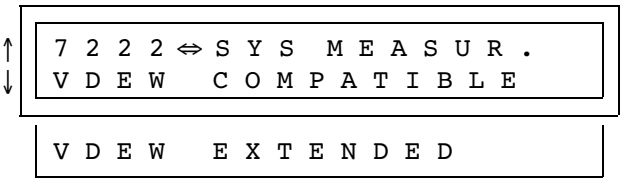
← transmission with *NO* parity and 1 *STOP*–bit, e.g. modem

Addresses 7221 to 7235 are valid for the system (LSA) interface (if fitted).



Format of annunciations and fault records for the system (LSA) interface:
← only data in accordance with *VDEW/ZVEI*

← data in accordance with *VDEW/ZVEI,* extended by Siemens specified data
← format for Siemens protection data processing program *DIGSI*® Version V3
← format of the former Siemens *LSA* version

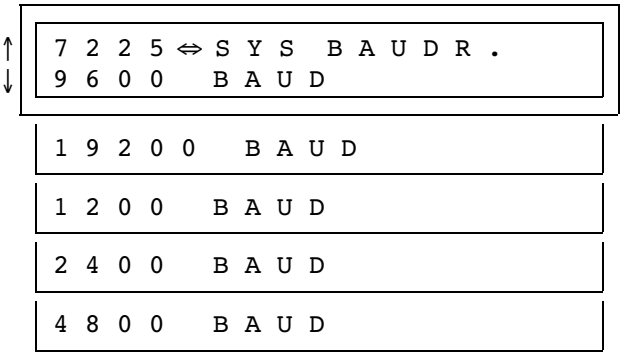


Format of measured values for the system (LSA) interface:
← only data in accordance with *VDEW/ZVEI*

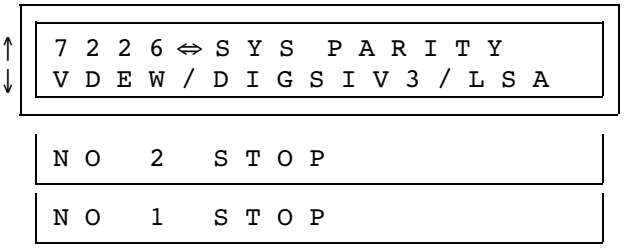
← data in accordance with *VDEW/ZVEI*, extended by Siemens specified data

Maximum permissible gaps within telegrams for modem transmission via the system interface.

Smallest setting value: **0.0s**
Largest setting value: **5.0s**



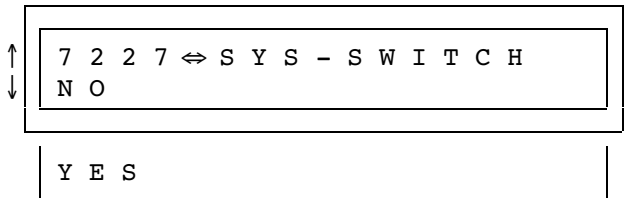
The transmission Baud–rate for communication via the system interface can be adapted to the system interface, e.g. LSA, if necessary. The available possibilities can be displayed by repeatedly depression of the "No"–key **N**. Confirm the desired Baud–rate with the entry key **E**.



Parity and stop–bits for the system (LSA) interface:
← format for VDEW–protocol or Siemens protection data processing program ***DIGSI***® Version V3 and former ***LSA***

← transmission with ***NO*** parity and 2 *STOP*–bits

← transmission with ***NO*** parity and 1 *STOP*–bit. e.g. modem

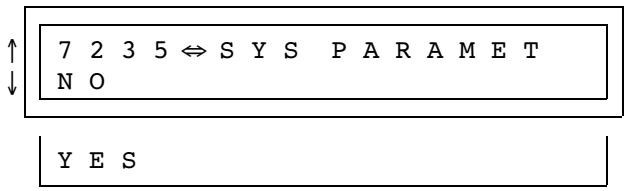


Switching to VDEW protocols (IEC 870-5-103) from DIGSI protocol via system interface is

← not enabled

← enabled

Address 7235 is relevant only in case the system interface is connected with a hardware that operates with the protection data processing program DIGSI® (**Addr. 7221** SYS INTERF = DIGSI V3). This address determines whether is shall be permitted to change parameters via this interface.



For connection of DIGSI® V3 to the system interface only:

Remote parameterization via the system interface

← *NO* – is not permitted

← *YES*– is permitted

4.3.4 Settings for the Fault Recording - Block 74

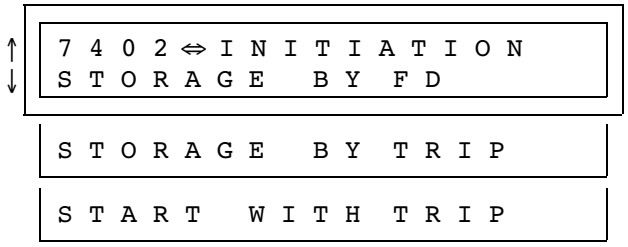
The 7SA518/519 numerical overhead contact–line protection is equipped with a fault data store (see Chapter 3.5.2). Distinction must be made between the reference instant and the storage criterion **(address 7402)**. Normally, the general fault detection signal of the protection is the reference instant. The storage criterion can be the general fault detection, too *(STORAGE BY FLT),* or the trip command *(STORAGE BY TRIP).* Alternatively, the trip command can be selected as reference instant *(START WITH TRIP),* in this case, the trip command is the storage criterion, too.

A fault event begins with the fault detection of any protection functions and ends with drop–off of the latest fault detection. The scope of a fault record is normally this fault event **(address 7403)**.

The actual recording time starts with the pre–trigger time T–PRE **(address 7411)** before the reference instant and ends with the post–fault time T-POST **(address 7412)** after the recording criterion has disappeared. The permissible recording time for each record is set under **address7410**. Altogether 5 s are available for fault recording. In this time range up to 8 fault records can be stored.

Data storage can also be initiated via a binary input or by operator action from the membrane keyboard on the front of the relay or via the operating interface. The storage is triggered dynamically, in these cases. The length of the data storage is determined by the settings in **addresses 7431 and 7432** Pre–trigger time and post–fault time are additive to the set values. If the storage time for start via binary input is set to ∞, then the storage time ends after de–energization of the binary input (statically), but not after T–MAX **(address 7410)**.

Beginning of block "Fault recordings"

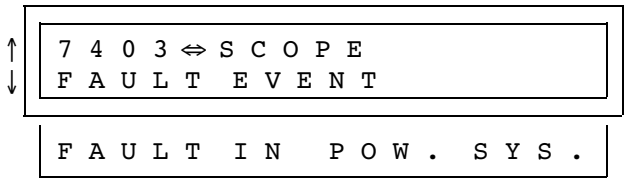


Data storage is initiated:

← fault detection is reference instant fault detection is storage criterion

← fault detection is reference instant trip command is storage criterion

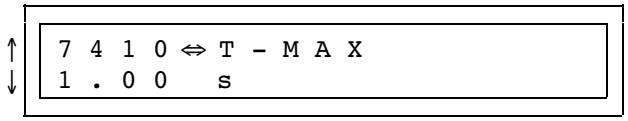
← trip command is reference instant trip command is storage criterion



Scope of a fault record:

← a fault record is stored for each *FAULT EVENT,* i.e. from pick–up until drop–off

← With the 7SA518/519 FAULT IN POW. SYS. has the same meaning as the fault event



Maximum time period of a fault record

Smallest setting value: . . . . . **0.30 s**
Largest setting value: . . . . . **5.00 s**

Pre–trigger time before the reference instant (reference time according to Addr. 7402)

Smallest setting value: . . . . . **0.05 s**
Largest setting value: . . . . . **0.50 s**

Post–fault time after the storage criterion disappears

Smallest setting value: . . . . . **0.05 s**
Largest setting value: . . . . . **0.50 s**

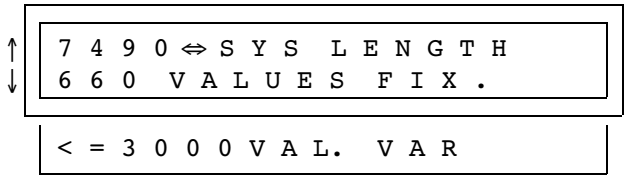
Storage time when fault recording is initiated via a binary input, pre–trigger (Addr. 7411) and post–fault times (Addr. 7412) are additive

Smallest setting value: . . . . . **0.10 s**
Largest setting value: . . . . . **5.00 s**
or ∞, i.e. as long as the binary input is energized (but not longer than T–MAX)

Storage time when fault recording is initiated via the membrane keyboard, pre–trigger (Addr. 7411) and post–fault times (Addr. 7412) are additive

Smallest setting value: . . . . . **0.10 s**
Largest setting value: . . . . . **5.00 s**

Address 7490 is only relevant if the relay is connected to a former LSA system, the relay must be informed how long a transmitted fault record must be so that the former LSA system receives the correct number of fault record values.



Only for communication with a former LSA system:

Length of a fault record which is transmitted via the serial system interface:
← 660 values fix for old LSA or

← variable length with a maximum of 3000 values

4.4 Configuration of the Protective Functions

The 7SA518/519 numerical overhead contact-line protection system is capable of providing a series of protection and additional functions. The scope of the hard– and firm–ware is matched to these functions. Furthermore, individual functions can be set (configured) to be effective or non–effective or the interaction of the functions can be modified by configuration parameters. Additionally, the relay can be adapted to the system frequency.

The configuration parameters are input through the integrated operation keyboard at the front of the device or by means of a personal computer, connected to this front–interface. The use of the integrated operating keyboard is described in detail in Chapter 5.1. Alteration of the programmed parameters requires the input of the codeword (see Chapter 4.3.1). Without codeword, the setting can be read out but not altered.

For the purpose of configuration, addresses 78** and 79** are provided. One can access the beginning of the configuration blocks either by direct dial

- press direct address key **DA**,
- type in address **7 8 0 0**,
- press execute key **E**;

or by paging with the keys ⇑ (forwards) or ⇓ (backwards), until address 7800 appears.

Within the block 78 one can page forward with ↑ or back with ↓. Each paging action leads to a further address for the input of a configuration parameter. In the following sections, each address is shown in a box and explained. In the upper line of the display, behind the number and the bar, stands the associated device function. In the second line is the associated text (e.g. *"EXIST")*. If this text is appropriate the arrow keys ↑ or ↓ can be used to page the next address. If the text should be altered press the "No"–key **N**; an alternative text then appears (e.g. *"NON–EXIST").* There may be other alternatives which can then be displayed by repeated depression of the "No"–key **N**. The required alternative must be confirmed with the key **E**!

Use of the double arrow key ⇑ brings one to the next address block, in this case 79. There one finds further setting parameters which can equally be confirmed or altered.

The configuration procedure can be ended at any time by the key combination **F E**, i.e. depressing the function key F followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS ?". Confirm with the "Yes"–key **J/Y** that the new settings shall become valid now. If you press the "No"–key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.

If one tries to leave the setting range for the configuration blocks (i.e. address blocks 60 to 79) with keys ⇑ ⇓, the display shows the question "END OF CODEWORD OPERATION ?". Press the "No"–key **N** to continue configuration. If you press the "Yes"–key **J/Y** instead, another question appears: "SAVE NEW SETTINGS ?". Now you can confirm with **J/Y** or abort with **N**, as described above.

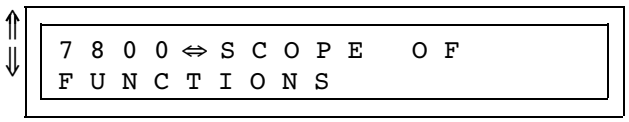
When one exits the setting program, the altered parameters, which until then have been stored in volatile memories, are then permanently secured in EEPROMs and protected against power outage. The processor system will reset and re–start. During re–start the device is not operational.

4.4.1 Programming the Scope of Functions - Block 78

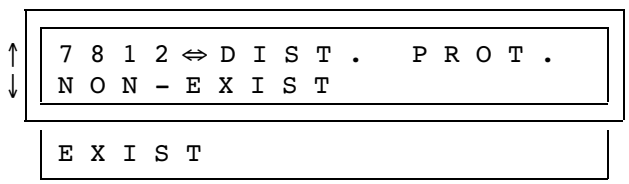
The available protective and additional functions can be programmed as existing or not existing. For some functions it may also be possible to select between multiple alternatives.

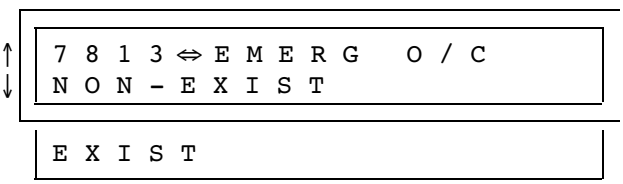
Functions which are configured as *NON EXIST will* not be processed in 7SA511: There will be no annunciations and the associated setting parameters (functions, limit values) will not be requested during setting. In contrast, switch–off of a function means that the function will be processed, that indication will appear (e.g.... "switched off") but that the function will have no effect on the result of the protective process (e.g. no tripping command).

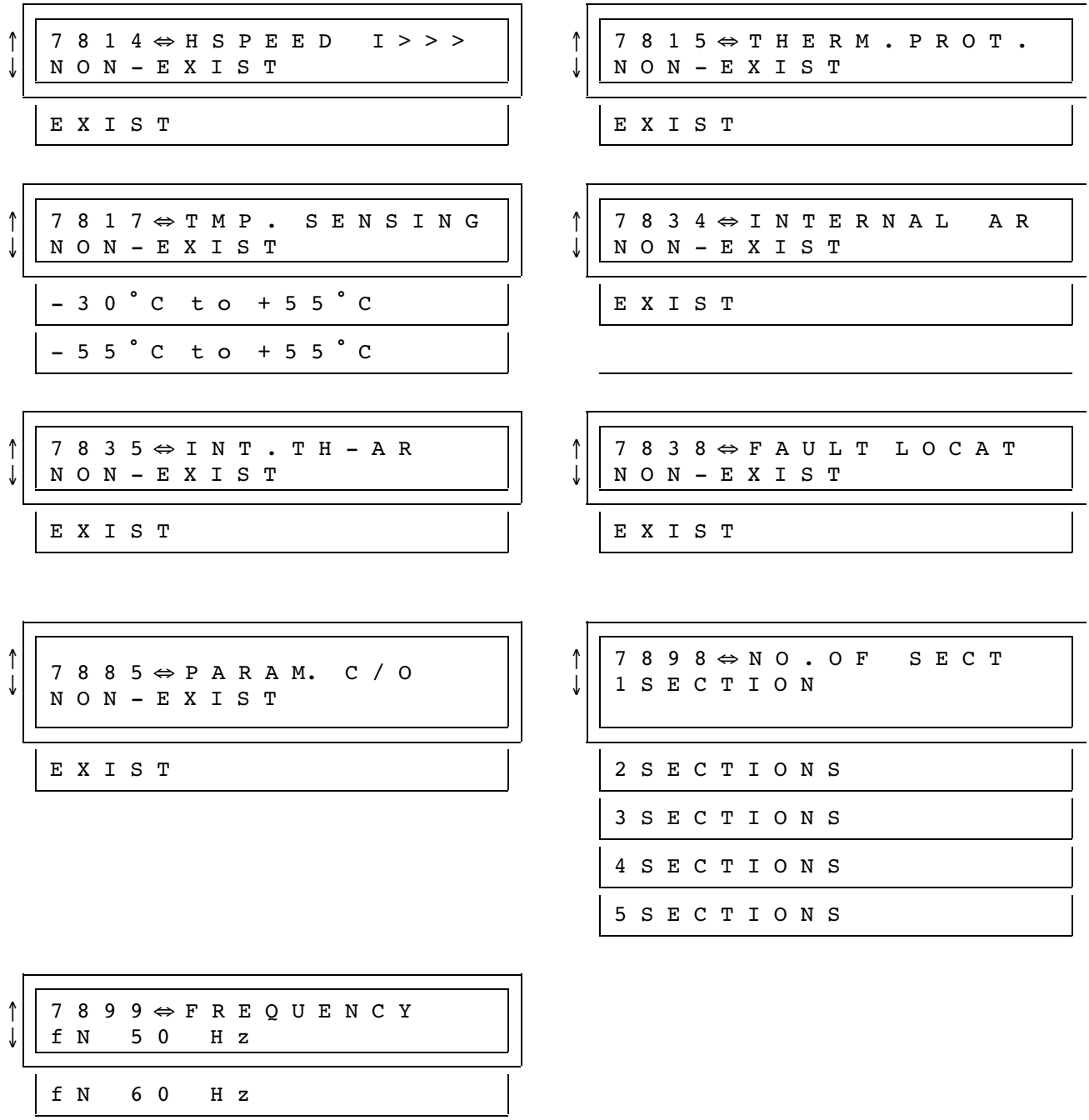
The following boxes show the possibilities for the maximum scope of the device. In an actual case, functions which are not available will not appear in the display.



Beginning of the block "Scope of functions".



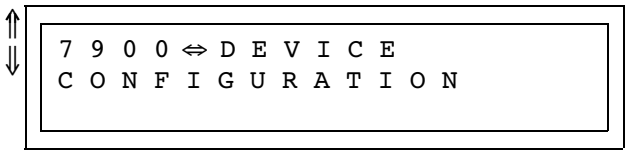



7814⇔HSPEED I>>>
NON-EXIST
EXIST
7815⇔THERM.PROT.
NON-EXIST
EXIST
7817⇔TMP. SENSING
NON-EXIST
-30°C to +55°C
-55°C to +55°C
7834⇔INTERNAL AR
NON-EXIST
EXIST
7835⇔INT.TH-AR
NON-EXIST
EXIST
7838⇔FAULT LOCAT
NON-EXIST
EXIST
7885⇔PARAM. C/O
NON-EXIST
EXIST
7898⇔NO.OF SECT
1 SECTION
2 SECTIONS
3 SECTIONS
4 SECTIONS
5 SECTIONS
7899⇔FREQUENCY
fN 50 Hz
fN 60 Hz

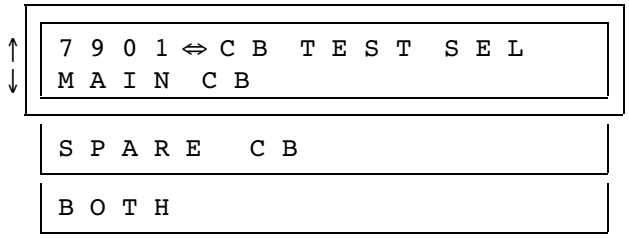
4.4.2 Setting of the Device Configuration - Block 79

The configuration describes how the protection and additional functions work together. In the case of the 7SA518/519 numerical overhead contact-line protection system, this includes:

- testing of the circuit breaker,
- switching over functions via a binary input and
- connecting the AR to the protection functions.



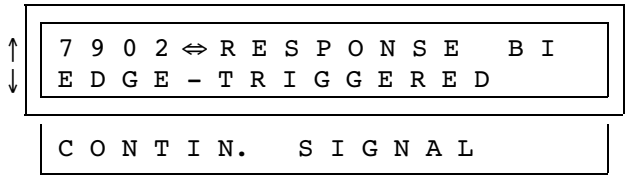
Beginning of the block "Device configuration"



Functional testing of the circuit breaker via a binary input refers to
← the main circuit breaker

← the spare circuit breaker

← both circuit breakers

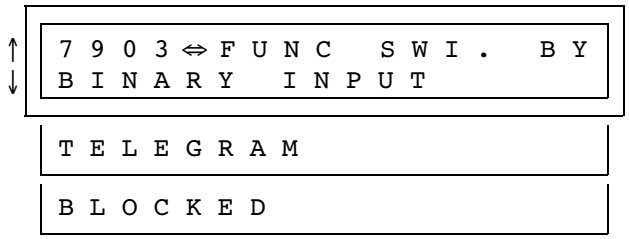


The binary inputs for catenary switching are activated
← edge-triggered

← by a continuous signal

Binary inputs for **switching over catenaries (FNo. 6603, 6604, 6605)**:

- **Edge-Triggered**
  Three binary inputs are necessary, since only the rising edges are evaluated. The catenary setting of the binary input with the last rising edge is active.
- **Continuous Signal**
  No trigger function at marshalling. During external control, only one signal in each case must be switched active (> Cat. 1 active or > Cat. 2 active or > Cat. 3 active).

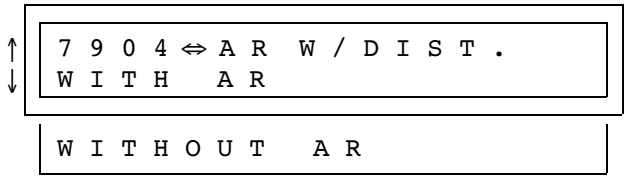


Catenary switching is carried out
← via a binary input

← by means of a telegram from the control system

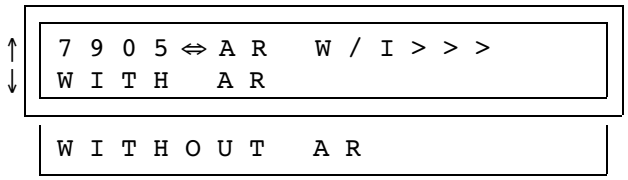
← is blocked

If automatic reclose, AR, is configured as EXIST, you can use **addresses 7904 to 7907** to link the appropriate protection functions to the AR. Each protection function is linked to the AR independently of the other protection functions. Only a protection function that is enabled for the AR can start the AR.



Tripping by distance protection may start AR cycle
← Enabled

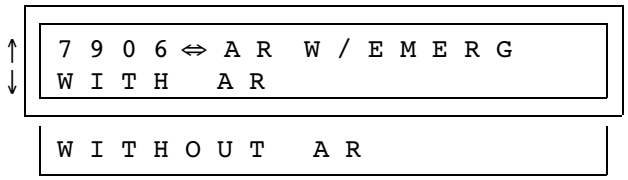
← Not enabled



High-speed overcurrent protection may start AR cycle

← Enabled

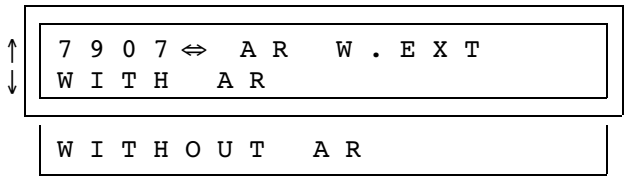
← Not enabled



Emergency overcurrent protection may start AR cycle

← Enabled

← Not enabled



An external trip via binary input addresses 2711 and 2712 starts an AR cycle
← Enabled

← Not enabled

4.5 Marshalling of Binary Inputs, Binary Outputs and LED Indicators

The assignment of the inputs and outputs of the internal functions can be rearranged and thus adapted to the on–site conditions.

Marshalling of the inputs, outputs and LEDs is performed by means of the integrated operator panel or vi8 the operating interface in the front. The operation of the operator panel is described in detail in Chapter 5.1. Marshalling begins at the parameter address 6000.

The input of the codeword is required for marshalling (see Chapter 4.3.1). Without codeword entry, parameters can be read out but not be changed. During codeword operation, i.e. from codeword entry until the termination of the marshalling procedure, the solid bar in the display flashes.

When the 7SA518/519 numerical overhead contact-line protection system programs are running the specific logic functions will be allocated to the physi-

cal input and output modules or LEDs in accordance with the selection.

Example: Fault detection is registered from the distance protection in phase L1. This event is generated as an "Annunciation" (logical function) and should be available at certain terminals of the unit as a N.O. contact.

Since specific unit terminals are hard–wired to a specific (physical) signal relay, e.g. to the signal relay 7, the processor must be advised that the logical signal "`Dist.Fault L1`" should be transmitted to the signal relay 7. Thus, when marshalling is performed two statements of the operator are important: **Which** (logical) annunciation generated in the protection unit program should trigger **which** (physical) signal relay? Up to 20 logical annunciations can trigger one (physical) signal relay.

A similar situation applies to binary inputs. In this case external information (e.g. voltage transformer m.c.b. tripped) is connected to the unit via a (physical) input module and should initiate a (logical) function, namely blocking. The corresponding question to the operator is then: **Which** signal from a (physical) input relay should initiate **which** reaction in the device? One physical input signal can initiate up to 10 logical functions.

The trip relays can also be assigned different functions. Each trip relay can be controlled by each command function or combination of command functions.

The logical annunciation functions can be used in multiple manner. E.g. one annunciation function can trigger several signal relays, several trip relays, additionally be indicated by LEDs, and be controlled by a binary input unit. The restriction is, that the total of all physical input/output units (binary inputs plus signal relays plus LEDs plus trip relays) which are to be associated with one logical for function must not exceed a number of 10. If this number is tried to be exceeded, the display will show a corresponding message.

Marshalling is structured such that the system polls for each (physical) input/output unit, i.e.

- binary inputs,
- signal relays,
- trip relays,
- LEDs

which (logical) functions are to take effect.

The offered logical functions are tabulated for the binary inputs, outputs and LEDs in the following sections.

The beginning of the marshalling parameter blocks is reached by directly selecting the address 6000, i.e.

- press direct address key, **DA**,
- enter address **6 0 0 0**,
- press enter key, **E**,

or by paging with keys ⇑ (forwards) or ⇓ (backwards) until address 6000 has been reached. The beginning of the marshalling blocks then appears:

Beginning of marshalling blocks

One can proceed through the marshalling blocks with the key ⇑ or go back with the key ⇓. Within a block, one goes forwards with ↑ or backwards with ↓. Each forward or backward step leads to display of the next input, output or LED position. In the display, behind the address and the solid bar, the physical input/output unit forms the heading.

The key combination **F** ↑, i.e. depressing the function key F followed by the arrow key ↑. switches over to the selection level for the logical functions to be allocated. During this change–over (i.e. from pressing the **F** key until pressing the ↑ key) the bar behind the address number is replaced by a "F". The display shows, in the upper line, the physical input/output

unit, this time with a three digit index number. The second display line shows the logical function which is presently allocated.

On this selection level the allocated function can be changed by pressing the "No"–key **N**. By repeated use of the key N all marshallable functions can be paged through the display. Back–paging is possible with the backspace key **R**.

After this, further functions can be allocated to the same physical input or output module (with further index numbers) by using the key ↑. Each selection must be confirmed by pressing the key **E**! If a selection place shall not be assigned to a function, selection is made with the function "not allocated".

You can leave the selection level by pressing the key combination **F** ↑ (i.e. depressing the function key **F** followed by the arrow key ↑). The display shows again the four digit address number of the physical input/output module. Now you can page with key ↑ to the next input/output module or with ↓ to the previous to repeat selection procedure, as above.

The logical functions are also provided with function numbers which are equally listed in the tables. If the function number is known, this can be input directly on the selection level. Paging through the possible functions is then superfluous. With direct input of the function number, leading zeros need not be entered. After input of the function number, use the enter key **E**. Immediately the associated identification of the function appears for checking purposes. This can be altered either by entering a different function number or by paging through the possible functions, forwards with the "No"–key **N** or backwards with the backspace key R. If the function has been changed, another confirmation is necessary with the enter key **E**.

In the following paragraphs, allocation possibilities for binary inputs, binary outputs and LED indicators are given. The arrows ⇑⇓ or ↑↓ at the left hand side of the display box indicate paging from block to block, within the block or on the selection level. The character F before the arrow indicates that the function key F must be pressed before–pushing the arrow key ↑.

The marshalling procedure can be ended at any time by the key combination **F E**, i.e. depressing the function key F followed by the entry key E. The display shows the question "SAVE NEW SETTINGS?". Confirm with the "Yes"–key **J/Y** that the new allocations shall become valid now. If you press the "No"–key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.

If one tries to leave the setting range for the configuration blocks (i.e. address blocks 60 to 79) with keys ⇑⇓. the display shows the question "END OF CODEWORD OPERATION ?". Press the "No"–key **N** to continue marshalling. If you press the "Yes"–key **J/Y** instead, another question appears: "SAVE NEW SETTINGS ?". Now you can confirm with **J/Y** or abort with **N**, as above.

When one exits the marshalling program, the altered parameters, which until then have been stored in volatile memory, are then permanently secured in EEPROMs and protected against power outage. The processor system will reset and restart. During re–start the device is not operational.

4.5.1 Marshalling of the Binary Inputs - Block 61

The unit contains 12 binary inputs which are designated INPUT 1 to INPUT 12. They can be marshalled in address block 61. The address block is reached by paging in blocks ⇑⇓ or by direct addressing with **DA 6 1 0 0 E**. One binary input may trip several logical functions; one logical function may be tripped by several binary inputs. The selection procedure is carried out as described in Chapter 4.5.

For each binary input function, you can also choose whether the input function is to be effective as an open or as a closed-circuit arrangement:

- **Open-circuit arrangement (A)**
  The input is effective as a make contact, i.e. a control voltage on the input terminals activates the function.

- **Closed-circuit arrangement (R)**
  The input is effective as a break contact (i.e., a control voltage on the input terminals cancels the function) and it is active without a control voltage.

When paging through the display, each input function is displayed with the index "A" or "R" when proceeding with the "No"–key **N**.

Table 4.2 shows a complete list of all the binary input functions with their associated function number FNo.

Input functions naturally have no effect if the corresponding protection function is not fitted in the relay or has been programmed out ("deconfigured", see Chapter 4.4.1).

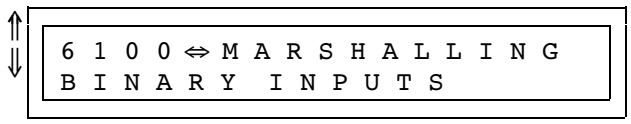
With direct input of the function number, leading zeros need not be used. To indicate the contact mode the function number can be extended by a decimal point followed by **0** or **1**, whereby

.0 Open-circuit arrangement
Corresponds to suffix **A**

.1 Closed-circuit arrangement
Corresponds to suffix **R**

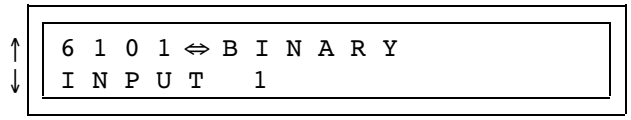
If you do not enter a **.0** or a **.1**, the short designation is initially shown with an "A". Pressing the No key, **N** switches to "R". After making a direct input, you can choose other functions with their short designations using the No key, **N** or by paging backwards using the **R** key. You must then confirm the chosen function again with the enter key, **E**.

The following boxes, as an example, the allocation for binary input 1. Table 4.2 lists all the possible settings. The default settings for the binary inputs are listed in Table 4.3.



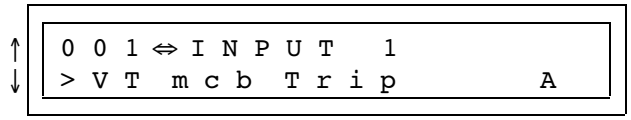
Beginning of block "Marshalling binary inputs"

The first binary input is reached with the key ↑



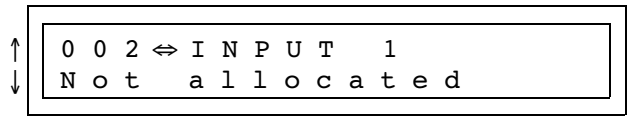
Allocations for binary input

Change over to the selection level with F ↑.



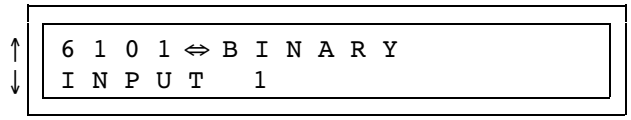
Binary input 1 has the default setting

Input for the transformer m.c.b



No further functions are initiated by binary input 1

Leave the selection level with key combination F ↑.
Address 6101 is displayed again. You can go then to the next binary input with the arrow key ↑.



Marshalling binary input 1

Table 4.2 Marshalling possibilities for binary inputs

FNo.	Abbreviation	Description
1	Not allocated	Binary input is not allocated to any input function
3	>Time Synchro	Synchronize internal real time clock
4	>Start FltRec	Start fault recording from external command via binary input
5	>LED reset	Reset LED indicators
7	>ParamSelec.1	Parameter set selection 1 (with >parameter selection 2)
8	>ParamSelec.2	Parameter set selection 2 (with >parameter selection 1)
11	>Annunc. 1	User definable annunciation 1
12	>Annunc. 2	User definable annunciation 2
13	>Annunc. 3	User definable annunciation 3
14	>Annunc. 4	User definable annunciation 4
15	>Sys-Test	System interface messages/values are marked with "Test operation"
16	>Sys-MM-block	System interface messages and measured values are blocked
355	>CB Aux. cl.	Circuit breaker auxiliary contact closed
356	>Manual Close	Circuit breaker is manually closed (from discrepancy switch)
361	>VT mcb Trip	Voltage transformer secondary m.c.b. (feeder) has tripped
365	>Ctrl. by BI	Control by binary input
1106	>Start FltLoc	Start fault locator from external command via binary input
1156	>CB Test	Start circuit breaker test externally
1158	>CBtstTRP/CLS	Start CB trip/close cycle test
1401	>B/F on	Switch on breaker fail protection
1402	>B/F off	Switch off breaker fail protection
1431	>B/F Start	Start breaker failure protection externally
2001	>Emer. ON	Switch ON emergency overcurrent protection
2002	>Emer. OFF	Switch OFF emergency overcurrent protection
2701	>AR on	Switch on internal auto–reclose function
2702	>AR off	Switch off internal auto–reclose function
2703	>AR blockWE block	Block internal auto–reclose function statically
2709	>DAR blockLU block.	Block complete DAR
2710	>Th-AR block	Th-AR: Block thermal AR function externally
2711	>ext.Start AR	AR: External start for internal AR
2712	>ext. Trip A	AR: External trip for internal AR
2718	>Th-AR ON	Th-AR: Switch on thermal AR function
2719	>Th-AR OFF	Th-AR: Switch off thermal AR function
2730	>CB ready	Circuit breaker ready for AR cycle

Table 4.2 (Continued)

FNo.	Abbreviation	Description
3601	>Dis.prot. on	Distance protection is switched on
3602	>Dis.prot. off	Distance protection is switched off
6601	>Th.Prot.on	Thermal protection is switched on
6602	>Th.Prot.off	Thermal protection is switched off
6603	>Cat.3 active	Third catenary is active
6604	>Cat.2 active	Second catenary is active
6605	>Cat.1 active	First catenary is active
6751	>O/C I>>> on	High-speed O/C I>>> is switched on
6752	>O/C I>>> off	High-speed O/C I>>> is switched off

Table 4.3 Default Settings for Binary Inputs

Address	1st Display Line	2nd Display Line		FNo.	Remarks
6100	MARSHALLING	BINARY INPUTS			Block heading
6101	BINARY INPUT 1	INPUT 1 >VT mcb Trip	A	361	U Line side VT MCB tripped
6102	BINARY INPUT 2	INPUT 2 >LED reset	A	5	Acknowledgement and resetting of stored LEDs and displays, testing of LEDs
6103	BINARY INPUT 3	not allocated			
6104	BINARY INPUT 4	not allocated			
6105	BINARY INPUT 5	not allocated			
6106	BINARY INPUT 6	not allocated			
6107	BINARY INPUT 7	not allocated			
6108	BINARY INPUT 8	INPUT 8 >Cat.1 active	A	6605	First catenary is active
6109	BINARY INPUT 9	INPUT 9 >Cat.2 active	A	6604	Second catenary is active
6110	BINARY INPUT 10	INPUT 10 >Cat.2 active	A	6603	Third catenary is active
6111	BINARY INPUT 11	INPUT 11 >AR block.	A	2703	Auto-reclose function blocked
6112	BINARY INPUT 12	INPUT 12 >CB test start	A	1156	Circuit breaker test start

4.5.2 Marshalling of the Signal Relays - Block 62

The 7SA518/519 numerical overhead contact-line protection system has signal outputs. The number of outputs depends on the version of the device:

- **7SA518:** 11 signal outputs that can be marshalled
- **7SA519:** 22 signal outputs that can be marshalled

The signal outputs are designated SIGNAL RELAY 1 to SIGNAL RELAY 11 or to SIGNAL RELAY 22. With version 7SA518, you cannot marshal signal output 12; in the case of version 7SA519, this applies to signal output 23. The Device Ready message is permanently assigned to these two relays.

All the other signal outputs can be marshalled in block 62. The block is reached by paging in blocks with ⇑⇓ or by directly addressing **DA 6 2 0 0 E**. The selection procedure is carried out as described in Chapter 4.5. Several logical signal functions can be grouped together as common annunciations. Multiple annunciations are possible, i.e. one logical annunciation function can be given to severai physical signal relays.

Table 4.4 gives a listing of all annunciation functions with the associated function numbers FNo. Annunciation functions are naturally not effective when the corresponding protection function is not fitted in the relay or has been programmed out.

Annunciations which are indicated by a leading ">" sign, represent the direct confirmation of the binary inputs and are available as long as the corresponding binary input is energized.

The following boxes show examples for marshalling. In the example for signal relay 4 the group annunciation for several annunciation functions on one signal relay is shown.

Table 4.5 shows all signal relays as preset from the factory. The default settings for signal relays 13 to 23 are not relevant to device version 7SA518.

⇑⇓

```
6 2 0 0 ⇔ M A R S H A L L I N G
S I G N A L   R E L A Y S
```

Beginning of the block "Marshalling of the output signal relays"

The first signal relay is reached with the key ↑:

↑↓

```
6 2 0 1 ⇔ S I G N A L
R E L A Y   1
```

Allocations for signal relay 1

Change over to the selection level with F ↑:

↑↓

```
0 0 1 ⇔ S I G N A L   R E L . 1
B / F   T R I P
```

The following default setting applies to signal relay 1:

Trip command due to expired breaker failure protection time, t_{HR} (FNo. 1471)

↑↓

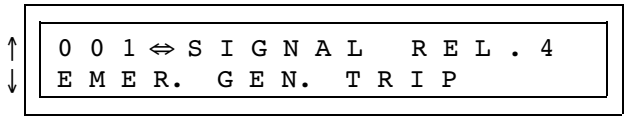
```
0 0 2 ⇔ S I G N A L   R E L .  1
N o t   a l l o c a t e d
```

no further functions are preset for signal relay 1

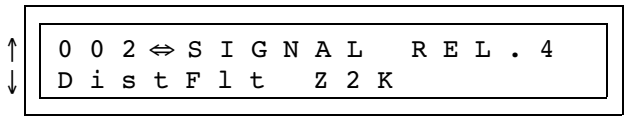
Press function key **F** and then the up arrow key (↑) to leave the selection level; you can then use the ↑ key to go the next signal relay. The screenshots below show an example of a common annunciation, i.e. several logical signal functions are issued to one common signal relay:

Note: You may only marshal the signal relays so that not more than 20 signal relays are addressed at the same time!

Allocations for signal relay 4



First:
Emergency general trip function (FNo. 2141)



Second:
Disturbance fault detection zone Z2k (FNo. 3925)

No further signal functions for signal relay 4

After input of all annunciation functions for signal relay 4, change back to the marshalling level is carried out with F ↑:

Allocations for signal relay 4

Table 4.4 Marshalling possibilities for signal relays and LEDs

FNo.	Abbreviation	Description
1	not allocated	No annunciation allocated
3	>Time Synchro	Synchronize internal real time clock
4	>Start FltRec	Start fault recording by external command via binary input
5	>LED reset	Reset LED indicators
7	>ParamSelec.1	Parameter set selection 1 (with >parameter selection 2)
8	>ParamSelec.2	Parameter set selection 2 (with >parameter selection 1)
11	>Annunc. 1	User definable annunciation 1

Table 4.4 (Continued)

FNo.	Abbreviation	Description
12	>Annunc. 2	User definable annunciation 2
13	>Annunc. 3	User definable annunciation 3
14	>Annunc. 4	User definable annunciation 4
15	>Sys-Test	System interface messages/values are marked with "Test operation"
16	>Sys-MM-block	System interface messages and measured values are blocked
51	Dev. operative	Protection device operative
52	Prot. operat.	At least one protection function is active
60	LED reset	Stored annunciations are reset
95	Param. running	Parameters are being set
96	Param. Set A	Parameter set A is active
97	Param. Set B	Parameter set B is active
98	Param. Set C	Parameter set C is active
99	Param. Set D	Parameter set D is active
143	Failure 15V	Failure 15 V internal dc supply
144	Failure 5V	Failure 5 V internal dc supply
145	Failure 0V	Failure 0 V A/D converter
155	Failure MEA1	Failure of analog input MEA1
156	Failure MEA2	Failure of analog inputMEA2
157	Fail MAIN CB	Failure of main circuit breaker
158	Fail TEMPSENS	Failure of outdoor temperature sensing (for 7SA519 only)
168	Failure Umeas	Failure measured voltage
355	>CB Aux. cl.	Circuit breaker auxiliary contact closed
356	>Manual Close	Circuit breaker is manually closed (from discrepancy switch)
361	>VT mcb Trip	Voltage transformer secondary m.c.b. (feeder) has tripped
501	Device FltDet	General fault detection of the device
511	Device Trip	General trip of the device
561	Manual Close	Manual close indication of circuit breaker
563	CB Alarm Supp	Circuit breaker operation alarm suppressed
564	CB Alarm Supp	Circuit breaker alarm suppressed thermal protection AR
1106	Start FltLoc	Start fault locator by external command via binary input
1110	FltLoc block	Fault location blocked
1156	>CB Test	Trigger circuit breaker test
1158	>CBtstTRP/CLS	Start Circuit breaker trip/close cycle test
1173	CBtstTRP/CLS	Circuit breaker trip/close cycle test in progress

Table 4.4 (Continued)

FNo.	Abbreviation	Description
1174	CB in Test	Circuit breaker test is in progress
1181	CB Test Trip	Trip by internal circuit breaker test function general
1186	Test MAIN CB	Circuit breaker test: Trip main circuit breaker
1187	Test SPARE CB	Circuit breaker test: Trip spare circuit breaker
1190	Op.Imp.forw	Operational impedance forwards
1401	>B/F on	Switch on breaker failure protection
1402	>B/F off	Switch off breaker failure protection
1431	>B/F Start	External starting of breaker failure protection
1451	B/F off	Breaker failure protection is switched off
1455	B/F fault	Breaker failure: fault detection
1471	B/F Trip	Trip by breaker failure protection
1484	B/F s.ordProt	B/F: pick up superordinated protection relay
1485	B/F T-SP	Delay time for back up trip expired
2001	>Emer. ON	Switch ON emergency overcurrent protection
2002	>Emer. OFF	Switch OFF emergency overcurrent protection
2051	Emer. off	Emergency overcurrent time protection is switched off
2054	Emer. mode	Emergency overcurrent time mode is running
2091	Emer. I>>	Fault detection by 1>> stage of emergency O/C protection
2121	Emer. TI>>	Emergency O/C protection time T–I>> expired
2141	Emer.Gen.Trip	General trip by emergency overcurrent protection
2701	>AR on	Switch on internal auto–reclose function
2702	>AR off	Switch off internal auto–reclose function
2703	>AR block	Block internal auto–reclose function (abort)
2709	>DAR block	Block complete delayed auto–reclosure (DAR, further shots)
2710	>Th-AR block	External blocking of thermal auto-reclose function
2711	>ext.Start AR	Start signal from external protection for AR
2712	>ext. Trip AR	Trip signal L1 from external protection for AR
2718	>Th-AR ON	Switch on thermal auto-reclose function
2719	>Th-AR OFF	Switch off thermal auto-reclose function
2730	>CB ready	Circuit breaker ready for AR cycle
2781	AR off	Internal auto–reclose function is switched off
2784	AR not ready	Internal auto–reclose function is not ready for reclose
2787	CB not ready	Circuit breaker not ready for a trip/reclose cycle
2793	Th-AR not rdy	Thermal auto-reclose is not ready

Table 4.4 (Continued)

FNo.	Abbreviation	Description
2794	Th-AR off	Thermal auto-reclose is switched off
2801	AR in prog.	Auto–reclose cycle is in progress
2805	Th-AR in prog	Thermal auto-reclose in progress
2812	RAR T-act.run	Auto–reclose function action time for RAR is running
2813	RAR Tdead run	Dead time for RAR is running
2817	RAR Zone Rel.	Internal AR function is ready to permit trip in RAR stage
2819	ThAR Tdead ru	Thermal auto-reclose dead time is running
2832	DAR T-act.run	Auto–reclose function action time for DAR is running
2833	DAR Tdead run	Dead time for DAR is running
2837	DAR Zone Rel.	Internal AR function is ready to permit trip in DAR stage
2851	AR Close Cmd.	Reclose command by internal auto–reclose function
2855	Th-AR ClosCmd	Close command from thermal auto-reclose
2861	AR T-Recl.run	Auto–reclose function reclaim time is running
2862	AR successful	Auto-reclose was successful
2863	Definit.Trip	Definitive (final) trip signal
2866	Th-AR T-Recl.	Thermal auto-reclose reclaim time is running
2867	Th-AR success	Thermal auto-reclose cycle successful
2868	Th-AR def.Trp	Thermal auto-reclose definitive trip
3601	>Dis.prot. on	Distance protection is switched on
3602	>Dis.prot.off	Distance protection is switched off
3651	Dis.prot.off	Distance protection is switched off
3653	Dist. active	Distance protection is active
3671	Dist.Gen.Flt.	Distance protection; General fault detection
3740	Dist. Z1	Fault detection Zone Z1
3747	Dist.Z1B	Fault detection Zone Z1B
3753	Dist.Z1L	Fault detection Zone Z1L
3771	Dist. T1	Distance protection: Time T1 (1st stage) expired
3780	Dist. T1B	Distance protection: Time T1L (1st extended stage) expired
3783	Dist T1L	Distance protection: Time T1L (2nd extended stage) expired
3801	Dis.Gen. Trip	Distance protection: General Trip command
3810	Dis.Trip Z1	Trip in Zone Z1

Table 4.4 (Continued)

FNo.	Abbreviation	Description
3920	Dis Z1 forw.	Zone Z1 forwards active
3921	Dis Z2 forw.	Zone Z2 forwards active
3925	Dist.Flt.Z2K	Flt. detect. Z2 (short circuit)
3926	Dist.Flt.Z2L	Fault detection Z2 (overload)
3930	Dis. Trip Z2K	Trip in zone Z2 (short circuit)
3931	Dis. Trip Z2L	Trip in zone Z2 (overload)
3935	Dist. T2K	Time T2K (Zone Z2) expired
3936	Dist. T2L	Time T2L (Zone Z2) expired
6601	>Th.Prot.on	Thermal protection is switched on
6602	>Th.Prot.off	Thermal protection is switched off
6603	>Cat.3 active	Third catenary is active
6604	>Cat.2 active	Second catenary is active
6605	>Cat.1 active	First catenary is active
6610	Th.Prot. off	Thermal protection is switched off
6612	Flt. Th.Prot.	Thermal prot. fault detection
6613	Trip Th.Prot.	Trip thermal protection
6614	Close-lockout	Thermal protection closing lock-out
6615	Th.Prot. Warn	Thermal protection warning stage
6616	Cat. 1 active	First catenary is active
6617	Cat. 2 active	Second catenary is active
6618	Cat. 3 active	Third catenary is active
6751	>O/C I>>> on	High-speed overcurrent I>>> is switched on
6752	>O/C I>>> off	High-speed overcurrent I>>> is switched off
6753	O/C I>>> on	High-speed overcurrent I>>> is switched off
6755	Flt.det. I>>>	High-speed overcurrent I>>> fault detection
6756	T-I>>> exp.	High-speed overcurrent T-I>>> expired
6757	Trip I>>>	Overcurrent protection I>>> phase trip

Table 4.5 Default Settings for Signal Relays

Address	1st Display Line	2nd Display Line	FNo.	Remarks
6200	MARSHALLING	SIGNAL RELAYS		Block heading
6201	SIGNAL SIGNAL REL. 1	RELAY 1 B/F Trip	1471	Trip by breaker failure protection
6202	SIGNAL SIGNAL REL. 2	RELAY 2 AR in prog.	2801	Auto-reclose in progress
6203	SIGNAL SIGNAL REL. 3	RELAY 3 Device Trip	511	General drop-off of device
6204	SIGNAL SIGNAL REL. 4	RELAY 4 Emer.Gen.Trip	2141	Emergency overcurrent protection: General Trip
6205	SIGNAL SIGNAL REL. 5	RELAY 5 Dist.Gen.Flt.	3671	Distance protection: General fault detection
6206	SIGNAL SIGNAL REL. 6	RELAY 6 Dis.Trip Z1	3810	Trip in zone Z1
6207	SIGNAL SIGNAL REL. 7	RELAY 7 Trip Th.Prot.	6613	Trip thermal protection
6208	SIGNAL SIGNAL REL. 8	RELAY 8 Trip I>>>	6757	Overcurrent protection I>>> phase trip
6209	SIGNAL SIGNAL REL. 9	RELAY 9 Th-AR in prog	2805	Thermal auto-reclose in progress
6210	SIGNAL SIGNAL REL.10	RELAY 10 Dis. Trip Z2K	3930	Trip in zone Z2 (short circuit)
6211	SIGNAL SIGNAL REL.11	RELAY 11 Dis. Trip Z2L	3931	Trip in zone Z2 (overload)
6212	SIGNAL SIGNAL REL.12	RELAY 12 B/F s.ordProt	1484	B/F: pick up superordinated protection relay (for 7SA519 only)
		RELAY 12 Dev. operative	51	Protection device is operative (for 7SA518 only)
6213	SIGNAL SIGNAL REL.13	not allocated		
6214	SIGNAL SIGNAL REL.14	not allocated		
6215	SIGNAL SIGNAL REL.15	not allocated		

Table 4.5 (Continued)

Address	1st Display Line	2nd Display Line	FNo.	Remarks
6216	SIGNAL SIGNAL REL.16	not allocated		
6217	SIGNAL SIGNAL REL.17	RELAY 17 Cat. 1 active	6616	First catenary is active
6218	SIGNAL SIGNAL REL.18	RELAY 18 Cat. 2 active	6617	Second catenary is active
6219	SIGNAL SIGNAL REL.19	RELAY 19 Cat. 3 active	6618	Third catenary is active
6220	SIGNAL SIGNAL REL.20	RELAY 20 FAil TEMPSENS	158	Failure of outdoor temperature sensing
6221	SIGNAL SIGNAL REL.21	RELAY 21 Th.Prot. Warn.	6615	Thermal protection warning stage
6222	SIGNAL SIGNAL REL.22	RELAY 22 Fail MAIN CB	157	Failure of main circuit breaker
6223	SIGNAL SIGNAL REL.23	RELAY 23 Dev. operative	51	Protection device is operative

4.5.3 Marshalling of the LED Indications - Block 63

The 7SA518/519 numerical overhead contact-line protection system has LED indications. The number of LEDs depends on the version of the device:

- **7SA518:** 8 LEDs, six of which can be marshalled
- **7SA519:** 16 LEDs, 14 of which can be marshalled

The LEDs are designated LED 1 to LED 6 or 14. They can be marshalled in block 63. The block is reaches by paging in blocks with ⇑⇓ or by directly addressing with **DA 6 3 0 0 E**. The selection procedure is carried out as described in Chapter 4.5. Multiple annunciations are possible, i.e., one logical annunciation function can be given to several LEDs.

Apart from the logical function, each LED can be marshalled to operate either in the stored mode (m for memorized) or unstored mode (nm for "not memorized"). Each annunciation function is displayed with the index m or nm when proceeding with the **N**–key. The marshallable annunciation functions are the same as those listed in Table 4.4.

Annunciation functions are, of course, not effective when the corresponding protection function is not fitted in the relay or has been programmed out (de–configured). With direct input of the function number it is not necessary to input the leading zeros. To indicate whether the stored or unstored mode shall be effective the function number can be extended by a decimal point followed by **0** or **1**, whereby

.0 unstored indication (not memorized) corresponds to "nm" as above,

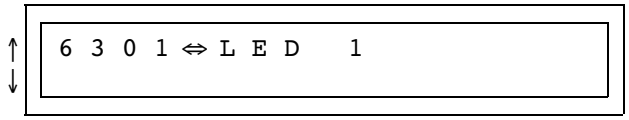
.1 stored indication (memorized) corresponds to "m" as above.

If the extension with .**0** or .**1** is omitted the display shows first the function designation in unstored mode with "nm". Press the "No"–key **N** to change to stored mode "m". After direct input other functions can be selected by paging through the functions forwards with the "No"–key **N** or backwards with the backspace key **R**. The changed function then must be re–confirmed by the enter–key **E**.

The assignment of the LEDs as preset by the factory is shown in the front of the unit. The following boxes show, as an example, the assignment for LED 1.Table 4.6 shows all LED indicators as they are preset from the factory.

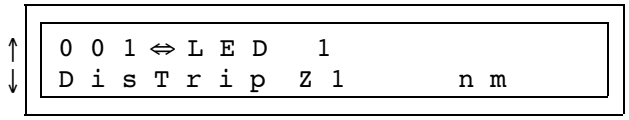
Beginning of the block "Marshalling of the LED indicators"

The first marshallable LED is reached with the key ↑:

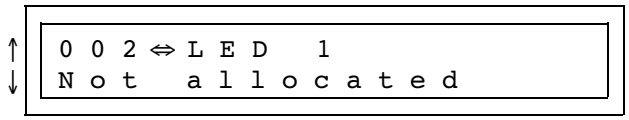


Allocations for LED 1

Change over to the selection level with F ↑:

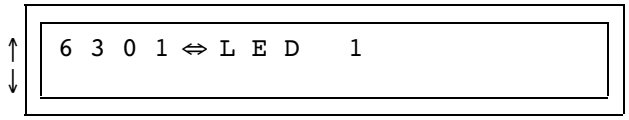


LED 1 has been preset for:
1st: Voltage transformer secondary m.c.b. has tripped, FNo 361



Second: No further signal functions

After input of all annunciation functions for LED 1, change–back to the marshalling level is carried out with F ↑:



Allocations for LED 1

Table 4.6 Default Settings for LED Indications

Address	1st Display Line	2nd Display Line		FNo.	Remarks
6300	MARSHALLING	LED Indicators			Block heading
6301	LED 1			3810	Trip in zone Z1
	LED 1	Dis.TripZ1	m		
6302	LED 2			3930	Trip in zone Z2 (short-circuit)
	LED 2	Dis. Trip Z2K	m		
6303	LED 3			3931	Trip in zone Z2 (overload)
	LED 3	Dis. Trip Z2L	m		
6304	LED 4			6757	Overcurrent protection I>>> phase trip
	LED 4	Trip I>>>	m		

Table 4.6 (Continued)

Address	1st Display Line	2nd Display Line	FNo.	Remarks
6305	LED 5 LED 5	 Emer.Gen.Trip m	2141	Emergency overcurrent protection: General Trip
6306	LED 6 LED 6	 Trip Th.Prot. m	6613	Trip thermal protection
6307	LED 7 LED 7	 Device Trip m	511	General trip of device
6308	LED 8 LED 8	 B/F Trip m	1471	Trip by breaker failure protection
6309	LED 9 LED 9	 Dist.Gen.Flt m	3671	Distance protection: General fault detection
6310	LED 10 LED 10	 Th.Prot. Warn nm	6615	Thermal protection warning stage
6311	LED 11 LED 11	 Close-lockout nm	6614	Thermal protection closing lock-out
6312	LED 12 LED 12	 AR in prog. m	2801	Auto-reclose in progress
6313	LED 13 LED 13	 Th-AR in prog m	2805	Thermal auto-reclose in progress
6314	LED 14 LED 14	 >VT mcb Trip m	361	U Line-side VT MCB tripped

4.5.4 Marshalling of the Command (Trip) Relays - Block 64

The 7SA518/519 numerical overhead contact-line protection system has trippable trip relays. The number of relays depends on the version of the device:

- **7SA518:** 4 trip relays
- **7SA519:** 5 trip relays

The unit contains 5 trip relays which are designated TRIP RELAY 1 to TRiP RELAY 5. The trip relays can be marshalled in the address block 64. The block is reached by paging in blocks with ⇑⇓ or by directly addressing with DA, input of the address number 6 4 0 0 and pressing the enter key E. The selection procedure is carried out as described in Chapter 4.5. Multiple commands are possible, i.e. one logical command function can be given to several trip relays.

In principle, you can also marshal all the messages to commands in accordance with Table 4.4. Command functions are naturally not effective when the corresponding protection function is not fitted in the relay or has been programmed out (de–configured).

The boxes below show examples of trip relays 1 and 2.

The complete default settings are listed in Table 4.7. The default settings are identical for both device versions.

If further protection functions shall trip the same breaker, each command relay must be triggered by the corresponding command function. Similar is valid for closing commands.

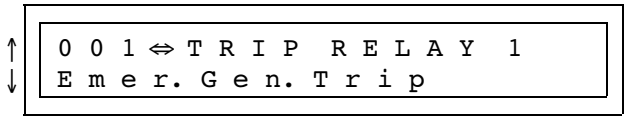
Beginning of the block "Marshalling of the trip relays"

The first trip relay is reached with the key ↑:

Allocations for trip relay 1

Change over to the selection level with F ↑:

The following default setting applies to trip relay 1:



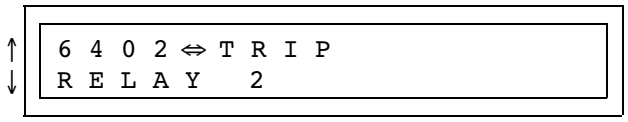
First:
Emergency overcurrent protection: General Trip, FNo. 2141

Second:
Overcurrent protection I>>> phase trip, FNo. 6757

Third:
Trip thermal protection, FNo. 6613

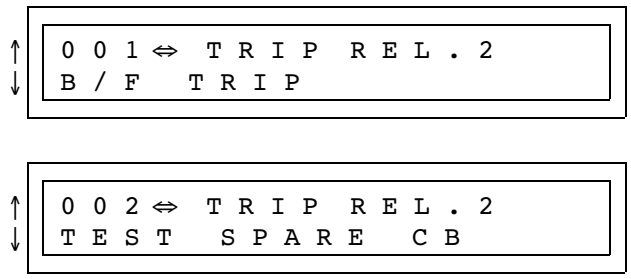
Fourth:
Distance protection: General Trip, FNo. 3801

Fifth:
Circuit breaker test: Trip main circuit breaker, FNo. 1186



Marshalling for trip relay 2

Use **F** ↑ to switch to the selection level:



The following default setting applies to trip relay 2:

First:
Trip by breaker failure protection, FNo. 1471

Second:
Circuit breaker test: Trip spare circuit breaker, FNo. 1187

Table 4.7 Default Settings for Command Outputs

Address	1st Display Line	2nd Display Line	FNo.	Remarks
6400	MARSHALLING	TRIP RELAY		Block heading
6401	TRIP TRIP RELAY 1	Emer.Gen.Trip	2141	Emergency overcurrent protection: General Trip
		Trip I>>>	6757	Overcurrent protection I>>> phase trip
		Trip Th.Prot.	6613	Trip thermal protection
		Dis. Gen. Trip	3801	Distance protection: General Protection
		Test MAIN CB	1186	Circuit breaker test: Trip main circuit breaker
6402	TRIP TRIP RELAY 2	B/F Trip	1471	Trip by breaker failure protection
		Test SPARE CB	1187	Circuit breaker test: Trip spare circuit breaker
6403	TRIP TRIP RELAY 3	AR Close Cmd.	2851	Close command from auto-reclose
		Th-AR ClosCmd	2855	Close command from thermal auto-reclose
6404	TRIP TRIP RELAY 4	B/F s.ordProt	1484	B/F: pick up superordinated protection relay
6405	TRIP TRIP RELAY 5	Not marshalled		

5 Operating Instructions

Warning

All safety precautions which apply for work in electrical installations are to be observed during tests and commissioning.

5.1 Dialog with the Relay

Setting, operation and interrogation of digital protection and automation systems can be carried out via the integrated membrane keyboard and display panel located on the front plate. All the necessary operating parameters can be entered and all the information can be read out from here. Operation is, additionally, possible via the interface socket by means of a personal computer or similar.

5.1.1 Membrane Keyboard and Display Panel

The membrane keyboard and display panel is externally arranged similar to a pocket calculator. Figures 5.1 and 5.2 show the front view of versions 7SA518 and 7SA519 of the numerical overhead contact-line protection system.

A two–line, each 16 character, liquid crystal display presents the information. Each character comprises a 5 x 8 dot matrix. Numbers, letters and a series of special symbols can be displayed.

During dialog, the upper line gives a four figure number, followed by a bar. This number presents the setting address. The first two digits indicate the address block, then follows the two–digit sequence number. In models with parameter change–over facility, the identifier of the parameter set is shown before the setting address.

The keyboard comprises 28 keys with numbers, Yes/No and control buttons. The significance of the keys is explained in detail in the following.

- **Numerical Keys for Input of Numerals**

  [0] to [9] Digits 0 to 9 for numerical input

  [•] Decimal point

  [∞] Infinity symbol

  [+/-] Change of sign (input of negative numbers)

- **Yes/No Keys for Text Parameters:**

  [J/Y] Yes key: operator affirms the displayed question

  [N] No key: operator denies the displayed question or rejects a suggestion and requests for alternative

- **Keys for Paging through the Displays:**

↑	Paging forwards: the next address is displayed
↓	Paging backwards: the previous address is displayed
⇑	Block paging forwards: the beginning of the next address block is displayed
⇓	Block paging backwards: the beginning of previous address block is displayed

- **Confirmation Key:**

E	Enter or confirmation key: each numerical input or change via the Yes/No keys must be confirmed by the enter key; only then does the device accept the change. The enter key can also be used to acknowledge and clear a fault prompt in this display; a new input and repeated use of the enter key is then necessary.

- **Control and Special Keys:**

CW	Codeword: prevents unauthorized access to setting programs (not necessary for call–up of annunciations or messages)
R	Backspace erasure of incorrect entries
F	Function key; explained when used
DA	Direct addressing: if the address number is known, this key allows direct call–up of the address
M/S	Messages/Signals: interrogation of annunciations of fault and operating data

The three keys ↑; ⇑; RESET which are somewhat separated from the rest of the keys, can be accessed when the front cover is closed. The arrows have the same function as the keys with identical symbols in the main field and enable paging in forward direction. Thus all setting values and event data can be displayed with the front cover closed. Furthermore, stored LED indications on the front can be erased via the RESET key without opening the front cover. During reset operation all LEDs on the front will be illuminated thus performing a LED test. With this reset, additionally, the fault event indications in the display on the front panel of the device are acknowledged; the display shows then the operational values of the quiescent state. The display is switched over to operating mode as soon as one of the keys **DA**, **M/S**, **CW** or ⇑ is pressed.

5.1.2 Operation with a Personal Computer

A personal computer (industrial standard) allows, just as the operator panel, all the appropriate settings, initiation of test routines and read–out of data, but with the added comfort of screen–based visualization and a menu–guided procedure.

All data can be read in from, or copied onto, magnetic data carrier (floppy disc) (e.g. for settings and configuration).

Additionally, all the data can be documented on a connected printer. It is also possible, by connecting a plotter, to print out the fault history traces.

For operation of the personal computer, the instruction manuals of this device are to be observed. The PC program DIGSI® is available for setting and processing of all digital protection data. Further information about facilities on request.

5.1.3 Operational Preconditions

For most operational functions, the input of a codeword is necessary. This applies to all the inputs you make via the operator keypad or the operating interface that affect 7SA518/519 numerical overhead contact-line protection system functions such as

- setting of functional parameters (thresholds, functions),
- allocation or marshalling of signals, binary inputs, LED indicators,
- configuration parameters for interface and device configuration,
- initiation of test procedures.

The codeword is not required for the read–out of annunciations, operating data or fault data, or for the read–out of setting parameters.

The instructions for preparation (see Chapter 4) describe in detail how you enter the codeword and adapt the operator interface to local conditions (by adapting the interfaces and choosing the operational and spontaneous messages in the displays).

5.1.4 Presentation of Device Versions 7SA518/519

Figures 5.1 and 5.2 show front views of device versions 7SA518 and 7SA519. Tables 5.1 and 5.2 give an overview of the default settings in each case of the LEDs that can be marshalled.

Table 5.1 Default settings of the LEDs that can be marshalled for the 7SA518

1	Dis.Trip Z1
2	Dis.Trip Z2K
3	Dis.Trip Z2L
4	Trip I>>>
5	Emer.Gen.Trip
6	TripTh. Prot.

Table 5.2 Default settings of the LEDs that can be marshalled for the 7SA519

1	Dis.Trip Z1
2	Dis.Trip Z2K
3	Dis.Trip Z2L
4	Trip I>>>
5	Emer.Gen.Trip
6	TripTh. Prot.
7	Gen. Device Trip
8	B/F Trip
9	Dist.Gen.Flt.
10	Th.Prot. Warn
11	Close-lockout
12	AR in prog.
13	Th-AR in prog.
14	>VT mcb Trip

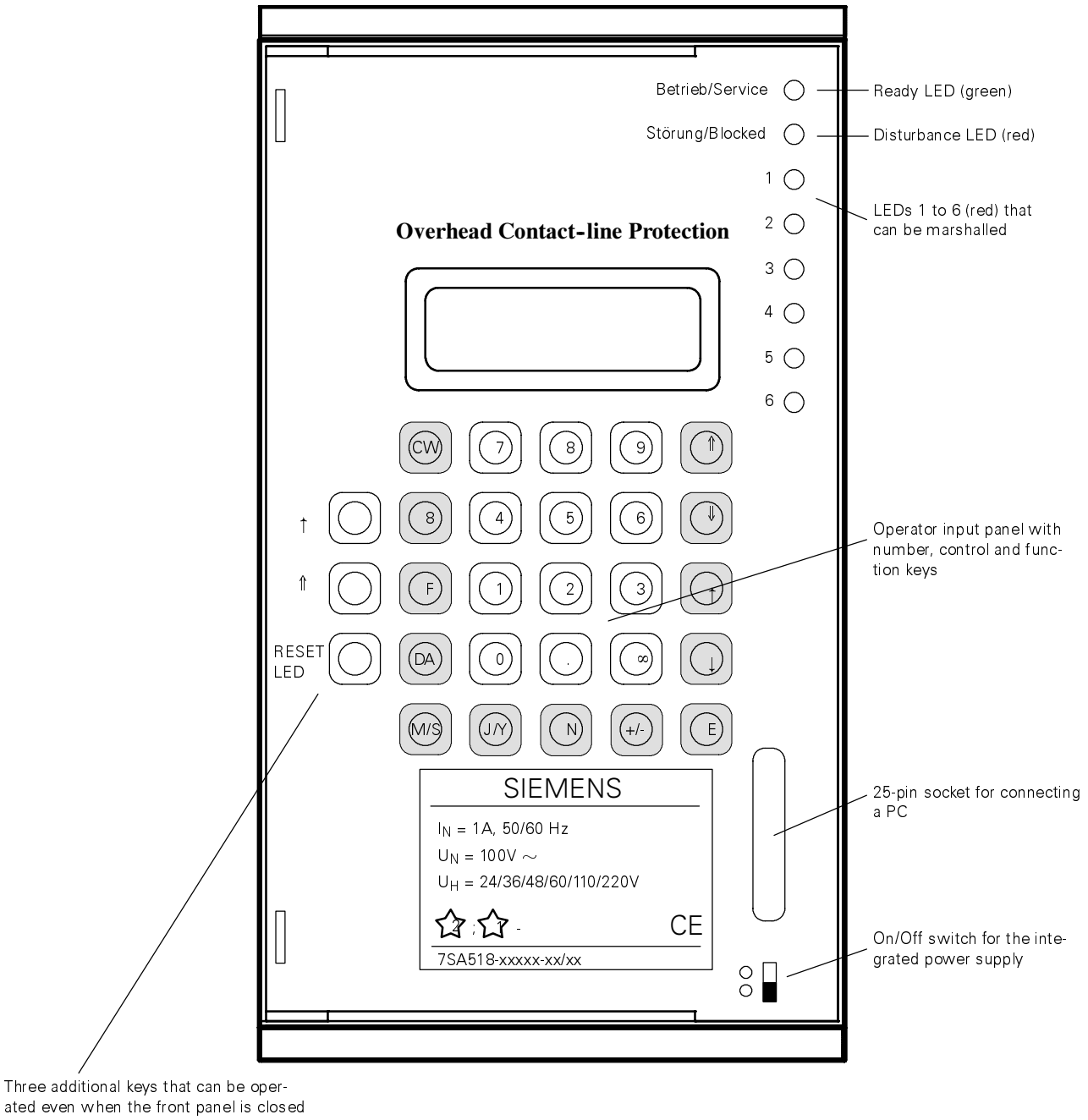


Figure 5.1 Front View of the 7SA518 with the Operator Panel and LEDs

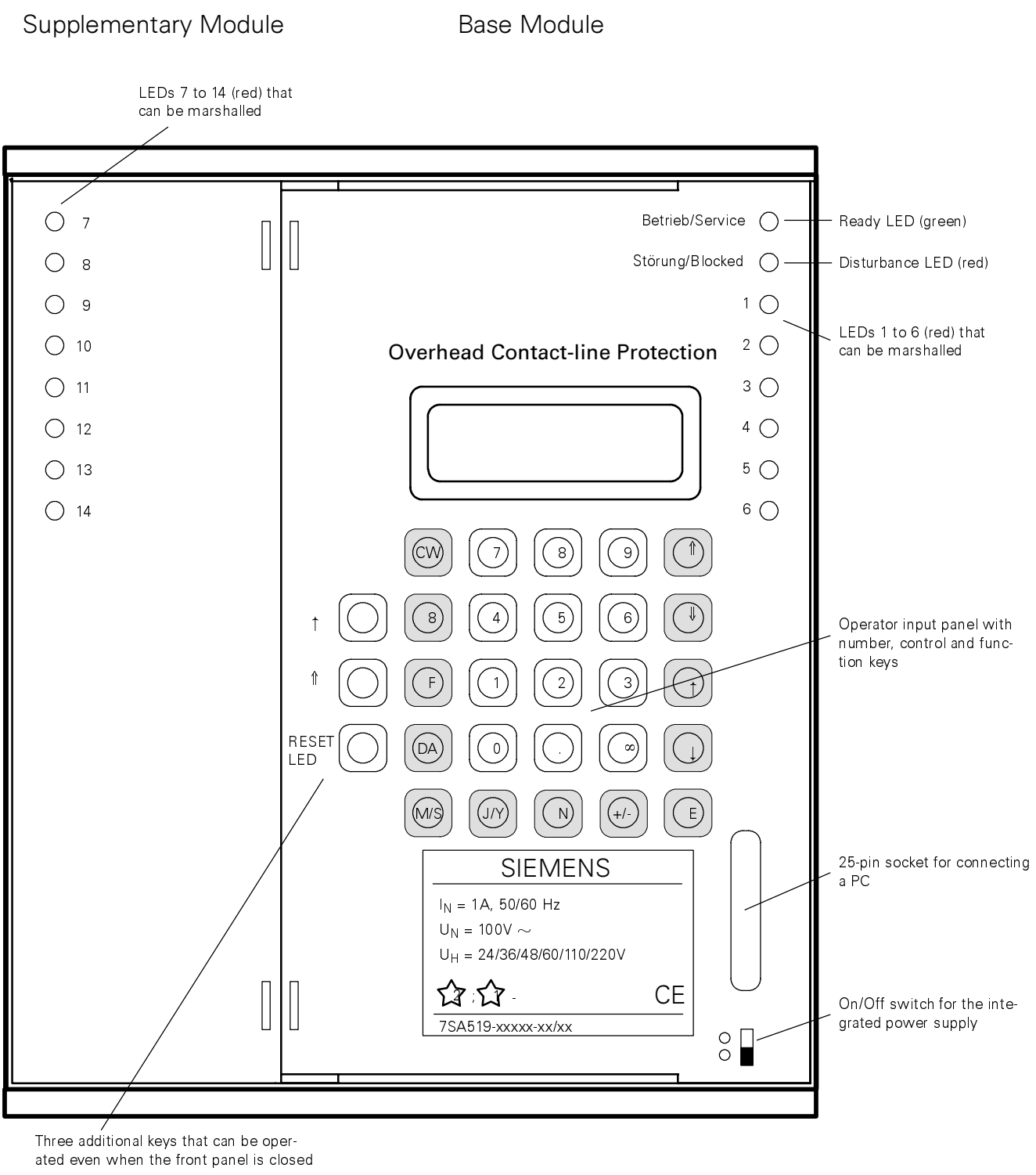


Figure 5.2 Front View of the 7SA519 with the Operator Panel and LEDs

5.1.5 Parameter Changeover (Option)

For the functional parameters, i.e. the addresses from above 1000 to less than 4000, up to 4 different parameter sets can be selected. Changeover between parameter sets can be performed locally during operation, using the operator panel, or from a PC via the user interface, or remotely via binary inputs.

If the changeover option is not used, only the values for the selected parameter set need to be entered; the rest of this section may be skipped. If it is used, parameter changeover must be set to EXIST (adress 7885, see Chapter 5.4.4). The first parameter set is Set A, the others Set B, Set C and Set D respectively. These parameter sets are defined successively when setting the functional parameters.

If the changeover option is used, the first step is to enter all parameters for the normal state of Set A before changing over to Set B as follows:

- Complete the parameter setting for Set A as described in Chapter 5.4.4.
- Press the key combination **F2**, i.e. press first function key and then numerical key 2. All entries that are made from now on will refer to parameter set B.

All parameter sets can be accessed in a similar way:

- Key combination **F1** invokes parameter set A
- Key combination **F2** invokes parameter set B
- Key combination **F3** invokes parameter set C
- Key combination **F4** invokes parameter set D

To change the settings of a selected parameter set, a codeword must be entered. If no codeword is entered, the settings can be read but not changed.

As in most applications parameter sets will only differ in a few parameters, stored parameter sets can be copied to another set.

It is also possible to restore the original parameters, i.e. the delivery setting, to an altered and stored parameter set. This is done by copying the original parameter set to the desired set.

In addition, the option allows to set the active parameter set, i.e. the parameter set that is relevant for the functions and limit values of the device. This is described in more detail in Chapter 5.4.4.

The parameter changeover option is accessed in address block 85. The easiest way to reach this block is by direct addressing:

- Press the direct address key DA,
- Enter the desired address, e.g. 8 5 0 0,
- Press the Enter key E.

Now the title of the Parameter changeover block will be displayed.

Use the ↑ key to page through the individual addresses. Table 5.3 shows the options for copying parameter sets.

Beginning of the block "Parameter change-over"

Table 5.3 Options for Copying Parameter Sets

Address	Copies setting of	To
8510	Original parameter set	Set A
8511	Original parameter set	Set B
8512	Original parameter set	Set C
8513	Original parameter set	Set D
8514	Set A	Set B
8515	Set A	Set C
8516	Set A	Set D
8517	Set B	Set A
8518	Set B	Set C
8519	Set B	Set D
8520	Set C	Set A
8521	Set C	Set B
8522	Set C	Set D
8523	Set D	Set A
8524	Set D	Set B
8525	Set D	Set C

After copying, you only have to alter those parameters that you want to be different.

Complete the parameter setting for each set as described in Chapter 5.4.4.

5.2 Setting the Functional Parameters

For setting the functional parameters it is necessary to enter the codeword (see Chapter 4.3.1). Without codeword entry, parameters can be read out but not be changed.

If the codeword is accepted, parameterizing can begin. In the following sections each address is illustrated in a box and is explained. There are three forms of display:

- **Addresses Without an Operator Input**
  The address is identified by the block number followed by 00 as sequence number (e.g. 1100 for block 11). Displayed text forms the heading of this block. No input is expected. By using keys ⇑ or ⇓ the next or the previous block can be selected. By using the keys ↑ or ↓ the first or last address within the block can be selected and paged.

- **Addresses Which Require Numerical Input**
  The display shows the four–digit address, i.e. block and sequence number (e.g. 1104 for block 11, sequence number 4). Behind the bar appears the meaning of the required parameter, in the second display line, the value of the parameter. When the relay is delivered a value has been preset. In the following sections, this value is shown. If this value is to be retained, no other input is necessary. One can page forwards or backwards within the block or to the next (or previous) block. If the value needs to be altered, it can be over written using the numerical keys and, if required, the decimal point and/or change sign (+/–) or, where appropriate, infinity sign ∞. The permissible setting range is given in the following text, next to the associated box. Entered values beyond this range will be rejected. The setting steps correspond to the last decimal place as shown in the setting box. Inputs with more decimal places than permitted will be truncated down to the permissible number. **The value must be confirmed with the entry key E!** The display then confirms the accepted value. The changed parameters are only saved after termination of parameterizing (refer below).

- **Addresses Which Require Text Input**
  The display shows the four–digit address, i.e. block and sequence number (e.g. 1102 for block 11, sequence number 2). Behind the bar appears the meaning of the required parameter, in the second display line, the applicable text. When the relay is delivered, a text has been preset. In the following sections, this text is shown. If it is to be retained, no other input is necessary. One can page forwards or backwards within the block or to the next (or previous) block. If the text needs to be altered, press the "No" key **N**. The next alternative text, also printed in the display boxes illustrated in the following sections, then appears. If the alternative text is not desired, the **N** key is pressed again, etc. The alternative which is chosen, is confirmed with the entry key **E**.

For each of the addresses, the possible parameters and text are given in the following sections. If the meaning of a parameter is not clear, it is usually best to leave it at the factory setting. The arrows ⇑⇓ or ↑↓ at the left hand side of the illustrated display boxes indicate the method of moving from block to block or within the block. Unused addresses are automatically passed over.

If the parameter address is known, then direct addressing is possible. This is achieved by depressing key **DA** followed by the four–digit address and subsequently pressing the enter key **E**. After direct addressing, paging by means of keys ⇑⇓ and keys ↑↓ is possible.

The setting procedure can be ended at any time by the key combination **F E** , i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS?". Confirm with the "Yes"–key **J/Y** that the new settings shall become valid now. If you press the "No"–key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.

If one tries to leave the setting range for the functional parameter blocks (i.e. address blocks 10 to 39) –with keys ⇑⇓ the display shows the question "END OF CODEWORD OPERATION ?". Press the "No"–key **N** to continue parameterizing. If you press the "Yes"–key **J/Y**, instead, another question appears: "SAVE NEW SETTINGS ?". Now you can confirm with **J/Y** or abort with **N**, as above.

After completion of the parameterizing process, the changed parameters which so far have only been stored in volatile memory, are then permanently stored in EEPROMs. The display confirms "NEW SETTINGS SAVED". After pressing the key **M/S** followed by RESET LED, the indications of the quiescent state appear in the display.

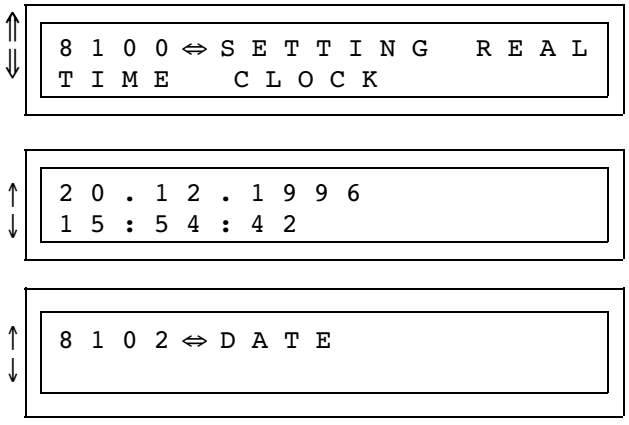
5.2.1 Setting of Date and Time - Block 81

The date and time can be set if the the real time clock is available. Setting is carried out in block 81 which is reached by direct addressing **DA 8 1 0 0 E** or by paging with ⇑ and ⇓. Input of the codeword is required to change the data.

Selection of the individual addresses is by further scrolling using ↑↓ as shown below. Each modification must be confirmed with the enter key **E**.

The date and time are entered with dots as separator signs since the keyboard does not have a colon or slash (for American date).

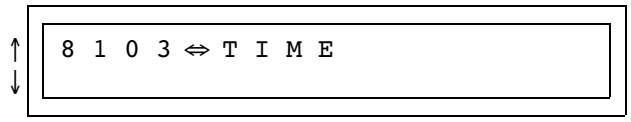
The clock is synchronized at the moment when the enter key **E** is pressed following input of the complete time. The difference time facility **(address 8104)** enables exact setting of the time since the difference can be calculated prior to the input, and the synchronization of the clock does not depend on the moment when the enter key **E** is pressed.



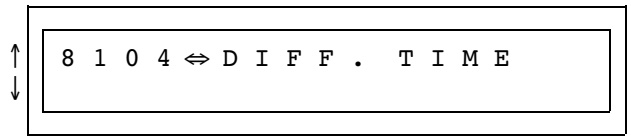
Beginning of the block "Setting the real time clock" Continue with ↑.

At first, the actual date and time are displayed. Continue with ↑.

Enter the new date: 2 digits for day, 2 digits for month and 4 digits for year (including century); use the order as configured under address 7102, but always use a dot for separator: **DD.MM.YYYY** or MM.DD.YYYY



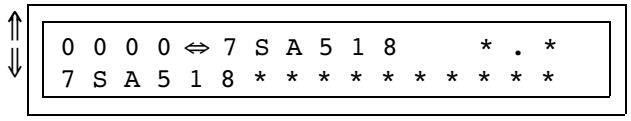
Enter the new time: hours, minutes, seconds, each with 2 digits, separated by a dot: **HH.MM.SS**



Using the difference time, the clock is set forwards by the entered time, or backwards using the +/–key. The format is the same as with the time setting above.

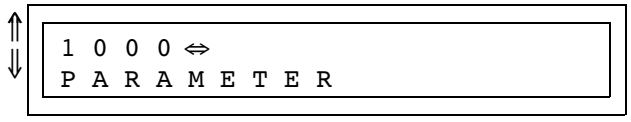
5.2.2 Initial Displays - Blocks 00 and 10

When the relay is switched on, firstly the address 0000 and the type identification of the relay appears. All Siemens relays have an MLFB (machine readable type number). When the device is operative and displays a quiescent message, any desired address can be reached e.g. by pressing the direct address key **DA** followed by the address number.



The relay introduces itself by giving its type number, the version of firmware with which it is equipped, and a hardware identifier. The second display line shows the complete ordering designation.

After address 1000, the functional parameters begin. Further address possibilities are listed under "Annunciations" and "Tests".



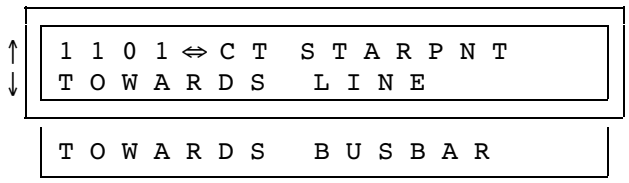
Commencement of functional parameter blocks

5.2.3 Power System Data - Block 11

5.2.3.1 General Substation Data

The device needs some data of the power system and of the substation.

Start of Powersystem Data block

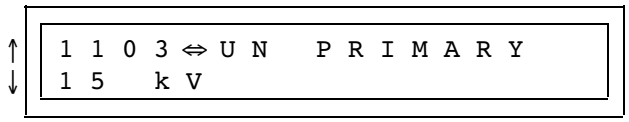


Polarity of the current transformers:

← Starpoint towards line

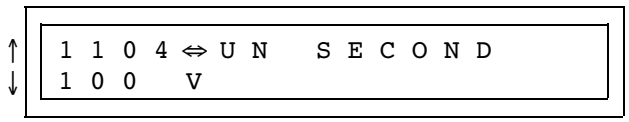
← Starpoint towards busbar

The setting determines the relay's direction of measurement (forwards is in the line direction)



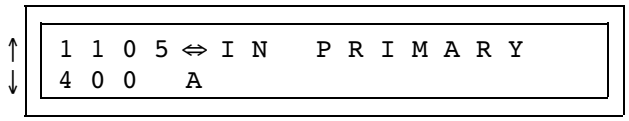
Primary rated voltage of the transformers (line-to-line voltage)

Minimum setting value: . . . . . **1 kV**
Maximum setting value : . . . . . **150 kV**



Secondary rated voltage of the transformers (line-to-line voltage)

Minimum setting value: . . . . . **100 V**
Maximum setting value : . . . . . **110 V**



Primary rated current of the transformer

Minimum setting value: . . . . . **10 A**
Maximum setting value : . . . . . **50000 A**

5.2.3.2 Further Substation Data

Further substation data is needed for various protection functions. There are minimum retention times, i.e. events are retained for at least as long as the set time even if the criterion for this is no longer fulfilled at an earlier time. On the other hand, if the criterion is fulfilled for longer than the set minimum retention times, these times have no effect.

You set the minimum retention time of alarm relays in **address 1133**. This time is effective for each alarm relay regardless of the message that is marshalled.

You set the limit for close commands in **address 1135**. This time is in the scope of an auto-reclose cycle's expired dead time unless another fault detection or an AR blocking is present. Once a close command has been initiated, it can only be cancelled by another fault detection.

You set the minimum retention time of trip commands in **address 1141**. The time is effective for the messages listed below, regardless of whether they are marshalled to a trip relay or a signal relay.

- Trip Z1
- Trip Z2L
- Trip Z2K
- Trip I>>>
- Trip I>>
- Trip Th.Prot
- SVS Trip

Note: If one of these trip messages is marshalled to a signal relay, both of the minimum retention times are effective. In this case, the signal continues to be controlled for the longer of the two set times.

↑ ↓
```
1 1 3 3 ⇔ T R E T . A L R E L
0 . 7 5 s
```

Minimum retention time of alarm relay

Minimum setting value: . . . . . **0.00 s**
Maximum setting value : . . . . . **1.00 s**

↑ ↓
```
1 1 3 5 ⇔ T - C L O S E
1 . 0   s
```

Limitation of close commands

Minimum setting value: . . . . . **0.01 s**
Maximum setting value : . . . . . **32.00 s**

↑ ↓
```
1 1 4 1 ⇔ T  T R I P
0 . 1 5 s
```

Minimum retention time of command relay

Minimum setting value: . . . . . **0.01 s**
Maximum setting value : . . . . . **32.00 s**

5.2.4 Settings for Distance Protection - Block 12

Since the 7SA518/519 device's main function is distance protection, we assume that at configuration of the distance protection (see Chapter 4.4.1) you set the distance protection function as EXIST **(Addr. 7812)**. Should you want to set NON-EXIST for the distance protection (e.g. because other device functions are to be used), this section is of no consequence. The distance protection has four distance zones and five time stages that are assigned as follows:

Zone Z1 Delay time T1

Zone Z1B Delay time T1B

Zone Z1L Delay time T1L

Zone Z2 Delay time T2K with short-circuit
Delay time T2L with overload

Zones Z1B and Z1L their corresponding delay times, T1B and T1L respectively, are only available if you configured auto-reclose, AR, as EXIST.

In the case of manual closing to a short-circuit, the distance protection in both zones can trip undelayed regardless of the set delay time (Z1/Z2 UNDELAYED). This is conditional on the control-discrepancy switch issuing the manual close command to the device via a binary input. INEFFECTIVE means that at manual closing, the stages operate as parameterized.

You can set a minimum current threshold, I>, for enabling the impedance zones.

The relevant parameters are set for each impedance zone. Impedance Z specifies the range of the zone in each case. It is also possible to set an extended range for the two zones, i.e. Z1 stroke and Z2 stroke. The option of whether the extended ranges are valid can be chosen by a binary input or a message from the substation **(configuration parameter 7903)**.

The trip segments are limited by angles Z1α, Z1β, Z2α and Z2β (see the trip characteristic, Figure 3.2 in Chapter 3.3.1.4). The angle settings apply to the normal ranges as well as to the extended ones.

It is advisable to draw up a selective tripping schedule, initially for the entire galvanically contiguous power system. In this schedule, you should enter the section lengths with their primary reactances, X, in Ω/phase. The reactances, X, dictate the ranges of the distance zones.

For zone Z1, you can set a delay time, T1. Normally, you would choose no delay (i.e. T1 = 0.00 s). In this case, the protection switches off faults at this distance with its operating time.

For zones Z1 and Z2, you can set delay times T2K and T2L. Depending on whether a short-circuit or an overload is detected, the system switches off with the following delay time:

Short-circuit Delay time T2K

Overload Delay time T2L

The values derived from the selective tripping schedule must be converted to the secondary circuit of the current and voltage transformers. In general, the following applies:

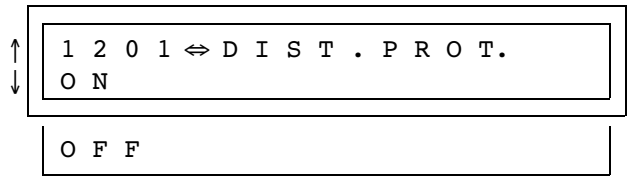
$$Z_{secondary} = \frac{\text{Actual transformation ratio of current transformer}}{\text{Actual transformation ratio of voltage transformer}} Z_{primary}$$

Thus, the conversion formula for the range of any distance zone is as follows:

$$Z_{sec} = \frac{Ratio_{ct}}{Ratiovt} Z_{prim}$$

Where
$Ratio_{ct}$: Actual transformation ratio of current transformer
$Ratio_{vt}$: Actual transformation ratio of voltage transformer

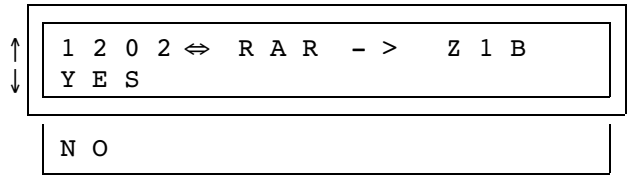
Start of Distance Protection block



Distance protection function

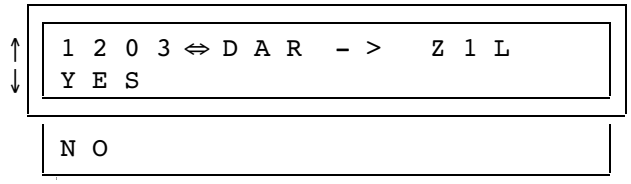
← Switched-on

← Switched-off



Release zone Z1B for RAR cycle (parameter visible only if you configure AR as EXIST)
← Yes

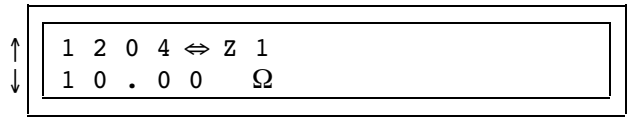
← No



Release zone Z1L for DAR cycle (parameter visible only if you configure AR as EXIST)
← Yes

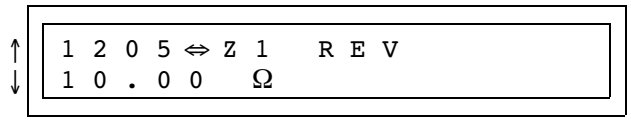
← No

	I_N = 1A	I_N = 5A



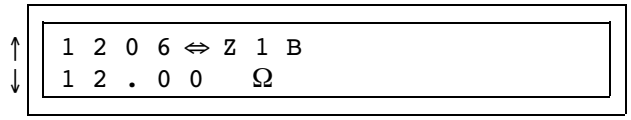
Zone Z1 impedance

Minimum setting value:	**0.20** Ω	**0.04** Ω
Maximum setting value :	**250.00** Ω	**50** Ω



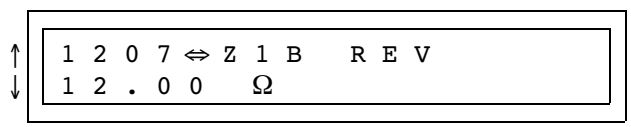
Zone Z1 impedance reverse

Minimum setting value:	**0.20** Ω	**0.04** Ω
Maximum setting value :	**250.00** Ω	**50** Ω



Zone Z1B impedance (parameter visible only if you configure AR as EXIST)

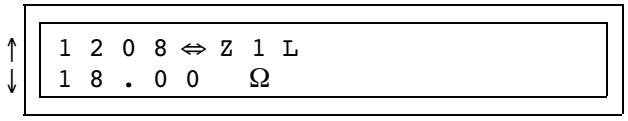
Minimum setting value:	**0.20** Ω	**0.04** Ω
Maximum setting value :	**250.00** Ω	**50** Ω



Zone Z1B impedance reverse (parameter visible only if you configure AR as EXIST)

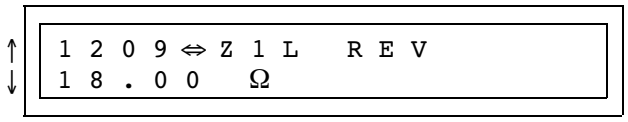
Minimum setting value:	**0.20** Ω	**0.04** Ω
Maximum setting value :	**250.00** Ω	**50** Ω

	I_N = 1A	I_N = 5A



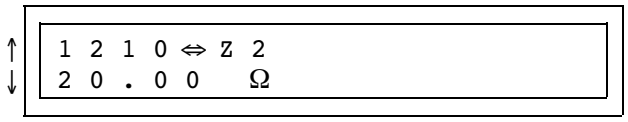
Zone Z1L impedance (parameter visible only if you configure AR as EXIST)

Minimum setting value: . . . . . **0.20** Ω **0.04** Ω
Maximum setting value : . . . . **250.00** Ω **50** Ω



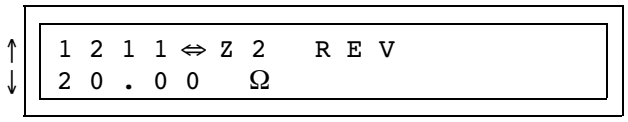
Zone Z1L impedance reverse (parameter visible only if you configure AR as EXIST)

Minimum setting value: . . . . . **0.20** Ω **0.04** Ω
Maximum setting value : . . . . **250.00** Ω **50** Ω



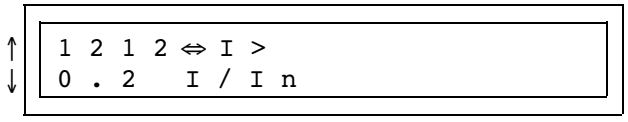
Zone Z2 impedance

Minimum setting value: . . . . . **0.20** Ω **0.04** Ω
Maximum setting value : . . . . **250.00** Ω **50** Ω



Zone Z2 impedance reverse

Minimum setting value: . . . . . **0.20** Ω **0.04** Ω
Maximum setting value : . . . . **250.00** Ω **50** Ω



Threshold current for enable impedance zones

Minimum setting value: . . . . . **0.1 I/In**
Maximum setting value : . . . . . **2.00 I/In**

Zone 1: Angle α

Minimum setting value: . . . . . **-70** °
Maximum setting value : . . . . . **45** °

Zone 1: Angle β

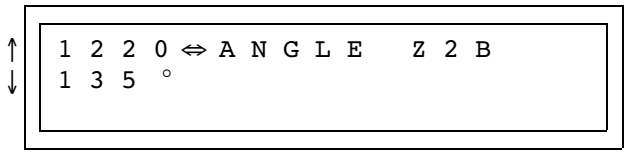
Minimum setting value: . . . . . **70** °
Maximum setting value : . . . . . **140** °

Zone 2: Angle α

Minimum setting value: . . . . . **-70** °
Maximum setting value : . . . . . **45** °

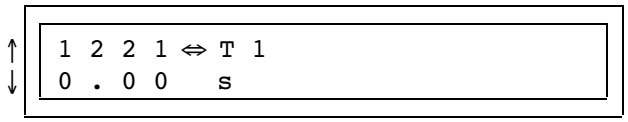
Zone 2: Angle β

Minimum setting value: . . . . . **70** °
Maximum setting value : . . . . . **140** °



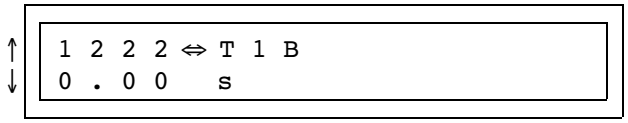
Zone 2 Angle β

Minimum setting value: . . . . . **70** °
Maximum setting value: . . . . . **140** °



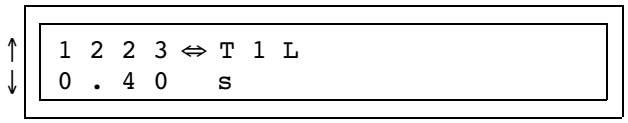
Zone Z1: Delay time

Minimum setting value: . . . . . 0.00 s
Maximum setting value : . . . . . 0.30 s
and ∞ (no trip in Z1)



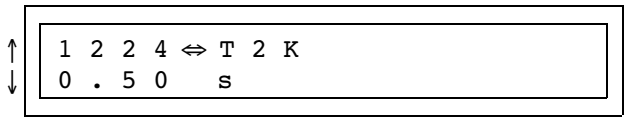
Zone Z1B delay time (parameter visible only if you configure AR as EXIST)

Minimum setting value: . . . . . 0.00 s
Maximum setting value : . . . . . 60.00 s
and ∞ (no trip in Z1B)



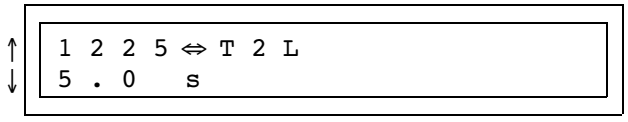
Zone Z1B delay time (parameter visible only if you configure AR as EXIST)

Minimum setting value: . . . . . 0.00 s
Maximum setting value : . . . . . 60.00 s
and ∞ (no trip in Z1L)



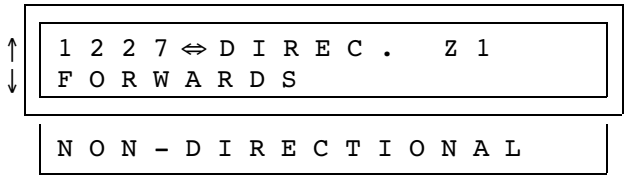
Zone Z2 delay time with short-circuit

Minimum setting value: . . . . . 0.10 s
Maximum setting value : . . . . . 10.00 s
and ∞ (no trip in Z2 with short-circuit)



Zone Z2 delay time with overload

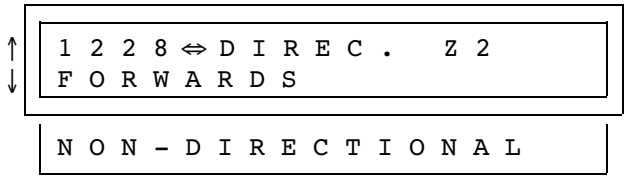
Minimum setting value: . . . . . 1.0 s
Maximum setting value : . . . . . 60.00 s
and ∞ (no trip in Z2 with overload)



Zone Z1: Direction

← Forwards

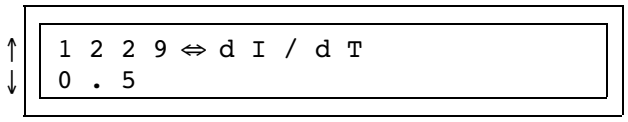
← Non-directional



Zone Z2: Direction

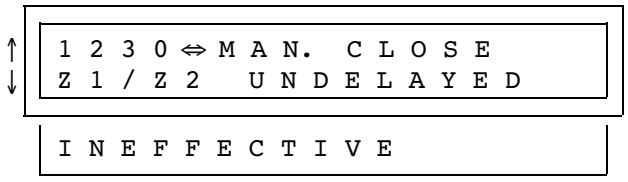
← Forwards

← Non-directional



Short-circuit detection (di/dt)

Minimum setting value: . . . . . 0.0 I/In
Maximum setting value : . . . . . 1.0 I/In
and ∞ (ineffective)



Distance protection effect: manual close

← Trip zones Z1 and Z2 undelayed

← Manual close signal is ineffective

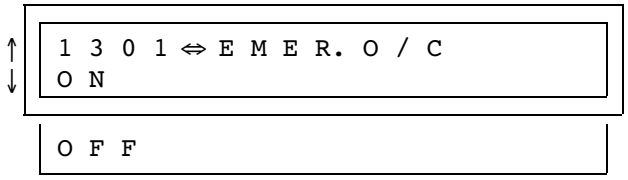
5.2.5 Settings for Emergency Overcurrent Protection - Block 13

In the case of a measuring voltage failure, e.g. due to the current transformer's protective switch tripping, the device can continue to run without voltage as an overcurrent-time protection (emergency overcurrent protection). This is conditional on your having configured EMERG. O/C as EXIST **(Addr. 7813)** in the scope of functions (see Chapter 4.4.1).

You set the parameters of the emergency overcurrent protection in block 13. The threshold value, I>>, **(Addr. 1302)** must be set above the maximum (over)load current to be expected. Set the delay time, TI>>, at **Address 1303**.

In the case of manual closing to a short-circuit, the emergency overcurrent protection can trip undelayed regardless of the set delay time (I>> UNDELAYED). This is conditional on the control-discrepancy switch issuing the manual close command to the device via a binary input. INEFFECTIVE means that at manual closing, the stage operates as parameterized.

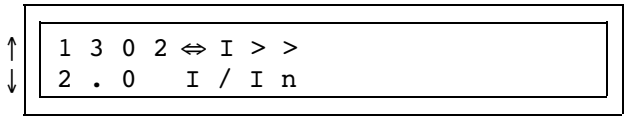
Start of Emergency Overcurrent Protection block



Emergency overcurrent protection function

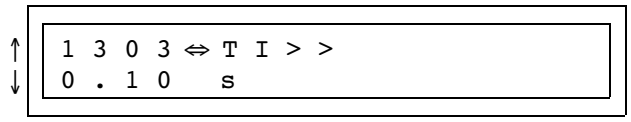
← Switched-on

← Switched-off



Overcurrent threshold

Minimum setting value: . . . . . **0.25 I/In**
Maximum setting value : . . . . . **4.00 I/In**



Delay time for emergency overcurrent stage

Minimum setting value: . . . . . 0.00 s
Maximum setting value : . . . . . 1.00 s
and ∞ (no trip with I >>)

Overcurrent stage effect: manual close

← Trip overcurrent protection stage undelayed

← Manual close signal ineffective

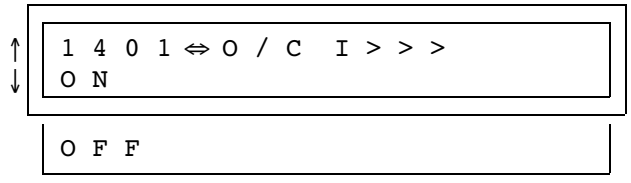
5.2.6 Settings for the High-Speed Overcurrent Protection I>>> - Block 14

In the case of short-circuits at the substation level (very high short-circuit currents) the high-speed overcurrent protection carries out very quick, non-directional tripping in time, TI>>>. This is conditional on your having configured O/C I>>> as EXIST **(Addr. 7814)** in the scope of functions (see Chapter 4.4.1).

You set the parameters of the emergency overcurrent protection in block 14. The threshold value, I>>>, is set at **address 1402** and the delay time, TI>>, is set at **address 1403**.

In the case of manual closing to a short-circuit, the high-speed overcurrent protection can trip undelayed regardless of the set delay time (I>> UNDELAYED). This is conditional on the control-discrepancy switch issuing the manual close command to the device via a binary input. INEFFECTIVE means that at manual closing, the stage operates as parameterized.

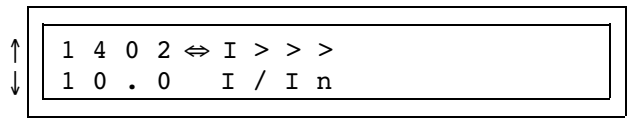
Start of High-speed Overcurrent Protection block



High-speed overcurrent protection

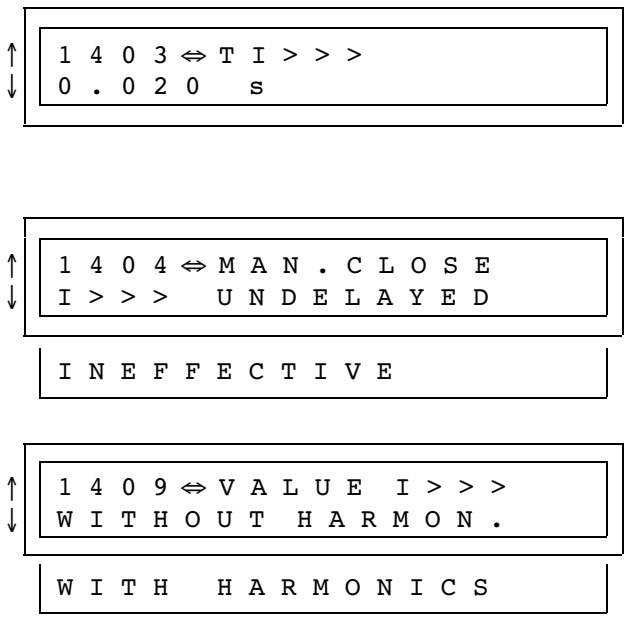
← Switched-on

← Switched-off



Threshold value of high-speed overcurrent protection

Minimum setting value: . . . . . **1.00 I/In**
Maximum setting value : . . . . **20.00 I/In**



Delay time of High-Speed Overcurrent Protection Block

Minimum setting value: 0.00s
Maximum setting value : . . . . . 1.00 s
and ∞ (no trip with I >>>)

High-speed overcurrent stage effect: manual close

← Trigger high-speed overcurrent protection undelayed
← Manual close signal is ineffective

Measurement processing

← Without harmonics, i. e. rms values

← With harmonics, i. e. instantaneous values

5.2.7 Settings for Thermal Protection - Block 15

The 7SA518/519 numerical overhead contact-line protection system has a thermal protection. This function is only effective and accessible if you configure it as EXIST **(Addr. 7815)** in the scope of functions (see Chapter 4.4.1).

In particular, thermal protection is intended to protect the range between the R-axis and the set limiting angles, Z1α and Z2α. Even though the impedance zones should not and cannot process this range, it is at risk from thermal overload.

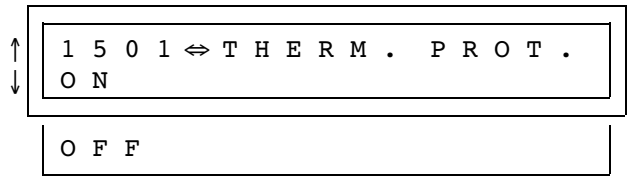
The thermal trip characteristic can be adapted to the load bearing capacity of the overhead line to be protected.

In **address 1505**, you can parameterize the maximum temperature starting at which the thermal protection is to generate a trip command. After you set an appropriate temperature alarm stage in **address 1506**, the system issues a warning message before the tripping temperature is reached. As a result, the load can be reduced soon enough to prevent a disconnection, for example.

Using **addresses 1508 and 1509**, you set correction factors for two or three catenaries. The option of which of the correction factors is to be valid can be chosen by a binary input or a message from the substation **(configuration parameter 7903)**.

During configuration, you specify in **Addr. 7817** whether ambient temperature sensing is connected to the protection device. If this is the case, the system uses the ambient temperature sensing's measured value to calculate the temperature of the contact line. If you configured ambient temperature sensing as NON-EXIST in **address 7817**, the system uses the value entered at **address 1510** for the calculation.

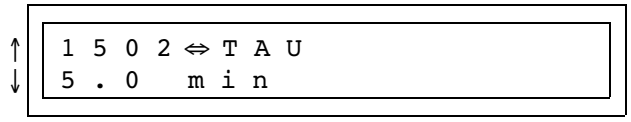
Start of Thermal Protection block



Thermal protection

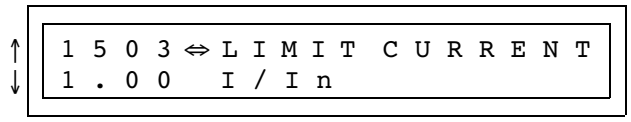
← Switched-on

← Switched-off



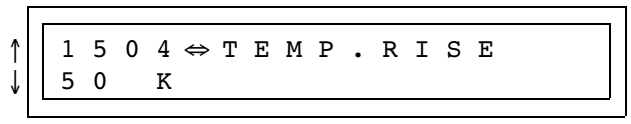
Time constant of catenary

Minimum setting value: ..... **2 .00 min**
Maximum setting value : ... **15.00 min**



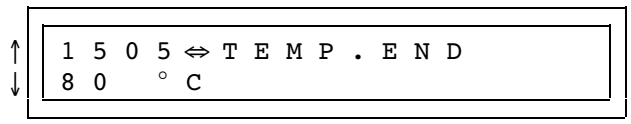
Permissible limit current I/In of catenary

Minimum setting value: ..... **0.25 I/In**
Maximum setting value : ..... **2.00 I/In**



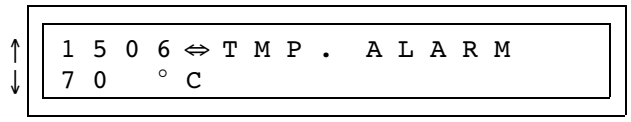
Overtemperature of catenary at rated current

Minimum setting value: ..... **0 K**
Maximum setting value : ..... **100 K**



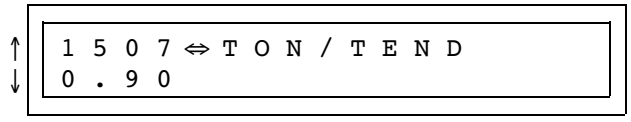
Maximum permissible temperature of catenary

Minimum setting value: ..... **50** °
Maximum setting value : ..... **100** °



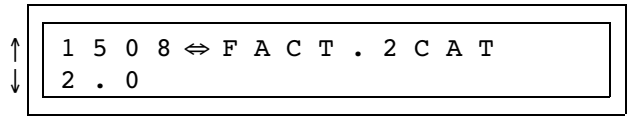
Temperature alarm stage of catenary

Minimum setting value: ..... **50** °
Maximum setting value : ..... **100** °



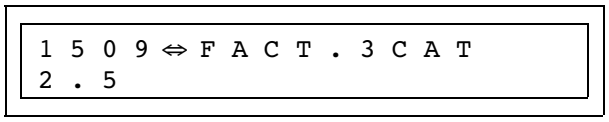
Cooling factor Ton/Tend (for close-lockout)

Minimum setting value: **0.50**
Maximum setting value : **0.90**



Correction factor for second catenary

Minimum setting value: **1.00**
Maximum setting value : **3.00**



Correction factor for third catenary

Minimum setting value: **1.00**
Maximum setting value : **3.00**

Fixed reference temperature for thermal protection (not available with external temperature sensing)

Minimum setting value: . . . . . **-30** °
Maximum setting value : . . . . . **40** °

5.2.8 Setting the Delay Times for User-Defined Annunciations - Block 28

Start of the Delay Times for User-Defined Annunciations

Delay time for user-defined annunciation 1

Minimum setting value: . . . . . **0.00 s**
Maximum setting value : . . . . . **10.00 s**

Delay time for user-defined annunciation 2

Minimum setting value: . . . . . **0.00 s**
Maximum setting value : . . . . . **10.00 s**

Delay time for user-defined annunciation 3

Minimum setting value: . . . . . **0.00 s**
Maximum setting value : . . . . . **10.00 s**

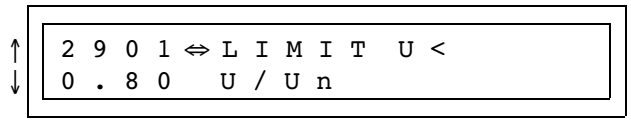
Delay time for user-defined annunciation 4

Minimum setting value: . . . . . **0.00 s**
Maximum setting value : . . . . . **10.00 s**

5.2.9 Settings for Measured Value Supervision - Block 29

In the 7SA518/519 numerical overhead contact-line protection system, the measuring voltage is monitored for failures. If the voltage falls below a parameterizable threshold, the system deactivates the distance protection (emergency overcurrent protection is active) after a set period of time has expired and issues a message. This is dependent on a minimum current of 0.06 I_N flowing.

Start of Measured Value Supervision block



Undervoltage threshold value

Minimum setting value: .... **0.05 U/Un**
Maximum setting value : ... **1.00 U/Un**

Delay time for undervoltage monitoring

Minimum setting value: ..... **1 s**
Maximum setting value : ..... **10 s**
and ∞ (ineffective)

5.2.10 Settings for Auto-Reclose (AR) - Block 34

Block 34 provides setting options for the AR. This block is only available if you configured the AR as EXIST in **address 7834**. Note that this optional function is not available in all versions of the device.

Auto-reclose, AR, must be explicitly switched on or off **(Addr. 3401)**. In addition, the desired protection stages for starting AR must be enabled in configuration block 7900. When enabling the high-speed overcurrent protection, you must specify for it the action area for starting the AR. The corresponding parameter, WE I>>> **(Addr. 3420)**, has a choice of settings RAR ONLY and RAR and DAR available for this.

The following zones are relevant to the AR:

Zone Z1B/Z1B REV For the RAR cycle

Zone Z1L/Z1L REV For all DAR cycles

Zone Z1/Z1 REV For definitive switch-off

You specify the settings for these zones and for their corresponding delay times in block 12 - Distance Protection.

In the case of manual closing, the AR can be blocked for a fixed time. For this, you must set parameter MCBLOCK **(Addr. 3403)** to YES. Parameter T-BLOCK MC **(Addr. 3407)** then makes it possible to set the duration of blocking. In **address 3404**, you can also set a current threshold as a further blocking criterion.

It is also possible to link blocking of the AR to reverse tripping of the protection. For this, you must set parameter AR BLO REV **(Addr. 3402)** to YES. However, blocking is conditional on the distance protection correctly determining the direction.

To specify time execution of an automatic reclosing procedure, you must set the following parameters:

- DAR No. **(Addr. 3443)** The number of possible delayed auto-reclose shots
- RAR T-ACT **(Addr. 3424)** The action time for rapid auto-reclose

- RAR T-DEAD **(Addr. 3426)** The dead time for rapid auto-reclose
- DAR T-ACT **(Addr. 3445)** The action time for the configured delayed auto-reclose shots
- DAR T-DEAD **(Addr. 3446)** The dead time for for the configured delayed auto-reclose shots
- T-RECLAIM **(Addr. 3405)** The reclaim time after a successful auto-reclose

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Start of Auto-Reclose Function block

Auto-reclose function is

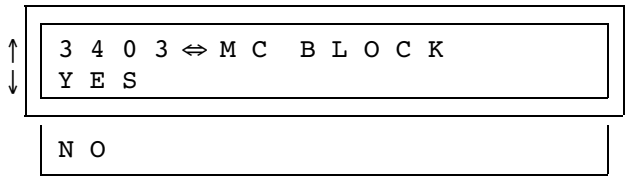
← Switched-on

← Switched-off

Auto-reclose block with reverse faults

← Yes

← No



Auto-reclose block with manual close

← Yes

← No

Current threshold from which onwards AR is blocked

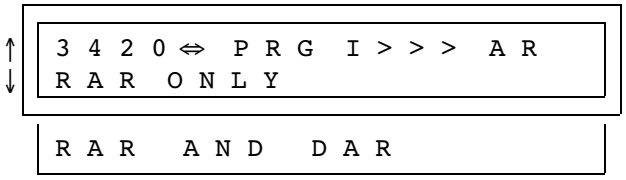
Minimum setting value: . . . . . **1 * IN**
Maximum setting value : . . . . . **25 * IN**
and ∞ (no limitation)

Reclaim time after an auto-reclose cycle

Minimum setting value: . . . . . **0.5 s**
Maximum setting value : . . . . . **320 s**

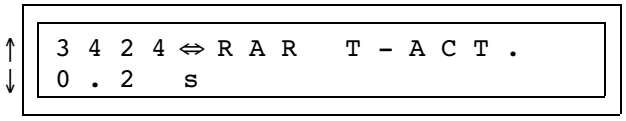
Blocking duration of AR with manual close

Minimum setting value: . . . . . **0.5 s**
Maximum setting value : . . . . . **320 s**



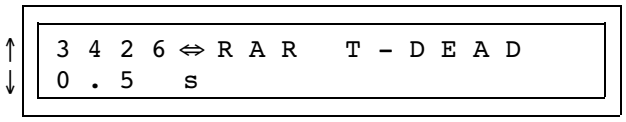
High-speed overcurrent protection is to start AR
← For RAR cycle only

← For RAR and DAR cycles



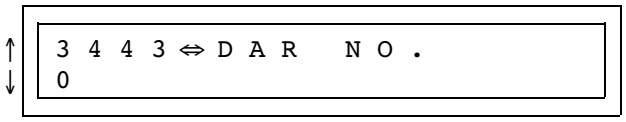
Action time for RAR

Minimum setting value: . . . . . **0.01 s**
Maximum setting value : . . . . . **320 s**
and ∞ (ineffective)



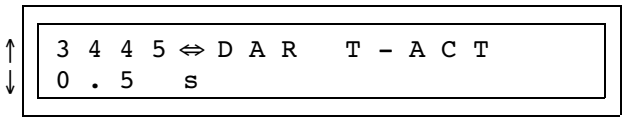
Dead time for RAR

Minimum setting value: . . . . . **0.01 s**
Maximum setting value : . . . . . **320 s**



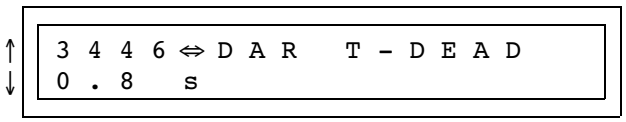
Number of possible DARs

Minimum setting value: **0**
Maximum setting value : **9**



Action time for DARs

Minimum setting value: . . . . . **0.01 s**
Maximum setting value : . . . . . **320 s**
and ∞ (ineffective)



Dead time for RARs

Minimum setting value: . . . . . **0.01 s**
Maximum setting value : . . . . . **1800 s**

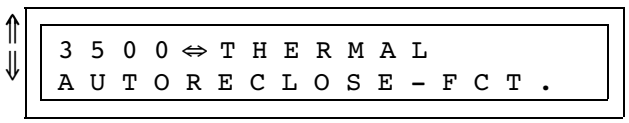
5.2.11 Settings for Thermal Protection Auto-Reclose - Block 35

Block 35 provides setting options for the thermal protection auto-reclose function (Thermal AR) in conjunction with thermal protection. This block is only available if you configured INT TH-AR as EXIST **(Addr. 7835)**. Note that this optional function is not available in all versions of the device.

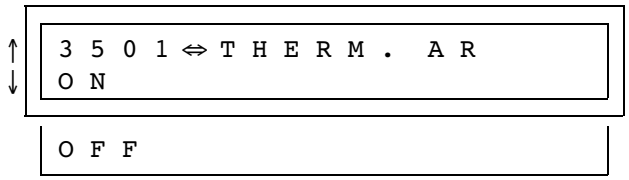
Thermal AR must be explicitly switched on or off **(Addr. 3501)**.

To specify time execution of a thermal AR procedure, you must set the following parameters:

- TH-AR No. **(Addr. 3502)** number of AR shots after trip thermal protection
- T-RECL-TH **(Addr. 3503)** Reclaim time after successful thermal AR



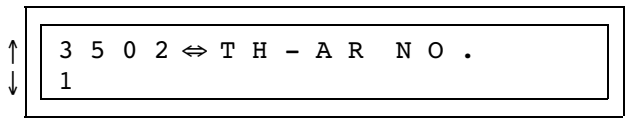
Start of Thermal AR Settings block



Thermal auto-reclosing is

← switched-on

← switched-off



Number of auto-reclose cycles on fault detection and tripping by the thermal protection

Minimum setting value: **0**
Maximum setting value : **9**

Post auto-reclose reclaim time after tripping by the thermal protection

Minimum setting value: . . . . . **0.01 s**
Maximum setting value : . . . . . **1800 s**

5.2.12 Settings for Fault Location - Block 38

Block 38 provides setting options for the fault location function. This block is only available if you configure fault location as EXIST **(Addr. 7838)**.

You must specify a start criterion for fault location. For this, parameter START **(Addr. 3802)** can be set to Trip command or Drop-off or trip.

As a rule, calculation of the fault location is started by the protection's trip command. It can, however, be started at drop-off of the trip, e.g. at switch off by another protection. Regardless of this, it is possible to start calculation of the fault location externally via a binary input **(>Start Flt.Loc, FNo. 1106)** assuming that the distance protection has detected a fault.

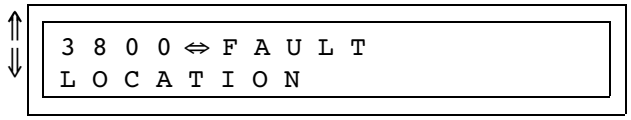
To define the parameterized number of sections **(Addr. 7989)**, you must enter the reactances per unit length and the line lengths for each section.

Enter the reactances per unit length as secondary values. Primary values are converted to secondary ones according to the formula below.

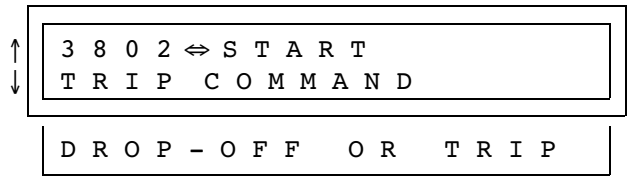
$$X_{sec} = \frac{Ratio_{ct}}{Ratio_{vt}} \; X_{prim}$$

Where
$Ratio_{ct}$: Actual transformation ratio of current transformer
$Ratio_{vt}$: Actual transformation ratio of voltage transformer
X_{sec}: Reactance value as a secondary variable
X_{prim}: Reactance value as a primary variable

If a line section contains a transformer booster, it is defined as its own line section. In this connection, the line length of this section is parameterized as zero (special input "0"). Enter as the reactance per unit length the transformer reactance relative to the value "1 km".



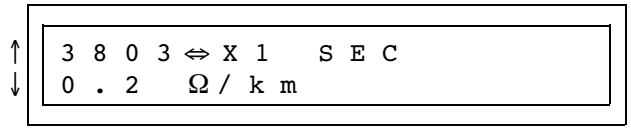
Start of Fault Location block



Starting of fault location on

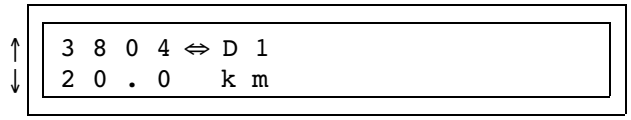
← Trip command

← Drop-off or trip command



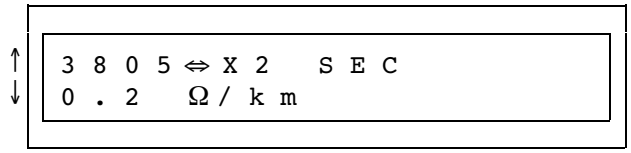
Reactance per unit length of section 1 with fault location

Minimum setting value: .... **0.05 Ω/km**
Maximum setting value : .. **50.00 Ω/km**



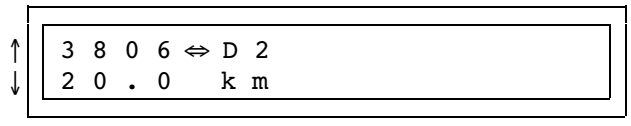
Line length of section 1 with fault location

Minimum setting value: ..... **1.00 km**
Maximum setting value : .... **200.0 km**



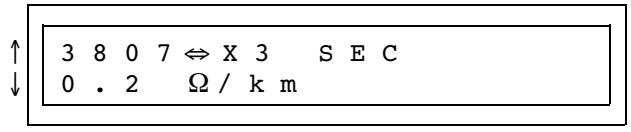
Reactance per unit length of section 2 with fault location

Minimum setting value: .... **0.05 Ω/km**
Maximum setting value : .. **50.00 Ω/km**



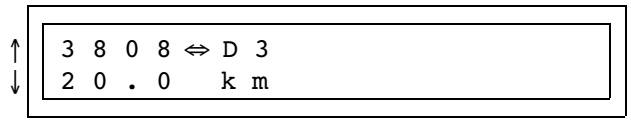
Line length of section 2 with fault location

Minimum setting value: ..... **1.00 km**
Maximum setting value : .... **200.0 km**



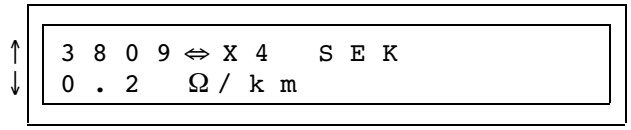
Reactance per unit length of section 3 with fault location

Minimum setting value: .... **0.05 Ω/km**
Maximum setting value : .. **50.00 Ω/km**



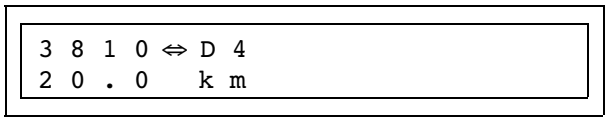
Line length of section 3 with fault location

Minimum setting value: ..... **1.00 km**
Maximum setting value : .... **200.0 km**



Reactance per unit length of section 4 with fault location

Minimum setting value: .... **0.05 Ω/km**
Maximum setting value : .. **50.00 Ω/km**

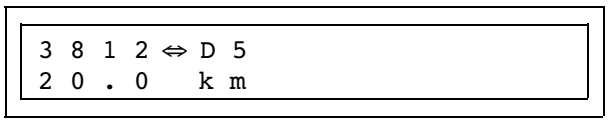


Line length of section 4 with fault location

Minimum setting value: . . . . . **1.00 km**
Maximum setting value : . . . . **200.0 km**

Reactance per unit length of section 5 with fault location

Minimum setting value: . . . . **0.05 Ω/km**
Maximum setting value : . . **50.00 Ω/km**



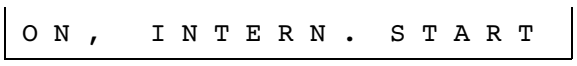
Line length of section 5 with fault location

Minimum setting value: . . . . . **1.00 km**
Maximum setting value : . . . . **200.0 km**

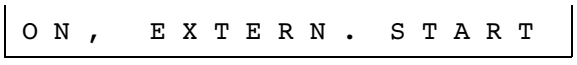
5.2.13 Settings for Breaker Failure Protection - Block 39

Start of Breaker Failure Protection block

Circuit breaker failure protection function is
← Switched off

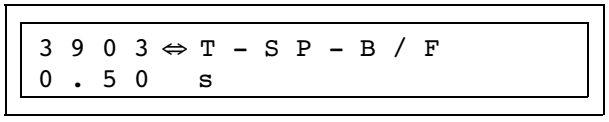


← Switched on and controlled by the internal protection



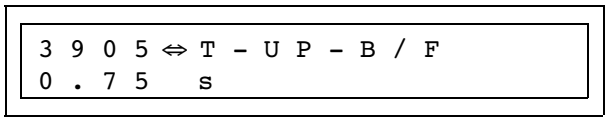
← Switched on and controlled by the external protection

← Switched on and controlled by the internal or the external protection



Delay time for controlling the back-up trip coil

Maximum setting value: . . . . . **0.10 s**
Minimum setting value: . . . . . **1 s**
and ∞ (ineffective)



Delay time for controlling the superordinated circuit breaker

Maximum setting value: . . . . . **0.10 s**
Minimum setting value: . . . . . **1 s**
and ∞ (ineffective)

5.3 Annunciations

After a disturbance in the power system, annunciations provide an overview of the most important data of the fault event and of the device function; they are used to check function executions at testing and commissioning. In addition, during operation, annunciations supply information about the status conditions of measuring data and about the device itself.

You do not need to enter a codeword to call annunciations.

You have various ways to access the annunciations generated in the device:

- By means of the LEDs on the front panels of the devices (Figures 5.1 and 5.2);
- By means of binary outputs (signal relays) via the device's connections;
- By means of the display on the device's front panel or on a PC's monitor via the operating interface;
- By means of transfer to the central control room via the rear serial interface.

Most annunciations can be marshalled to the LEDs and binary outputs (see Chapter 4.5); multiple and common annunciations are possible in this context. The following options are provided for calling annunciations via the operator panel:

- Using the double up and down arrow keys (⇑ and ⇓) to page block-by-block forwards or backwards to address 5000;
- Pressing key **DA** to directly select address **5 0 0 0** and then pressing the enter key **E** to confirm;
- Pressing key **M/S** (message/signalling); the system then automatically displays address 5000 with the start of the annunciation blocks.

To configure the transfer of annunciations to a central processing system or to a control room, you must enter the necessary configuration data in block 72 (see Chapter 4.3.3).

Annunciations are structured as follows:

Block 51 Operational annunciations: these are annunciations that can occur during operation of the device. They provide information about the status of device functions, measured values, etc.

Block 52 Annunciations of the last fault to the third last fault; fault detection, tripping, chronology, calculated distance, etc. By definition, a power system fault starts with fault detection.

Block 53 Annunciation of the fourth last power system fault to the sixth last one: same as block 52

Block 54 Annunciation of the seventh last power system fault to the ninth last one: same as block 52

Block 55 Annunciation of the tenth last power system fault to the twelfth last one: same as block 52

Block 56 Annunciations for the switching statistics: these are counters for trip command, accumulated interrupted current and last trip current.

Block 57 Display of operational measured values (currents, voltages, reactance, resistance, angle, temperature, frequency).

For a complete list of all the signal and output functions generated in the device with the associated function numbers (**FNos.**), refer to Appendix A.1. In this connection, the list also states the location to which each annunciation can be signalled.

Start of annunciation blocks

5.3.1 Operational Annunciations - Block 51

Operational annunciations are informative messages that the device generates during operation and about operation. They start at address 5100. The system lists in chronological order important events and changes of status with time information in hours and minutes also being given. A maximum of 50 operational annunciations are stored and if more than this number occur, the oldest one is lost.

Short-circuits in the power system are shown only as Syst.Flt and a serial number for the fault. Detailed information about the course of the fault is contained in the Power System Faults blocks (see Chapter 5.3.2).

You do not need to enter the codeword.

After you choose address 5100 (by directly selecting **DA 5 1 0 0 E** and/or paging using ⇑ or ⇓ and paging on with ↑↓), the system displays the operational annunciations. All the available operational annunciations are shown below; in individual cases, only the appropriate annunciations are shown on the display. Annunciations starting with a greater than sign (>) are the annunciations returned directly by the binary inputs.

Next to the annunciation there is an indication of whether it is issued COMING only (C with events) or COMING and GOING ([C/G] with status conditions). The first annunciation shows as an example the date and time on the first display line and the annunciation text marked COMING on the second display line.

⇑⇓

```
5100⇔OPERATIONAL
ANNUNCIATIONS
```

Start of Operational Annunciations block

↑↓

```
11.12.96    12:02
B/F  off    :C
```

1st line: Date and time of the event or the change of status

2nd line: Annunciation text, in the example marked Coming

Direct Return Information of Binary Inputs:

`> Start FltRec`	Fault recording started via a binary input (C)
`> Annunc. 1`	User-defined annunciation 1 via binary input (C/G)
`> Annunc. 2`	User-defined annunciation 2 via binary input (C/G)
`> Annunc. 3`	User-defined annunciation 3 via binary input (C/G)
`> Annunc. 4`	User-defined annunciation 4 via binary input (C/G)
`> VT mcb Trip`	Voltage transformer circuit breaker (substation voltage) tripped (C)
`> Ctrl. by BI`	Control by binary input is active (C/G)

Direct Return Information of Binary Inputs (Continued):

> Start FltLoc	Start fault locator (C/G)
> DAR block	AR: Block delayed auto-reclose externally (C/G)
> CB Aux. cl.	CB: Auxiliary contact closed (C/G)
> AR block	AR: Block auto-reclose function externally (C/G)
> ext.Start AR	AR: External start for internal AR (C)
> ext. Trip AR	AR: External trip for internal AR (C)

General Operational Annunciations of the Device:

Dev. operative	The device is operative (C/G).
Prot. operative	At least one protective function is operative (C/G).
Initial start	Initial starting of the processor system (C)
LED reset	LEDs are reset (C)
LogMeasBlock	Annunciations and measured values are blocked (C/G).
Test mode	Test mode (C/G)
Param.running	Parameterization of the device is running (C/G).
Syst.Flt	A system fault (general) is running with serial number (C/G); for details refer to earth fault log.
Manual Close	Manual closing of the circuit breaker detected (C)

Operational Annunciations of the Monitoring Functions:

Wrong SW-vers.	The device's software version is wrong (C).
Wrong dev.ID	The device's identification number is wrong (C).
Annunc. lost	Annunciations lost, fault buffer overflow (C)
Annu. PC lost	Annunciations for the PC interface lost
Oper.Ann.Inva	Operational annunciation archive invalid (C/G)

Operational Annunciations of the Monitoring Functions (Continued):

Flt. Ann. Inval	Power system fault log is invalid (C/G).
Stat. Buff. Inv	Switching statistics buffer is invalid (C/G).
LED Buff. Inv	Buffer for LED storage is invalid (C/G).
VDEW-StateInv	The status of the VDEW/ZVEI annunciations is invalid (C/G).
Chs error	Checksum error (C/G)
Failure 15V	Failure of 15-V supply voltage (C/G)
Failure 5V	Failure of 5-V supply voltage (C/G)
Failure 0V	Failure of 0-V offset monitoring (C/G)
Fail. TripRe1	Supervision of trip circuit
Failure MEA1	Failure of analog signal of MEA1 (C/G)
Failure MEA2	Failure of analog signal of MEA2 (C/G)
Fail. MAIN CB	Failure of main circuit breaker (C)
Fail. TEMPSENS	Failure of external temperature sensing (C/G)
LSA disrupted	LSA operation disrupted (C/G)
Failure Umeas	Failure: measuring voltages absent (C/G)
Flt.RecDatDel	Fault recording data deleted (C)
Flt.Rec.viaBI	Fault recording started via a binary input (C)
Flt.Rec.viaKB	Fault recording started via membrane keypad (C)
Flt.Rec.viaPC	Fault recording started via PC interface (C)

Operational Annunciations from the Distance Protection:

Dist. off	Distance protection is switched off (C/G).
Dist. active	Distance protection is active (C/G).
Dis Z1 forw.	Zone Z1 active forwards (C/G)
Dis Z2 forw.	Zone Z2 active forwards (C/G)

Operational Annunciations of the Emergency Overcurrent Protection:

Emer. off	Emergency overcurrent protection is switched-off (C/G).
Emer. Mode	Emergency overcurrent protection is running for distance protection (C/G).

Operational Annunciation of the High-Speed Emergency Overcurrent Protection:

O/C I>>> off	High-speed overcurrent protection is switched-off (C/G).

Operational Annunciations of the Thermal Protection

Th.Prot off	Thermal protection is switched-off (C/G).
Trip Th.Prot.	Thermal protection trip command (C)
Close-lockout	Close lockout of thermal protection (C/G)
Th.Prot Warn	Thermal protection alarm stage (C)
Cat. 1 active	Thermal protection of catenary 1 is active (C/G)
Cat. 2 active	Thermal protection of catenary 3 is active (C/G)
Cat. 3 active	Thermal protection of catenary 2 is active (C/G)

Operational Annunciation of the Breaker Failure Protection

B/F off	Breaker failure protection is switched-off (C/G).

Operational Annunciations of Auto-Reclose AR

AR off	Auto-reclose is switched-off (C/G).
CB not ready	Circuit breaker is not ready (C/G).

Operational Annunciation of the Fault Locator

F l t L o c b l o c k	Fault locator is blocked (C).

Operational Annunciations of Thermal AR

T h - A R o f f	Thermal AR is switched-off (C/G).
T h - A R s u c c e s s	Thermal AR was completed successfully (C).
T h - A R C l o s C m d	Thermal AR close command
T h - A R d e f . T r p	Thermal AR definitive trip
T h - A R i n p r o g	Thermal AR has been started.

Annunciations of Circuit Breaker Testing:

C B t s t T R I P/C L S	Circuit breaker trip/close cycle running (C/G)
C B i n T e s t	Circuit breaker test running (C/G)
T e s t M A I N C B	Circuit breaker test tripping main CB coil (C)
L S p r f R - A U S	Circuit breaker test tripping reserve CB coil (C)

Operational Annunciations of the Parameter Changeover and Control:

P a r a m. S e t A	Parameter set A is active
P a r a m. S e t B	Parameter set B is active
P a r a m. S e t C	Parameter set C is active
P a r a m. S e t D	Parameter set D is active
C t r l . b y B I	Control by binary input is active
C t r l . b y S Y S	Control by system-interface is active

Annunciation on Clearing the Temperature Backup

R e s e t T e m p B u p	Reset temperature backup (C)

Miscellaneous Entries:

T a b l e f u l l	This means that more fault event data have occurred but the memory is full.
T a b l e e n d	If not all the fault memory is used, Table end is indicated.

5.3.2 Fault Annunciations - Blocks 52 to 55

You can read out the annunciations of the last twelve power system faults. These are sorted from the newest to the oldest and located in **addresses 5200, 5300, 5400 and 5500** (three power system faults each). When a new fault arrives, the system deletes the data of the oldest one. Each fault buffer can store up to 25 annunciations.

You do not need to enter the codeword.

After you choose address 5200, or 5300 to 5500 (by directly selecting **DA 5 2 0 0 E** and/or paging using ⇑ or ⇓ and paging on with ↑↓), the system displays the fault annunciations. Each annunciation has an index number. Annunciations that belong to one fault event have the same first digit in first position the index number within a block:

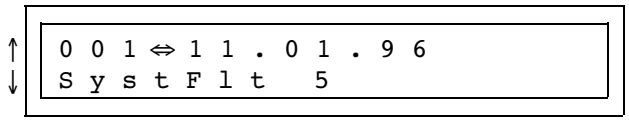
Index no. 001-0xx	Newest fault event within a block
Index no. 101-1xx	Second newest fault event within a block
Index no. 201-2xx	Oldest fault event within a block

A power system fault event is defined such that a short-circuit procedure is considered to be a fault until it has been definitively cleared up.

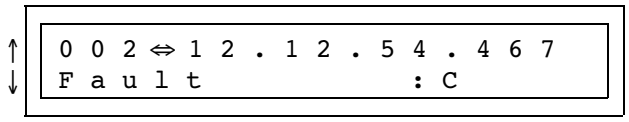
All the available fault annunciations are shown below; in individual cases, only the appropriate annunciations are shown on the display.

First of all a few typical examples are shown of the fault messages of a power system fault with explanations of the display lines.

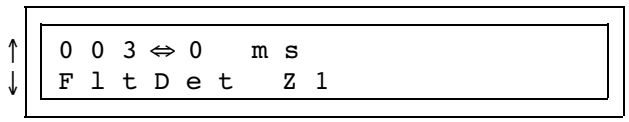
Start of Last Fault to Third Last Fault block



Under index number 1, the display shows the date and the serial number of the power system fault.



Under index number 2, the display shows the time at which the fault started with a resolution of 1-ms.



The display now shows the fault annunciations in the chronological order in which they were detected with a time relative to the instant of fault detection.

etc.

General Fault Annunciations of the Device:

S y s t F l t.	Power system fault with serial number
F a u l t	Start of fault
F l t B u f f . O v e r	Fault annunciations are lost (C).
I / I n =	Current switched-off
D e v. D r o p - o f f	Device drop-off, i.e. none of the protection functions are fault-detecting any more.

Annunciations of the Distance Protection:

D i s t . G e n F l t	Distance protection general fault detection
D i s t Z 1	Distance protection fault detection in Z1
D i s t Z 1 B	Distance protection fault detection in Z1B
D i s t Z 1 L	Distance protection fault detection in Z1L
D i s t T 1	Distance protection T1 expired
D i s t T 1 B	Distance protection T1B expired
D i s t T 1 L	Distance protection T1L expired
D i s . G e n. T r i p	Distance protection general trip
D i s t . F l t . Z 2 K	Distance protection fault detection in Z2 short-circuit
D i s t . F l t . Z 2 L	Distance protection fault detection in Z2 overload
D i s t . T 2 K	Distance protection T2K expired
D i s t . T 2 L	Distance protection T2L expired

Annunciations of the Emergency Overcurrent Protection:

E m e r . I > >	Emergency overcurrent protection fault detection
E m e r . T I > >	Emergency overcurrent protection TI>> expired
E m e r . G e n. T r i p	Emergency overcurrent protection general trip

Annunciations of the Fault Locator

R p r i =	Calculated fault resistance in Ohms, primary (C)
X p r i =	Calculated fault reactance in Ohms, primary (C)
R s e c =	Calculated fault resistance in Ohms, secondary (C)
X s e c =	Calculated fault reactance in Ohms, secondary (C)
d =	Calculated distance to fault in km (C)
d [%] =	Calculated distance to fault in percent of line length (C)
F l t L o c i m p o s s	No distance to fault, since reactance is negative (C)
F l t d i s t >	Fault is outside the defined sections (C).
F a u l t f o r w a r d	Direction of fault is forwards.
F a u l t r e v e r s e	Direction of fault is backwards.
F a u l t s e c t i o n	Number of the section containing the fault

Annunciations of the AR:

A R C l o s e C m d .	Auto-reclose close command (C)
A R s u c c e s s f u l	AR completed successfully (C)
D e f i n i t . T r i p	Definitive trip (C)

Annunciations of the High-Speed Overcurrent Protection:

F l t . d e t . I > > >	High-speed overcurrent protection fault detection
T I > > > e x p .	High-speed overcurrent protection TI>>> expired
T r i p I > > >	High-speed overcurrent protection trip

Annunciations of the Breaker Failure Protection:

B / F f a u l t	Breaker failure protection fault detection
B / F T r i p	Breaker failure protection trip
B / F s . o r d P r o t	Annunciation to superordinated protection
B / F T - S P	Breaker failure protection T-SP expired

Miscellaneous Entries

T a b l e e m p t y	This means that (up to now) no fault has occurred.
T a b l e f u l l	This means that more fault event data have occurred but the memory is full.
T a b. o u t o f t i m e	While reading out, a new fault occurred; page on using the ↑↓ keys; the system displays the first annunciation of the new fault.
T a b l e e n d	If not all the annunciation memory is used, Table end is indicated.

5.3.3 Annunciations for Circuit Breaker Operating Statistics - Block 56

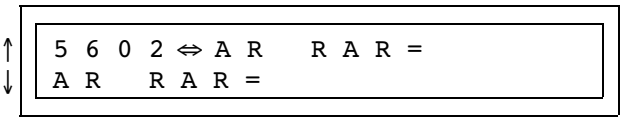
The device counts the number of breaking operations that the 7SA518/519 numerical overhead contact-line protection system triggered. In addition, at every trip command, the system determines the interrupted current, outputs it under the fault annunciations and adds it in a memory register. The counter and memory readings are buffered against auxiliary voltage failures; you can read them out at **address 5600**. You get to the block by directly addressing it, **DA 5 6 0 0 E**, and/or by paging using the double up arrow key, ⇑ and paging on with the double down arrow key, ⇓ to address 5600. Using the single up arrow key, ↑, you can page through the counter and memory readings or you can page back with the single down arrow key, ↓.

You do not need to enter the codeword.

In block 82 you can zero the counter readings.

Example:

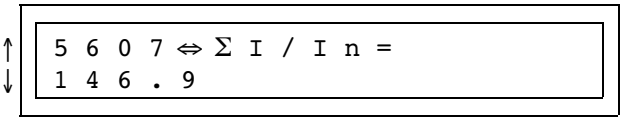
⇑ ⇓ 5 6 0 0 ⇔ C B O P E R A T . S T A T I S T I C S	Start of Circuit Breaker Operating Statistics block
↑ ↓ 5 6 0 1 ⇔ T H - A R = T H A R =	Number of AR commands of thermal AR



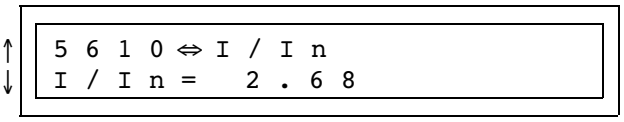
Number of auto-reclose commands after RAR (first cycle)

Number of auto-reclose commands after DAR (subsequent cycle)

Number of trip commands: 0 to 65,535



Accumulated interrupted current, e.g. 146.9 I/In



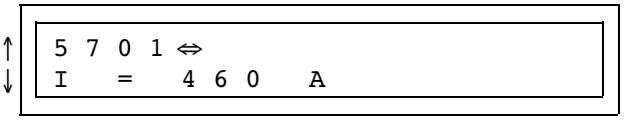
Last breaking current, e.g. 2.68 I/In

5.3.4 Reading Out Operational Measured Values - Block 57

Operational measured values can be displayed in block 57. Here too, you can get to the block either by directly selecting **DA 5 7 0 0 E** or by paging using the ⇑⇓ keys. To find individual measured values, page on through the addresses using the ↑↓ keys. Each measured value also has an address that you can directly address by pressing the **DA** key followed by the address number. You do not need to enter the codeword. The values are cyclically updated.

The values are displayed as primary quantities and as a percentage of the rated quantities. Correct displaying is conditional on the rating data being parameterized properly in address block 11 (see Chapter 5.2.3). The values shown in the screenshots below are examples; in actual fact the system displays the current values.

Start of Operational Measured Values block



U = 15.0 KV	Operational voltage
Tmp.cat [°C] = 40	Temperature of catenary
Tmp.amb [°C] = 18	Ambient temperature
I [%] = 28.7	Operational current as a percentage of I_N
U [%] = 100,0	Operational voltage as a percentage of U_N
FREQ. = 50.1 Hz	Frequency
R [Ω] = 110.7	Resistance
X [Ω] = 69.2	Reactance
Phi [°] = 32	Power angle

5.4 Control Options During Operation

During operation of the device, there are several options that allow you to influence individual functions and annunciations. Above all, these include correcting the date and time, clearing stored information and event counters and activating and deactivating subfunctions for operational reasons. The scope of control options during operation depends on the scope of functions you order.

There are control options that are available from the operator panel, via the operating interface and via binary inputs. Control via binary inputs is conditional on the corresponding control functions being marshalled and connected to binary inputs at installation of the device (see Chapter 4.5).

For control via the operator panel or the operating interface, the operating blocks start at **address 8000**. You get to the address by

- paging to **address 8000** block-by-block forwards or backwards using the up or down arrow keys (⇑ or ⇓)
- directly selecting using the **DA** key, entering the address **8 0 0 0** and then pressing the enter key **E** to confirm.

5.4.1 Setting and Synchronizing the Date and Time - Block 81

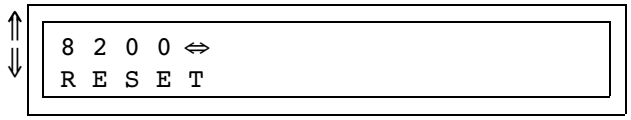
At any time during operation, you can correct the date and the time in block 81. You get to this block, as usual, by directly selecting **DA 8 1 0 0 E** or by paging using the double up or down arrow keys (⇑⇓). You must enter the codeword to be able to change the data.

By paging on using the single up or down arrow keys (↑↓), you get to the individual addresses as shown below. Every time you make a change, you must press the Enter, **E** key to confirm it.

⇑ ⇓ 8 1 0 0 ⇔ s E T T I N G R E A L T I M E C L O C K	Start of Setting Real Time Clock block Press ↑ to continue.
↑ ↓ 2 0 . 1 2 . 1 9 9 6 1 5 : 5 4 : 4 2	The system first displays the current date and clock time. Press ↑ to page on.
↑ ↓ 8 1 0 2 ⇔ D A T E	In address 8102, you can enter a new date: The day, the month and the year in that order separated by a period; the day and the month in two-digit form, the year in four-digit form, i.e. **DD.MM.YYYY**
↑ ↓ 8 1 0 3 ⇔ T I M E	In address 8103, you can enter a new time in order of Hours, Minutes and Seconds separated by a period, in two-digit form in each case, i.e. **HH.MM.SS**.
↑ ↓ 8 1 0 4 ⇔ D I F F . T I M E	You can also set a difference time, i.e. the clock is set forward by the entered time; pressing the **+/-** key before entering digits sets the clock back. The format is the same as with time setting above.

5.4.2 Resetting Stored Annunciations and Counter Readings - Block 82

The annunciations of the circuit breaker operating statistics **(address 5600)** are stored in EEPROMs in the 7SA518/519. This means that they are not lost in the event of an auxiliary voltage failure. You can zero the counters in block 82. You get to the block by using the up or down double arrow keys (⇑ or ⇓) to page block-by-block or by directly selecting **DA 8 2 0 0 E**. You must enter the codeword to clear memory **(except for address 8201)**. Resetting of the counters is carried out separately for the different groups of memory, counters and annunciations. Paging using the single up and down arrow keys, ↑ and ↓ brings you to the individual prompts. You must confirm deletion by pressing the Yes key, **J/Y**. After this, the display shows a message confirming the operation. If you do not want to carry out deletion, press the No key, **N**, or page on.



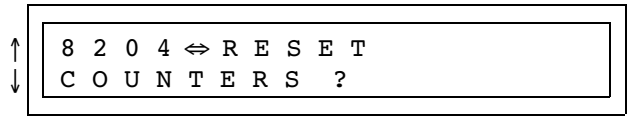
Start of Reset block

Prompt for whether you want to delete the LED memories

The device acknowledges deletion of the LED memory with END on the second display line

Prompt for whether you want to clear the operational annunciation buffer

Prompt for whether you want to clear the fault annunciation buffer



Prompt for whether you want to clear the counter for trip and auto-reclose commands

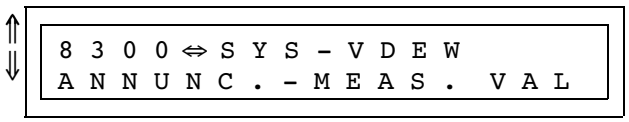
Prompt for whether you want to zero the accumulated interrupted currents

While the system is carrying out deletion, the display shows the message RESET IN PROGRESS. After deletion is completed, the system reports this with the following message, for example

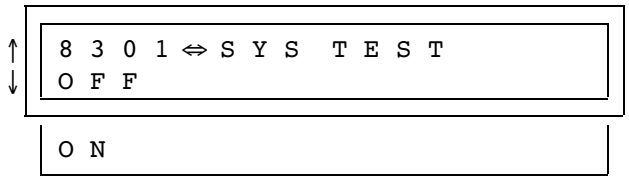
If the circuit breaker operation counter (address 8204) has been cleared

5.4.3 Special Settings for the VDEW/ZVEI Interface - Block 83

Addresses 8301 and 8302 are only relevant if VDEW/ZVEI-standard protocols are to be exchanged via the system interfaces (**address 7221** SYS INTERF. = VDEW COMPATIBLE or VDEW EXTENDED). In this case, you can specify here that all the annunciations that are generated during test operation of the device are transferred with the cause "Test operation", or that no annunciations and measured values at all are transferred.

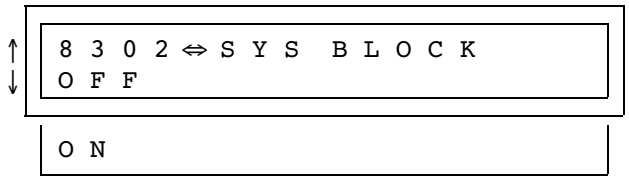


Start of VDEW System Interface block



For VDEW-ZVEI-compatible protocols only:

In the ON position, Test operation is entered as the cause during test operation with VDEW/ZVEI-compatible annunciations.



In the ON position, no annunciations and measured values are transferred.

5.4.4 Parameter Changeover - Block 85

For the functional parameters, i.e. the addresses from above 1000 to less than 4000, up to 4 different parameter sets can be selected. Changeover between parameter sets can be performed locally during operation, using the operator panel, or from a PC via the user interface, or remotely via binary inputs.

The first parameter set is Set A, the others Set B, Set C and Set D respectively. These parameter sets are defined successively when setting the functional parameters.

5.4.4.1 Reading out the Settings of a Parameter Set

To **view** the data of a parameter set **in the display**, simply select any address within the functional parameters (from 1000 to less than 4000), either by direct addressing with the **DA** key, by entering the 4-digit address number, followed by **E**, or by paging with the ⇑ or ⇓ key. You can now have the parameters of a specific set displayed, e.g.:

- Press the key combination **F2**, i.e. press first function key and then numerical key 2. All parameters displayed now will be those of parameter set B.

The parameter set displayed is indicated by its letter (A to D) before the address number.

The other parameter sets are accessed in a similar way:

- Key combination **F1**: invokes parameter set A
- Key combination **F2**: invokes parameter set B
- Key combination **F3**: invokes parameter set C
- Key combination **F4**: invokes parameter set D

During read-out of a parameter set, the currently active parameter set always remains valid for the functioning of the protection system. The changeover operation described here refers only to **reading out** parameters **in the display**.

5.4.4.2 Parameter Changeover using the Operator Panel

Parameter changeover, i.e. activating another parameter set, is performed in address block 85. The input of a codeword is necessary for this.

Once again, the block for parameter changeover is accessed either by direct addressing with **DA 8 5 0 0 E** or by paging block-by-block using the ⇑ or ⇓ key. Now the title of the Parameter changeover block will be displayed.

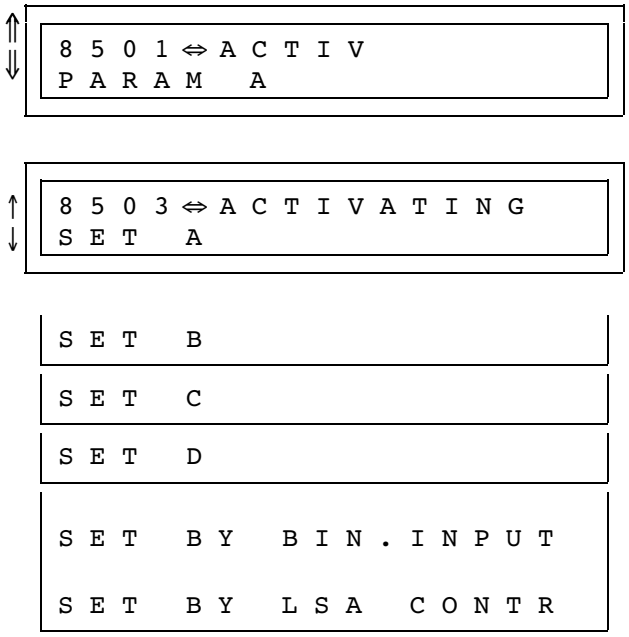
Use the ↑ key to page through the addresses, and the ↓ to leaf backwards.

Beginning of block "Parameter change-over"

Address 8501 shows the currently active parameter set, i.e. the set that is currently in use.

To change over to a different parameter set, use the ↑ ↓ keys to page to **Addr. 8503**. You can now have any set displayed using the "No" key **N**, or have the active parameter set controlled by binary inputs or via the system interface with the VDEW/ZVEI protocol. Confirm the selected parameter set using the Enter key **E**.

As with all changes that require the entry of a codeword, codeword operation must be exited by the key combination **FE** i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS?". Confirm with the "Yes"–key **J/Y** that the new settings shall become valid now. If you press the "No"–key **N** instead, codeword operation will be aborted, i.e. all alterations which have been changed since the last codeword entry are lost. Thus, erroneous alterations can be made ineffective.



Address 8501 shows the currently active parameter set, e.g. Set A

Use the"No" key **N** to page through the sets offered. Confirm the selected set with the Enter key **E** .

If *by BINary INPUT*, is selected, the parameter change-over can be controlled via binary input.

If *by LSA CONTR* is selected, the parameter change-over can be controlled via the system inferface with the VDEW/ZVEI protocol.

The binary input function **>Ctrl. by BI (FNo. 365)** has been added to the protection system. This function allows the operator to switch between functions locally even with the function switch **(Addr. 7903)** set to "telegram". The parameter changeover option is controlled by **SET BY LSA CONTR (Addr. 8503)** .

This level-triggered binary input allows to enable in active state function switching by binary input and in passive state function switching by system interface. Following a switchover (e.g. to control via system interface), the settings that were active last under the same conditions (i.e. for control via system interface) are activated again (see Table 4.3).

5.4.4.3 Parameter Changeover by Binary Input

For a parameter changeover by binary input, the following points must be observed:

- Locally (via operator panel or user interface), ACTIVATING under **Address 8503** must be set to *BY BIN. INPUT* (see Chapter 5.4.4.2).
- There are two binary inputs to control the 4 parameter sets. The binary inputs are named ">ParamSelec1" und "ParamSelec2" (**FNo. 7** and **FNo. 8**)

- The binary inputs must be marshalled to physical input modules to be controllable. Binary inputs that are not marshalled cannot be selected.
- The control signals must be permanently present for the selected parameter set to be activated and remain active.

The correlation between the binary inputs and the parameter sets is shown in Table 5.4.

Table 5.4 Parameter Changeover by Binary Inputs

Binary input ParamSelec.1	Binary input ParamSelec.2	activates
no	no	Set A
yes	no	Set B
no	yes	Set C
yes	yes	Set D

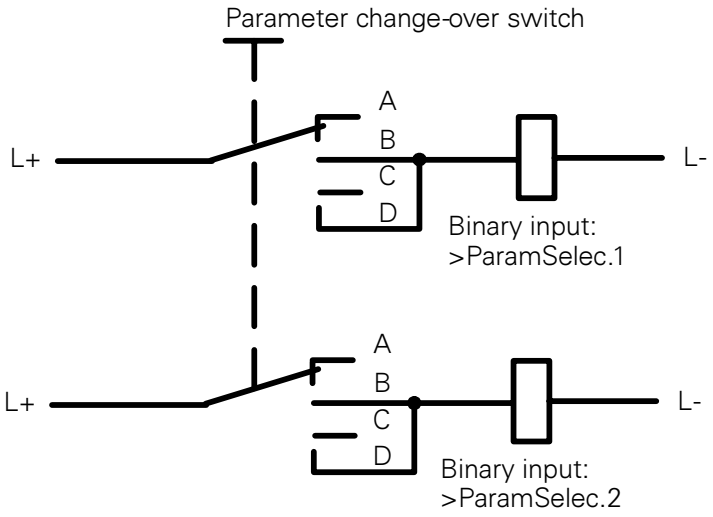


Figure 5.3 Circuit Diagram (Sample) for Parameter Changeover via Binary Input

5.5 Testing and Commissioning

Warning

Hazardous voltages are present in this electrical equipment during operation. Non observance of the safety rules can result in severe personal injury or property damage.

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

Commissioning is conditional on the preparatory measures described in Chapter 4 having been completed.

Particular attention must be drawn to the following:

- The earthing screw of the device must be connected solidly to the protective earth conductor before any other connection is made.
- Hazardous voltages can be present on all circuits and components connected to the supply voltage or to the measuring and test quantities.
- Hazardous voltages can be present in the device even after disconnection of the supply voltage (storage capacitors!).
- The limit values given in the Technical data must not be exceeded at all, not even during testing and commissioning.

When testing the unit with a secondary injection test set, it must be ensured that no other measured values are connected and that the tripping leads to the circuit breaker trip coils have been interrupted.

Danger

Secondary connections of the current transformers must be short circuited before the current leads to the relay are interrupted!

If a test switch is installed which automatically short circuits the current transformer secondary leads, it is sufficient to set this switch to the "Test" position. The short circuit switch must be checked beforehand.

For functional testing, you need a single-phase testing instrument with current and voltage outputs that can be regulated separately.

NOTE: The accuracy which can be achieved during testing depends on the accuracy of the testing equipment. The accuracy values specified in the Technical data can only be reproduced under the reference conditions set down in IEC 255 resp. VDE 0435/part 303 and with the use of precision measuring instruments. The tests are therefore to be looked upon purely as functional tests.

During all the tests it is important to ensure that the correct command (trip) contacts close, that the proper indications appear at the LEDs and the output relays for remote signalling. If the relay is connected to a central memory device via the serial interface, correct communication between the relay and the master station must be checked.

After tests which cause LED indications to appear, these should be reset, at least once by each of the possible methods: the reset button on the front plate and via the remote reset relay (see connection diagrams, Appendix A). If the reset functions have been

tested, resetting the stored indications is no more necessary as they are erased automatically with each new pick up of the relay and replaced by the new annunciations.

5.5.1 Testing Distance Zones

For the loop to be tested, you must apply $I_p = 2 * I_N$, assuming that the test voltage at the upper response threshold does not exceed the rated voltage. Otherwise, reduce the test current until it is guaranteed that the minimum current threshold **(Addr. 1212)** is exceeded. During measurement, keep the test current constant!

To test the fault detection of zone 2, set the voltage once to 1.1 times the value of the upper response threshold for Z2, the distance protection may not fault-detect. Carry out the second test at 0.9 times the upper response threshold for Z2, the distance protection must trip in Z2.

Carry out the same procedure for the upper response threshold of zone Z2 after zone Z1:

- Set the voltage to 1.1 times the upper response threshold of Z1, the protection must trip in Z2;
- Set the voltage to 0.9 times the upper response threshold for Z1, the protection must trip in Z1.

5.5.2 Testing the Times

You should carry out at least one additional dynamic test for each stage to check that the time stages annunciate correctly. To do this, simulate a short-circuit approximately in the middle between two zones.

When measuring the times, note that the parameterized values are pure delay times. The measuring and trip times of the protection must be added to them.

5.5.3 Testing the Thermal Protection

You can test the thermal protection function if you configured it as EXIST **(Addr. 7815)** and it is activated **(Addr. 1501)**.

The trip time must be calculated in accordance with the formula for t_{AUS} (see Chapter 3.3.3.2). If no ambient temperature sensing is present, you must use a fixed temperature value **(Addr. 1510)**.

Before every new trip, it is crucial to monitor the real contact line temperature **(Addr. 5700 - Operational Measured Values)**. If no current is flowing through the protection before tripping, the value of the contact line temperature must be reduced to the level of the ambient temperature. You can easily do this using test function CAL.TMP.CAT **(Addr. 4101)**.

5.5.4 Testing the AR and the Thermal AR

You can test the AR if you configured it as EXIST **(Addr. 7834)** and it is activated **(Addr. 3401 or 3501)**.

At testing, binary input AR: Circuit breaker ready for reclose, **(FNo. 2730)**, must be controlled. This is not necessary if it was configured as a normally closed circuit.

A short-circuit should be simulated inside Z1 and outside Z1, but within Z1B. You must carry it out with a successful and an unsuccessful reclosing procedure. Check the correct response in accordance with the set AR program.

Note that each new test may not start until the reclaim time of the previous one has expired; otherwise, auto-reclosing is not possible. If the circuit breaker is not ready before the test, auto-reclosing may not be carried out. Short-circuits outside Z1 are switched off delayed by T2.

In the case of multiple auto-recloses, check execution in accordance with the set program and the number of desired auto-recloses.

At testing of thermal AR, function AR: Circuit breaker ready for reclose, **(FNo. 2730)**, must also be marshalled to a binary input.

During this test, you should ensure that no other protection functions trip. In this case, the thermal AR blocks. You must configure reclaim time of the thermal AR **(Addr. 3503)** appropriately; i.e. after a trip, the contact line temperature must have fallen below the temperature threshold of the close-lockout before the reclaim time expires. Otherwise, there are no further auto-reclose cycles.

5.6 Commissioning Using Primary Quantities

During commissioning testing is carried out on the entire scope of functions including connection wiring and setting values. In this connection, the device-internal help functions provide valuable information and reduce the need for measurements and measuring equipment.

You can generate commissioning documentation by printing

- the setting values,
- the parameter data for marshalling the inputs and outputs and
- the test results.

You must remove all the secondary testing equipment and connect the measuring quantities. The preparatory measures described in Chapter 4 must have been completed. The line must be switched on for the primary tests.

Warning

Primary tests may only be carried out by qualified personnel who are familiar with the commissioning of protection systems, the operation of the power system as well as with the safety regulations and instructions (switching, earthing, etc.).

5.6.1 Current and Voltage Testing

Primary quantities are used to test the connections of the current and voltage transformer. For this, a load current is needed of at least 10% of the rated current.

You can read out the current and the voltage in block 57 either on the display on the front panel, or using a PC via the operating interface; you can compare these values with the actual measured values.

Switch off the voltage transformer circuit breaker of the branch circuit. Below the operational measured values (block 57), the system shows a voltage value close to zero (low voltage values are meaningless).

In the operational measured values, check that the annunciation VT mcb trip is present in block 51 to show that the system has noticed that the circuit breaker has dropped and that ↑, with a current connected, the protection has switched to independent maximum voltage time relay Emergency Operation (operational annunciation in block 51).

Switch the circuit breaker back on: The system shows the annunciations under the operational annunciations as GOING by the abbreviation G, e.g. VT mcb trip G. Should one of the annunciations not be displayed, check the connection and marshalling of these signals.

If the C and G abbreviations are reversed, you must check the type of contact (normally closed or normally open) and correct it (Chapter 4.5.1).

5.6.2 Directional Testing with Load Current

You check that the current and voltage transformer is connected correctly using a load current across the contact line that is to be protected. To do this, the line must be connected on-load. A load current of at least $0.10 \bullet I_N$ must flow across the line; the current should be ohmic to ohmic-inductive. You must know the direction of current flow.

To check the direction, choose operational measured value X_{sec} in block 57. The sign of X_{sec} shows the direction of flow, i.e. positive means forwards and negative means backwards.

5.6.3 Trip Testing with the Circuit Breaker

The 7SA518/519 numerical overhead contact-line protection system makes it possible to easily test the trip circuits and the circuit breakers.

For this, you have the option in block 44 of separately testing the main circuit breaker coil and the spare circuit breaker via the keypad.

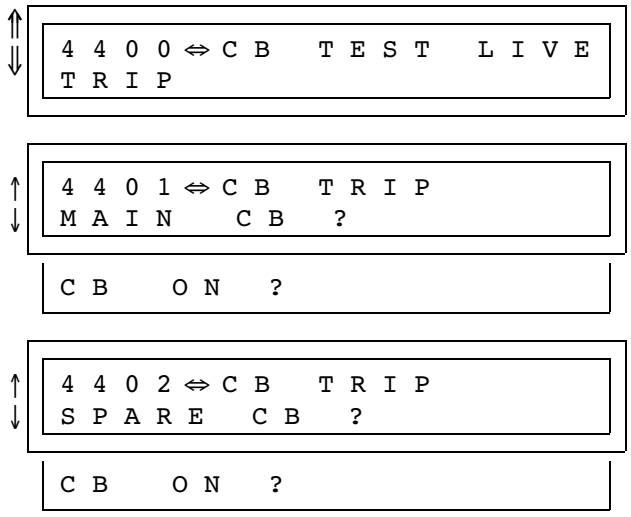
Assuming that the circuit breaker auxiliary contact gives the switch position to the device by means of a binary input, **(FNo. 355)**, the test cycle can only be triggered if the circuit breaker is closed. You should not omit this additional safety measure.

At marshalling of the binary inputs (Chapter 4.5.1), you can inform the device of the setting of the circuit breaker via the auxiliary contact.

If the auxiliary contact is marshalled, it must be connected too. If it is not marshalled, the device carries out the test cycle without interrogating the circuit breaker setting!

You activate testing from the keypad or via the front operating interface; you must enter the codeword. Activation starts at address 4400; you get to this address either by directly addressing **DA 4 4 0 0 E** or by paging to it using the double up or down arrow keys (⇑ or ⇓). In the addresses of this block, two options are available that are shown in the screenshots below.

Test activation is conditional on there being no fault detection present from one of the device's protection functions.



Start of Circuit Breaker Test Live Trip block

Trip the main circuit breaker trip coil? Press **J/Y** to confirm or cancel by paging on with ↑

Press **J/Y** to confirm that the circuit breaker is switched-on or cancel by paging on with ↑

Trip the spare circuit breaker trip coil? Press **J/Y** to confirm or cancel by paging on with ↑

Press **J/Y** to confirm that the circuit breaker is switched-on or cancel by paging on with ↑

After you confirm that the circuit breaker is switched-on, the test cycle is executed. The system either reports that it was carried out successfully or another annunciation is displayed.

If, for example, the circuit breaker auxiliary contact is marshalled and connected, the system first tests the setting of the circuit breaker. If it detects a circuit breaker that is not switched-on, the device refuses to start the test cycle. In this context, it makes no difference if you confirmed a different circuit breaker setting. In the case described, the system issues the message CB NOT ON.

Note: If testing is to be started by means of a binary input **(FNo. 1156)**, you must set configuration parameter address **7901** appropriately. You can parameterize whether the circuit breaker test is to trip

- only the main circuit breaker trip coil,
- only the spare circuit breaker trip coil, or
- both.

For the test, you must marshal the appropriate output function to a command relay:

FNo. 1181 Circuit breaker test: General trip

FNo. 1186 Circuit breaker test: Trip main CB

FNo. 1187 Circuit breaker test: Trip spare CB

5.6.4 Circuit Breaker Test Trip-Close Cycle

Using the auto-reclose function, AR, you can test the circuit breaker with a DAR cycle.

You can activate a test DAR cycle by means of the integrated operator panel or via the front operating interface. Enter the codeword before carrying out activation (see Chapter 4.3.1).

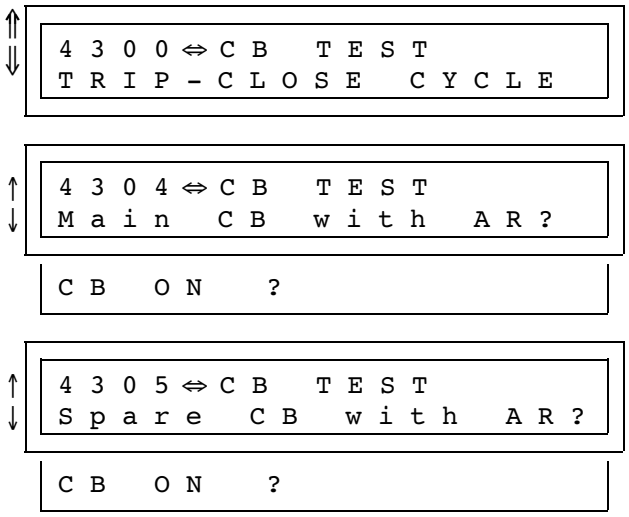
It is also possible to activate the test DAR cycle via a binary input **(FNo. 1158)**. In this case, you do not need to enter the codeword. You can parameterize **(Addr. 7901)** which trip element is to be controlled for the trip cycle

The test cycle has the following times:

- The TRIP is pending for the duration of T TRIP **(Addr. 1141)**.
- After this, the dead time RAR T-DEAD is started **(Addr. 3426)**.
- After this time has expired, the close command is issued for the duration T-CLOSE **(Addr. 1135)**.

To be able to activate a test cycle, auto-reclose, AR, must be

- switched-on **(Addr. 3401)** and
- configured as EXIST **(Addr. 7834)**.



Start of Circuit Breaker Test Trip Close Cycle block

Carry out circuit breaker test with the main circuit breaker trip coil?
Press **J/Y** to confirm or cancel by paging on with ↑

Press **J/Y** to confirm that the circuit breaker is switched-on or cancel by paging on with ↑

Carry out circuit breaker test with the spare circuit breaker trip coil?
Press **J/Y** to confirm or cancel by paging on with ↑

Press **J/Y** to confirm that the circuit breaker is switched-on or cancel by paging on with ↑

After you confirm that the circuit breaker is switched-on, the test cycle is executed. The system either reports that it was carried out successfully or another annunciation is displayed.

If, for example, the circuit breaker auxiliary contact is marshalled and connected, the system first tests the setting of the circuit breaker. If it detects a circuit breaker that is not switched-on, the device refuses to start the the test cycle. In this context, it makes no difference if you confirmed a different circuit breaker setting. In the case described, the system issues the message CB NOT ON.

Note: If testing is to be started by means of a binary input **(FNo. 1158)**, you must set configuration parameter address **7901** appropriately. You can parameterize whether the circuit breaker test is to trip

- only the main circuit breaker trip coil,
- only the spare circuit breaker trip coil, or
- both.

For the test, you must marshal the appropriate output function to a command relay:

FNo. 1181 Circuit breaker test: General trip

FNo. 1186 Circuit breaker test: Trip main CB

FNo. 1187 Circuit breaker test: Trip spare CB

Function AR Cls. Cmd. **(address 2851)** must also be marshalled to a command relay.

5.7 Switching the Protection to the Ready State

Check the setting values again if they were changed during testing. In particular, you should check that all the protection and additional functions are set correctly in the configuration parameters (Chapter 4.4) and that all the functions are activated.

The counters for circuit breaker operational statistics must be zeroed (see Chapter 5.4.2).

Press the **M/S** key. The display shows the start of the signal blocks. This may mean that the operational measured values are shown permanently **(Addr. 7105 and 7106)** on the display.

After you press the RESET LED key, the system clears the LEDs on the front panel. As a result, the operational measured values are shown on the display. While you press the RESET LED key, the LEDs that can be marshalled which are integrated on the front panel light up too. This allows you to check that the LEDs are functioning properly.

Ensure that the modules are seated firmly and locked. The green Service LED must be on and the red Blocked LED must be off.

Close the housing cover.

Tighten the screws. All the terminal screws - including ones that are not being used - must also be screwed tightly.

If there is a test switch, you must switch it to the normal service position.

The protection is now ready for operation.

6 Maintenance and Trouble-Shooting

The digital protection equipment requires no special maintenance. All the circuits for process measuring and signals are solid-state. All the input modules are also solid-state and the output relays have a protective cover.

In the case of devices that have a battery for buffered storage of annunciations and for feeding the internal system clock in the case of a power failure, you should change the battery after ten years of service as a prophylactic measure (see Chapter 6.3). This applies regardless of whether the battery has been used or not during occasional power failures.

Since the device is virtually entirely self-monitoring, hardware and software faults and errors are reported automatically. This guarantees a high level of protection availability and makes frequent maintenance testing unnecessary.

If hardware faults are detected, the device blocks itself automatically. The protection operative relay drops and reports the disturbance with its normally closed contact. In the case of faults in the external connection circuits, the system generally only issues a message.

On detecting software errors, the system resets the processor and reboots. If rebooting does not clear the error, the system tries another reboot. After three unsuccessful attempts at rebooting, the protection shuts itself down automatically. This is shown by the red Blocked LED on the front panel; the protection operative relay drops and reports the disturbance with its normally closed contact.

For trouble-shooting, you can call the fault responses in chronological order as operational annunciations at **address 5100** (see Chapter 5.3.1).

When you connect the device to the substation control and protection system or any other central storage equipment, the supervisory annunciations are also reported via the serial optical waveguide interface.

6.1 Routine Checks

Routine checking of characteristics or response values is not necessary, since they are components of the continually monitoring firmware programs. The maintenance intervals for testing or maintenance can be used to check the safety equipment. This is due to the fact that the primary purpose of maintenance is to check the interfaces of the device, i.e. the connection to the substation.We recommend proceeding as follows.

- Read out the operational measured values **(address 5700)** and compare them with the actual values to check the analog interfaces.
- Simulate an internal short-circuit with $4 \bullet I_N$ to check analog input at high current levels.
- The trip circuits to the circuit breaker are tested by a live trip (see Chapters 5.6.3 and 5.6.4).

Warning

Dangerous voltages can occur in all circuits connected to the supply voltage and the measuring and testing variables.

Caution

Testing with currents greater than four times the rated device current overloads of the input circuits and may only be carried out for a short time (refer to Technical Data in Reference Section R.1). Afterwards, take a break to allow the unit to cool down!

6.2 Removal and Insertion of Modules

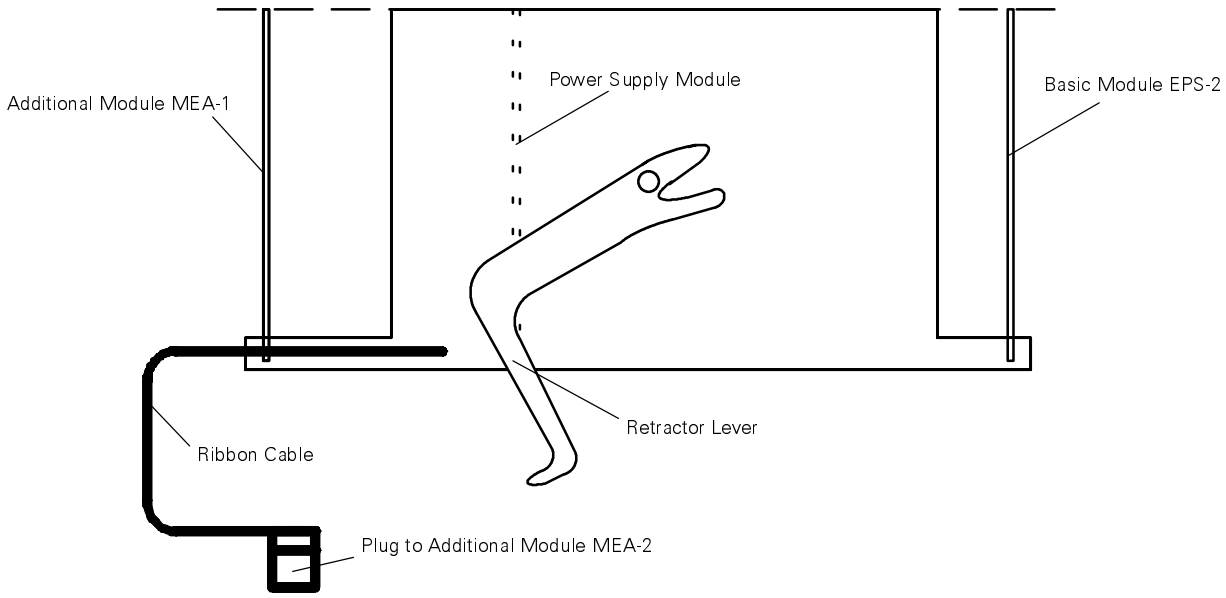


Figure 6.1 Retractor and Ribbon Cable of the Basic Module (Viewed from Above)

6.2.1 Removal

Warning

Dangerous voltages can still be present in the device even after the supply voltage has been separated (capacitor).

- Prepare the workplace: provide a conducting surface for the module;
- Switch off the auxiliary voltage;
- Open the housing lid;
- See Figure 6.1;

- Loosen the additional module that is located in the housing to the left of the main module using the retractors on the top and bottom. Carefully pull the additional module far enough out until you can see the ribbon cable leading to the basic module;
- Loosen the plug of the ribbon cable on the additional module; pull the additional module all the way out ensuring that you do not damage the ribbon cable;
- Lay the additional module on the conductive surface;
- Loosen the basic module using the retractors on the top and bottom and pull the module out;
- Lay the module on the conductive surface;

Caution

Touch a grounded metal component first to avoid electrostatic discharges via the connections of the components, the busbars and the plug-in terminals.

6.2.2 Insertion

- See Figure 6.1;
- Insert the basic module into the housing on the right hand side; before pressing it in, make sure that the retractor levers are all the way to the right;
- Press the plug-in card firmly into place using the retractor levers;
- Carefully pull the ribbon cable out of the basic module such that you can insert the additional module;
- Insert the additional module into the housing on the left in the guide rails, push it about half way into the housing; ensure that you do not damage the ribbon cable;
- Insert the plug of the ribbon cable into the plug receptacle on the additional module;
- Press the additional module firmly into place;
- Close the housing lid;
- Switch the auxiliary voltage back on.

6.3 Replacing the Clock Chip

The device is fitted with non-volatile RAM. This memory can store device annunciations. The clock and the back-up battery for the non-volatile memory are located on the clock chip.

You should replace the clock chip after ten years of operation at the latest.

Recommended clock chip:
DALLAS DS 1386 32 K RAMified TIMEKEEPER

This is mounted as a plug-in chip on the device's basic board (EPS-2).

To replace the clock chip, you must pull the module out of the housing and dismount it.

The procedure for replacing the clock chip is described below.

- Prepare the workplace: provide a conducting surface for the module;
- Open the housing lid;
- Read out the annunciations of the device, i.e. all the information of the addresses that start with 5 (5000 and above). We recommend doing this via the front operating interface using a PC with the help of the DIGSI® operating and evaluation software. This means that the information is stored in the PC.

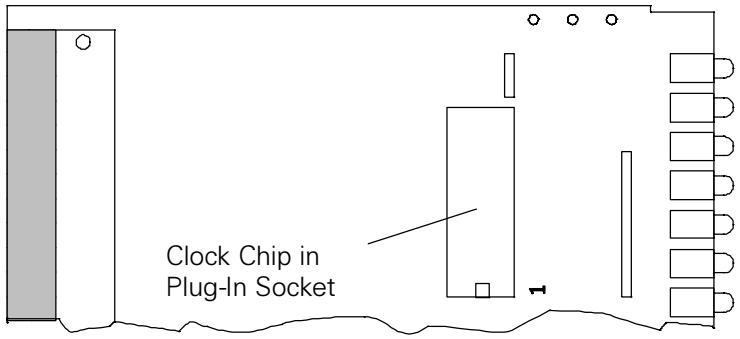


Figure 6.2 Position of the Clock Chip on the Basic Card (EPS2)

Note

All of the configuration and setting values are stored in EEPROMs that are battery-buffered against power failures. They are stored independently of the back-up battery integrated in the clock chip and are therefore not lost when you replace the battery.

Warning

Dangerous voltages can still be present in the device even after the supply voltage has been separated (capacitor).

- Pull out the basic module (see Chapter 6.2) and place it on a conducting surface ;
- Dismount the basic card (EPS-2; for layout see Chapter 6.2) from the basic module: loosen the fastening screws on the connection modules and the hexagon bolt of the 25-pin SUB-D plug on the front; handle the ribbon cable between the basic module and the basic card with care. Carefully remove the ribbon cable leading to the basic module;
- Pull the used clock chip out of its socket as shown in Figure 6.1; do not place it on the conductive surface!

Warning

The battery in the clock chip contains lithium. It is crucial to dispose of it according to the appropriate regulations!

Do not change the polarity! Do not recharge! Keep away from fire! Danger of explosion!

- Plug a new clock chip into the socket and ensure that the fitting position is correct!
- Install the basic card in the basic module in the opposite order to which you removed it;
- Insert the basic module see Chapter 6.2;
- If the internal system clock is not automatically synchronized via the LSA interface, you can now set and synchronize it as described in Chapter.
- Close the housing lid.

Caution

Touch a grounded metal component first to avoid electrostatic discharges via the connections of the components, the busbars and the plug-in terminals.

6.4 Trouble-Shooting

Should the device report a defect, we recommend proceeding as described below.

If none of the LEDs on the device's front panel light up, check the following points:

- Are the modules firmly seated and locked tight?
- Is the On/Off switch on the front panel for the integrated transformer in the on position?
- Is an adequate auxiliary voltage with the correct polarity connected to the appropriate connections?
- Is the fuse in the power supply section of the module undamaged?

If the red Blocked LED lights up and the green Operative one does not light up, you can try to initialize the protection by switching the auxiliary voltage off and on again.

If the fuse in the power supply section of the module is defective, you must replace it. To replace the fuse, proceed as follows.

- Have a 5 x 20 mm replacement fuse, as shown in Figure 6.3, ready. Ensure that it has the correct rated value, the correct lag and the identification letter (see Table 6.1).
- Remove the modules (see Chapter 6.2).
- The fuse is located in the middle at the back on the power supply module and you can access it without dismantling the base rack.
- Remove the defective fuse from its holder.
- Insert a new fuse in the holder.
- Insert the modules, see Chapter 6.2.

Switch the device back on. If an auxiliary voltage failure is still signalled there is an internal fault or a short circuit. You should send the device back to the manufacturer (see Chapter 7).

Table 6.1 Overview of Miniature Fuses

U_{HN} in V	Rated current; Identification letter
24/48	2A; E
60/110/125	1,6A; E
220/250	1A; G

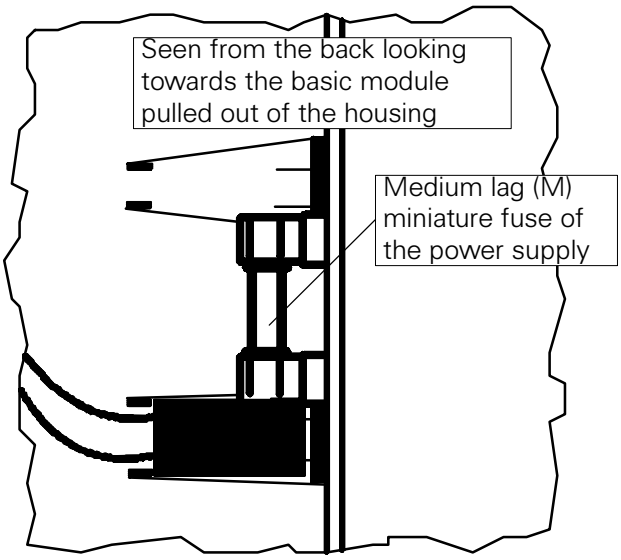


Figure 6.3 Miniature Fuse of the Power Supply

7 Corrective Maintenance

It is not advisable to carry out corrective maintenance on defective devices or modules, since they contain specially selected electronic components that must be handled in accordance with the regulations on electrostatic sensitive devices (ESD). For work on the PCBs in particular, special techniques are necessary that do not damage the flow-soldered PCBs, the sensitive components and the protective lacquer.

If it is not possible to correct a defect using the methods described in Chapter 6, we recommend sending the complete device back to the manufacturer.

If you cannot avoid replacing individual modules, it is crucial to observe the regulations on the handling of electrostatic sensitive devices (ESD).

Warning

Dangerous voltages can still be present in the device even even after the supply voltage has been separated (capacitor)!

Caution

Touch a grounded metal component first to avoid electrostatic discharges via the connections of the components, the busbars and the plug-in terminals. Use electrostatic protective packaging when returning components.

When installed (in the device) the modules are not at risk.

After replacing devices or modules, a complete reparameterization must be performed. For more information, refer to Chapters 4 and 5.

8 Storage

Solid state protective relays shall be stored in dry and clean rooms. The limit temperature range for storage of the relays or associated spare parts is 25 °C to +55 °C, corresponding to 12 °F to 130 °F.

The relative humidity must be within limits such that neither condensation nor ice forms.

It is recommended to reduce the storage temperature to the range +10 °C to +35 °C (50 °F to 95 °F); this prevents from early ageing of the electrolytic capacitors which are contained in the power supply.

For very long storage periods, it is recommended that the relay should be connected to the auxiliary voltage source for one or two days every other year, in order to regenerate the electrolytic capacitors. The same is valid before the relay is finally installed. In extreme climatic conditions (tropics) pre warming would thus be achieved and condensation avoided.

R.1 Technical Data

Table R.8.1 General Device Data

Input Circuits	Rated current I_N	1 or 5 A
	Rated voltage U_N	100, 110 V
	Rated frequency f_N	50/60 Hz (parameterizable)
	Consumption in current path	
	at I_N = 1 A	<0.1 VA
	at I_N = 5 A	<0.2 VA
	Consumption in voltage path	
	at 110 V	<0.2 VA
	Loadability of current path, thermic	
	100 x I_N	1 s
	10 x I_N	10 s
	4 x I_N	Continuous
	Loadability of voltage path, thermic	140 V continuous
Auxiliary Voltage	Auxiliary voltage supply via integrated converter permissible voltage ranges	
	U_H = 24/48 V	19 to56 V
	U_H = 60/110/125 V	48 to 244 V
	U_H = 220/250 V	176 to 288 V
	Maximum ripple	12% at rated voltage 6% at limits of voltage range
	Power consumption of 7SA518	
	Non-excited	Typically 7 W
	Excited	Typically 10 W
	Power consumption of 7SA519	
	Non-excited	Typically 7W
	Excited	Typically 12 W
	Buffering time at failure/short-circuit of the auxiliary direct voltage	≥50 ms with $U \geq 110$ V
LED Indications	Service indication, green	1
	Blocked indication, red	1
	LEDs reconnectable, red	
	7SA518	6
	7SA519	14

Table R.8.1 (Continued)

Device Version	Housing	See Chapter 2.4
	Dimensions	See dimensional drawings 2.1 to 2.4 in Chapter 2.5
	Weight of 7SA518	
	in housing for installation in control panel/cabinet	Approx. 8 kg
	in housing for mounting on control panel	Approx. 6.5 kg
	Weight of 7SA519	
	in housing for installation in control panel/cabinet	Approx. 11.5 kg
	in housing for mounting on control panel	Approx. 9.5 kg
	Type of protection according to EN 60 529 for control panel mounting	
	Terminals	IP21
	Housing	IP51
	Type of protection according to EN 60 529 for cabinet installation	IP51

R.1.1 Interfaces

Table R.8.2 Interfaces

Trip circuits, general	Number of relays with two normally closed contacts each	
	7SA518	4 (reconnectable)
	7SA519	5 (reconnectable, 1 of which has an instantaneous tripping stage)
	Switching capacity	1000 W/VA
	ON	30 W/VA
	OFF	AC/DC 250 V
	Switching voltage	5 A continuously
	Permissible current	30 A for 0.5 s
Trip circuit with instantaneous tripping stage (for 7SA519 only)	Trip circuit	2 normally closed contacts, polarity-dependent
	60-V variant	Typically 0.045 Ω
	Volume resistance	5 A continuously
	Permissible current	30 A for 0.5 s 71 A for 3 ms
	110-/220-V variant	
	Volume resistance	Typically 0.22 Ω
	Permissible current	5 A continuously 22 A for 0.5 s 33 A for 3 ms

Table R.8.2 (Continued)

Signal Contacts	Number of signal relays	
	7SA518	12
	7SA519	23
	Version for installation in control panel and switching cabinet, contacts	
	7SA518	3 NO contacts (3 reconnectable) 9 changeover contacts (8 reconnectable)
	7SA518	14 NO contacts (14 reconnectable) 9 changeover contacts (8 reconnectable)
	Version for mounting on control panel, contacts	
	7SA518	11 NO contacts (11 reconnectable) 1 changeover contact
	7SA519	16 NO contacts (16 reconnectable) 7 changeover contacts (6 reconnectable)
	Switching capacity ON/OFF	20 W/VA
	Switching voltage	AC/DC 250 V
	Permissible current, continuously	1 A
Binary Inputs	Number	12 (reconnectable)
	Voltage range	DC 24 to 250 V
	The response threshold can be raised (recommended when controlling with 110 V or more) to	Approx. 65 V
	Current consumption, excited	Typically 2.5 mA
External Temperature Processing (for 7SA519 only)	Measuring range	-30 to +55° C
	Loop current	4.9 to 20 mA
	Range for internal diagnostics	0 to <4.9 mA and >20 to 40 mA
	Input impedance R_E	R_E = 0.4 V/I_S +25.625 Ω (I_S = current in the current loop)
	Input power	≤80 mW
Serial Interfaces	Operating interface	
	Connection	On front, non-isolated, 25-pin suitable for connection of a PC
	Speed	1200 to 19,200 bps
	System interface	
	Protocol	Potential-free for linking to a control centre
	Security	Acc. to VDEW/ZVEI recommendation Hamming distance d = 4
	Speed	4,800, 9,600 or 19,200 bps
	Connection of optical waveguide (system interface only)	2 integrated FSMA plug-in connectors for connection of an OWG, e.g. fibreglass 62.5/125 µm; With installation housing: on back- With mounting housing: on bottom ofhousing
	Optical wavelength	820 nm
	Permissible path attenuation	Maximum of 8 dB with fibreglass 62.5/125 µm
	Bridgable distance	Maximum of 2 km

R.1.2 Functions

Table R.8.3 Distance Protection

Setting Ranges	Minimum current $I>/I_N$	0.1 to 2.0 (steps of 0.01)
	Distance zones	4, 2 of them overreach zones
	I_N = 1 A	
	Range forwards	0.2 to 250 Ω (graduations of 0.01 Ω)
	Range backwards	0.2 to 250 Ω (graduations of 0.01 Ω)
	I_N = 5 A	
	Range forwards	0.04 to 50 Ω (graduations of 0.01 Ω)
	Range backwards	0.04 to 50 Ω (graduations of 0.01 Ω)
	Trigger angle α,	-15 to 45° (graduations of 1°)
	Trigger angle β	70 to 140° (graduations of 1°)
	Trigger threshold for di/dt (ΔI)	0 to 1 (graduations of 0.1)
Time Stages	Number	3
	Times	
	Ranges	
	Zone Z1	0 to 0.3 s (graduations of 0.01 s)
	Zone Z2K	0.1 to 1.0 s (graduations of 0.01 sec)
	Zone Z2L	1.0 to 60 s (graduations of 0.01 sec)
	Shortest trip time	7SA518: 35 ms; 7SA519: 28 ms
	Drop-off time	Approximately 30 ms
Tolerances	Distance measurement	$\Delta Z/Z \leq 5$ %
	Amplitude measurement	±5 %
	Time tolerance	±1 % of set value. or 10 ms
Direction Determination	With fault-free voltage and voltage store	
Emergency Mode	In the case of measuring voltage failure, e.g. voltage transformer circuit breaker drop	
	Overcurrent fault detection $I>>/I_N$	0.25 to 4.0 (graduations of 0.01)
	Delay time *TI*>>	0 to 1.00 s (graduations of 0.01 s) ∞ (stage ineffective)

Table R.8.4 Fault Location

Setting Ranges	Reactance per unit length	0.05 to 50 Ω/km (graduations of 0.01 Ω/km)
Output of Fault Distance	In Ω secondary, km, percent	
Start Signal	Trip, fall back of fault detection or external trip signal on binary input	
Number of Monitored Line Sections	1 to 5	
Tolerances	Measuring tolerances according to DIN VDE 0435, Part 303 (with sinusoidal measuring quantities)	≤5 %

Table R.8.5 High-Speed Overcurrent Protection I>>>

Setting Ranges	Overcurrent $I>>>/I_N$	1.0 to 20.0 (graduations of 0.1)
Times	Delay time $TI>>>$	0 to 0.05 s (graduations of 0.001 s) ∞ (stage ineffective)
	Trip time	7SA518: 11 ms 7SA519: 4 ms
Tolerances	Measuring tolerances according to DIN VDE 0435, Part 303 (with sinusoidal measuring quantities)	$\leq$5 %

Table R.8.6 Thermal Protection

Trip Time Characteristic	$T_{t2} = T_{t1} + [T_N (I/I_{Pre} \bullet KW)^2 - T_{t1}] [1 - \exp (t_1 - t_2) / \tau]$	
Setting Ranges	Contact line time constant τ	2.0 to 15.0 min (grad. of 0.1 min)
	Limit current I/I_N	0.25 to 2.0 (graduations of 0.01)
	Overtemperature T_N	0 to 100 K (graduations of 1 K)
	Maximum permissible temperature of catenary	50 to 100° C (graduations of 1 °C)
	Temperature warning stage	50 to 100° C (graduations of 1 °C)
	Cooling factor T_{on}/T_{end}	0.50 to 0.90 (graduations of 0.01)
	Correction factor for 2nd/3rd catenary	1.0 to 3.0 (graduations of 0.1)

Table R.8.7 Auto-Reclose AR

Number of Auto-Reclosures	1 rapid auto-reclose, RAR Up to 9 delayed auto-reclosures, DARs	
Setting Ranges	Action time for RAR and DAR cycle	0.01 to 320 s (graduations of 0.01 s) ∞ (stage ineffective)
	Dead time in RAR cycle	0.01 to 320 s (graduations of 0.01 s)
	Dead time in DAR cycle	0.01 to 1800 s (grad. of 0.01 s)
	Reclaim time	0.5 to 320 s (graduations of 0.01 s)
	Duration of close command	0.01 to 32 s (graduations of 0.01 s)
	Current threshold for AR blocking (I_G/I_N)	1.0 to 25 (graduations of 1.0) ∞ (stage ineffective)
	Blocking duration with manual close detection	0.5 to 320 s (graduations of 0.01 s)

Table R.8.8 Thermal Protection Auto-Reclose

Number of Auto-Reclosures	Up to 9 delayed auto-reclosures, DARs	
Setting Ranges	Reclaim time	1.0 to 1800 s (graduations of 0.01 s)

Table R.8.9 Breaker Failure Protection

Setting Ranges	Trigger current	95% of the minimum current $I>$ (address 1206)
	Delay for back-up circuit breaker trip coil	0.1 to 1 s (graduations of 0.01 s) ∞ (stage ineffective)
	Delay for superordinated circuit breaker	0.1 to 1 s (graduations of 0.01 s) ∞ (stage ineffective)

Table R.8.10 Overcurrent Time Protection and Emergency Overcurrent Time Protection

Setting Ranges	Overcurrent $I>>/I_N$ Delay time $TI>$	0.25 to 4.0 (graduations of 0.01) 0 to 1.0 s (graduations of 0.01 s)
Tolerances	Measuring tolerances according to DIN VDE 0435, Part 303 (with sinusoidal measuring quantities)	±5 %

Table R.8.11 User-Defined Annunciations

Number		4
Setting Ranges	Delay time (can be set separately for each stage)	0 to 10.0 s (graduations of 0.1 s)

Table R.8.12 Fault Recordings

Measuring Variables	I, U	
Start Signal	Trip, fault detection, external trip signal at binary input, operator panel, PC	
Storage	Storage management Max. number of records available at the same time Sampling interval Max. storage time (total of all records) 50 Hz 60 Hz	Dynamic ring buffer 8 20 sample values per system period 5 s 4.2 s
Setting Ranges	Pre-trigger time Post-fault time Max. time for one recording	0.05 to 0.5 s (graduations of 0.01 s) 0.05 to 0.5 s (graduations of 0.01 s) 0.3 to 5 s (graduations of 0.01 s)

Table R.8.13 Measured Value Supervision

Setting Ranges	Threshold for failed voltage monitoring Delay time	0.05 to 1.0 U_N (graduations of 0.01) 1 to 10 s (graduations of 1.0 s)

Table R.8.14 Additional Functions

Operational measuring values for	Current Voltage Frequency Contact line and ambient temperatures Reactance, resistance Angle	I in A primary and in % I_N U in kV primary and in % U_N f in Hz Tmp.cat., Tmp.amb. in degrees C R, X in Ω φ in degrees
Measuring Ranges	0 to 240% I_N, 0 to 120% U_N	
Tolerance	≤ 2% of the respective rated value	

R.2 Standards and Guidelines

Table R.8.15 Standards and Guidelines

Specifications, Guidelines	DIN VDE 0435, Part 303; IEC 255-5; IEC 255-6	
Electrical protection and safety requirements	Safety requirements VDE 0100 and DIN 40050	
	Special requirements Shock-hazard protection according to VDE 0106, Part 100; VBG 4	
	Protection class VDE 0106, Part 1	
Insulation Tests IEC 255-5, DIN VDE 0435 Part 303	Voltage test (routine test), all circuits except auxiliary voltage	2 kV (r.m.s), 50 Hz
	Voltage test (routine test), auxiliary voltage only	DC 2.8 kV
	Surge withstand capability test (type test), all circuits, class III	5 kV (peak); 1.2/50 μs; 0.5 J; 3 positive and 3 negative surges at five-second intervals
EMC Tests of Noise Immunity (Type tests) Standards: IEC 255-22 (product standard) EN 50082-2 (basic specification) DIN VDE 0435 Part 303	High-frequency test DIN VDE 0435, Part 303, class III IEC 255-22-1: class III	2.5 kV (peak value), 1 MHz, τ = 15 μs, 400 surges per second, test duration 2 s
	Discharge of static electricity IEC 255-22-2, class III EN 61000-4-2, class III	4 kV/6 kV contact discharge, 8 kV air discharge, both polarities, 150 pF, R_i = 330 Ω
	Radiant exposure to an RF field, unmodulated IEC 255-22-3 (Report), class III	10 V/m, 27 MHz to 500 MHz
	Radiant exposure to an RF field, amplitude-modulated ENV 50140. class III	10 V/m, 80 MHz to 1000 MHz, 80% AM, 1 kHz,
	Radiant exposure to an RF field, pulse-modulated ENV 5014 / ENV 50204, class III	10 V/m, 900 MHz, repeat rate 2000 Hz, c.d.f 50%
	Rapid transient disturbance variables/burst IEC 255-22-4, class III EN 61000-4-4, class III	2 kV, 5/60 ns, 5 kHz, burst length 15 ms, repeat rate 300 ms, both polarities, R_i = 50 Ω, Test duration 1 min
	Conducted RF, amplitude-modulated ENV 50141, class III	10 V/m, 150 kHz to 80 MHz, 80% AM, 1 kHz,
EMC Tests for Emitted Interference (Type tests) Standards: EN 50081-2 (basic specification)	Radio interference voltage EN 55022, limit value class B DIN VDE 0878, Part 22	150 kHz to 30 MHz
	Interference field strength EN 55022, limit value class B DIN VDE 0878, Part 22	30 MHz to 1000 MHz

Table R.8.15 (Contiued)

Mechanical Test Loading	Operation	
	IEC 68-2-6, Table 5	Test Fc:
	IEC 255-21-1, Table 1, class 1	10 to 55 Hz, amplitude excursion 0.035 mm; 55 to 150 Hz, amplitude of acceleration 0.5 g; 10 to 60 Hz, amplitude excursion 0.035 mm; 60 to 150 Hz, amplitude of acceleration 0.5 g
	Transport	Test Fc:
	DIN IEC 68, Parts 2 to 6, Table 4	5 to 8 Hz, amplitude excursion 7.5 mm; 8 to 150 Hz, amplitude of
	DIN IEC 255-21-1, Table 2, class 2	acceleration 2 g: 10 to 150 Hz, amplitude of acceleration 2 g
	Seismic loading (earthquakes)	1.6 to 35 Hz, amplitude of acceleration 0.5 g, magnification factor *K*
	DIN IEC 68-3-3	on-site 2
	DIN IEC 255-21-3, Table 1, class 1	
	SN29010. Part 3, Table 1 und 2	
	Shock loading	Test Ea:
	DIN IEC 68-2-27, Table 1	Acceleration 15 g; duration 11 ms
	DIN IEC 255-21-2, Table 2	3 pulses in each direction; acceleration 15 g; duration 11 ms
Climatic Stress	(Testing methods oriented towards basic specification IEC 68, conditions of operation in accordance with IEC 255, VDE 0435 Part 303, or IEC 870)	
	Permissible ambient temperature for	Condensation is not allowed
	operation	-5 to +55° C
	transportation	-25 to +70° C
	storage	-25 to 55° C
	Storage and transportation in ex-works packaging	
	Damp stress (damp heat in the factory)	
	DIN IEC 68-2-3	Test Cb: T = +40 °C, 93% rel. hum.,
	DIN IEC 68-2-56	4 days (modules)
		Test Ca: T = +40 °C, 93% rel. hum.,
		4 days (devices)

R.3 Operating Conditions

The relay is designed for use in industrial environment, for installation in standard relay rooms and compartments so that with proper installation electro magnetic compatibility (EMC) is ensured. The following should also be heeded:

- All contactors and relays which operate in the same cubicle or on the same relay panel as the digital protection equipment should, as a rule, be fitted with suitable spike quenching elements.
- All external connection leads in sub stations from 100 kV upwards should be screened with a screen capable of carrying power currents and earthed at both sides. No special measures are normally necessary for sub stations of lower voltages.
- It is not permissible to withdraw or insert individual modules under voltage. In the withdrawn condition, some components are electrostatically endangered: during handling the standards for electrostatically endangered components must be observed. The modules are not endangered when plugged in.

WARNING! The relay is not designed for use in residential, commercial or light industrial environment as defined in EN 50081.

R.4 Interchangeability

- **Devices**
  Protective devices in housings or racks fitted at the factory are delivered complete and can be interchanged as a unit without restrictions.
- **Modules**
  In general, you can interchange plug-in modules whose order numbers are identical up to the slash (the data after the slash is coded internal information that does not generally affect interchangeability).

After replacing digital devices or modules, you may have to carry out a complete reparameterization. For more information, refer to Chapters 4 and 5.

R.5 Jumper/Solder Jumper Settings

Figure R.8/1 shows the layout of the solder jumpers for setting the control voltages of binary inputs 1 to 6 on basic module EPS-2. The solder jumpers are on the solder side of the module, i.e. on the outside of the supporting rack.

Figure R.8/2 shows the layout of the jumpers for setting the control voltages of binary inputs 7 to 12 on additional module MEA-1. The jumpers are on the component side of the module. Due to the fact that the jumpers are positioned towards the top, they are accessible from the top of the supporting rack.

Tables R.8.16 and R.8.17 show the operating areas of the binary inputs on modules EPS-2 and MEA-2.

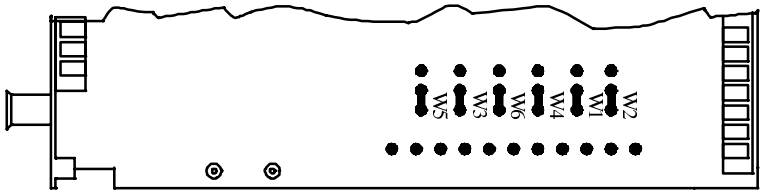


Figure R.8/1 Solder Jumpers for Binary Inputs on Basic Module EPS-2

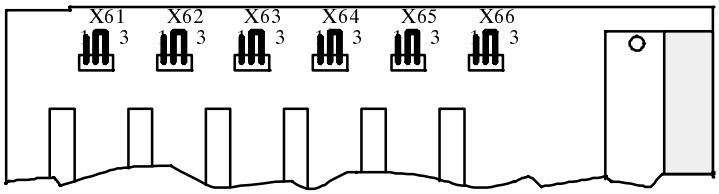


Figure R.8/2 Jumpers for Binary Inputs on Additional Module MEA-1

Table R.8.16 Operating Area of Binary Inputs for Module EPS-2

Binary Input	Solder jumper/ Jumper	Position	Operating Range
1	W1	Closed	19 V - 288 V
		Open	65 V - 288 V
2	W2	Closed	19 V - 288 V
		Open	65 V - 288 V
3	W3	Closed	19 V - 288 V
		Open	65 V - 288 V
4	W4	Closed	19 V - 288 V
		Open	65 V - 288 V
5	W5	Closed	19 V - 288 V
		Open	65 V - 288 V
6	W6	Closed	19 V - 288 V
		Open	65 V - 288 V

Table R.8.17 Operating Area of Binary Inputs for Module MEA-1

Binary Input	Solder jumper/ Jumper	Position	Operating Range
7	X61	2-3	19 V - 288 V
		1-2	65 V - 288 V
8	X62	2-3	19 V - 288 V
		1-2	65 V - 288 V
9	X63	2-3	19 V - 288 V
		1-2	65 V - 288 V
10	X64	2-3	19 V - 288 V
		1-2	65 V - 288 V
11	X65	2-3	19 V - 288 V
		1-2	65 V - 288 V
12	X66	2-3	19 V - 288 V
		1-2	65 V - 288 V

R.6 Connection

Figures R.8/3 and R.8/4 show the connecting plugs of versions 7SA518 and 7SA519 of the digital overhead contact-line protection system in an installation housing. Figures R.8/5 and R.8/6 on the next two pages show the wiring diagrams of versions 7SA518 and 7SA519 of the digital overhead contact-line protection system.

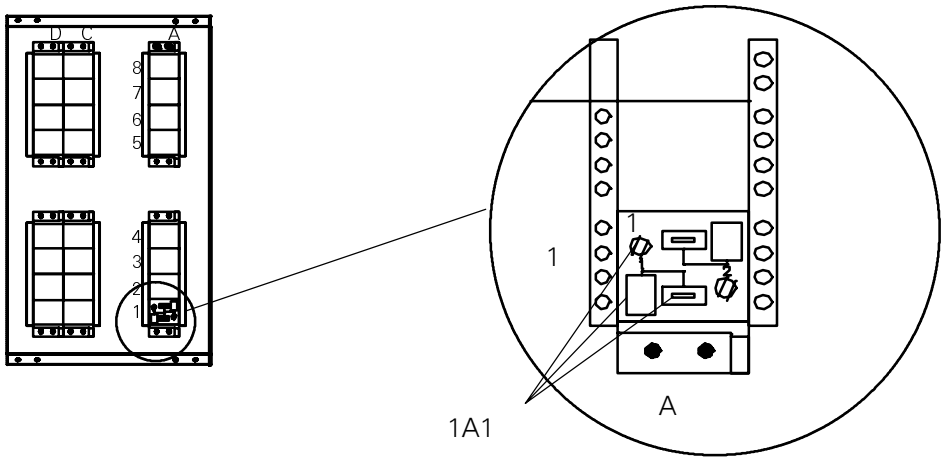


Figure R.8/3 Connecting Plugs on Installation Housing (Back View), Device Version 7SA518

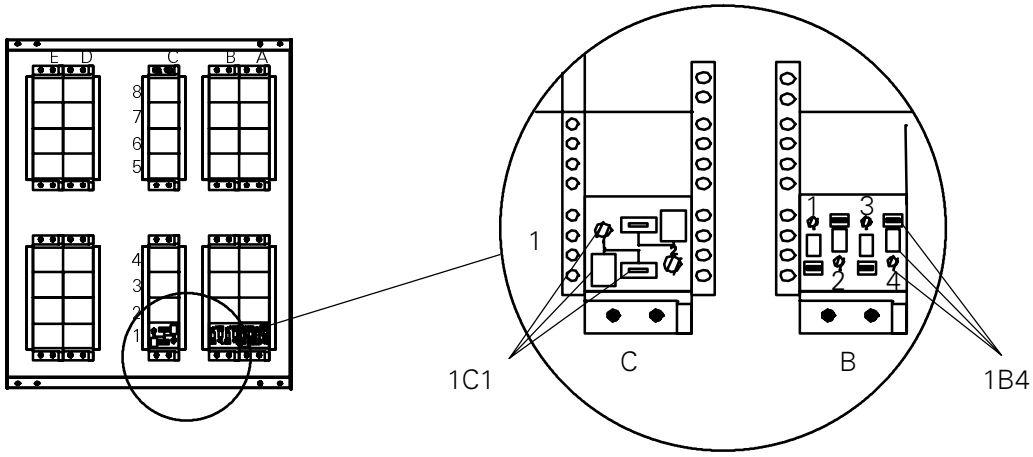


Figure R.8/4 Connecting Plugs on Installation Housing (Back View), Device Version 7SA519

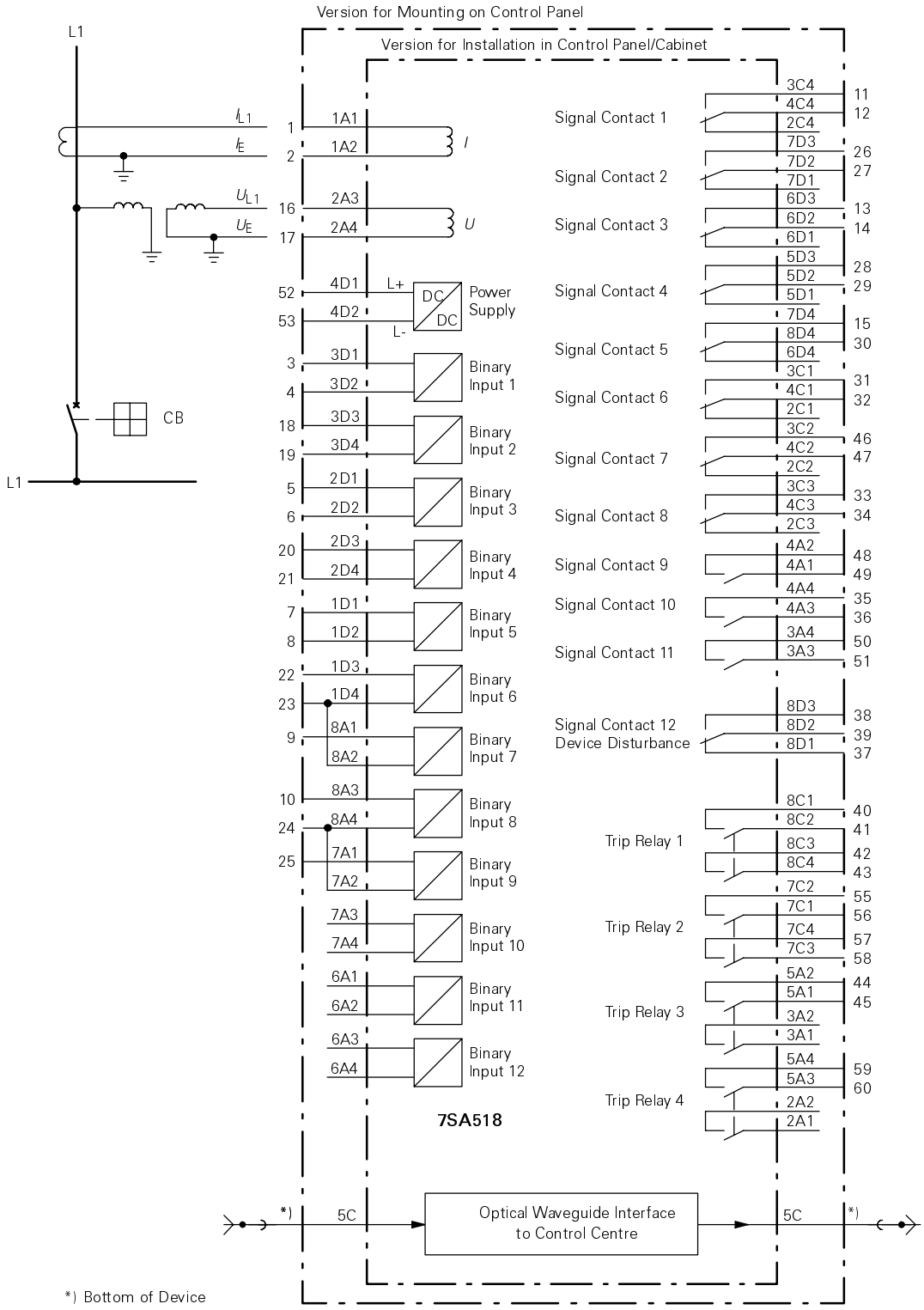


Figure R.8/5 Terminal Connection Diagram for Version 7SA518

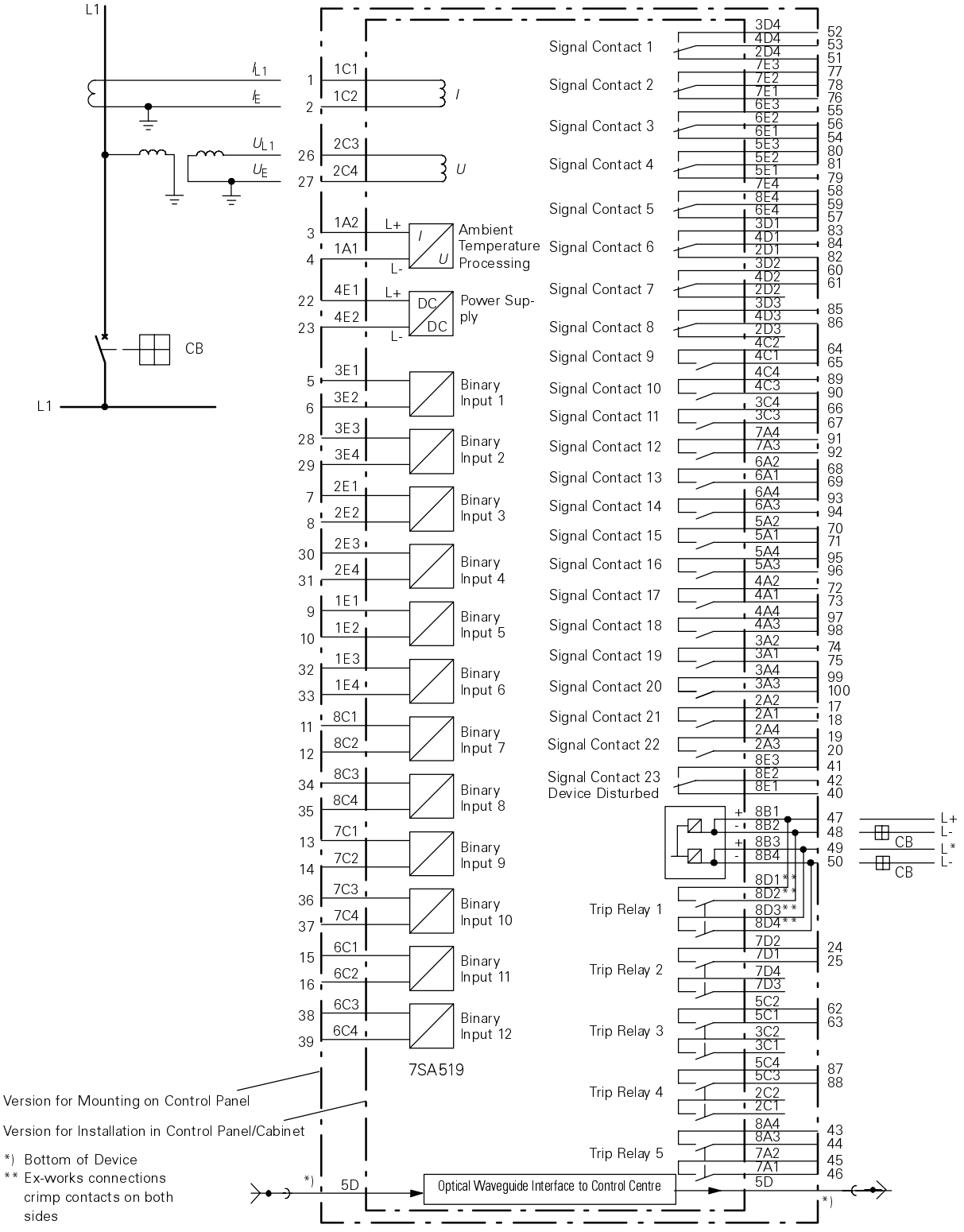


Figure R.8/6 Terminal Connection Diagram for Version 7SA519

R.7 Block Diagrams

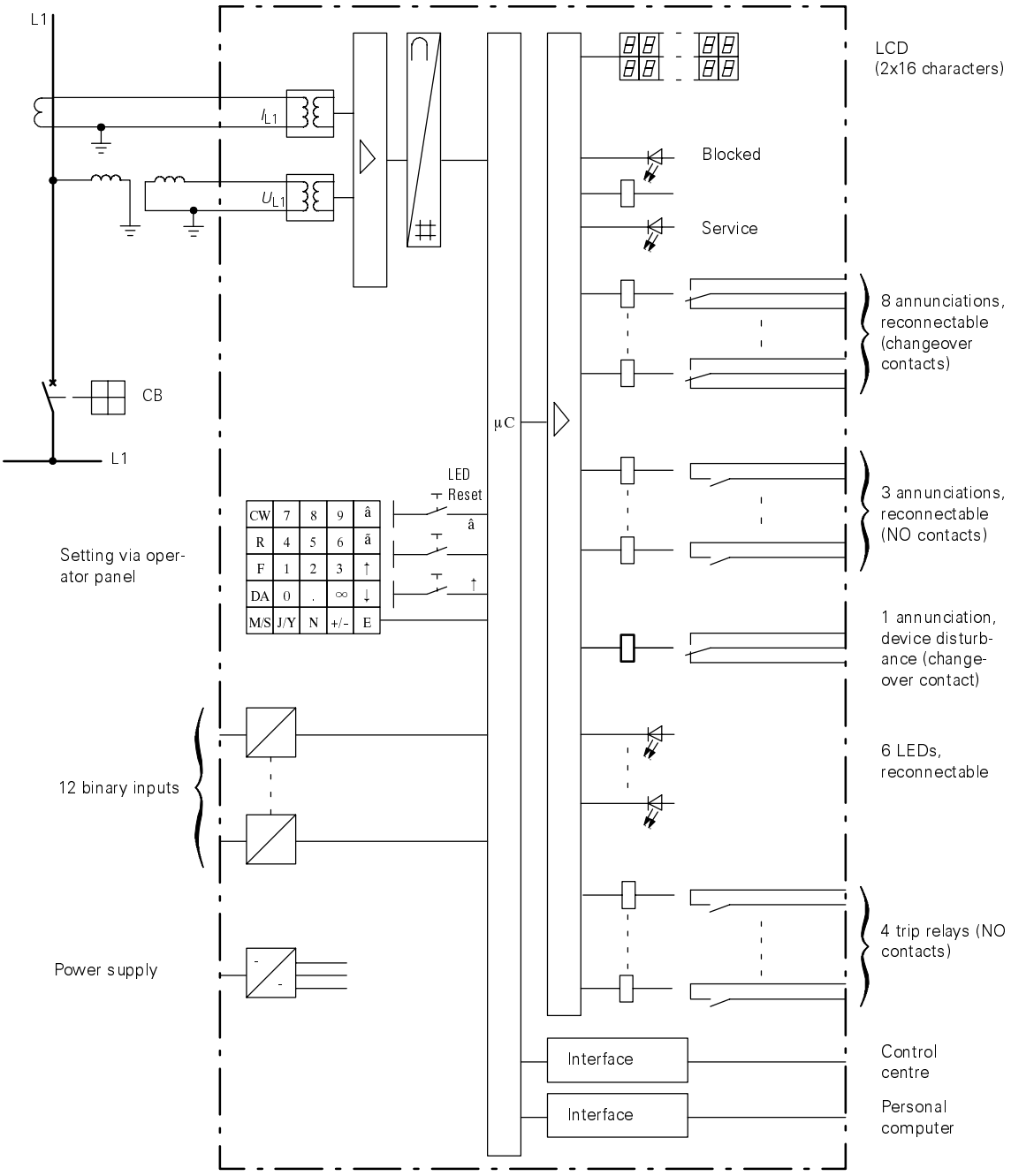


Figure R.8/7 Block Diagram for Device Version 7SA518 Using the Installation in Control Panel and Cabinet as an Example

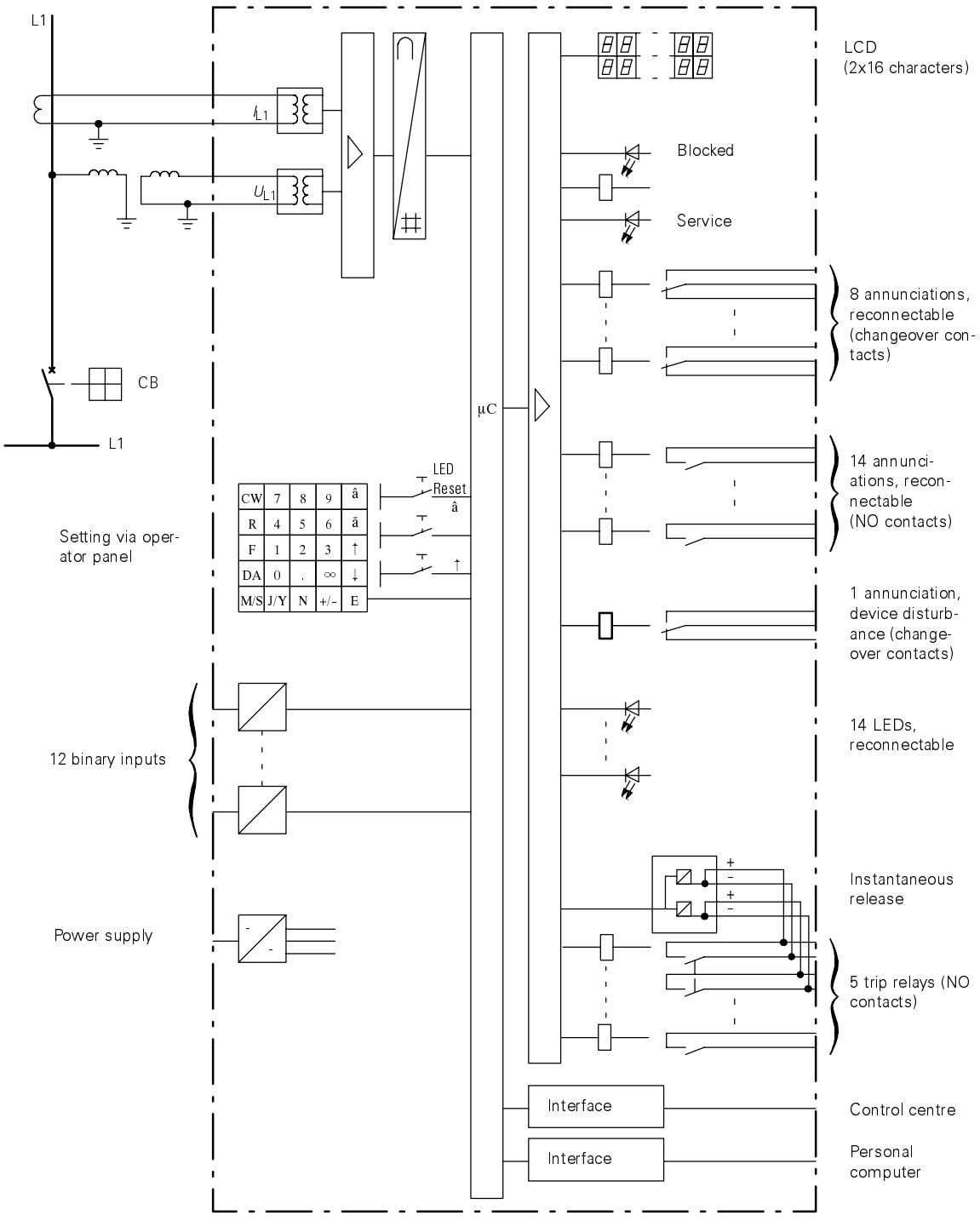


Figure R.8/8 Block Diagram for Device Version 7SA519 Using the Installation in Control Panel and Cabinet as an Example

R.8 List of Abbreviations

ATE	Ambient temperature sensing
AR	Auto-reclose
DAR	Delayed auto-reclose
FetLoc	Fault location
LSA	Substation control and protection system
RAR	Rapid auto-reclose
Thermal AR	Thermal auto-reclose
VDEW/ZVEI protocol	Recommendations of the association of German electrical power plants; standardization in IEC 870-5-103

A.1 Complete List of Annunciations

Appendix A.1 contains a complete list of annunciations

- for the substation control and protection system,
- for PC, LCD and binary inputs and outputs.

Annunciations 7SA51X for LSA (DIN 19244 and according VDEW/ZVEI)

FNo. - Function number of annunciation
Op/Ft - Operation/Fault annunciation
C/CG: Coming/Coming and Going annunciation
V : Annunciation with Value
M : Measurand
LSA No. - Number of annunciation for former LSA (DIN 19244)acc. to VDEW/ZVEI:
CA - Compatible Annunciation
GI - Annunciation for General Interrogation
BT - Binary Trace for fault recordings
Typ - Function type (p: according to the configured "Function type")
Inf - Information number

		Ann.		LSA	VDEW/ZVEI				
FNo.	Meaning	Op	Ft	No.	CA	GI	BT	Typ	Inf
11	>User defined annunciation 1	CG			CA	GI	BT	p	27
12	>User defined annunciation 2	CG			CA	GI	BT	p	28
13	>User defined annunciation 3	CG			CA	GI	BT	p	29
14	>User defined annunciation 4	CG			CA	GI	BT	p	30
51	Device operative / healthy	CG				GI		135	81
52	Any protection operative	CG			CA	GI		p	18
55	Re-start of processor system	C			CA			p	4
56	Initial start of processor system	C			CA			p	5
59	Real time response to LSA	C							
60	LED Reset	C			CA			p	19
61	Logging and measuring functions blocked	CG			CA	GI		p	20
62	Test mode	CG			CA	GI		p	21
63	PC operation via system interface	CG				GI		135	83
95	Parameters are being set	CG		11	CA	GI		p	22
96	Parameter set A is active	CG		40	CA	GI		p	23
97	Parameter set B is active	CG		41	CA	GI		p	24
98	Parameter set C is active	CG		42	CA	GI		p	25
99	Parameter set D is active	CG		43	CA	GI		p	26
110	Annunciations lost (buffer overflow)	C						135	130
112	Annunciations for LSA lost	C						135	131
113	Fault tag lost						BT	135	136
140	General internal failure of device	CG			CA	GI		p	47
143	Failure of internal 15 VDC power supply	CG		97				135	163
144	Failure of internal 5 VDC power supply	CG		98				135	164

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FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	VDEW/ZVEI GI	VDEW/ZVEI BT	VDEW/ZVEI Typ	VDEW/ZVEI Inf
145	Failure of internal 0 VDC power supply	CG		99				135	165
154	Supervision trip circuit	CG		104	CA	GI		p	36
157	Failure of main circuit breaker	CG		105		GI		135	43
158	Failure of outdoor temp. sensing	CG		106		GI		135	40
160	Common alarm	CG			CA	GI		p	46
164	Measured value supervision of voltages	CG		108	CA	GI		p	33
168	Failure: Measuring voltages absent	CG		107				135	187
301	Fault in the power system		CG					135	231
302	Flt. event w. consecutive no.		C					135	232
361	>U Line side VT MCB tripped	CG			CA	GI		p	38
501	General fault detection of device		CG	142			BT	150	151
502	General drop-off of device		C	138				150	152
511	General trip of device		C	143			BT	150	161
524	Interrupted current (I/In)		V	249				150	174
561	Circuit breaker manually closed (pulse)	C		18				150	211
618	Operational measurement: I[%]=	M			CA			134	127
628	Operational measurement:U[%]=	M			CA			134	127
644	Frequency f [%] =	M						134	127
962	Operat. meas. temp. of catenary [%]	M						134	127
1110	Fault locator is blocked	C		245				151	25
1114	Fault resistance, Ohm prim.		V					151	14
1115	Fault reactance, Ohm prim.		V		CA			p	73
1117	Fault resistance, Ohm sec.		V	250				151	17
1118	Fault reactance, Ohm sec.		V	202				151	18
1119	Distance to fault in km		V	203				151	19
1120	Distance to fault in %		V					151	20
1121	Fault in section		V					151	21
1129	No calculation of distance possible		C	247				151	23
1130	Distance to fault out of range		C	248				151	24
1156	>CB test start	C						151	56
1158	>CB test trip/close cycle start	C						151	58
1173	CB test trip/close cycle in progress	CG		22				151	75
1174	Circuit breaker test in progress	CG		21				151	74
1181	Circuit breaker test: General trip	C						151	81
1186	Circuit breaker test: Trip main CB	C						151	86
1187	Circuit breaker test: Trip spare CB	C						151	87
1190	Operational Impedance forward dir.	CG				GI		151	88
1451	Breaker fail protection is switched off	CG		56				166	151
1455	Breaker failure : fault detection		C	227				166	155
1471	Trip by breaker failure protection		C	228	CA			p	85
1484	B/F: pick up superordinat.prot.relais		C	230			BT	166	159
1485	Delay time for back up trip expired		C	231			BT	166	160
2051	Emergency O/C protect. is switched off	CG		50				61	51
2054	Emergency O/C protection is running	CG		54	CA	GI		p	37
2091	Emerg. O/C phase fault detection I>>		CG	180				61	91
2121	Emerg. O/C prot.: Time TI>> expired		C	181				61	121

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	VDEW/ZVEI GI	VDEW/ZVEI BT	VDEW/ZVEI Typ	VDEW/ZVEI Inf
2141	Emerg. O/C protection: General Trip		C	182	CA		BT	p	72
2701	>AR: Switch on auto-reclose function	CG						40	1
2702	>AR: Switch off auto-reclose function	CG						40	2
2708	>AR: Block rapid auto-reclose	CG		139				40	8
2709	>AR: Block delayed auto-reclose	CG		145				40	9
2711	>AR: External start for internal AR	CG		140				40	11
2712	>AR: External. trip for internal AR	CG		141				40	12
2718	>Th-AR: Switch on thermal-AR function	CG						40	18
2719	>Th-AR: Switch off thermal-AR function	CG						40	19
2781	AR: Auto-reclose is switched off	CG		146				40	81
2782	AR: Auto-reclose is switched on	CG			CA	GI		p	16
2784	AR: Auto-reclose is not ready	CG			CA	GI	BT	p	130
2787	AR: Circuit breaker not ready	C		149				40	87
2793	Th-AR: Thermal AR not ready	CG				GI		40	136
2794	Th-AR: Thermal AR is switched off	CG		151				40	94
2795	Th-AR: Thermal AR is switched on	CG				GI		40	17
2801	AR: Auto-reclose in progress	CG		152				40	101
2805	Th-AR: Thermal AR in progress	CG		153				40	104
2813	AR: dead time for RAR is running	C		154				40	113
2819	Th-AR: dead time is running	C		155				40	138
2833	AR: dead time for DAR is running	C		156				40	133
2851	AR: Close command from auto-reclose	C	C	157	CA		BT	p	128
2855	Th-AR: Close command from thermal AR	C		158				40	139
2877	AR: I limit blocks AR function		C	159				40	86
3651	Distance protection is switched off	CG		53				28	51
3653	Distance protection is active	CG		69				28	53
3671	Dist.: General fault detection		CG	163	CA	GI	BT	p	84
3771	Dist.: Time T1 (Zone Z1) expired		C	164	CA		BT	p	78
3780	Dist.: Time T1B (Zone Z1B) expired		C	167			BT	28	180
3783	Dist.: Time T1L (Zone Z1L) expired		C	168			BT	28	183
3801	Distance protection: General trip		C	170	CA		BT	p	68
3925	Dist.: Flt. detect. Z2 (short circuit)		C	161			BT	28	98
3935	Dist.: Time T2K (Zone Z2) expired		C	165			BT	28	181
3936	Dist.: Time T2L (Zone Z2) expired		C	166			BT	28	182
3941	Fault impedance, Ohm sec.		V	252				151	99
3943	Fault detection forward		C	254	CA		BT	p	74
3944	Fault detection reverse		C	255	CA		BT	p	75
6613	Trip thermal protection	C		192			BT	231	1
6615	Thermal protection warning stage	CG		194		GI		231	2
6616	First catenary is active	CG		60		GI		137	161
6617	Second catenary is active	CG		61		GI		137	162
6618	Third catenary is active	CG		62		GI		137	163
6753	High-speed O/C I>>> is switched off	CG		51				231	22
6755	High-speed O/C I>>> fault detection		CG	185				231	67
6756	High-speed O/C T-I>>> expired		C	186				231	68
6757	O/C protection I>>> phase trip		C	187			BT	231	69

A Appendix

Annunciations 7SA51X for PC, LC-display and binary inputs/outputs

FNo. - Function number of annunciation
Op/Ft - Operation/Fault annunciation
C/CG: Coming/Coming and Going annunciation
M : Measurand
Ear - Earth fault annunciation
IO - I: can be marshalled to binary input
O: can be marshalled to binary output (LED, trip/signal relais)

FNo.	Abbreviation	Meaning	Op	Ft	IOT
3	>Time Synchro	>Time synchronization			IO
4	>Start FltRec	>Start fault recording	C		IO
5	>LED reset	>Reset LED indicators			IO
7	>ParamSelec.1	>Parameter set selection 1 (with No.8)			IO
8	>ParamSelec.2	>Parameter set selection 2 (with No.7)			IO
11	>Annunc. 1	>User defined annunciation 1	CG		IOT
12	>Annunc. 2	>User defined annunciation 2	CG		IOT
13	>Annunc. 3	>User defined annunciation 3	CG		IOT
14	>Annunc. 4	>User defined annunciation 4	CG		IOT
15	>Sys-Test	>Testing via system-interface			IO
16	>Sys-MM-block	>Block. of monitoring dir. via sys.-int			IO
51	Dev.operative	Device operative / healthy	CG		O
52	Prot. operat.	Any protection operative	CG		O
56	Initial start	Initial start of processor system	C		
60	LED reset	LED Reset	C		O
61	LogMeasBlock	Logging and measuring functions blocked	CG		
62	Test mode	Test mode	CG		
95	Param.running	Parameters are being set	CG		O
96	Param. Set A	Parameter set A is active	CG		O
97	Param. Set B	Parameter set B is active	CG		O
98	Param. Set C	Parameter set C is active	CG		O
99	Param. Set D	Parameter set D is active	CG		O
100	Wrong SW-vers	Wrong software-version	C		
101	Wrong dev. ID	Wrong device identification	C		
110	Annunc. lost	Annunciations lost (buffer overflow)	C		
111	Annu. PC lost	Annunciations for PC lost	C		
115	Flt.Buff.Over	Fault annunciation buffer overflow		C	
118	Ctrl. by BI	Control by binary input is activ	CG		
119	Ctrl. by SYS	Control by system-interface is activ	CG		
120	Oper.Ann.Inva	Operational annunciations invalid	CG		
121	Flt.Ann.Inval	Fault annunciations invalid	CG		
122	E/F.Prot Inva	Earth fault annunciations invalid	CG		
123	Stat.Buff.Inv	Statistic annunciation buffer invalid	CG		
124	LED Buff.Inva	LED annunciation buffer invalid	CG		

FNo.	Abbreviation	Meaning	Op	Ft	IOT
129	VDEW-StateInv	VDEW state invalid	CG		
135	Chs Error	Error in check sum	CG		
136	Chs.A Error	Error in check sum for parameter set A	CG		
137	Chs.B Error	Error in check sum for parameter set B	CG		
138	Chs.C Error	Error in check sum for parameter set C	CG		
139	Chs.D Error	Error in check sum for parameter set D	CG		
143	Failure 15V	Failure of internal 15 VDC power supply	CG		OT
144	Failure 5V	Failure of internal 5 VDC power supply	CG		OT
145	Failure 0V	Failure of internal 0 VDC power supply	CG		OT
154	Fail. TripRel	Supervision trip circuit	CG		
155	Failure MEA 1	Failure of analog input MEA1	CG		OT
156	Failure MEA 2	Failure of analog input MEA2	CG		OT
157	Fail. MAIN CB	Failure of main circuit breaker	C		OT
158	Fail.TEMPSENS	Failure of outdoor temp. sensing	CG		OT
159	LSA disrupted	LSA (system interface) disrupted	CG		
168	Failure Umeas	Failure: Measuring voltages absent	CG		OT
203	Flt.RecDatDel	Fault recording data deleted	C		
204	Flt.Rec.viaBI	Fault recording initiated via bin.input	C		
205	Flt.Rec.viaKB	Fault recording initiated via keyboard	C		
206	Flt.Rec.viaPC	Fault recording initiated via PC interf	C		
244	D Time=	Diff. time of clock synchronism	M		
301	Syst.Flt	Fault in the power system	CG	C	
302	Fault	Flt. event w. consecutive no.		C	
355	>CB Aux. cl.	>Circuit breaker aux. contact closed	CG		IOT
356	>Manual Close	>Manual close			IOT
361	>VT mcb Trip	>U Line side VT MCB tripped	C		IOT
365	>Ctrl. by BI	>Control by binary input	CG		I
501	Device FltDet	General fault detection of device			OT
502	Dev. Drop-off	General drop-off of device		C	
511	Device Trip	General trip of device			OT
524	I/In=	Interrupted current (I/In)		C	
545	T-Drop	Time from fault detection to drop-off			
546	T-Trip	Time from fault detection to trip			
561	Manual Close	Circuit breaker manually closed (pulse)	C		OT
563	CB Alarm Supp	CB alarm suppressed			OT
564	CB Alarm Supp	CB alarm suppressed thermal prot. AR			OT
618	I[%]=	Operational measurement: I[%]=	M		
628	U[%]=	Operational measurement:U[%]=	M		
668	I =	Operational measurement: I =	M		
678	U =	Operational measurement: U =	M		
694	f [Hz]=	Frequency f [Hz] =	M		
950	Tmp.cat=	Operat. meas. temp. of catenary	M		
951	Tmp.amb=	Operat. meas. ambient temperature	M		
952	R[Ω]=	Resistance	M		
953	X[Ω]=	Reactance	M		
954	Phi[°]=	Power angle	M		
1000	Trip No =	Number of trip commands issued	M		

FNo.	Abbreviation	Meaning	Op	Ft	IOT
1007	ΣI/In=	Accumulated interrupted curr. I/In	M		
1011	TH-AR=	No. of AR commands: therm. prot.	M		
1012	AR RAR=	No. of auto-reclose commands: RAR	M		
1013	AR DAR=	No. of auto-reclose commands: DAR	M		
1018	I/In=	Last trip current I/In=	M		
1106	>Start FltLoc	>Start fault locator	CG		IOT
1110	FltLoc block	Fault locator is blocked	C		
1114	Rpri=	Fault resistance, Ohm prim.		C	
1115	Xpri=	Fault reactance, Ohm prim.		C	
1117	Rsec=	Fault resistance, Ohm sec.		C	
1118	Xsec=	Fault reactance, Ohm sec.		C	
1119	d km=	Distance to fault in km		C	
1120	d % =	Distance to fault in %		C	
1121	Fault section	Fault in section		C	
1129	FltLoc imposs	No calculation of distance possible		C	
1130	Flt dist >	Distance to fault out of range		C	
1156	>CB Test	>CB test start			IOT
1158	>CBtstTRP/CLS	>CB test trip/close cycle start			IOT
1173	CBtstTRIP/CLS	CB test trip/close cycle in progress	CG		OT
1174	CB in Test	Circuit breaker test in progress	CG		OT
1181	CB Test Trip	Circuit breaker test: General trip			OT
1186	Test MAIN CB	Circuit breaker test: Trip main CB	C		OT
1187	Test SPARE CB	Circuit breaker test: Trip spare CB	C		OT
1190	Op.Imp.forw.	Operational Impedance forward dir.			OT
1192	Reset Tmp Bup	Reset temperature back up	C		
1401	>B/F on	>Switch on breaker fail protection			IOT
1402	>B/F off	>Switch off breaker fail protection			IOT
1431	>B/F Start	>ext. start breaker failure protection			IOT
1451	B/F off	Breaker fail protection is switched off	CG		OT
1455	B/F fault	Breaker failure : fault detection		C	OT
1471	B/F Trip	Trip by breaker failure protection		C	OT
1484	B/F s.ordProt	B/F: pick up superordinat.prot.relais		C	OT
1485	B/F T-SP	Delay time for back up trip expired		C	OT
2001	>Emer. ON	>Switch ON emerg. overcurrent prot.			IOT
2002	>Emer. OFF	>Switch OFF emerg. overcurrent prot.			IOT
2051	Emer. off	Emergency O/C protect. is switched off	CG		OT
2054	Emer. mode	Emergency O/C protection is running	CG		OT
2091	Emer. I>>	Emerg. O/C phase fault detection I>>		C	OT
2121	Emer. TI>>	Emerg. O/C prot.: Time TI>> expired		C	OT
2141	Emer.Gen.Trip	Emerg. O/C protection: General Trip		C	OT
2701	>AR on	>AR: Switch on auto-reclose function			IOT
2702	>AR off	>AR: Switch off auto-reclose function			IOT
2703	>AR block	>AR: Block auto-reclose function	CG		IOT
2708	>RAR block	>AR: Block rapid auto-reclose	CG		IOT
2709	>DAR block	>AR: Block delayed auto-reclose	CG		IOT
2710	>Th-AR block	>Th-AR: Block thermal AR-function			IOT
2711	>ext.Start AR	>AR: External start for internal AR	C		IOT

FNo.	Abbreviation	Meaning	Op	Ft	IOT
2712	>ext. Trip AR	>AR: External. trip for internal AR	C		IOT
2718	>Th-AR ON	>Th-AR: Switch on thermal-AR function			IOT
2719	>Th-AR OFF	>Th-AR: Switch off thermal-AR function			IOT
2730	>CB ready	>AR: Circuit breaker ready for reclose			IOT
2781	AR off	AR: Auto-reclose is switched off	CG		OT
2784	AR not ready	AR: Auto-reclose is not ready			OT
2787	CB not ready	AR: Circuit breaker not ready	CG		OT
2793	Th-AR not rdy	Th-AR: Thermal AR not ready			OT
2794	Th-AR off	Th-AR: Thermal AR is switched off	CG		OT
2801	AR in prog.	AR: Auto-reclose in progress			OT
2805	Th-AR in prog	Th-AR: Thermal AR in progress	CG		OT
2812	RAR T-act.run	AR: Action time for RAR is running			OT
2813	RAR Tdead run	AR: dead time for RAR is running			OT
2817	RAR Zone Rel.	AR: Zone extension for rapid reclosing			OT
2819	ThAR Tdead ru	Th-AR: dead time is running			OT
2832	DAR T-act.run	AR: Action time for DAR is running			OT
2833	DAR Tdead run	AR: dead time for DAR is running			OT
2837	DAR Zone Rel.	AR: Zone extension for delayed reclose			OT
2851	AR Close Cmd.	AR: Close command from auto-reclose		C	OT
2855	Th-AR ClosCmd	Th-AR: Close command from thermal AR	C		OT
2861	AR T-Recl.run	AR: Reclaim time is running			OT
2862	AR successful	AR: Auto-reclose cycle successful		C	OT
2863	Definit.Trip	AR: Definitive trip		C	OT
2866	Th-AR T-Recl.	Th-AR: Therm.AR reclaim time is running			OT
2867	Th-AR success	Th-AR: Thermal AR cycle successful	C		OT
2868	Th-AR def.Trp	Th-AR: Thermal AR definite trip	C		OT
2877	Ilimit blckAR	AR: I limit blocks AR function		C	
3601	>Dis.prot. on	>Distance protection is switched on			IOT
3602	>Dis.prot.off	>Distance protection is switched off			IOT
3651	Dist. off	Distance protection is switched off	CG		OT
3653	Dist. active	Distance protection is active	CG		OT
3671	Dist.Gen.Flt.	Dist.: General fault detection		C	OT
3740	Dist. Z1	Dist.: Fault detection Zone Z1		C	OT
3747	Dist.Z1B	Dist.: Fault detection Zone Z1B		C	OT
3753	Dist. Z1L	Dist.: Fault detection Zone Z1L		C	OT
3771	Dist. T1	Dist.: Time T1 (Zone Z1) expired		C	OT
3780	Dist. T1B	Dist.: Time T1B (Zone Z1B) expired		C	OT
3783	Dist. T1L	Dist.: Time T1L (Zone Z1L) expired		C	OT
3801	Dis.Gen. Trip	Distance protection: General trip		C	OT
3810	Dis.Trip Z1	Dist.: Trip in Zone Z1			OT
3920	Dis Z1 forw.	Dist.: Zone Z1 forward active	CG		OT
3921	Dis Z2 forw.	Dist.: Zone Z2 forward active	CG		OT
3925	Dist.Flt.Z2K	Dist.: Flt. detect. Z2 (short circuit)		C	OT
3926	Dist.Flt.Z2L	Dist.: Fault detection Z2 (overload)		C	OT
3930	Dis. Trip Z2K	Dist.: Trip in zone Z2 (short circuit)			OT
3931	Dis. Trip Z2L	Dist.: Trip in zone Z2 (overload)			OT

FNo.	Abbreviation	Meaning	Op	Ft	IOT
3935	Dist. T2K	Dist.: Time T2K (Zone Z2) expired		C	OT
3936	Dist. T2L	Dist.: Time T2L (Zone Z2) expired		C	OT
3941	Zsec=	Fault impedance, Ohm sec.		C	
3943	Fault forward	Fault detection forward		C	
3944	Fault reverse	Fault detection reverse		C	
6601	>Th.Prot.on	>Thermal protection is switched on			IOT
6602	>Th.Prot.off	>Thermal protection is switched off			IOT
6603	>Cat.3 active	>Third catenary is active			IOT
6604	>Cat.2 active	>Second catenary is active			IOT
6605	>Cat.1 active	>First catenary is active			IOT
6610	Th.Prot. off	Thermal protection is switched off	CG		OT
6612	Flt. Th.Prot.	Thermal prot. fault detection			OT
6613	Trip Th.Prot.	Trip thermal protection	C		OT
6614	Close-lockout	Thermal protection closing lock-out	CG		OT
6615	Th.Prot. Warn	Thermal protection warning stage	C		OT
6616	Cat. 1 active	First catenary is active	CG		OT
6617	Cat. 2 active	Second catenary is active	CG		OT
6618	Cat. 3 active	Third catenary is active	CG		OT
6751	>O/C I>>> on	>High-speed O/C I>>> is switched on			IOT
6752	>O/C I>>> off	>High-speed O/C I>>> is switched off			IOT
6753	O/C I>>> off	High-speed O/C I>>> is switched off	CG		OT
6755	Flt.det. I>>>	High-speed O/C I>>> fault detection		C	OT
6756	T-I>>> exp.	High-speed O/C T-I>>> expired		C	OT
6757	Trip I>>>	O/C protection I>>> phase trip		C	OT

A.2 Reference Tables

Appendix A.2 contains reference tables for

- function parameters,
- test/commissioning aids,
- addresses for annunciations, measured values, etc.,
- configuration parameters,
- operational control of the device.

The following tables list the texts for the maximum scope of device functions. In individual cases, the system displays only the data that applies to the respective version.

Reference Table for Functional Parameters 7SA51X

1000	PARAMETERS		
1100	POWERSYSTEM DATA		
1101	CT STARPNT		Current transformer polarity
	TOWARDS LINE	[ ]	Towards line
	TOWARDS BUSBAR	[ ]	Towards busbar
1103	Un PRIMARY		Primary rated voltage
	min. 1.00		kV
	max. 150.00	____	
1104	Un SECOND.		Secondary rated voltage
	min. 100		V
	max. 110	____	
1105	In PRIMARY		Primary rated current
	min. 10		A
	max. 50000	____	
1133	Tret.AlRel		Minimum retention time of alarm relay
	min. 0.00		s
	max. 1.00	____	
1135	T-CLOSE		Maximum close command duration
	min. 0.01		s
	max. 32.00	____	
1141	T TRIP		Minimum trip command duration
	min. 0.01		s
	max. 32.00	____	

1200	DISTANCE PROTECTION		
1201	DIST.PROT.		Distance protection function
	ON	[ ]	on
	OFF	[ ]	off
1202	RAR -> Z1B		Distance zone Z1B effective before 1st RAR
	YES	[ ]	yes
	NO	[ ]	no
1203	DAR -> Z1L		Distance zone Z1L effective before DAR
	YES	[ ]	yes
	NO	[ ]	no
1204	Z1		Zone Z1: Impedance
	min. 0.20		Ω
	max. 250.00	____	
1205	Z1 REV		Zone Z1: Impedance reverse
	min. 0.20		Ω
	max. 250.00	____	
1206	Z1B		Zone Z1B: Impedance
	min. 0.20		Ω
	max. 250.00	____	
1207	Z1B REV		Zone Z1B: Impedance reverse
	min. 0.20		Ω
	max. 250.00	____	
1208	Z1L		Zone Z1L: Impedance
	min. 0.20		Ω
	max. 250.00	____	
1209	Z1L REV		Zone Z1L: Impedance reverse
	min. 0.20		Ω
	max. 250.00	____	
1210	Z2		Zone Z2: Impedance
	min. 0.20		Ω
	max. 250.00	____	
1211	Z2 REV		Zone Z2: Impedance reverse
	min. 0.20		Ω
	max. 250.00	____	
1212	I>		Current threshold for enable impedance zones
	min. 0.1		I/In
	max. 2.0	____	
1213	ANGLE Z1a		Zone Z1: Angle alpha
	min. -70		°
	max. 45	____	
1214	ANGLE Z1b		Zone Z1: Angle beta
	min. 70		°
	max. 140	____	
1219	ANGLE Z2a		Zone Z2: Angle alpha
	min. -70		°
	max. 45	____	

1220	ANGLE Z2b		Zone Z2: Angle beta
	min. 70		°
	max. 140	____	
1221	T1		Zone Z1: Delay time
	min. 0.00		s
	max. 0.30/∞	____	
1222	T1B		Zone Z1B: Delay time
	min. 0.00		s
	max. 60.00/∞	____	
1223	T1L		Zone Z1L: Delay time
	min. 0.00		s
	max. 60.00/∞	____	
1224	T2K		Zone Z2: Delay time short-circuit
	min. 0.10		s
	max. 10.00/∞	____	
1225	T2L		Zone Z2: Delay time overload
	min. 1.00		s
	max. 60.00/∞	____	
1227	DIREC. Z1		Zone Z1: Direction
	FORWARDS	[ ]	Forwards
	NON-DIRECTIONAL	[ ]	Non-directional
1228	DIREC. Z2		Zone Z2: Direction
	FORWARDS	[ ]	Forwards
	NON-DIRECTIONAL	[ ]	Non-directional
1229	dI/dT		Short-circuit detection (di/dt)
	min. 0.0		
	max. 1.0/∞	____	
1230	MAN. CLOSE		Distance protection effect: Manual close
	Z1/Z2 UNDELAYED	[ ]	Z1/Z2 undelayed
	INEFFECTIVE	[ ]	Ineffective

1300	EMERGENCY OVERCURRENT PROT		
1301	EMER.O/C		State of emergency overcurrent protection
	ON	[ ]	on
	OFF	[ ]	off
1302	I>>		Overcurrent threshold (DT) I>>
	min. 0.25		I/In
	max. 4.00	____	
1303	TI>>		Delay time for I>> TI>>
	min. 0.00		s
	max. 1.00/∞	____	
1321	MAN. CLOSE		Overcurrent stage effect: Manual close
	I>> UNDELAYED	[ ]	I>> undelayed
	INEFFECTIVE	[ ]	Ineffective

1400	HIGH-SPEED OVERCURRENT I>>>		
	1401 O/C I>>>		State of high-speed current protection I>>>
	ON	[ ]	on
	OFF	[ ]	off
1402	I>>>		Highset o/c threshold I>>>
	min. 1.0		I/In
	max. 20.0	____	
1403	TI>>>		Delay time for I>>> TI>>>
	min. 0.000		s
	max. 1.000/∞	____	
1404	MAN. CLOSE		High-speed O/C stage effect.: Manual close
	I>>> UNDELAYED	[ ]	I>>> undelayed
	INEFFECTIVE	[ ]	Ineffective
1409	VALUE I>>>		High-speed O/C measurement processing
	WITHOUT HARMON.	[ ]	Without harmonics
	WITH HARMONICS	[ ]	With harmonics

1500	THERMAL PROTECTION		
1501	THERM.PROT		State of thermal protection
	ON	[ ]	on
	OFF	[ ]	off
1502	TAU		Contact line time factor TAU
	min. 2.0		min
	max. 15.0	____	
1503	LIMIT CURR		Limit current I/In catenary
	min. 0.25		I/In
	max. 2.00	____	
1504	TEMP. RISE		Temperature rise of catenary
	min. 0		K
	max. 100	____	
1505	TEMP.END		MAX. permitted temperature of catenary
	min. 50		°C
	max. 100	____	
1506	TMP. ALARM		Temperature alarm stage
	min. 50		°C
	max. 100	____	
1507	Ton/Tend		Cooling factor Ton/Tend
	min. 0.50		
	max. 0.90	____	
1508	FACT.2CAT.		Correction factor for 2nd catenary
	min. 1.0		
	max. 3.0	____	
1509	FACT.3CAT.		Correction factor for 3rd catenary
	min. 1.0		
	max. 3.0	____	

1510	VAL.AMBTMP		Fixed reference temp. for thermal protection
	min. -30		°C
	max. 40	____	

2800	DELAYTIMES ANNUNCIATIONS		
2801	T-Annunc.1		Delay time for 1st user defined annunciation
	min. 0.00		s
	max. 10.00	____	
2802	T-Annunc.2		Delay time for 2nd user defined annunciation
	min. 0.00		s
	max. 10.00	____	
2803	T-Annunc.3		Delay time for 3rd user defined annunciation
	min. 0.00		s
	max. 10.00	____	
2804	T-Annunc.4		Delay time for 4th user defined annunciation
	min. 0.00		s
	max. 10.00	____	

2900	MEAS.VALUE SUPERVISION		
2901	LIMIT U<		Threshold for failed voltage monitoring
	min. 0.05		U/Un
	max. 1.00	____	
2902	T FAILED V		Delay time for failed voltage monitoring
	min. 1		s
	max. 10/∞	____	

3400	AUTORECLOSE FUNCTION		
3401	AR FUNCT		Auto-reclose function
	ON	[ ]	on
	OFF	[ ]	off
3402	AR BLO REV		Auto-reclose block with reverse faults
	NO	[ ]	no
	YES	[ ]	yes
3403	MC BLOCK		Auto-reclose block with manual close
	YES	[ ]	yes
	NO	[ ]	no
3404	I LIMIT AR		Current threshold for blocking AR
	min. 1		I/In
	max. 25/∞	____	
3405	T-RECLAIM		Reclaim time after successful AR
	min. 0.50		s
	max. 320.00	____	
3407	T-BLOCK MC		Blocking duration with manual close
	min. 0.50		s
	max. 320.00	____	

3420	PRG I>>>AR		AR-program for high-speed O/C
	RAR ONLY	[ ]	RAR only
	RAR AND DAR	[ ]	RAR and DAR
3424	RAR T-ACT.		Rapid auto-reclose action time
	min. 0.01		s
	max. 320.00/∞	____	
3426	RAR T-DEAD		RAR dead time
	min. 0.01		s
	max. 320.00	____	
3443	DAR No.		Number of DAR shots
	min. 0		
	max. 9	____	
3445	DAR T-ACT.		Delayed auto-reclose action time
	min. 0.01		s
	max. 320.00/∞	____	
3446	DAR T-DEAD		DAR dead time
	min. 0.01		s
	max. 1800.00	____	

3500	THERMAL AUTORECLOSE-FCT.		
3501	THERM. AR		Auto-reclose function for thermal protection
	ON	[ ]	on
	OFF	[ ]	off
3502	TH-AR No.		No. of AR shots after trip thermal-protection
	min. 0		
	max. 9	____	
3503	T-RECL-TH		Reclaim time after successful thermal-AR
	min. 1.00		s
	max. 1800.00	____	

3800	FAULT LOCATION		
3802	START		Start condition for fault locator
	TRIP COMMAND	[ ]	Trip command
	DROP-OFF or TRIP	[ ]	Drop-off or trip
3803	X1 SEC		Reactance per unit length of section 1
	min. 0.05		Ω/km
	max. 50.00	____	
3804	d1		Linelength of section 1
	min. 1.0		km
	max. 200.0	____	
3805	X2 SEC		Reactance per unit length of section 2
	min. 0.05		Ω/km
	max. 50.00	____	
3806	d2		Linelength of section 2
	min. 1.0		km
	max. 200.0	____	

3807	X3 SEC		Reactance per unit length of section 3
	min. 0.05		Ω/km
	max. 50.00	____	
3808	d3		Linelength of section 3
	min. 1.0		km
	max. 200.0	____	
3809	X4 SEC		Reactance per unit length of section 4
	min. 0.05		Ω/km
	max. 50.00	____	
3810	d4		Linelength of section 4
	min. 1.0		km
	max. 200.0	____	
3811	X5 SEC		Reactance per unit length of section 5
	min. 0.05		Ω/km
	max. 50.00	____	
3812	d5		Linelength of section 5
	min. 1.0		km
	max. 200.0	____	

3900	BREAKER FAILURE PROTEC.		
3901	B/F PROT.		CB failure protection will be activated by
	OFF	[ ]	off
	ON, INTERN.START	[ ]	
	On, internal start		
	ON, EXTERN.START	[ ]	On, external start
	ON, INT. OR EXT.	[ ]	On, int.or ext.start
3903	T-SP-B/F		Delay time for back-up trip
	min. 0.10		s
	max. 1.00/∞	____	
3905	T-UP-B/F		Delay time for superordinated protect. relays
	min. 0.10		s
	max. 1.00/∞	____	

Tests and Commissioning Aids 7SA51X

4000	TESTS	
4100	THERMAL PROTECTION TESTS	
4101	CAL.TMP.CAT	Clearing the calculated temp. of catenary
4300	CB TEST TRIP-CLOSE CYCLE	
4304	CB TEST	Circuit breaker test with AR (main CB)
4305	CB TEST	Circuit breaker test with AR (spare CB)
4400	CB TEST LIVE TRIP	
4401	CB TRIP	Circuit breaker trip test main circuit breaker
4402	CB TRIP	CB trip test spare circuit breaker
4900	TEST FAULT RECORDING	
4901	FAULT REC.	Initiation of fault recording

Annunciations, Measured Values etc. 7SA51X

5000	ANNUNCIATIONS	
5100	OPERATIONAL ANNUNCIATIONS	
5200	LAST FLT TO 3rd LAST FAULT	
5300	4th LAST TO 6th LAST FAULT	
5400	7th LAST TO 9th LAST FAULT	
5500	10th LST TO 12th LAST FAULT	
5600	CB OPERAT. STATISTICS	
5601	TH-AR=	No. of AR commands: therm. prot.
5602	AR RAR=	No. of auto-reclose commands: RAR
5603	AR DAR=	No. of auto-reclose commands: DAR
5604	Trip No =	Number of trip commands issued
5607	_I/In=	Accumulated interrupted curr. I/In
5610	I/In=	Last trip current I/In=
5700	OPERATIONAL MEASURED VALUES	
5701	I =	Operational measurement: I =
5702	U =	Operational measurement: U =
5703	Tmp.cat=	Operat. meas. temp. of catenary
5704	Tmp.amb=	Operat. meas. ambient temperature
5705	I[%]=	Operational measurement: I[%]=
5706	U[%]=	Operational measurement:U[%]=
5707	f [Hz]=	Frequency f [Hz] =
5709	R[_]=	Resistance
5710	X[_]=	Reactance
5711	Phi[°]=	Power angle

Reference Table for Configuration Parameters 7SA51X

6000 MARSHALLING

6100	MARSHALLING BINARY INPUTS		
6101	BINARY INPUT 1	Binary input 1	
6102	BINARY INPUT 2	Binary input 2	
6103	BINARY INPUT 3	Binary input 3	
6104	BINARY INPUT 4	Binary input 4	
6105	BINARY INPUT 5	Binary input 5	
6106	BINARY INPUT 6	Binary input 6	
6107	BINARY INPUT 7	Binary input 7	

6108	BINARY INPUT 8	Binary input 8	
6109	BINARY INPUT 9	Binary input 9	
6110	BINARY INPUT 10	Binary input 10	
6111	BINARY INPUT 11	Binary input 11	
6112	BINARY INPUT 12	Binary input 12	

6200	MARSHALLING SIGNAL RELAYS		
6201	SIGNAL RELAY 1	Signal relay 1	
6202	SIGNAL RELAY 2	Signal relay 2	
6203	SIGNAL RELAY 3	Signal relay 3	

6204	SIGNAL RELAY 4	Signal relay 4	
6205	SIGNAL RELAY 5	Signal relay 5	
6206	SIGNAL RELAY 6	Signal relay 6	
6207	SIGNAL RELAY 7	Signal relay 7	
6208	SIGNAL RELAY 8	Signal relay 8	
6209	SIGNAL RELAY 9	Signal relay 9	
6210	SIGNAL RELAY 10	Signal relay 10	
6211	SIGNAL RELAY 11	Signal relay 11	

6212	SIGNAL RELAY 12	Signal relay 12	
6213	SIGNAL RELAY 13	Signal relay 13	
6214	SIGNAL RELAY 14	Signal relay 14	
6215	SIGNAL RELAY 15	Signal relay 15	
6216	SIGNAL RELAY 16	Signal relay 16	
6217	SIGNAL RELAY 17	Signal relay 17	
6218	SIGNAL RELAY 18	Signal relay 18	
6219	SIGNAL RELAY 19	Signal relay 19	

6220	SIGNAL RELAY 20	Signal relay 20	
6221	SIGNAL RELAY 21	Signal relay 21	
6222	SIGNAL RELAY 22	Signal relay 22	
6223	SIGNAL RELAY 23	Signal relay 23	

6300	MARSHALLING LED INDICATORS		
6301	LED 1	LED 1	
6302	LED 2	LED 2	
6303	LED 3	LED 3	
6304	LED 4	LED 4	

6305	LED 5	LED 5	
6306	LED 6	LED 6	
6307	LED 7	LED 7	
6308	LED 8	LED 8	
6309	LED 9	LED 9	
6310	LED 10	LED 10	
6311	LED 11	LED 11	
6312	LED 12	LED 12	

6313	LED 13	LED 13	
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
6314	LED 14	LED 14	
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

6400	MARSHALLING TRIP RELAYS		
6401	TRIP RELAY 1	Trip relay 1	
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
6402	TRIP RELAY 2	Trip relay 2	
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
6403	TRIP RELAY 3	Trip relay 3	
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
6404	TRIP RELAY 4	Trip relay 4	
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
6405	TRIP RELAY 5	Trip relay 5	
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

7000	OP. SYSTEM CONFIGURATION		
7100	INTEGRATED OPERATION		
7101	LANGUAGE		Language
	ENGLISH	[ ]	English
	DEUTSCH	[ ]	German
7102	DATE FORMAT		Date format
	DD.MM.YYYY	[ ]	dd.mm.yyyy
	MM/DD/YYYY	[ ]	mm/dd/yyyy
7105	OPER. 1st L		Operational message for 1st display line
	_____		_____
7106	OPER. 2nd L		Operational message for 2nd display line
	_____		_____
7107	FAULT 1st L		Fault message for 1st display line
	_____		_____
7108	FAULT 2nd L		Fault message for 2nd display line
	_____		_____
7110	FAULT INDIC		Fault indication: LED and LCD
	WITH FAULT DETEC	[ ]	With fault detection
	WITH TRIP COMM.	[ ]	With trip command
7151	CW-LEVEL 1		Codeword for level 1
	min. 1		
	max. 999999	____	
7152	CW-LEVEL 2		Codeword for level 2
	min. 1		
	max. 999999	____	
7153	CW-LEVEL 3		Codeword for level 3
	min. 1		
	max. 999999	____	
7154	CW-LEVEL 4		Codeword for level 4
	min. 1		
	max. 999999	____	

7200	PC/SYSTEM INTERFACES		
7201	DEVICE ADD.		Device address
	min. 1		
	max. 254	____	
7202	FEEDER ADD.		Feeder address
	min. 1		
	max. 254	____	
7203	SUBST. ADD.		Substation address
	min. 1		
	max. 254	____	
7208	FUNCT. TYPE		Function type in accordance with VDEW/ZVEI
	min. 1		
	max. 254	____	

7209	DEVICE TYPE		Device type
	min. 0		
	max. 255	____	
7211	PC INTERF.		Data format for PC-interface
	DIGSI V3	[ ]	DIGSI V3
	ASCII	[ ]	ASCII
7214	PC GAPS		Transmission gaps for PC-interface
	min. 0.0		s
	max. 5.0	----	
7215	PC BAUDRATE		Transmission baud rate for PC-interface
	9600 BAUD	[ ]	9600 Baud
	19200 BAUD	[ ]	19200 Baud
	1200 BAUD	[ ]	1200 Baud
	2400 BAUD	[ ]	2400 Baud
	4800 BAUD	[ ]	4800 Baud
7216	PC PARITY		Parity and stop-bits for PC-interface
	DIGSI V3	[ ]	DIGSI V3
	NO 2 STOP	[ ]	No parity,2 stopbits
	NO 1 STOP	[ ]	No parity,1 stopbit
7221	SYS INTERF.		Data format for system-interface
	VDEW COMPATIBLE	[ ]	VDEW compatible
	VDEW EXTENDED	[ ]	VDEW extended
	DIGSI V3	[ ]	DIGSI V3
	LSA	[ ]	LSA
7222	SYS MEASUR.		Measurement format for system-interface
	VDEW COMPATIBLE	[ ]	VDEW compatible
	VDEW EXTENDED	[ ]	VDEW extended
7224	SYS GAPS		Transmission gaps for system-interface
	min. 0.0		s
	max. 5.0	----	
7225	SYS BAUDR.		Transmission baud rate for system-interface
	9600 BAUD	[ ]	9600 Baud
	19200 BAUD	[ ]	19200 Baud
	1200 BAUD	[ ]	1200 Baud
	2400 BAUD	[ ]	2400 Baud
	4800 BAUD	[ ]	4800 Baud
7226	SYS PARITY		Parity and stop-bits for system-interface
	VDEW/DIGSIV3/LSA	[ ]	VDEW/DIGSI V3/LSA
	NO 2 STOP	[ ]	No parity,2 stopbits
	NO 1 STOP	[ ]	No parity,1 stopbit
7227	SYS-SWITCH		Online-switch VDEW-DIGSI enabled
	NO	[ ]	no
	YES	[ ]	yes
7235	SYS PARAMET		Parameterizing via system-interface
	NO	[ ]	no
	YES	[ ]	yes

7400	FAULT RECORDINGS			
7402	INITIATION			Initiation of data storage
	STORAGE BY FD.		[ ]	Storage by fault det
	STORAGE BY TRIP		[ ]	Storage by trip
	START WITH TRIP		[ ]	Start with trip
7403	SCOPE			Scope of stored data
	FAULT EVENT		[ ]	Fault event
	FAULT IN POW.SYS		[ ]	Fault in power syst.
7410	T-MAX			Maximum time period of a fault recording
	min.	0.30		s
	max.	5.00	_____	
7411	T-PRE			Pre-trigger time for fault recording
	min.	0.05		s
	max.	0.50	_____	
7412	T-POST			Post-fault time for fault recording
	min.	0.05		s
	max.	0.50	_____	
7431	T-BINARY IN			Storage time by initiation via binary input
	min.	0.10		s
	max.	5.00/∞	_____	
7432	T-KEYBOARD			Storage time by initiation via keyboard
	min.	0.10		s
	max.	5.00	_____	
7490	SYS LENGTH			Length of fault record (former LSA)
	660 VALUES FIX		[ ]	660 values fix
	<=3000 VAL. VAR		[ ]	<=3000 val. var

7800	SCOPE OF FUNCTIONS			
7812	DIST. PROT.			Distance protection
	EXIST		[ ]	Existent
	NON-EXIST		[ ]	Non-existent
7813	EMERG. O/C			Emergency overcurrent time protection
	EXIST		[ ]	Existent
	NON-EXIST		[ ]	Non-existent
7814	HSPEED I>>>			High-speed overcurrent protection
	NON-EXIST		[ ]	Non-existent
	EXIST		[ ]	Existent
7815	THERM.PROT.			Thermal protection
	NON-EXIST		[ ]	Non-existent
	EXIST		[ ]	Existent
7817	TMP.SENSING			Outdoor temperature sensing
	NON-EXIST		[ ]	Non-existent
	-30°C TO +55°C		[ ]	-30°C to +55°C
	-55°C TO +55°C		[ ]	-55°C to +55°C

7834	INTERNAL AR		Internal auto-reclose function
	NON-EXIST	[ ]	Non-existent
	EXIST	[ ]	Existent
7835	INT. TH-AR		Internal AR-function for thermal protection
	NON-EXIST	[ ]	Non-existent
	EXIST	[ ]	Existent
7838	FAULT LOCAT		Fault locator
	NON-EXIST	[ ]	Non-existent
	EXIST	[ ]	Existent
7885	PARAM. C/O		Parameter change-over
	NON-EXIST	[ ]	Non-existent
	EXIST	[ ]	Existent
7898	NO. OF SECT		Total number of sections
	1 SECTION	[ ]	1 line section
	2 SECTIONS	[ ]	2 line sections
	3 SECTIONS	[ ]	3 line sections
	4 SECTIONS	[ ]	4 line sections
	5 SECTIONS	[ ]	5 line sections
7899	FREQUENCY		Rated system frequency
	fN 50 Hz	[ ]	fN 50 Hz
	fN 60 Hz	[ ]	fN 60 Hz

7900	DEVICE CONFIGURATION		
7901	CB TEST SEL		Switch functional test circuit breaker
	MAIN CB	[ ]	Main circuit breaker
	SPARE CB	[ ]	Spare CB
	MAIN + SPARE CB	[ ]	Main and spare CB
7902	RESPONSE BI		Response-level for binary input
	EDGE-TRIGGERED	[ ]	Edge triggered
	CONTIN. SIGNAL	[ ]	Continuos signal
7903	FUNC.SWI.BY		Function switch by
	BINARY INPUT	[ ]	Binary input
	TELEGRAM	[ ]	Telegram
	BLOCKED	[ ]	blocked
7904	AR w/ DIST.		Auto-reclose with distance protection
	WITH AR	[ ]	With AR
	WITHOUT AR	[ ]	Without AR
7905	AR w/I>>>		AR initiated by high speed O/C
	WITHOUT AR	[ ]	Without AR
	WITH AR	[ ]	With AR
7906	AR w/ EMERG		Auto-reclose with emergency overcurrent prot.
	WITHOUT AR	[ ]	Without AR
	WITH AR	[ ]	With AR
7907	AR w/ EXT.		Auto-reclose with ext. trip via binary input
	WITHOUT AR	[ ]	Without AR
	WITH AR	[ ]	With AR

Operational Device Control Facilities 7SA51X

8000	DEVICE CONTROL		
8100	SETTING REAL TIME CLOCK		
8101	DATE / TIME		Actual date and time
8102	DATE		Setting new date
8103	TIME		Setting new time
8104	DIFF. TIME		Setting difference time
8200	RESET		
8201	RESET		Reset of LED memories
8202	RESET		Reset of operational annunciation buffer
8203	RESET		Reset of fault annunciation buffer
8204	RESET		Reset of CB operation counters
8205	RESET		Reset of the total of interrupted currents
8300	SYS-VDEW ANNUNC.-MEAS.VAL		
8301	SYS TEST		Testing via system-interface
	OFF	[ ]	off
	ON	[ ]	on
8302	SYS BLOCK		Blocking of monitoring direction via sys.-int.
	OFF	[ ]	off
	ON	[ ]	on
8500	PARAMETER CHANGE-OVER		
8501	ACTIV PARAM		Actual active parameter set
8503	ACTIVATING		Activation of parameter set
	SET A	[ ]	Set a
	SET B	[ ]	Set b
	SET C	[ ]	Set c
	SET D	[ ]	Set d
	SET BY BIN.INPUT	[ ]	Set via binary input
	SET BY LSA CONTR	[ ]	Set by lsa control
8510	COPY		Copy original parameter set to set A
8511	COPY		Copy original parameter set to set B
8512	COPY		Copy original parameter set to set C
8513	COPY		Copy original parameter set to set D
8514	COPY		Copy parameter set A to set B
8515	COPY		Copy parameter set A to set C

8516	COPY	Copy parameter set A to set D
8517	COPY	Copy parameter set B to set A
8518	COPY	Copy parameter set B to set C
8519	COPY	Copy parameter set B to set D
8520	COPY	Copy parameter set C to set A
8521	COPY	Copy parameter set C to set B
8522	COPY	Copy parameter set C to set D
8523	COPY	Copy parameter set D to set A
8524	COPY	Copy parameter set D to set B
8525	COPY	Copy parameter set D to set C

9800	OPERATING SYSTEM CONTROL	
9802	MONITOR	Monitor

A

B

C

D

E

F

G

H

I

J

K

L

M

O

P

R

S

T

U

V

To

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for document	**order no.**	**version**
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Power to the Point

Siemens Aktiengesellschaft

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