SIEMENS

Numerical Current Comparison Protection
with Auto–Reclosure
7SD512 V3.0

Instruction Manual Order No. C53000–G1176–C105–4

Figure 1 Illustration of the numerical current comparison protection relay 7SD512 (in flush mounting case)

SIEMENS

CE

Conformity

This product is in conformity with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 89/336/EEC) and concerning electrical equipment for application within specified voltage limits (Low–voltage directive 73/23 EEC).

Conformity is proved by tests that had been performed according to article 10 of the Council Directive in accordance with the generic standards EN 50081 and EN 50082 (for EMC directive) and the standards EN 60255–6 (for low–voltage directive) by Siemens AG.

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

The device is designed in accordance with the international standards of IEC 60255 and the German standards DIN 57435 part 303 (corresponding to VDE 0435 part 303).

Contents

1 Introduction ... **7**

1.1 Application ... 7

1.2 Features ... 8

1.3 Implemented functions ... 9

2 Design ... **11**

2.1 Arrangements ... 11

2.2 Dimensions ... 13

2.3 Ordering data ... 15

3 Technical Data ... **16**

3.1 General data ... 16
3.1.1 Inputs/outputs ... 16
3.1.2 Electrical tests ... 18
3.1.3 Mechanical stress tests ... 19
3.1.4 Climatic stress tests ... 19
3.1.5 Service conditions ... 20
3.1.6 Design ... 20

3.2 Current comparison protection ... 21

3.3 External local and transfer trip ... 23

3.4 Emergency overcurrent time protection ... 24

3.5 Thermal overload protection ... 26

3.6 Auto−reclosure ... 28

3.7 Ancillary functions ... 29

4 Method of operation ... **30**

4.1 Operation of complete unit ... 30

4.2 Current comparison protection ... 32
4.2.1 Matching of measured values ... 32
4.2.2 Comparison of measured values ... 32
4.2.3 Transmission of data to the opposite line end ... 33

4.3 External local and transfer trip ... 34
4.3.1 External local trip ... 34
4.3.2 Transfer trip ... 34

4.4 Emergency overcurrent time protection ... 35

4.5 Thermal overload protection ... 35

4.6 Automatic reclosure ... 36
4.6.1 Selectivity during automatic reclosure ... 38
4.6.2 Action times and reclaim times ... 38
4.6.3 Interrogation for readiness of the circuit breaker ... 39

4.6.4 Three–pole auto–reclosure . . . 39
4.6.5 Single–pole auto–reclosure . . . 40
4.6.6 Single– and three–pole auto–reclosure . . . 40
4.6.7 Treatment of evolving faults for single–pole auto–reclosure . . . 41
4.6.8 Multi–shot auto–reclosure . . . 41
4.6.9 Connection of external auto–reclose system . . . 42
4.6.10 Control of the internal auto–reclose function by an external protective relay . . . 43
4.6.11 Two protection relays with two auto–reclose devices . . . 44

4.7 Circuit breaker trip test . . . 45

4.8 Ancillary functions . . . 46
4.8.1 Processing of annunciations . . . 46
4.8.1.1 Indicators and binary outputs (signal relays) . . . 46
4.8.1.2 Information on the display panel or to a personal computer . . . 46
4.8.1.3 Information to a central unit (optional) . . . 47
4.8.2 Data storage and transmission for fault recording . . . 47
4.8.3 Operating measurements and conversion . . . 48
4.8.4 Monitoring functions . . . 48
4.8.4.1 Hardware monitoring . . . 48
4.8.4.2 Software monitoring . . . 49
4.8.4.3 Monitoring of external measuring transformer circuits . . . 49

5 Installation instructions . . . **51**

5.1 Unpacking and repacking . . . 51

5.2 Preparations . . . 51
5.2.1 Mounting and connections . . . 52
5.2.1.1 Model 7SD512⋆–⋆B⋆⋆⋆ for panel surface mounting . . . 52
5.2.1.2 Model 7SD512⋆–⋆C⋆⋆⋆ for panel flush mounting or–⋆E⋆⋆⋆ for cubicle installation . . . 52
5.2.1.3 Optical fibre link for protection data . . . 52
5.2.2 Checking the rated data . . . 53
5.2.2.1 Control d.c. voltage of binary inputs . . . 53
5.2.3 Inserting the back–up battery . . . 57
5.2.4 Checking the protection data transmission link . . . 57
5.2.5 Checking the transmission link to LSA . . . 59
5.2.6 Connections . . . 59
5.2.6.1 Current transformer connections . . . 59
5.2.6.2 Connections for circuit breaker auxiliary contacts . . . 60
5.2.7 Checking the connections . . . 61

5.3 Configuration of operation and memory functions . . . 62
5.3.1 Operational preconditions and general . . . 62
5.3.2 Settings for the integrated operation – address block 71 . . . 63
5.3.3 Configuration of the serial interfaces – address block 72 . . . 65
5.3.4 Settings for fault recording – address block 74 . . . 68

5.4 Configuration of the protective functions . . . 70
5.4.1 Introduction . . . 70
5.4.2 Programming the scope of functions – address block 78 . . . 71
5.4.3 Setting the device configuration – address block 79 . . . 72

5.5 Marshalling of binary inputs, binary outputs and LED indicators . . . 73
5.5.1 Introduction . . . 73
5.5.2 Marshalling of the binary inputs – address block 61 . . . 75
5.5.3 Marshalling of the signal output relays – address block 62 . . . 78
5.5.4 Marshalling of the LED indicators – address block 63 . . . 84
5.5.5 Marshalling of the command (trip) relays – address block 64 . . . 86

6 Operating instructions ... **89**

6.1 Safety precautions ... 89

6.2 Dialog with the relay ... 89
6.2.1 Membrane keyboard and display panel ... 89
6.2.2 Operation with a personal computer ... 90
6.2.3 Operational preconditions ... 90
6.2.4 Representation of the relay (front view) ... 91

6.3 Setting the functional parameters ... 92
6.3.1 Introduction ... 92
6.3.1.1 Parameterizing procedure ... 92
6.3.1.2 Selectable parameter sets ... 93
6.3.1.3 Setting of date and time ... 94
6.3.2 Initial displays – address blocks 00 and 10 ... 95
6.3.3 Power system data – address block 11 ... 95
6.3.4 Settings for current comparison protection – address block 15 ... 96
6.3.5 Data for the transmission of protection signals – address block 16 ... 99
6.3.6 Settings for the external local trip facility – address block 21 ... 100
6.3.7 Settings for the transfer trip facility – address block 22 ... 101
6.3.8 Settings for emergency overcurrent time protection – address block 26 ... 102
6.3.8.1 Phase fault overcurrent time protection ... 102
6.3.8.2 Earth fault overcurrent time protection ... 104
6.3.9 Settings for thermal overload protection – address block 27 ... 106
6.3.10 Settings for measured value monitoring – address block 29 ... 108
6.3.11 Settings for auto–reclosure – address block 34 ... 109

6.4 Annunciations ... 114
6.4.1 Introduction ... 114
6.4.2 Operational annunciations – address block 51 ... 115
6.4.3 Fault annunciations – address blocks 52 to 54 ... 121
6.4.4 Circuit breaker operation statistics – address block 56 ... 125
6.4.5 Read–out of operational measured values – address blocks 57 to 59 ... 126
6.4.6 Statistics about data transmission faults – address block 92 ... 129

6.5 Operational control facilities ... 130
6.5.1 Adjusting and synchronizing the real time clock – address block 81 ... 130
6.5.2 Erasing stored annunciations and counters – address block 82 ... 131
6.5.3 Information to LSA during test operation – address block 83 ... 132
6.5.4 Selection of parameter sets – address block 85 ... 133
6.5.4.1 Read–out of settings of a parameter set ... 133
6.5.4.2 Change–over of the active parameter set from the operating panel ... 133
6.5.4.3 Change–over of the active parameter set via binary inputs ... 134

6.6 Testing and commissioning ... 135
6.6.1 General ... 135
6.6.2 Testing the current comparison protection function ... 136
6.6.2.1 Testing the steady–state tripping threshold ... 136
6.6.2.2 Testing the dynamic tripping threshold ... 136
6.6.2.3 Testing the time delay ... 136
6.6.3 Testing the emergency overcurrent time protection ... 137
6.6.3.1 Testing the high–set overcurrent stages I>>, I_E>> ... 137
6.6.3.2 Testing the definite time overcurrent stages I>, I_E> ... 137
6.6.3.3 Testing the inverse time overcurrent stages I_p, I_{Ep} ... 137
6.6.4 Testing the thermal overload protection function ... 138
6.6.5 Testing the auto–reclose functions ... 138

6.7 Commissioning using primary tests . . . 139
6.7.1 Measuring the signal transmission time . . . 139
6.7.2 Polarity check with load current . . . 140
6.7.3 Checking the stabilization . . . 143
6.7.4 Operational test facility . . . 143
6.7.5 Checking the external local and transfer trip facility . . . 144
6.7.6 Tripping test including circuit breaker . . . 144
6.7.6.1 TRIP–CLOSE test cycle – address block 43 . . . 144
6.7.6.2 Live tripping of the circuit breaker – address block 44 . . . 145
6.7.7 Starting a test fault record – address block 49 . . . 147
6.8 Putting the relay into operation . . . 148

7 Maintenance and fault tracing . . . **149**
7.1 Routine checks . . . 149
7.2 Replacing the back–up battery . . . 150
7.3 Fault tracing . . . 152
7.3.1 Replacing the mini–fuse . . . 152

8 Repairs . . . **154**

9 Storage . . . **154**

Appendix . . . **155**

A General diagrams . . . 156
B Current transformer connections . . . 160
C Tables . . . 163

NOTE:

This instruction manual does not purport to cover all details in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the local Siemens sales office.

The contents of this instruction manual shall not become part nor modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligations of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens. Any statements contained herein do not create new warranties nor modify the existing warranty.

1 Introduction

1.1 Application

The numerical current comparison protection is a fast and selective short-circuit protection for cables and overhead lines. Since the comparison of the measured data is performed individually per phase, the treatment of the network neutral is without importance as long as the short-circuit current is sufficiently high for the protection to pick-up.

It is particularly suited to short lines, where, for example, the first zone of a distance protection cannot be set sufficiently short. It can be used with lines down to any length. One set of current transformers is required at each end of the line. Voltage transformers are not required.

An essential advantage of the current comparison protection is its ability to initiate the immediate disconnection of any short-circuit at any location in the protected zone. The current transformers at each end separate the protected zone from the rest of the network. This precise zone cut-off is the reason for the absolute selectivity of the comparison protection principle. This eliminates the need to delay the trip signal which is necessary with time-graded protection.

The current comparison protection system requires the installation of one 7SD512 or 7SD511 (from firmware version V2.0 or higher) unit at each end of the line. The data exchange required for the interaction of both units is performed by digital signals via an interface and a data link. For this, optical fibres are recommended. Since fault-free data transmission is a prerequisite for the correct functioning of the protection system, it is continuously supervised within the relay.

When the data link fails, or when the received data are not plausible, the relay can switch automatically over to emergency overcurrent time protection mode. In this case the relay can continue operating either as definite time or as inverse time overcurrent protection for phase and earth faults.

Since the comparison protection does not disconnect faults outside the protected zone, an additional time-graded protection must be installed at at least one end of the line to serve as superimposed back-up protection.

In cases where a transformer is directly connected (i.e. without a circuit breaker) to a cable or to an overhead line, current transformers should be installed at the connection point and the 7SD512 should only be used as line protection. Since the line comparison protection is not suitable for the inclusion of a transformer in the protected zone, the transformer must be equipped with a transformer differential protection, e.g. 7UT51.

A thermal overload protection is integrated for use on cables.

For use on overhead lines, an automatic reclose function is integrated which permits three-pole, single-pole, or single- and three-pole auto-reclosure. Additionally, repeated auto-reclose attempts are possible (up to 9 shots).

Throughout a fault in the network the magnitudes of the instantaneous values are stored for a period of max. 5 seconds (at 50 Hz) and are available for subsequent fault analysis. Fault inception is tagged with the real time provided the internal real time clock is available.

Continuous monitoring of the measured values permits rapid annunciation of any fault in the measuring transformer circuits. Continuous plausibility monitoring of the internal measured value processing circuits and monitoring of the auxiliary voltages to ensure that they remain within tolerance are obviously inherent features.

Serial interfaces allow comprehensive communication with other digital control and storage devices (optional). For data transmission a standardized protocol in accordance with VDEW/ZVEI and 60870–5–103 is used, as well as according to DIN 19244. The device can therefore be incorporated in Localized Substation Automation networks (LSA).

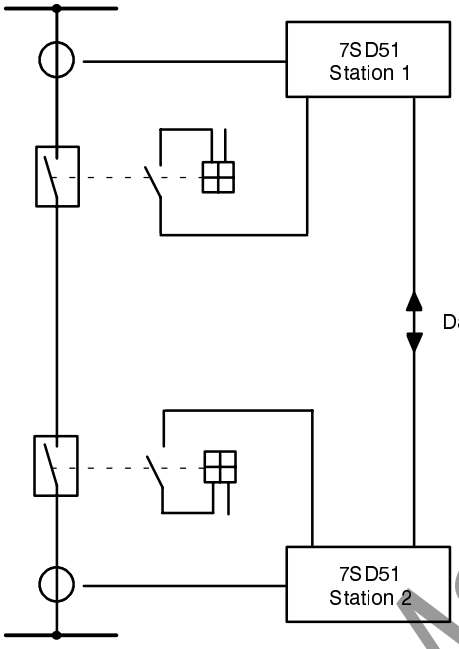


Figure 1.1 Current comparison protection for lines and cables 7SD51, scheme

1.2 Features

– Processor system with powerful 16-bit-microprocessor;

– complete digital measured value processing and control from data acquisition and digitizing of the measured values up to the trip and close decisions for the circuit breakers;

– complete galvanic and reliable separation of the internal processing circuits from the measurement, control and supply circuits of the system, with screened analog input transducers, binary input and output modules and d.c. converter;

– comprehensive supplementary functions (refer to Section 1.3);

– continuous calculation of operational measured values and indication on the front display;

– simple setting and operation using the integrated operation panel or a connected personal computer with menu-guided software;

– storage of fault data, storage of instantaneous values during a fault for fault recording;

– data exchange with opposite station via optical fibre for data transmission; isolated V.24 (RS232) interface possible for connection with a optical fibre transmission device;

– compatible with 7SD511 from firmware V2.0;

– communication with central control and storage devices via serial interfaces is possible with optical fibre connection;

– continuous monitoring of the measured values and the hardware and software of the relay.

1.3 Implemented functions

The numerical current comparison protection relay 7SD512 contains the following functions:

Current comparison protection

– protection for all kinds of short-circuits in systems with earthed or non-earthed star-point;

– reliable distinction between load conditions and fault conditions;

– phase-segregated measurement, thus pick-up sensitivity independent of the type of fault;

– single-pole trip possible for single-phase faults (for operation with single-pole or single- and three-pole auto-reclosure);

– adjustable steady-state pick-up level together with high dynamic sensitivity;

– insensitive to inrush and charging currents as well as to high-frequency transients;

– insensitive to d.c. components and transformer errors of current transformers;

– high stability even with differing current transformer saturation;

– data exchange with opposite station via optical fibre for data transmission; isolated V.24 (RS232) interface possible for connection with a optical fibre transmission device;

– intertripping signal for rapid phase-segregated trip even at line ends without infeed or with weak infeed;

– continuous supervision of data link and data transmission time;

– automatic correction of the data transmission time is possible.

Emergency overcurrent function

– for ”emergency operation” during disturbance or failure on the data transmission link;

– operates as definite time or inverse time overcurrent protection with selectable characteristics;

– separate high current stage with definite time characteristic or instantaneous trip;

– separate earth current stages with separately selectable characteristics.

External local trip

– tripping of the local circuit breaker from an external source with adjustable delay and reset time;

– includes signal of external protective or supervisory devices into the processing of trip commands and signalling.

Transfer trip

– provides tripping of the remote end circuit breaker by an external signal, e.g. breaker failure protection.

User definable annunciations

– includes user definable signals and messages into the processing of annunciations;

– transmission of user definable signals and messages to the remote line end.

Automatic reclose function

– single-pole, three-pole or single and three-pole;

– single or multi-shot (e.g. RAR and DAR, three-pole DAR from second shot on);

– with separately allocated action times and dead times for single-pole, three-pole RAR (rapid AR for first shot) and three-pole DAR (delayed AR for further shots);

– can be initiated by current comparison protection and/or emergency overcurrent time protection.

Thermal overload protection

– provides thermal replica of the current heat losses;

– true r.m.s. measurement of all three conductor currents;

– adjustable warning stage.

The standard functions also include:

– continuous self-monitoring right from the d.c. circuits, through the current inputs to the tripping relays, thus achieving maximum availability and a more corrective than preventive maintenance strategy;

– measurement and test routines under normal load conditions:
measurement of load currents,
measuring of the signal transmission time,
measurement of current direction and phase sequence;

– annunciation storage for the last three network faults, optionally with real time clock;

– data storage and transmission for fault recording giving
rapid fault analysis,
detailed fault records;

– counting of tripping and closing commands as well as recording of fault data and accumulative addition of the interrupted fault currents;

– commissioning aids such as connection check, signal transmission time measurement, and circuit breaker live test.

2 Design

2.1 Arrangements

All protection functions including dc/dc converter are accommodated on two plug-in modules of Double Europa Format. These modules are installed in a housing 7XP20. Two different types of housings can be delivered:

– **7SD512⋆–⋆B⋆⋆⋆–** in housing 7XP2040–1 for **panel surface mounting**

  The housing has full sheet-metal covers, as well as a removable front cover with transparent plastic window.

  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. Additionally, terminal 26 is connected to the case.

  All external signals are connected to 100 screwed terminals which are arranged over cut-outs on the top and bottom covers. The terminals are numbered consecutively from left to right at the bottom and top.

  The heavy duty current plug connectors provide automatic shorting of the c.t. circuits whenever the modules are withdrawn. This does not release from the care to be taken when c.t. secondary circuits are concerned. With differential protection relays, trip may occur when modules are withdrawn or inserted.

  For the optional interface to a central control and storage unit, an additional coupling facility has been provided. For the interface for optical fibre connection (model 7SD512⋆–⋆⋆⋆⋆–⋆**C**), two F–SMA connectors have been provided.

  For protection data transmission to the opposite line end a further serial interface is provided (optical fibre or V.24/RS 232 C).

  The degree of protection for the housing is IP51, for the terminals IP21. For dimensions please refer to Figure 2.2.

– **7SD512⋆–⋆C⋆⋆⋆–** in housing 7XP2040–2 for **panel flush mounting** or **7SD512⋆–⋆E⋆⋆⋆–** in housing 7XP2040–2 for **cubicle installation**

  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.

  All external signals are connected to connector modules which are mounted on the rear cover over cut-outs. For each electrical connection, one screwed terminal and one parallel snap-in terminal are provided. For field wiring, the use of the screwed terminals is recommended; snap-in connection requires special tools.

  The heavy duty current plug connectors provide automatic shorting of the c.t. circuits whenever the modules are withdrawn. This does not release from the care to be taken when c.t. secondary circuits are concerned. With differential protection relays, trip may occur when modules are withdrawn or inserted.

  For protection data transmission to the opposite line end a further serial interface is provided (optical fibre or V.24 / RS 232 C).

  For the optional interface to a central control and storage unit (7SD512⋆–⋆⋆⋆⋆–⋆**C**) a module with 2 F–SMA connectors is provided.

  The plug modules are labelled according to their mounting position by means of a grid system (e.g. **1A**2). The individual connections within a module are numbered consecutively from left to right (when viewed from the rear), (e.g. 1A**2**); refer Figure 2.1.

  Degree of protection for the housing is IP51 (for cubicle installation IP 30), for the terminals IP21. For dimensions please refer to Figure 2.3.

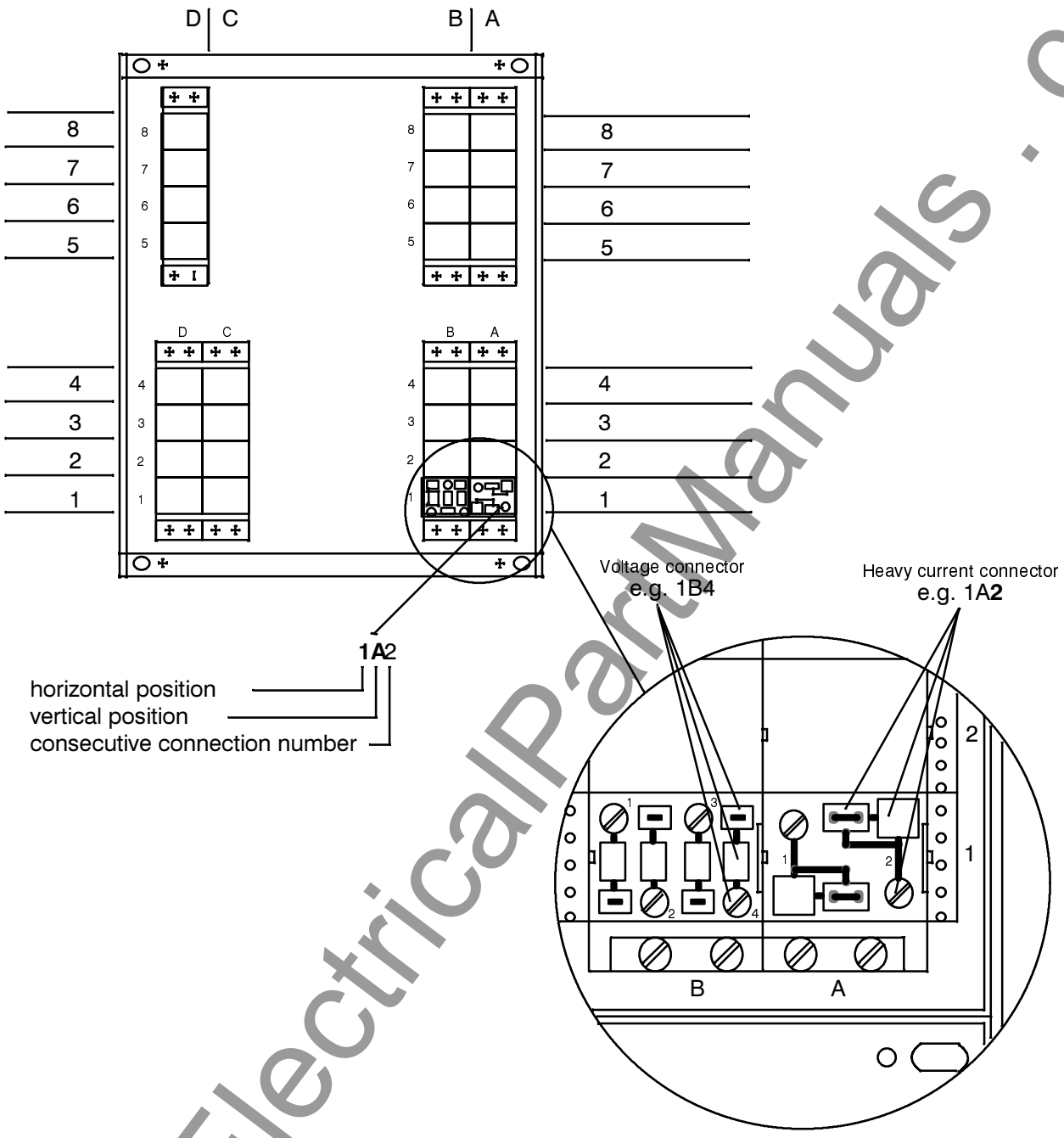
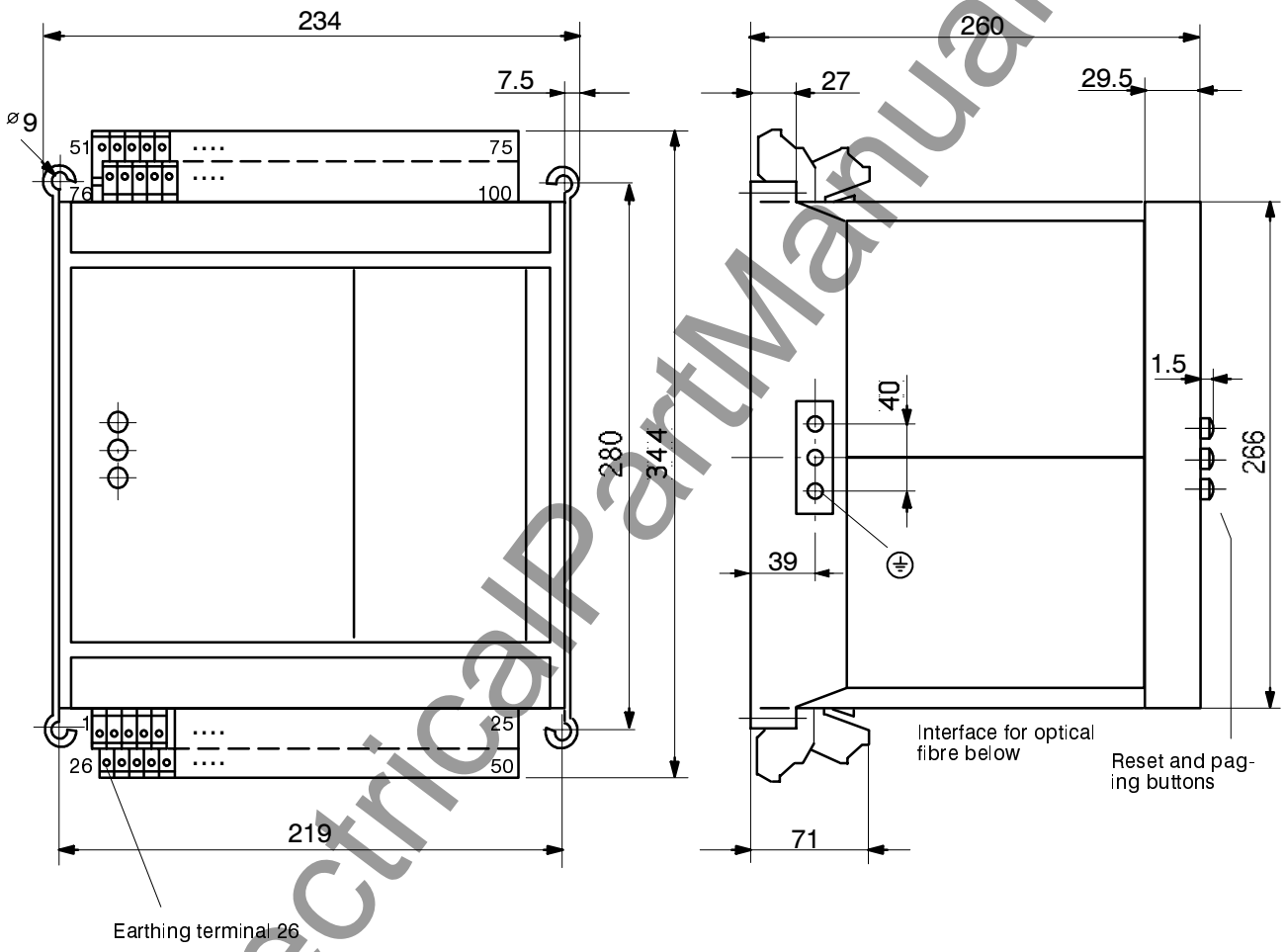


Figure 2.1 Connection plugs (rear view) – housing for flush mounting – example

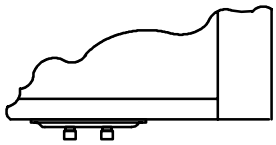
2.2 Dimensions

Figures 2.2 and 2.3 show the dimensions of the various types of housings available.

7SD512 Housing for **panel surface mounting** 7XP2040 – 1



Max. 100 terminals for cross-section max. 7 mm^2

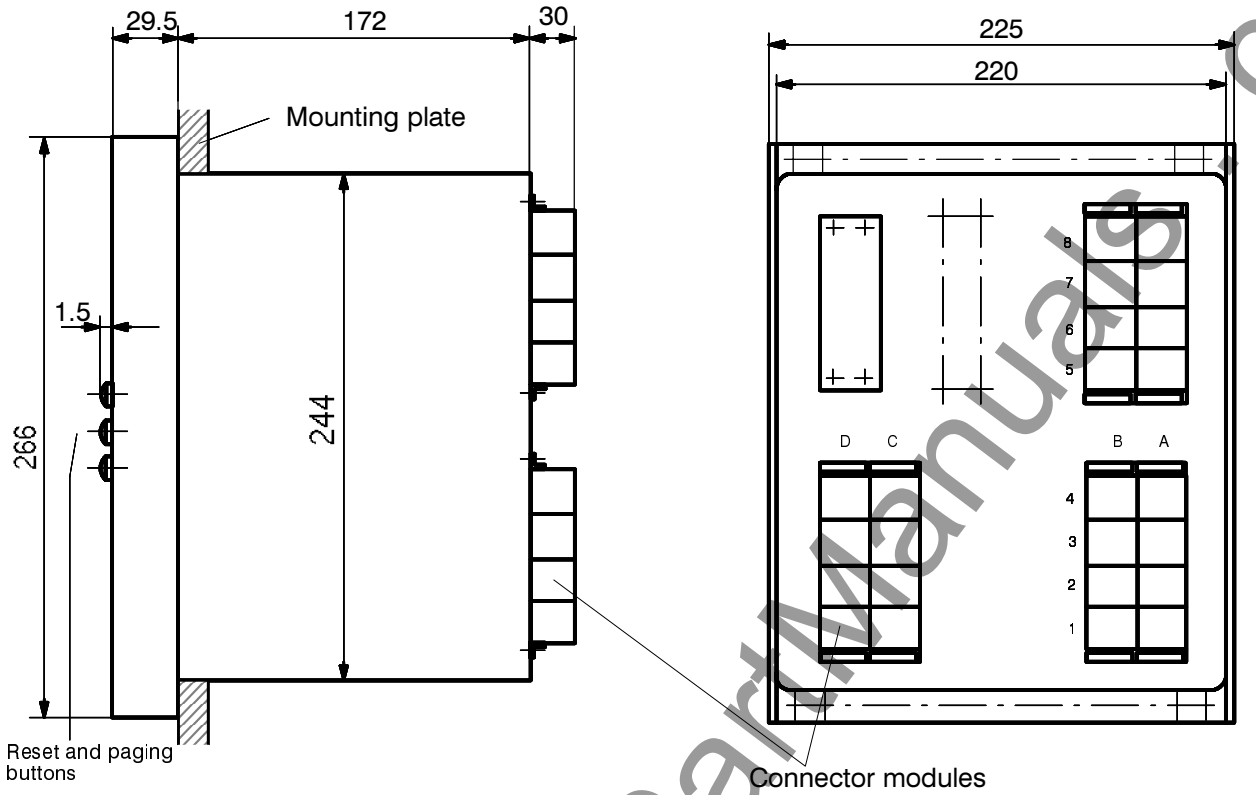


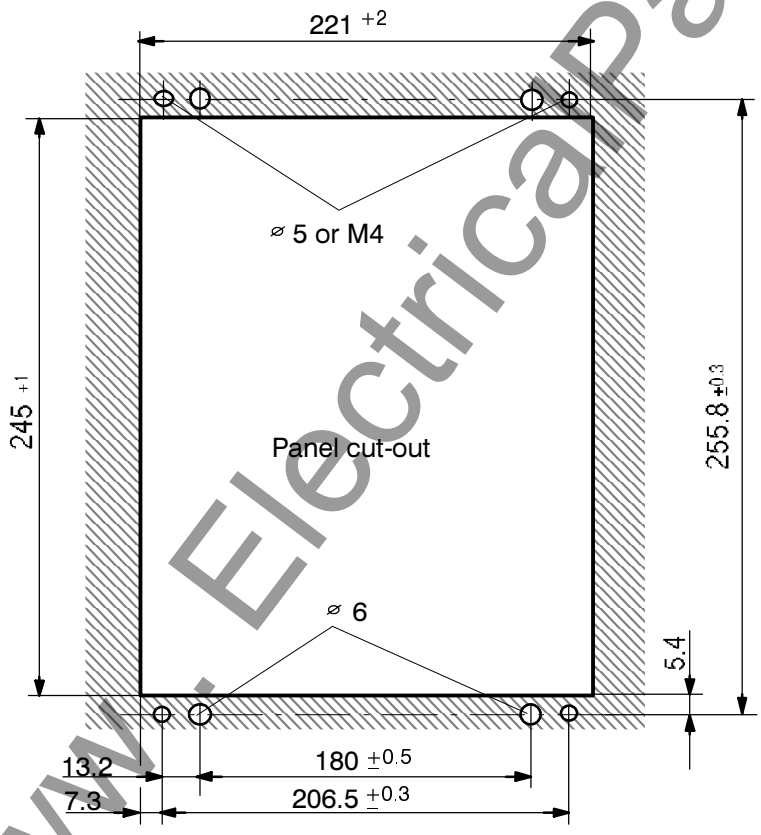
optical fibre connectors
integrated F – SMA connector,
with ceramic post,
e.g for glass fibre 62.5/125 µm

Dimensions in mm

Figure 2.2 Dimensions for housing 7XP2040 – 1 for panel surface mounting

7SD512 Housing for **panel flush mounting** or **cubicle installation** 7XP2040 – 2





Heavy current connectors:
Screwed terminal for max. 4 mm².
Twin spring crimp connector in parallel for max. 2.5 mm².

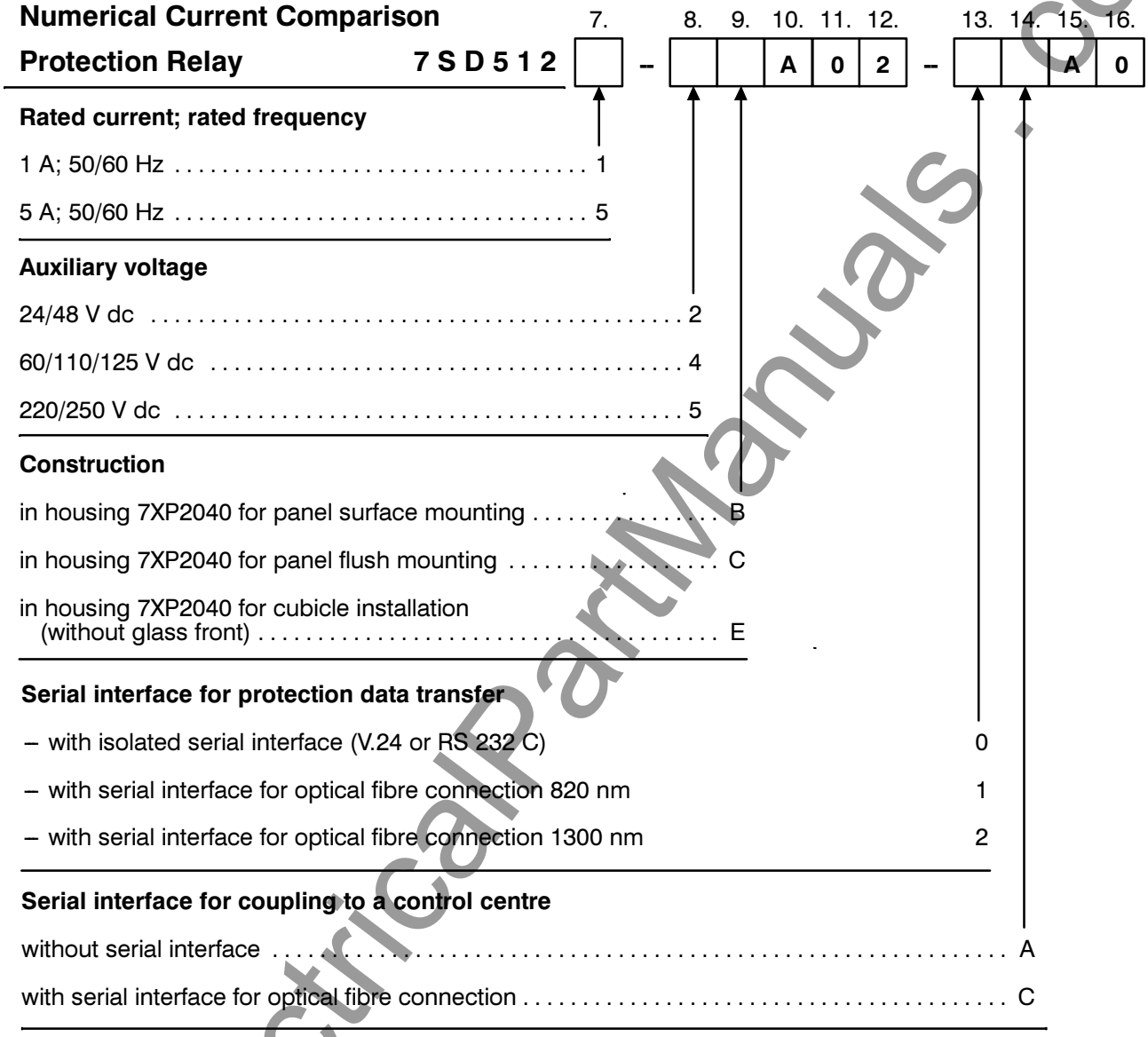
Further connectors:
Screwed terminal for max. 1.5 mm².
Twin spring crimp connector in parallel for max. 1.5 mm².

Optical fibre connectors:
integrated F – SMA connector,
with ceramic post,
e.g for glass fibre 62.5/125 µm

Dimensions in mm

Figure 2.3 Dimensions for housing 7XP2040 – 2 for panel flush mounting or cubicle installation

2.3 Ordering data



3 Technical data

3.1 General data

3.1.1 Inputs/outputs

Measuring circuits

Rated current I_N		1 A or 5 A
Rated frequency f_N		50 Hz/60 Hz (settable)
Power consumption	current path at I_N = 1 A	<0.1 VA per phase
	current path at I_N = 5 A	<0.5 VA per phase
Overload capability	current path	
– thermal (rms)		100 $\times I_N$ for $\leq$1 s
		20 $\times I_N$ for $\leq$10 s
		4 $\times I_N$ continuous
– dynamic (pulse current)		250 $\times I_N$ one half cycle

Auxiliary voltage

Power supply via integrated dc/dc converter

Rated auxiliary voltage U_H	24/48 Vdc	60/110/125 Vdc	220/250 Vdc
Permissible variations	19 to 56 Vdc	48 to 144 Vdc	176 to 288 Vdc

Superimposed ac voltage, peak-to-peak	$\leq$ 12 %	at rated voltage
	$\leq$ 6 %	at limits of admissible voltage
Power consumption	quiescent	approx. 11 W
	energized	approx. 20 W
Bridging time during failure/short-circuit of auxiliary voltage	$\geq$ 50 ms at $U_{rated} \geq$ 110 Vdc	

Heavy duty (command) contacts

Command (trip) relays, number		5
Contacts per relays		2 NO
Switching capacity	MAKE	1000 W/VA
	BREAK	30 W/VA
Switching voltage		250 V
Permissible current		5 A continuous
		30 A for 0.5 s

Signal contacts

Signal/alarm relays		11
Contact per relays		1 CO
Switching capacity	MAKE/BREAK	20 W/VA
Switching voltage		250 V
Permissible current		1 A

Binary inputs

Number	10
Operating voltage	reconnectable 24 to 250 V dc, up to production series /DD in 2, from production series /EE or later in 4 ranges:

for rated control voltage	24/48 Vdc	60 Vdc	110/125 Vdc	220/250 Vdc
pick-up value, approx.	16 Vdc	44 Vdc	80 Vdc	160 Vdc

Current consumption	approx 1.7 mA independent of operating voltage

Serial interfaces

Operator terminal interface	non-isolated
– Connection	at the front, 25-pole subminiature connector acc. ISO 2110 for connection of a personal computer or similar
– Transmission speed	as delivered 9600 Baud min 1200 Baud, max 19200 Baud
Floating interface for data transfer to the remote line end	isolated
– Standards	similar V.24/V.28 to CCITT; RS 232 C to EIA
– Transmission speed	19200 Baud
– Transmission security	Hamming distance d = 4
– Connection	data cable or optical fibre, refer to Section 3.2
Floating interface for data transfer to a control centre (optional)	isolated
– Standards	Protocol acc. VDEW/ZVEI and IEC 60870–5–103, or acc. DIN 19244 (selectable)
– Transmission speed	as delivered 9600 Baud min 1200 Baud, max. 19200 Baud
– Transmission security	Hamming distance d = 4
– Connection optical fibre	integrated F–SMA connector for direct optical fibre connection, with ceramic post, e.g. glass fibre 62.5/125 µm for flush mounted housing: at the rear for surface mounted housing: on the bottom cover
Optical wave length	820 nm
Permissible line attenuation	max. 8 dB
Transmission distance	max. 1.5 km
Normal signal position	reconnectable; factory setting: ”light off”

3.1.2 Electrical tests

Insulation tests	
Standards:	IEC 6060255−5
– High voltage test (routine test) except d.c. voltage supply input	2 kV (rms); 50 Hz
– High voltage test (routine test) only d.c. voltage supply input	2.8 kV dc
– Impulse voltage test (type test) all circuits, class III	5 kV (peak); 1.2/50 μs; 0.5 J; 3 positive and 3 negative shots at intervals of 5 s
EMC tests; immunity (type tests)	
Standards:	IEC 60255−6, IEC 60255−22 (product standards) EN 50082−2 (generic standard) VDE 0435 /part 303
– High frequency IEC 60255−22−1, class III	2.5 kV (peak); 1 MHz; τ =15 μs; 400 shots/s; duration 2 s
– Electrostatic discharge IEC 60255−22−2 class III and IEC 61000−4−2, class III	4 kV/6 kV contact discharge; 8 kV air discharge; both polarities; 150 pF; R_i = 330 Ω
– Radio-frequency electromagnetic field, non-modulated; IEC 60255−22−3 (report) class III	10 V/m; 27 MHz to 500 MHz
– Radio-frequency electromagnetic field, amplitude modulated; IEC 61000−4−3, class III	10 V/m; 80 MHz to 1000 MHz; 80 % AM; 1 kHz
– Radio-frequency electromagnetic field, pulse modulated; IEC 61000−4−3/ENV 50204, class III	10 V/m; 900 MHz; repetition frequency 200 Hz; duty cycle 50 %
– Fast transients IEC 60255−22−4 and IEC 61000−4−4, class III	2 kV; 5/50 ns; 5 kHz; burst length 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; duration 1 min
– Conducted disturbances induced by radio-frequency fields, amplitude modulated IEC 61000−4−6, class III	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
– Power frequency magnetic field IEC 61000−4−8, class IV IEC 60255−6	30 A/m continuous; 300 A/m for 3 s; 50 Hz 0.5 mT; 50 Hz
EMC tests; emission (type tests)	
Standard:	EN 50081−⋆ (generic standard)
– Conducted interference voltage, aux. voltage CISPR 22, EN 55022, class B	150 kHz to 30 MHz
– Interference field strength CISPR 11, EN 55011, class A	30 MHz to 1000 MHz

3.1.3 Mechanical stress tests

Vibration and shock during operation

Standards:	IEC 60255−21 and IEC 60068−2
− Vibration IEC 60255−21−1, class 1 IEC 60068−2−6	sinusoidal 10 Hz to 60 Hz: ± 0.035 mm amplitude; 60 Hz to 150 Hz: 0.5 g acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
− Shock IEC 60255−21−2, class 1	half sine acceleration 5 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
− Seismic vibration IEC 60255−21−3, class 1 IEC 60068−3−3	sinusoidal 1 Hz to 8 Hz: ± 3.5 mm amplitude (hor. axis) 1 Hz to 8 Hz: ± 1.5 mm amplitude (vert. axis) 8 Hz to 35 Hz: 1 g acceleration (hor. axis) 8 Hz to 35 Hz: 0.5 g acceleration (vert. axis) sweep rate 1 octave/min 1 cycle in 3 orthogonal axes

Vibration and shock during transport

Standards:	IEC 60255−21 and IEC 60068−2
− Vibration IEC 60255−21−1, class 2 IEC 60068−2−6	sinusoidal 5 Hz to 8 Hz: ± 7.5 mm amplitude; 8 Hz to 150 Hz: 2 g acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
− Shock IEC 60255−21−2, class 1 IEC 60068−2−27	half sine acceleration 15 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
− Continuous shock IEC 60255−21−2, class 1 IEC 60068−2−29	half sine acceleration 10 g, duration 16 ms, 1000 shocks each direction of 3 orthogonal axes

3.1.4 Climatic stress tests

− recommended temperature during service	−5 °C to +55 °C	(> 55 °C decreased display contrast)
− permissible temperature during service	−20 °C to +70 °C	
permissible temperature during storage	−25 °C to +55 °C	
permissible temperature during transport	−25 °C to +70 °C	

Storage and transport with standard works packaging!

– Permissible humidity	mean value per year $\leq$ 75 % relative humidity; on 30 days per year 95 % relative humidity; condensation not permissible!

We recommend that all units are installed such that they are not subjected to direct sunlight, nor to large temperature fluctuations which may give rise to condensation.

3.1.5 Service 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.

3.1.6 Design

Housing	7XP20; refer to Section 2.1
Dimensions	refer to Section 2.2
Weight	
– in housing for surface mounting	approx. 10.0 kg
– in housing for flush mounting	approx. 7.6 kg
Degree of protection acc. to EN 60529	
– Housing	IP 51 *)
– Terminals	IP 21

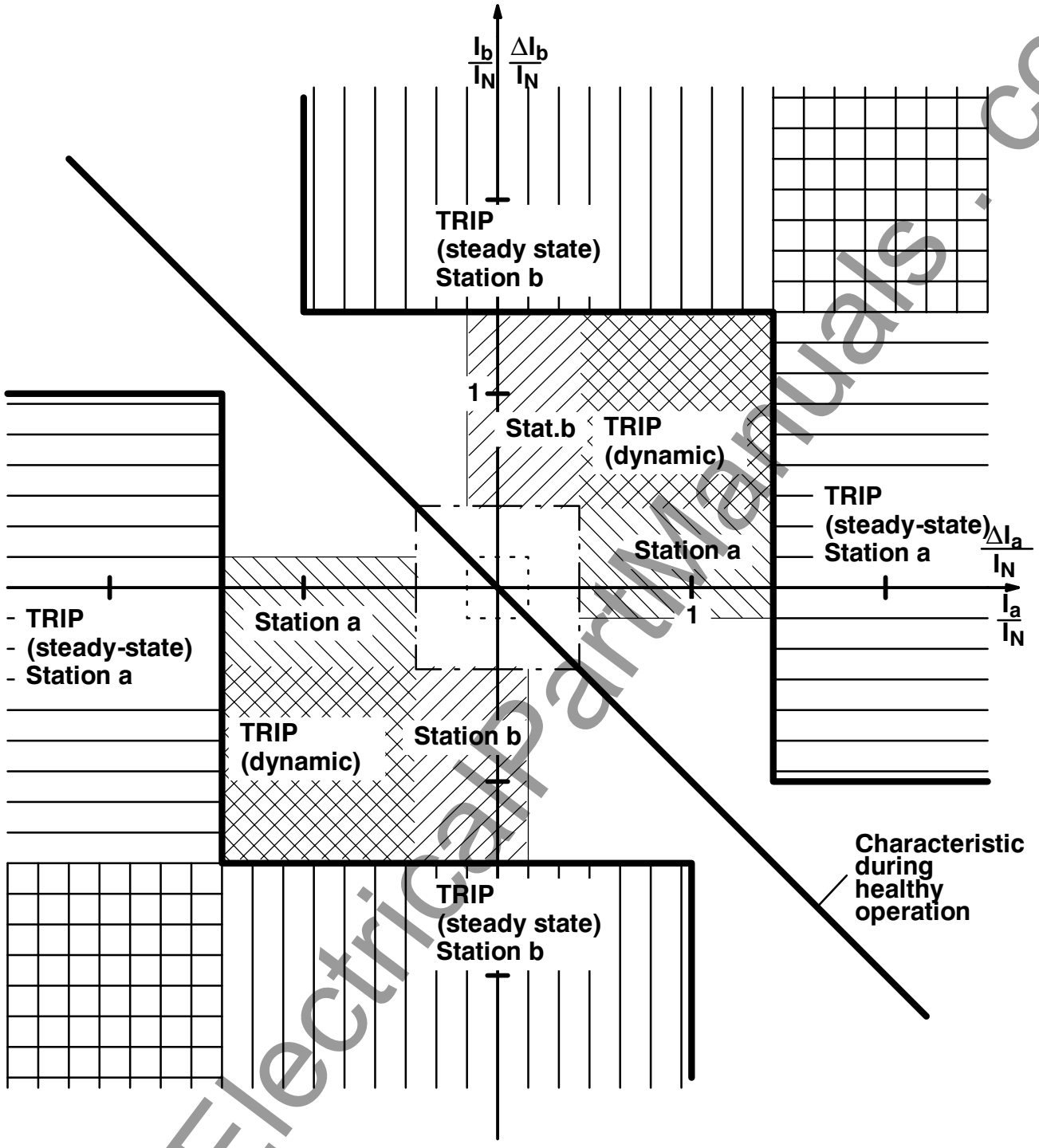
*) IP30 for cubicle installation; the degree of protection required for the point of installation must be ensured by the cubicle.

3.2 Current comparison protection

Setting ranges/steps			
Steady-state trip threshold	I/I_N	0.50 to 4.00	(steps 0.01)
Dynamic trip threshold (for abrupt current changes)	I/I_N	0.20 to 1.00	(steps 0.01)
Pick-up characteristics		refer to Figure 3.1	
Reset value		$0.15 \cdot I_N$	
Frequency range		45 to 55 Hz or 55 to 65 Hz	
Times			
Pick-up time with double-ended infeed – with 4 x setting value I> DYN		approx. 30 ms to 35 ms	
Reset time		approx. 100 ms	
Tolerances of pick-up limits		± 5 % of should-be value $\pm$ 0.01 · I_N (with single-ended infeed)	
Influence variables – Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$		$\leq$ 1%	
– Temperature in range 0 °C $\leq \vartheta_{amb} \leq$ 40 °C		$\leq$ 0.5 %/10 K	
Protection data transmission			
Connection for coupling with opposite station			
Direct wire connection (e.g. for connection of an electro-optical converter)		isolated for flush mounted housing: at the rear, 4-pole connector module for surface mounted housing: at terminals above	
– data cable		2 core pairs, with individual and common screening 150 Ω/km, 60 nF/km; e.g. LI YCY–CY/2 x 2 x 0.25 mm^2	
max. signal jitter at transmission output		$\leq$ 0.23 UI (unit interval)	
adm. signal jitter at receive input		$\leq$ 0.25 UI (unit interval)	
– permissible line attenuation		max. 10 dB	
– transmission distance		approx. 1 km	
Optical fibre connection		integrated connector for optical fibre, with ceramic post for flush mounted housing: at the rear; for surface mounted housing: on the bottom cover	
– direct fibre-optic connection:			

optical wave length	F–SMA plug 820 nm	FC plug 1300 nm
max. signal jitter at transmission output	$\leq$ 0.11 UI (unit interval)	$\leq$ 0.11 UI (unit interval)
adm. signal jitter at receive input	$\leq$ 0.43 UI (unit interval)	$\leq$ 0.43 UI (unit interval)
glass fibre type	62.5/125 µm multi-mode	9/125 µm single mode
permissible line attenuation	typ. 8 dB	typ. 21.5 dB
transmission distance (guide value)	approx. 1.5 km	approx. 30 km

normal signal position	factory setting: ”Light off”; with 820 nm reconnectable “Light on”
– via optical fibre transmission device	e.g 7VR50 or PCM 30 unit for longer distances



I_a Current in station a (local station) in direction of line
I_b Current in station b (opposite station) in direction of line

Figure 3.1 Pick-up characteristics of 7SD51

3.3 External local and transfer trip

External local trip via binary input

Setting ranges/steps		
Trip delay	0.00 s to 60.00 s	(steps 0.01 s)
Reset delay	0.00 s to 60.00 s	(steps 0.01 s)
Tolerances	1 % or 10 ms	

Operating times	
Pick-up time	approx. 25 to 35 ms
Reset time	approx. 45 ms

Transfer trip via binary input

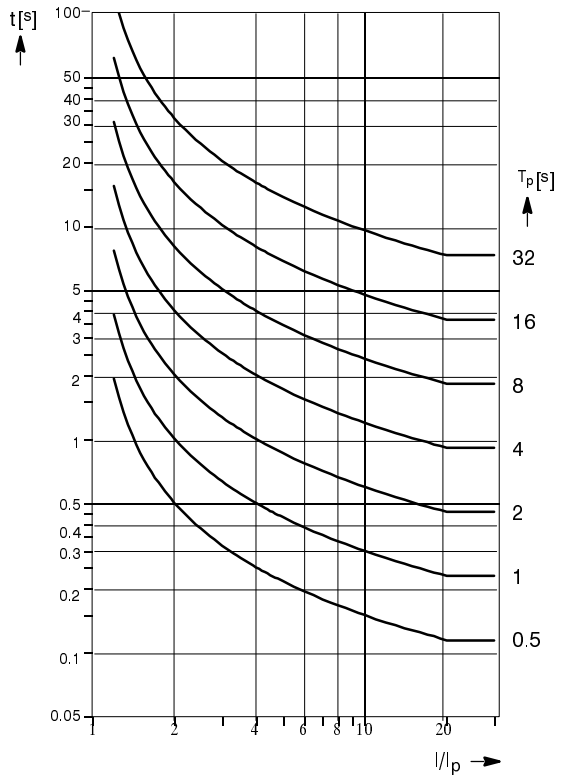
Setting ranges/steps		
Send delay before transmission	0.00 s to 60.00 s	(steps 0.01 s)
Send prolongation time	0.00 s to 60.00 s	(steps 0.01 s)
Reception prolongation time	0.00 s to 60.00 s	(steps 0.01 s)
Tolerances	1 % or 10 ms	

Operating times	
Pick-up time (incl. transmission)	approx. 50 ms
Reset time	approx. 45 ms

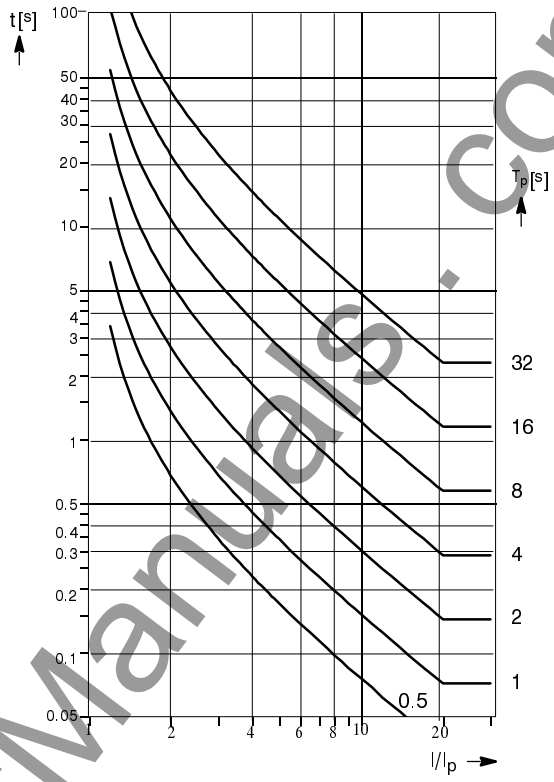
The set times are pure delay times.

3.4 Emergency overcurrent time protection

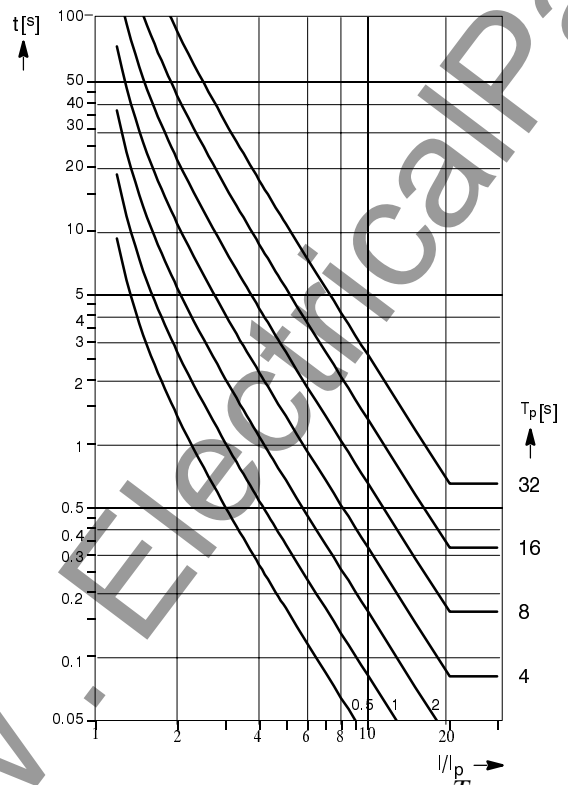
Emergency operation			during data transmission failure
operation modes			optionally definite time overcurrent protection or inverse time overcurrent protection; with definite time or instantaneous high current stage
Characteristics			
for **definite** time overcurrent protection			
– shortest trip time			approx. 30 ms
for **inverse** time overcurrent protection			
– trip time characteristics			normal inverse, very inverse, extremely inverse (type A, B, C) acc. IEC 60255–3; refer to Figure 3.2
Pick-up/Times			
high-current stage	$I>>/I_N$ (phases)	0.10 to 15.00	(steps 0.01)
high-current stage	$I_E>>/I_N$ (earth)	0.10 to 10.00	(steps 0.01)
delay time $T_{I>>}$		0.00 s to 32.00 s	(steps 0.01 s)
		or ∞ (stage ineffective)	
overcurrent stage (phases) for **definite** time	$I>/I_N$	0.10 to 15.00	(steps 0.01)
delay time $T_{I>}$		0.00 s to 32.00 s	(steps 0.01 s);
		or ∞ (stage ineffective)	
earth current stage for **definite** time	$I_E>/I_N$	0.10 to 4.00	(steps 0.01)
delay time $T_{IE>}$		0.00 s to 32.00 s	(steps 0.01 s)
		or ∞ (stage ineffective)	
overcurrent stage (phases) for **inverse** time	I_p/I_N	0.10 to 4.00	(steps 0.01)
time multiplier T_p		0.50 to 32.00	(steps 0.01)
earth current stage for **inverse** time	I_{Ep}/I_N	0.10 to 4.00	(steps 0.01)
time multiplier T_{IEp}		0.50 to 32.00	(steps 0.01)
measuring time		approx. 35 ms	
reset time		approx. 35 ms	
overshot time		approx. 35 ms	
drop-off ratio		approx. 0.95	
measurement tolerances acc. VDE 0435 part 303			
– for definite time stages, $I>>$, $I_E>>$, $I>$, $I_E>$		± 3 % of set value	
– for inverse time stages I_p, I_{Ep}		pick-up at $1.05 < I/I_{(E)p} < 1.15$	
time tolerances			
– for definite time stages		1 % of set value or 10 ms	
– for inverse time stages		$\leq$ 5% ±30 ms for	$2 \leq I/I_{(E)p} \leq 20$
			$1 \leq T_{(E)p}/s \leq 20$



Normal inverse : $t = \dfrac{0.14}{(I/I_p)^{0.02} - 1} \cdot \dfrac{T_p}{10} \quad [s]$



Very inverse : $t = \dfrac{13.5}{(I/I_p) - 1} \cdot \dfrac{T_p}{10} \quad [s]$



Extremely inverse : $t = \dfrac{80}{(I/I_p)^2 - 1} \cdot \dfrac{T_p}{10} \quad [s]$

t tripping time
T_p set time delay
I earth fault current
I_p set earth fault pick-up value

$T_p/10$ corresponds to the usual time multiplier TM

Note: For earth faults read I_{Ep} instead of I_p and T_{Ep} instead of T_p

Figure 3.2 Tripping time characteristics of inverse time overcurrent protection

3.5 Thermal overload protection

Setting ranges/steps

Factor k according to IEC 60255−8	0.10 to 4.00	(steps 0.01)
Time constant τ	1.0 to 999.9 min	(steps 0.1 min)
Thermal warning stage $\Theta_{warn}/\Theta_{trip}$	50 to 100 % referred to trip temperature rise	(steps 1 %)
Current warning stage I_{warn}/I_N	0.10 to 4.00	(steps 0.01)

Trip time characteristic

$$t = \tau \cdot \ln \frac{(I / k \cdot I_N)^2 - (I_{pre} / k \cdot I_N)^2}{(I / k \cdot I_N)^2 - 1}$$

t	trip time
τ	time constant
I	load current
I_{pre}	preload current
k	factor according to IEC 60255−8 refer also Figures 3.3 and 3.4

Reset ratios

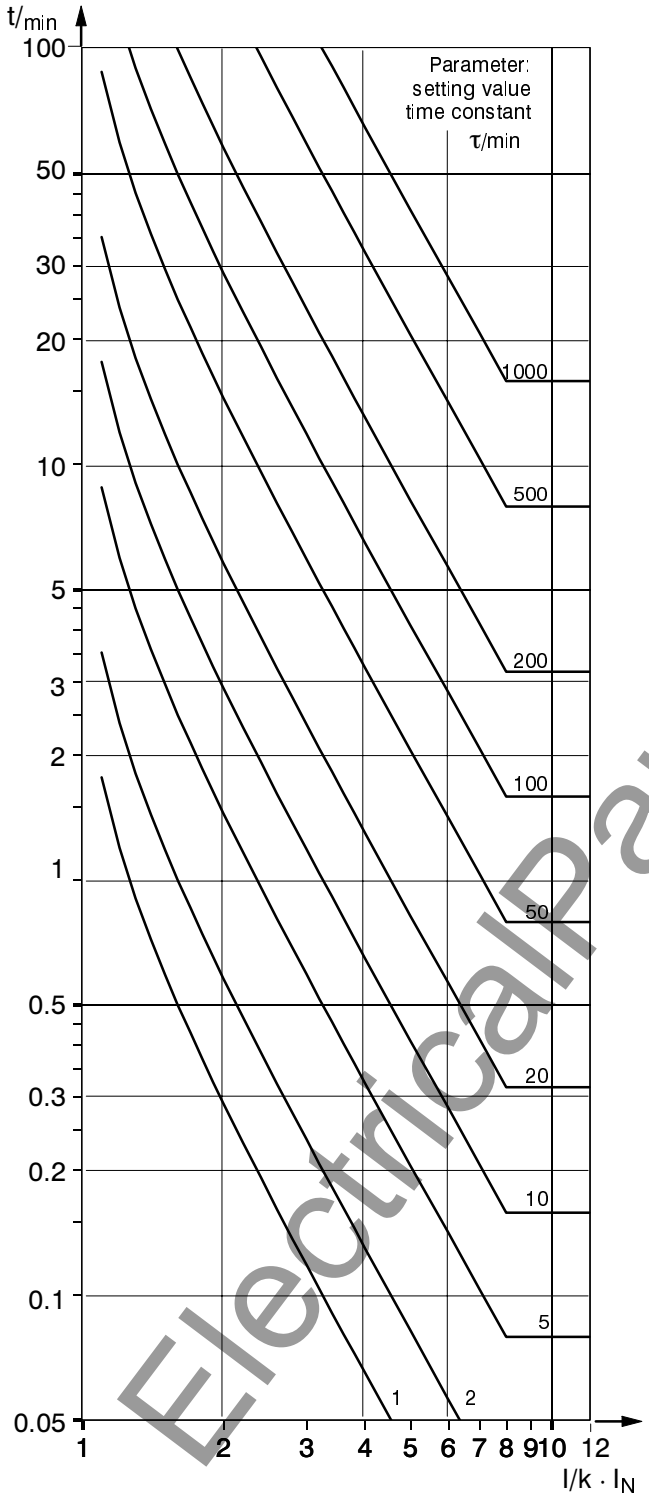
Θ/Θ_{trip}	approx. 0.99
Θ/Θ_{warn}	approx. 0.99
I/I_{warn}	approx. 0.97

Tolerances

– referring to k· I_N	± 10 %
– referring to trip time	± 10 % ± 2 s

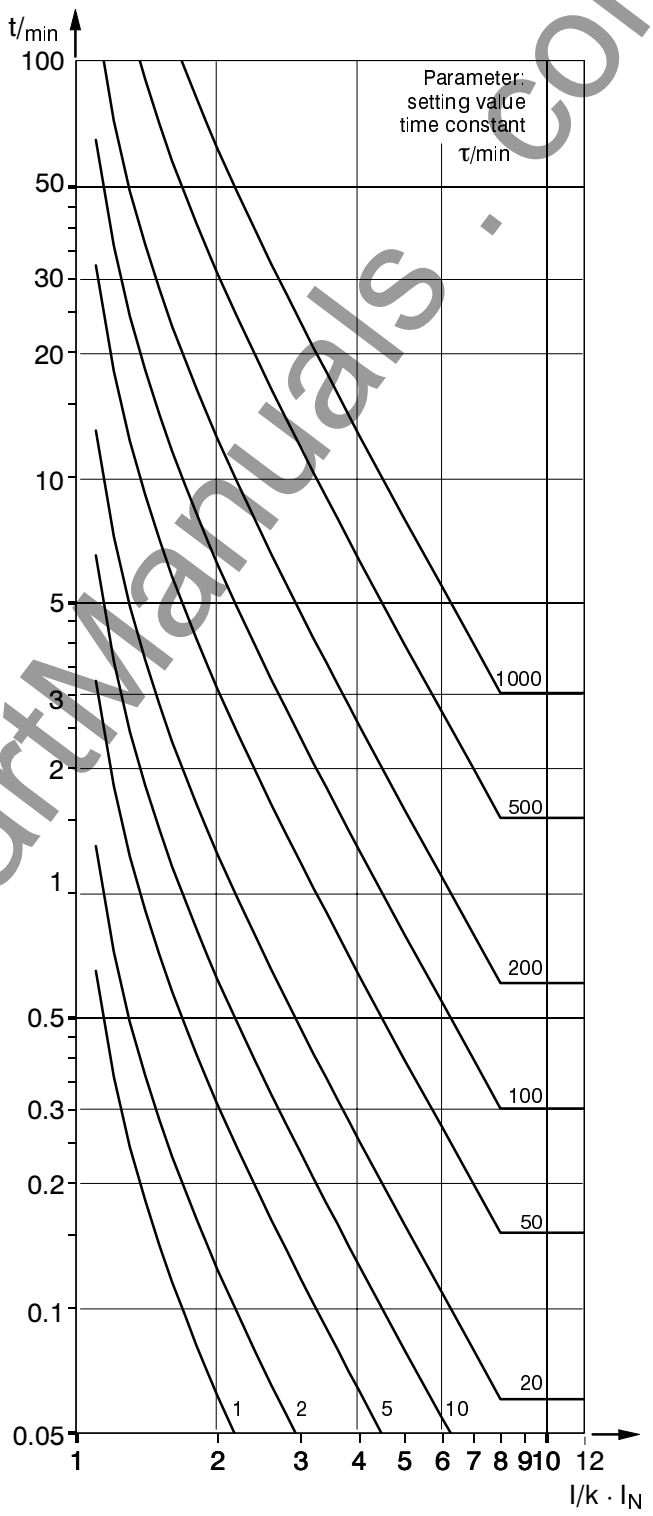
Influence variables referred to k·I_N

– Auxiliary dc voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	≤ 1 %
– Temperature in range $-5\ ^\circ C \leq \vartheta_{amb} \leq +40\ ^\circ C$	≤ 0.5 %/10 K
– Frequency in range $0.95 \leq f/f_N \leq 1.05$	≤ 1 %



$$t = \tau \cdot \ln \frac{(I / k \cdot I_N)^2}{(I / k \cdot I_N)^2 - 1}$$

Figure 3.3 Trip time characteristic of overload protection – with preload –



$$t = \tau \cdot \ln \frac{(I / k \cdot I_N)^2 - (I_{pre} / k \cdot I_N)^2}{(I / k \cdot I_N)^2 - 1}$$

for 90 % preload

Figure 3.4 Trip time characteristic of overload protection – with 90 % preload –

3.6 Auto-reclosure

Max. number of possible shots	1 RAR (first shot) up to 9 DAR (further shots)
Auto-reclose modes	single-pole or three-pole or single/three-pole (1st shot RAR); further shots three-pole (DAR)
Possible programs for RAR	three-pole for all kinds of fault single-pole, no AR after three-pole trip single- and three-pole, depending on trip command
Possible programs for DAR	DAR only after RAR DAR also without RAR no DAR
Action times	0.01 s to 320.00 s (steps 0.01 s)
RAR dead time single-pole	0.01 s to 320.00 s (steps 0.01 s)
RAR dead time three-pole	0.01 s to 320.00 s (steps 0.01 s)
DAR dead times	0.01 s to 1800.00 s (steps 0.01 s)
Discrimination time for evolving faults	0.01 s to 320.00 s (steps 0.01 s)
Reclaim time	0.50 s to 320.00 s (steps 0.01 s)
Lock-out time	0.50 s to 320.00 s (steps 0.01 s); ∞
Reclaim time after manual close	0.50 s to 320.00 s (steps 0.01 s)
Duration of RECLOSE command	0.01 s to 320.00 s (steps 0.01 s)

3.7 Ancillary functions

Operational value measurements	
– Operational current values	I_{L1}; I_{L2}; I_{L3}; I_E of local line end I_{L1}; I_{L2}; I_{L3}; I_E of remote line end in A primary and % of I_N
Measurement range	0 % to 240 % I_N
Tolerance	$\leq$ 2 % of respective rated value
– Overload protection measured values	
Calculated temperature rise	Θ/Θ_{trip}
Measurement range	0 % to 240 %
Tolerance	3 % referred to Θ_{trip}
Annunciations via binary inputs	
– 4 user definable annunciations for each of	local line end remote line end
Measured values plausibility checks	
– Sum of currents	phases and earth
Steady-state measured value supervision	
Current unbalance	I_{max}/I_{min} > symmetry factor as long as $I > I_{limit}$
Fault event data storage	
Storage of annunciations of the last four fault events, three of which can be read out in the display	
Real time clock	
Resolution for operational annunciations	1 min
Resolution for fault event annunciations	1 ms
Max time deviation	0.01 %
Buffer battery	Lithium battery 3 V/1 Ah, Type CR 1/2 AA Self-discharge time > 5 years
Data storage for fault recording	max. 8 fault events (3 can be read out locally)
Storage period	max 5 s per fault event, max. 20 s total, adjustable pre-fault an post-fault time
Sampling rate	1 instantaneous value per 1.67 ms at 50 Hz 1 instantaneous value per 1.38 ms at 60 Hz
Tripped current log	
Number of stored trip events	max. 9 digits
Total of tripped currents	max. 7 digits plus 1 decimal digit

4 Method of operation

4.1 Operation of complete unit

The numerical current comparison protection relay 7SD51 is equipped with a powerful and proven 16–bit microprocessor. This provides fully digital processing of all functions from data acquisition of measured values to the trip signals for the circuit breakers.

Figure 4.1 shows the base structure of the unit.

The transducers of the measured value input section ME transform the currents from the measurement transformers of the switch–gear and match them to the internal processing level of the unit. Apart from the galvanic and low–capacitive isolation provided by the input transformers, filters are provided for the suppression of interference. The filters have been optimized with regard to bandwidth and processing speed to suit the measured value processing. The matched analog values are then passed to the analog input section AE.

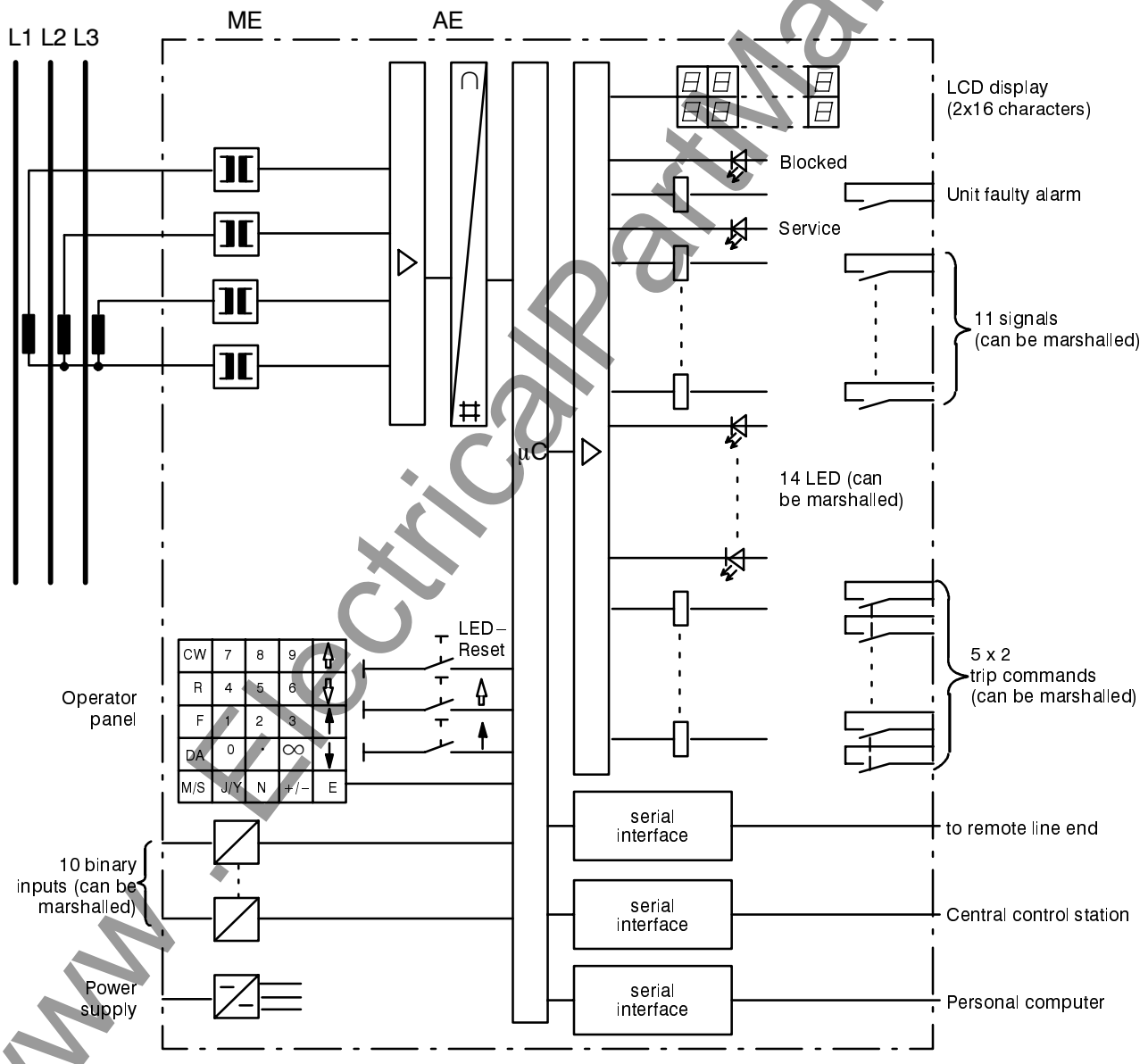


Figure 4.1 Hardware–structure of current comparison protection relay 7SD512

The analog input section AE contains input amplifiers, sample and hold elements for each input, analog–to–digital converters and memory circuits for the data transfer to the microprocessor.

Apart from control and supervision of the measured values, the microprocessor processes the actual protective functions. These include in particular:

– filtering and formation of the measured quantities to form the comparison data,
– formulation of the comparison data protocol,
– checking of the received data protocol,
– comparison of local data and received data,
– calculation of r.m.s. values for overload detection,
– scanning of limit values and time sequences,
– decision about trip and close commands,
– storage of measured quantities during a fault for analysis.

Binary inputs and outputs to and from the processor are channelled via the input/output elements. From these the processor receives information from the switch–gear (e.g. remote resetting) or from other equipment (e.g. blocking signals). Outputs include, in particular, trip commands to the circuit breakers, signals for remote signalling of important events and conditions as well as visual indicators (LEDs), and an alphanumerical display on the front.

An integrated membrane keyboard in connection with a built–in alphanumerical LCD display enables communication with the unit. All operational data such as setting values, plant data, etc. are entered into the protection from this panel (refer to Section 6.3). Using this panel the parameters can be recalled and the relevant data for the evaluation of a fault can be read out after a fault has occurred (refer to Section 6.4). The dialog with the relay can be carried out alternatively via the serial interface in the front plate by means of an operator panel or a personal computer.

Via a second serial interface, the comparison data are transmitted to the relay at the remote line end. For this second interface, optical fibre connections are recommended. In certain cases data cable transmission is possible; this interface is then isolated and thus satisfies the requirements for external signals, i.e. isolation and interference suppression comply with the requirements according to IEC 60255 and VDE 0435, part 303 (refer to Section 2.3 Ordering data). The isolated interface is mainly intended for coupling to a local electro–optical converter device which is installed in the substation (<300 m).

Via a further serial interface (optional, refer Section 2.3 Ordering data), fault data can be transmitted to a central evaluation unit. During healthy operation, measured values can also be transmitted, e.g. the measured currents at the point of installation. This interface is suitable for optical fibre connection.

A power supply unit provides the auxiliary supply on the various voltage levels to the described functional units. +24 V is used for the relay outputs. The analog input requires ±15 V whereas the processor and its immediate peripherals are supplied with +5 V. Transient failures in the supply voltage, up to 50 ms, which may occur during short–circuits in the d.c. supply system of the plant are bridged by a dc voltage storage element (rated auxiliary supply voltage > 110 Vdc).

4.2 Current comparison protection

The line protection operates according to the comparison principle. Each phase current at each end of the protected line is required. The data to be compared must be transmitted from one end of the line to the other end and vice versa. The comparison and thus the resulting trip decision for the circuit–breakers is made individually for each end of the line.

The current comparison protection system comprises the 7SD51 units to be installed at each end of the line and the signal transmission link between the units. 7SD512 V3 can operate with a 7SD511 V3 unit at the other line end. Additionally, it is possible to link 7SD51 V3 with relays of the former version 7SD511 V2 or 7SD512 V2.

4.2.1 Matching of measured values

The measured currents are fed to the unit per phase via input transformers in the current input section. The inputs are galvanically isolated from each other and from the electronic circuitry. This allows the starpoint to be formed outside the unit or to include further devices in the current circuit.

If the current transformers' secondary rating is I_N = 5 A at one end of the line and I_N = 1 A at the other end of the line, then the 5 A model 7SD51★**5** must be used for one end and the 1 A model 7SD51★**1** for the other end respectively. If the current transformers have deviating primary rated currents then matching can be performed numerically in the relay, within specific limitations, provided the current transformer data are correctly entered to the unit during setting (refer to Section 6.3.3), and by taking these deviations into account during setting of the threshold values (refer to Section 6.3.4). External matching transformers are, therefore, not necessary in most cases.

The secondary currents of the input transformers are transformed into proportional voltages via shunt resistors and then converted for further processing into numerical values by means of the analog/digital converters.

4.2.2 Comparison of measured values

Comparison is performed separately for each individual phase.

The digitized currents are filtered in order to suppress d.c. components and higher harmonics. The filter algorithms used are particularly optimized with regard to frequency and time characteristic to suit the tasks of the 7SD51.

After filtering, the instantaneous values of the currents are compared with the stored instantaneous values measured two periods earlier. If, hereby, a set dynamic threshold is exceeded, then the protection picks up: The polarity of the current change is transmitted to the opposite end of the line. The information is evaluated at either end of the line such that a definite differentiation can be made between load jumps, external short–circuits and internal short–circuits.

If the short–circuit current exceeds a further, steady–state threshold, then the protection picks up: The polarity of the currents is transmitted and compared at both ends of the line.

If the comparison recognizes a definite short–circuit on the protected line, the trip relays are energized. In order to ensure reliable tripping at both ends of the line, even with different circuit–breaker operating times, a trip signal, once initiated, is maintained for a minimum (adjustable) period.

The information exchange between the two units guarantees disconnection of the short–circuit current even with single–ended infeed. The non–contributing line end can, in this case, also be disconnected by means of an intertripping signal.

Due to the dynamic threshold, the comparison principle is very sensitive to short–circuits on the protected line. For external faults, however, it is very stable, even with different current transformer saturation levels at both line ends.The extraordinarily high stability is illustrated in the trip characteristics in Section 3.2: Even at small overcurrents the characteristics turn away from the characteristic during healthy operation.

The reduction of the comparison data to be transmitted to one binary signal per phase, permits the data per phase to be transmitted by **one** data channel per direction with modest requirements on the transmission link. Note that the operating time for single–pole trip may slightly spread since the data for each phase must be transmitted serially, i.e. one after the other.

4.2.3 Transmission of data to the opposite line end

The comparison principle requires a measurement unit at each line end, which compares the measured values from both ends. Secure and fault–free data transmission is therefore a mandatory prerequisite for the reliability of the protection system. Continuous monitoring of the signals is therefore an integral function of the 7SD51. The data received are checked several times as to their correctness before evaluation. Overfunctioning of the unit due to faulty data is therefore practically excluded. If the data transmission fails or if incorrect data are continuously being received, then an alarm is initiated after a set time delay.

Transmission of data is performed asynchronous according to V.24/RS232 C. In order to achieve the high transmission security required, the transmission protocols are designed for a Hamming distance d = 4.

The transmission protocol permits, apart from the transmission of protection comparison data, the transmission of further information. Besides an intertripping signal, a direct remote trip signal is possible as well as transmission of measured values and user definable signals or binary messages.

The encoding, transmission and de–coding of data requires time which cannot be neglected. However, in order to be able to compare instantaneous values, the signals of the measurement unit at one end are delayed by the signal transmission time before they are processed together with the signals received from the opposite line end. The signal transmission time can be measured by the relay itself during commissioning. Additionally, it is possible that the relay checks the transmission time during operation and corrects it automatically when necessary.

For transmission of the data, transmission media are suitable which fulfil the requirements of the interface. Pre–requisites for suitability are mainly the capability of transmitting at 19200 Baud as well as keeping the tolerances for damping and character distortion (refer also to Section 3.2 under Technical data). Generally optical fibre is recommended (refer to Table 4.1 for examples). The model with electrical V.24 (RS 232 C) interface is intended for connection of a electro–optical converter over short distances, not for transmission to the remote line end. Dependent of the ordered model (refer to Section 2.3 Ordering data), connection modules for direct optical fibre connectors are provided at the housing. Up to approximately 1.5 kilometers distance, glass fibre cables with ceramic post and 820 nm optical wave length can be connected directly. Models with 1300 nm optical wave length are suitable for approximately 10 km to 15 km distance. Longer distances require the the use of an optical fibre transmission unit with PCM transmission (e.g. 7VR50 or PCM 30 unit) which then is suitable for other telecommunication purposes.

Example of suitable optical fibres	**Indoor cable** flame retardant polyurethane sheath	**Exterior cable** waterproof hollow–core with polyethylene sheath, non–metallic rodent protection
Attenuation at 820 nm	3.2 dB / km	3.2 dB / km
Band width at 820 nm	200 MHz x km	200 MHz x km
Weight (mass)	18 kg / km	57 kg / km
Operating temperature range	–20 °C to +80 °C	–20 °C to +70 °C
Bending radius (without tensile stress)	$\geq$ 30 mm	$\geq$ 255 mm
Tensile capability (short–time)	400 N	1600 N
Glass fibre	2 G 62.5/125 µm	2 G 62.5/125 µm
Installation	in pipes, cable tunnels, or for flexible application	directly in soil and in mechanically protected environment
Order code (MLFB)	6XV8100 – 0B**C****	6XV8100 – 0B**B****

Table 4.1 Examples for suitable optical fibre cables

4.3 External local and transfer trip

4.3.1 External local trip

Any desired signal can be coupled into the processing of annunciations and trip commands via a binary input of the relay from an external protective or supervisory device. Like the internal trip signals, it can be delayed and given to one or more of the trip relays. The delay can, for example, bridge out bouncing periods of the energizing contact. A reset delay can be set in order to ensure that the breaker is safely tripped even in case the originating signal is very short.

Additionally, four annunciations are available, which can be defined by the user himself. Signals and messages of other devices which have no interfaces (PC or LSA interface) can be included in the annunciation processing of the device. Like the internal annunciations, they can be allocated to signal relays, LEDs or trip relays, or transmitted to the front display, a PC or LSA.

4.3.2 Transfer trip

Current comparison protection relay 7SD512 comprises an integrated remote trip function. This can be used to trip the circuit breaker at the remote line end by a command from an external source, e.g. a breaker failure protection or other back–up functions.

The remote trip command is entered to the relay via a binary input. It can be delayed before it is transmitted, e.g. to bridge out bouncing periods. Once being transmitted, it can be maintained for a settable period in order to ensure that the signal is safely transmitted even in case the originating signal is very short.

The received signal can even be maintained for a settable period in order to ensure that the breaker is safely tripped even in case the received signal is very short. This trip command is always three–pole.

Transmission of a remote trip signal is possible for each direction independent of each other.

Do not confuse the remote trip facility and the intertrip function which latter is integral part of the comparison protection as described in Section 4.2.2.

Additionally, four annunciations are available, which can be defined by the user himself and transmitted to the remote end relay.

4.4 Emergency overcurrent time protection

7SD512 provides an emergency overcurrent time protection. Whereas comparison protection can operate only as long as the protection data link is properly available, the overcurrent time protection needs the local currents only.

Under this condition, selectivity can only be achieved by time delay, just as for all other types of overcurrent protection scheme.

As soon as the device recognizes that the transmitted values have reappeared, the system switches back to current comparison protection.

The emergency overcurrent time protection can be used as definite time or inverse time overcurrent protection. Three standardized inverse time characteristics according to IEC 60255–3 are available for inverse time mode. The trip time characteristics and the applied formulae are given in the Technical data, refer to Figure 3.2, Section 3.4.

The selected overcurrent time characteristic can be superimposed by a high–set instantaneous or definite time delayed stage.

The characteristics can be individually set for phase currents and for earth currents. In total, the following stages are available:

- $I>>$ High current limit value threshold for phase currents
  $T_{I>>}$ associated delay time
- $I>$ Definite time limit value threshold
  $T_{I>}$ associated delay time or
- I_p Inverse time base value phase currents
  T_p associated time multiplier
- $I_E>>$ High current limit value threshold for earth currents
  $T_{IE>>}$ associated delay time
- $I_E>$ Definite time limit value threshold
  $T_{IE>}$ associated delay time or
- I_{Ep} Inverse time base value for earth currents
  T_{Ep} associated time multiplier.

All stages are independent from each other and can be set individually.

Under conditions of manual closing onto fault, the emergency overcurrent protection can also provide a rapid trip. A choice can be made whether the $I>>$ stages or the $I>/I_p$ stages are decisive for an undelayed trip, i.e. the associated time delay is by–passed for this condition.

The emergency protection can also be used in conjunction with auto–reclosure. In these cases the $I>>$ stages becomes valid before reclosure.

4.5 Thermal overload protection

The thermal overload protection prevents the power line, particularly in case of cables, from damage caused by thermal overloading.

The unit computes the temperature rise according to a thermal single–body model as per the following thermal differential equation:

$$\frac{d\Theta}{dt} + \frac{1}{\tau} \cdot \Theta = \frac{1}{\tau} \cdot I^2$$

with Θ – actual temperature rise related on the final temperature rise for the maximum permissible cable current $k \cdot I_N$

τ – thermal time constant for heating–up of the cable

I – actual cable current (r.m.s. value) referred to the maximum permissible cable current $I_{max} = k \cdot I_N$

When the temperature rise reaches the first set threshold, a warning alarm is given, in order to render possible an early load reduction. If the second temperature threshold is reached the line can be disconnected from the network.

The temperature rises are calculated separately for each individual phase. A choice can be made whether the maximum calculated temperature rise of the three phases, the average temperature rise, or the temperature rise calculated from the phase with maximum current should be decisive. A true r.m.s. value measurement is performed in order to include for the effect of harmonic content.

The maximum permissible continuous thermal overload current I_{max} is described as a multiple of the rated current I_N:

$$I_{max} = k \cdot I_N$$

In addition to the k–value, the time constant τ as well as the alarm temperature Θ_{warn} must be entered into the protection unit.

Apart from the temperature–dependent warning stage, the overload protection also includes a current–dependent warning stage. This latter alarm stage can give an early annunciation of an impending overload current even when the temperature rise has not yet reached the alarm or trip temperature rise values.

4.6 Automatic reclosure

Experience has shown that approximately 85 % of short circuits are caused by an arc, on overhead lines, and self–extinguish after interruption by the protective device. The line can therefore be re–energized. This is carried out by the automatic reclosure (AR) function. Figure 4.2 shows an example for the time sequence of a two–shot auto–reclosure with a RAR cycle followed by a DAR cycle.

If the circuit breaker poles can be tripped individually, then AR is often carried out single–pole for single–phase faults, and three–pole for multi–phase faults, in networks with earthed starpoint. If the short–circuit is still present after the auto–reclosure (arc not quenched or metallic short circuit), then the protective relay finally disconnects the power. Multiple auto–reclosure attempts, often with a first rapid auto–reclosure (RAR) and subsequent delayed auto–reclose cycles (DAR) are possible in some networks.

Measurement and current comparison of each individual phase allows reliably single–pole auto–reclosure. The 7SD512 is equipped with automatic single– and three–pole as well as single– and multi–shot reclosure.

7SD512 can also work in conjunction with an external auto–reclose system. In this case, the signal exchange between 7SD512 and the external AR–unit must be accomplished via the binary inputs and outputs (see Section 4.6.9).

Furthermore, it is also possible to allow the internal AR–function to be triggered from an external protection relay (e.g. back–up relay) (see Section 4.6.10). The use of two 7SD512 with internal AR–function is also possible as well as the use of one 7SD512 with AR–function and a second protection relay with separate AR–unit (example see Section 4.6.11).

The possible programs of the internal AR–function for the first AR–cycle (designated in the following with RAR – rapid auto–reclosure) are:

– RAR PROG. = *THREE–POLE*, i.e. all types of faults result in three–pole AR.

– RAR PROG. = *SINGLE–POLE*, i.e. single–phase faults result in single–pole AR, multi–phase faults in three–pole final disconnection.

– RAR PROG. = *SINGLE/THREE–POLE*, i.e. single–phase faults result in single–pole AR, multi–phase faults in three–pole AR.

If more than one reclose attempt will be carried out, the second and any further auto–reclose cycle are designated in the following with DAR (delayed auto–reclosure) independent on the setting of the dead times of the cycles. It is possible to skip the RAR cycle so that only DAR cycles occur. DAR cycles are always three–pole. For the DAR–function, the following programs are selectable:

– DAR PROG. = *DAR AFTER RAR*, i.e. the DAR cycles can only be initiated after an unsuccessful RAR.

– DAR PROG. = *DAR WITHOUT RAR*, i.e. DAR cycles can be carried out even without a preceding RAR cycle (e.g. RAR is by–passed because blocked).

– DAR PROG. = *NO DAR*, i.e. no DAR occurs; unsuccessful RAR results in final trip.

The possibilities and functions of the internal AR–unit are described in the following sections. Prerequisite for initiation of the AR–function is always that the circuit breaker is ready for operation when pick–up occurs. This information has to be transmitted to the device via a binary input.

Furthermore, reclosure is blocked if the tripping command occurs after the action time, which can be set individually for RAR and DAR.

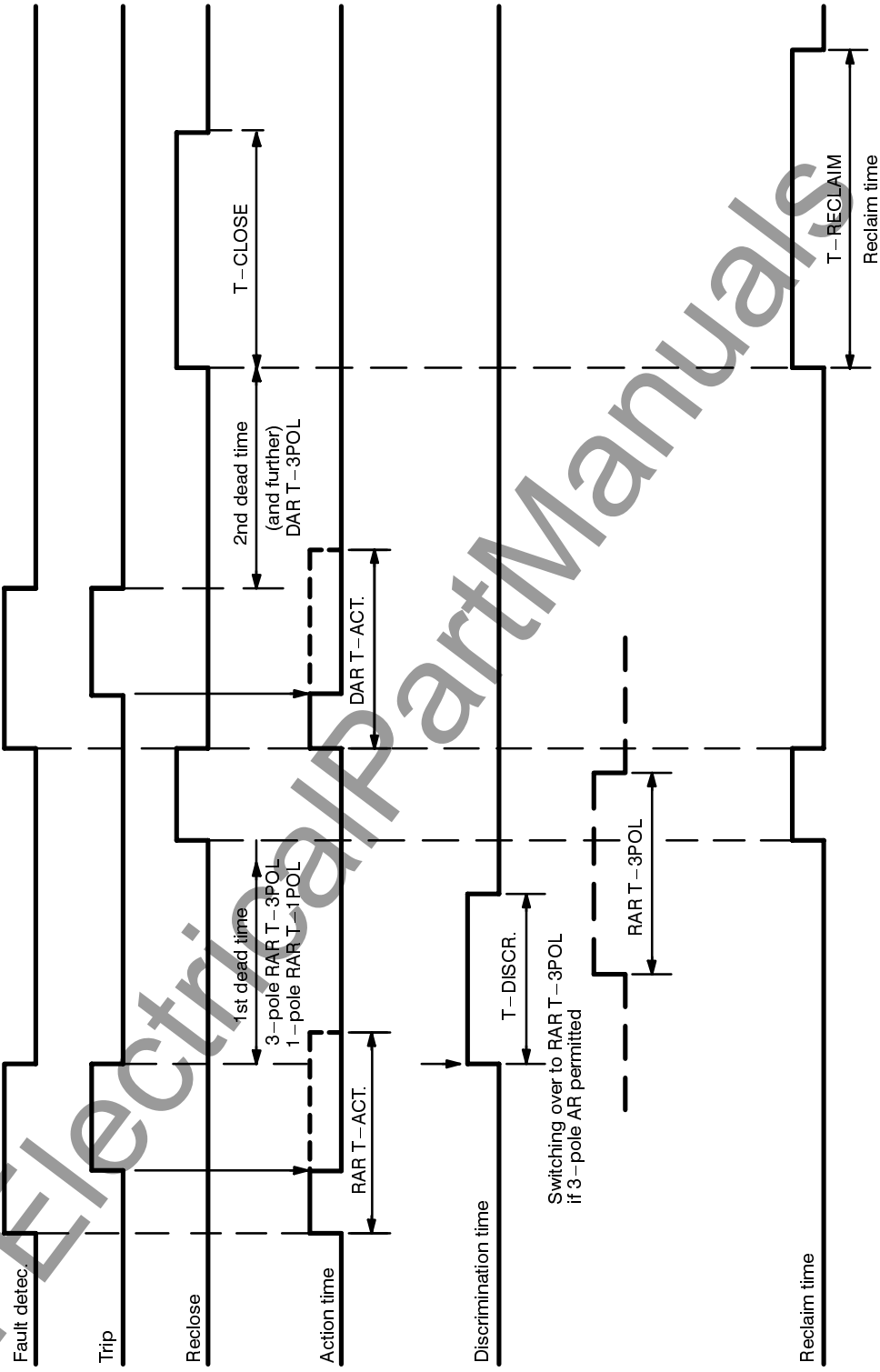


Figure 4.2 Diagram of an auto–reclosure sequence: RAR cycle followed by a DAR cycle

4.6.1 Selectivity during automatic reclosure

For the auto–reclosure sequence to be successful, faults on any part of the line must be cleared from both line ends within the same – shortest possible – time. Usually, therefore, an instantaneous stage of the short–circuit protection is set to operate before a reclosure by the AR–unit. Therefore, each short–circuit protection function which can initiate the auto–reclose function provides a special RAR stage. Furthermore, one can decide for each short–circuit protection whether or not it shall initiate the auto–reclose function.

The principle of current comparison protection guarantees selectivity over 100 % of the line length **and** fast, simultaneous disconnection so that a particular AR stage is superfluous. Nevertheless, for special applications the trip command of the current comparison protection can be delayed. In this case, delay is bypassed when trip will result in an auto–reclosure, i.e. trip will be instantaneous before auto–reclose.

During emergency overcurrent time operation, stage I>> operates undelayed as RAR stage. Before any reconnection, i.e. when the RAR–function is ready for operation, disconnection is effected with I>>. After an unsuccessful auto–reclosure attempt or when the AR–function is not ready for operation, stage I>> is blocked. In order to maintain selectivity, disconnection then is effected with I> or I_p after expiry of the delay time T–I> or according to the trip time characteristic. When the AR–function is blocked or switched off, I>> is blocked. This can be changed in that the I>> stage is effective always, independent of the RAR. Optionally, the I> or I_p stage can be operated as instantaneous RAR stage.

The remaining protection functions – in 7SD512 the overload protection – always operate without auto–reclosure, therefore they have no RAR stage.
The auto–reclose function provides an action time for each of RAR and DAR function which can separately set. The action times are started with any fault detection. If the action time has elapsed before any trip signal is given, it is assumed that the fault is not on the protected line but on another line; auto–reclosure is not initiated.

4.6.2 Action times and reclaim times

It is often appropriate to prevent readiness for reclosure, when the fault has persisted for a specified time; for example, when it can be assumed that the arc has burnt itself in to such an extent, that there is no chance of natural quenching during the dead time.

Tripping after faults which are cleared in a delayed time should, for reasons of selectivity (refer foregoing section) also not result in an auto–reclosure.
The AR–functions of 7SD512 are provided with settable action times, separate for RAR and DAR, which are started by the fault detection signal. If, after expiry of the action time, no tripping signal has been given, reclosure is blocked.

The AR–functions of 7SD512 are provided with three settable reclaim times, which do not discriminate between RAR and DAR. Generally, the reclaim time is the time period during which no further reclosure attempt is permitted.

The reclaim time T–RECLAIM is started at every reclose command. If auto–reclosure has been successful, all functions reset to the quiescent condition after expiry of T–RECLAIM; any fault occurring after the expiry of the reclaim time is considered to be a new system fault. When a renewed trip command is given within this reclaim time, the next auto–reclose cycle is started if multi–shot AR is permitted; if no further AR cycle is permitted, a renewed trip command within the reclaim time is final: AR has been unsuccessful.

The lock–out time T–LOCK is the time period during which any further close command by the 7SD512 relay is blocked after final disconnection. This applies for all closing attempts which are performed by the relay. If this time is set to ∞, closing is locked out until the AR function is reset by energization of the binary input ">AR Reset". After the reset signal all functions reset to the quiescent condition.

A special reclaim time T–BLOCK MC is provided for manual closing. During this time after manual close, reclosure is blocked; any trip command will be a three–pole final trip.

4.6.3 Interrogation for readiness of the circuit breaker

Pre–condition for a reclose attempt after short–circuit interruption is that the circuit breaker is ready for at least one TRIP–CLOSE–TRIP–cycle when the AR function is initiated (i.e. at the instant of trip command). The readiness information from the breaker has to be transmitted to the device via a binary input. In case that such readiness information is not available, interrogation can be suppressed since otherwise no auto–reclose would be possible at all.

When single–shot auto–reclosure is performed it is sufficient to interrogate the breaker readiness one single time before initiation of AR. As, for example, the air pressure for breaker operation will collapse during the trip execution, no further interrogation should be carried out.

When multi–shot auto–reclosure is used, it is advantageous to interrogate breaker readiness not only at the instant of the first trip command but also before every reclose attempt or before every other reclose attempt. If this facility is selected, reclosure is blocked as long as the circuit breaker is not ready for another TRIP–CLOSE sequence.

The recovery time of the circuit breaker can be supervised by the 7SD512 relay. This supervision time T–CB–SUPV will run as long as the circuit breaker does not inform about readiness. In this case, the dead time may be extended when the breaker is not ready after expiry of the set dead time. But if the breaker is not yet ready after expiry of the supervision time then reclosure is blocked. This blocking is canceled only after the lock–out time T–LOCK (refer to Section 4.6.2) has elapsed. If T–LOCK is set to ∞, closing is locked out until the AR function is reset by energization of the binary input ”>AR Reset”. After the reset signal all functions reset to the quiescent condition.

4.6.4 Three–pole auto–reclosure

When the AR function is ready for operation, the short–circuit protection trips three–pole for all faults within the stage valid for RAR (if available). The AR–function is initiated provided tripping occurs within the action time (refer to Section 4.6.2). With fault clearance, the (settable) dead time RAR T–3POL commences for three–pole RAR. After this, the circuit breaker receives a closing command, the duration of which is settable. Simultaneously, the (settable) reclaim time T–RECLAIM (Section 4.6.2) is started.

If the fault is cleared (successful RAR), the reclaim time T–RECLAIM (Section 4.6.2) expires and all functions reset to the quiescent condition. The network fault is cleared.

If the fault has not been cleared (unsuccessful AR) then the short–circuit protection carries out a final disconnection in the stage that is valid without RAR. If delay times have been parameterized, these become effective now. Also, every fault during the reclaim time will result in final disconnection.

After unsuccessful AR (final disconnection) the lock–out time T–LOCK (Section 4.6.2) is started. For this time any close command from 7SD512 is locked.

The above sequence comes into effect with single–shot RAR. With 7SD512, multiple AR–attempts (up to 9 DAR–shots, refer Section 4.6.8) are also possible. Additionally, it is possible to skip the RAR cycle by a signal via a binary input of the device. In this case only DAR is effective (refer Section 4.6.8).

4.6.5 Single–pole auto–reclosure

When only single–pole auto–reclosure is carried out and the RAR function is ready for reclose, the short–circuit protection trips single–pole if a single–phase fault is detected in the stage valid for RAR (if available). This is valid for all protection function which can identify the faulty phase.

After occurrences of multi–phase faults the short–circuit protection trips finally, three–pole. Every three–pole trip is a final trip. The lock–out time T–LOCK (Section 4.6.2) is started. For this time any close command from 7SD512 is locked.

After a single–pole trip, the AR–function is initiated provided tripping occurs within the action time. With the clearance of the fault, the (settable) dead time RAR T–1POL for single–pole AR commences. After this, the circuit breaker receives a closing command, the duration of which is settable. Simultaneously, the (settable) reclaim time T–RECLAIM (Section 4.6.2) is started.

If the fault is cleared (successful RAR), the reclaim time T–RECLAIM (Section 4.6.2) expires and all functions reset to the quiescent condition. The network fault is cleared.

If the fault has not been cleared (unsuccessful AR) then the short–circuit protection carries out a final disconnection. If delay times have been parameterized, these become effective now. Also, every fault during the reclaim time will result in final disconnection.

After unsuccessful AR (final disconnection) the lock–out time T–LOCK (Section 4.6.2) is started. For this time any close command from 7SD512 is locked.

In this mode, only single–shot auto–reclosure is possible.

4.6.6 Single– and three–pole auto–reclosure

When the AR function is ready for operation, the short–circuit protection trips single–pole for single–phase faults and three–pole for multi–phase faults. The stage for RAR (if available) is valid for all types of fault.

The AR–function is initiated provided tripping occurs within the action time (refer to Section 4.6.2). With fault clearance, the (settable) dead time RAR T–1POL commences for single–pole RAR, or the separately settable dead time RAR T–3POL for three–pole RAR. After this, the circuit breaker receives a closing command, the duration of which is settable. Simultaneously, the (settable) reclaim time T–RECLAIM (Section 4.6.2) is started.

If the fault is cleared (successful RAR), the reclaim time T–RECLAIM (Section 4.6.2) expires and all functions reset to the quiescent condition. The network fault is cleared.

If the fault has not been cleared (unsuccessful AR) then the short–circuit protection carries out a final disconnection in the stage that is valid without RAR If delay times have been parameterized, these become effective now. Also, every fault during the reclaim time will result in final disconnection.

After unsuccessful AR (final disconnection) the lock–out time T–LOCK (Section 4.6.2) is started. For this time any close command from 7SD512 is locked.

The above sequence comes into effect with single–shot RAR. With 7SD512, multiple AR–attempts (up to 9 DAR–shots, refer to Section 4.6.8) are also possible. Additionally, it is possible to skip the RAR cycle by a signal via a binary input of the device. In this case only DAR is effective (refer to Section 4.6.8).

4.6.7 Treatment of evolving faults for single–pole auto–reclosure

When single–pole or single– and three–pole auto–reclosures are carried out in the network, special attention has to be directed to evolving faults. Evolving faults are those which, after clearance of the first–detected fault, occur during the dead time of an AR cycle.

The reaction of the AR–function to a recognized evolving fault can be selected, dependent upon the requirements of the network:

a) Blocking of auto–reclosure after evolving faults *NEVER*:

As soon as an evolving fault has been detected, the unit switches to the three–pole auto–reclosure cycle. Every trip will be three–phase. If three–pole auto–reclosure is permitted, then the dead time for three–pole auto–reclosure begins simultaneously with the interruption of the evolving fault. When the dead time has expired, the circuit breaker receives the command to close. The further sequence is the same as for single– and three–pole auto–reclosure.

The total dead time in this case consists of the dead time for the single–pole auto–reclosure, which has expired when the evolving fault is interrupted, plus the dead time for the three–pole auto–reclosure. This is useful because only the dead time for three–pole auto–reclosure is of importance for the stability of the network.

b) Blocking of auto–reclosure after evolving faults *ALWAYS*:

As soon as an evolving fault has been detected, reclosure is blocked. Every trip will be three–pole regardless whether three–pole AR is permitted or not.

c) Blocking after evolving faults after an adjustable discrimination time, *>T–DISCRIM*:

The discrimination time starts simultaneously with the dead time. It is used to discriminate from which point in time an evolving fault is identified as such. If the evolving fault occurs before the expiry of the discrimination time, the device is switched to a three–pole AR–cycle (if permitted), as under a). If however, the evolving fault occurs after the discrimination time has expired, reclosure is blocked, as under b).

4.6.8 Multi–shot auto–reclosure

The internal auto–reclose feature in 7SD512 will also permit multi–shot reclosure, up to 9 consecutive DAR–cycles. The second and each further cycle are always three–pole. Also the action time and several dead times can be independently set for these DAR cycles.

Different numbers of DAR cycles can be set for single–phase faults and multi–phase fault; tripping command is, nevertheless, always three–pole. The set number of DAR cycles does not include the first RAR cycle.

Dead times can be individually set for the first three AR cycles; further cycles operate with the dead time of the third cycle. In this case, all AR cycles are decisive, i.e. also the RAR cycle. The RAR cycle operates with its dead time (RAR T–1POL for single– or RAR T–3POL for three–pole RAR), the first DAR is the second cycle with the dead time for the second cycle DAR T3POL2, etc.! If no RAR cycle has occurred (e.g. RAR blocked) then the first DAR cycle operates with the dead time for the first cycle DAR T3POL1, etc.

Each new pick–up restarts the action time DAR T–ACT. within which a tripping command must occur. After fault clearance, the dead time begins. At the end of this, the circuit breaker is given a new closing command. Simultaneously, the reclaim time T–RECLAIM (Section 4.6.2) is started.

As long as the permitted number of cycles has not been reached, the reclaim time is reset by each new pick–up and recommences with the next closing command.

If one of the cycles is successful, that is, after reclose the fault is no longer present, the reclaim time T–RECLAIM equally runs out and all functions return to the quiescent condition. The network fault is cleared.

If none of the AR–cycles have been successful then the short–circuit protection carries out a final disconnection after the last permissible cycle. The lock–out time T–LOCK (Section 4.6.2) is started. For this time any close command from 7SD512 is locked.

4.6.9 Connection of external auto–reclose system

7SD512 can operate in conjunction with an external auto–reclose system. The internal AR–function cannot then be allowed to operate. The internal AR function must be programmed to be ineffective (de–configured, Section 5.4.2).

Signal exchange between 7SD512 and the external auto–reclose device be made via the binary input and outputs of the relay. The following list may be regarded as a recommendation.

Binary inputs:

`383 >RAR Release` The external AR device releases the RAR stages which shall operate with AR via this binary input

`382 >Only 1pole` The external AR device is programmed to reclose only in case of single–pole tripping. RAR stages are released only when a single–phase fault is detected; with multi–phase fault delays are effective if parameterized.

`381 >1p Trip Perm` The external AR permits single–pole tripping, i.e. is ready for reclosure after single–pole trip. This is the logical inversion of three–pole coupling. If this binary input is not allocated then only three–pole tripping can occur.

Binary outputs:

`501 Device FltDet` General fault detection of the device.

`515 Dev.Trip 3p` Three–pole trip command of the device.
`512 Dev.Trip 1pL1` Single–pole trip command L1 of the device.

`515 Dev.Trip 3p` Three–pole trip command of the device.
`513 Dev.Trip 1pL2` Single–pole trip command L2 of the device.

`515 Dev.Trip 3p` Three–pole trip command of the device.
`514 Dev.Trip 1pL3` Single–pole trip command L3 of the device.

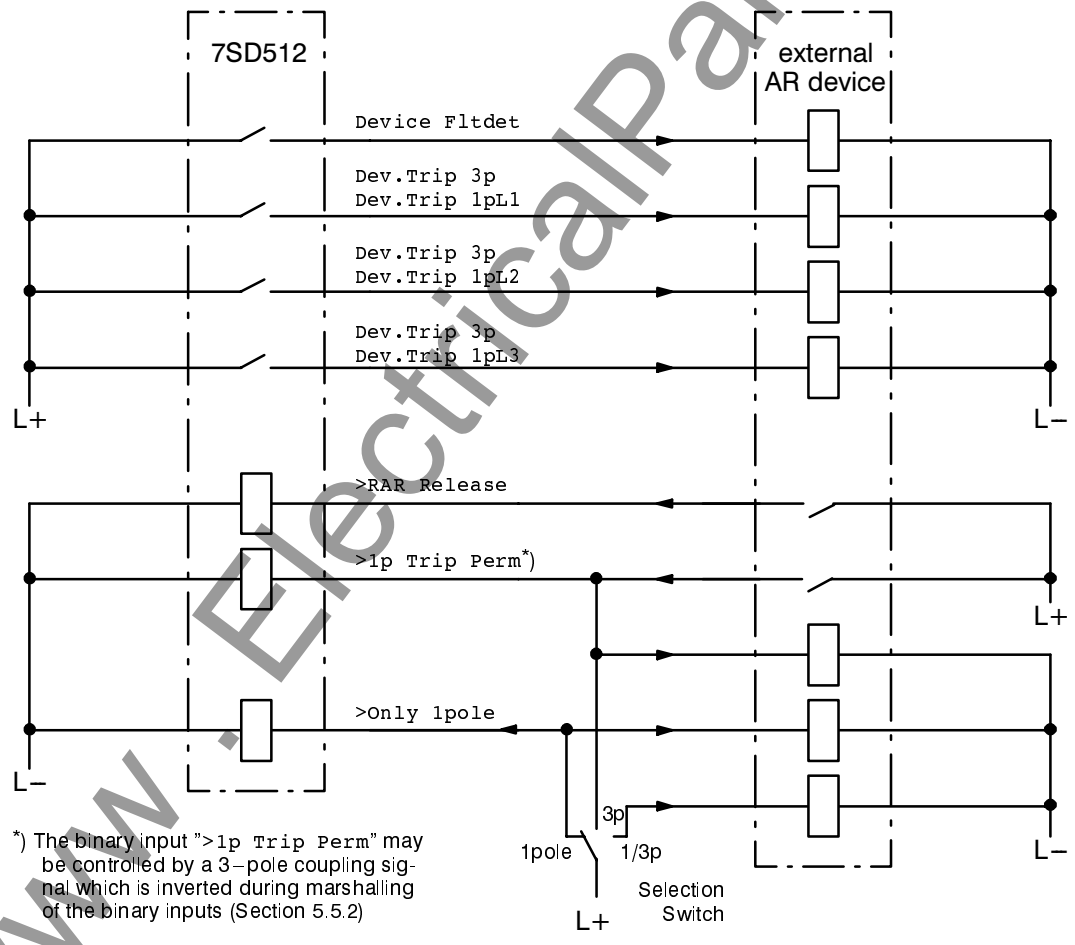


Figure 4.3 Example of connections with external AR–system

In order to achieve a phase segregated trip signal, the single–pole trip command for each pole and the three–pole trip command must be combined to the phase trip signal.

Dependent of the features of the external auto–reclose device it is also possible to combine the three single–pole trip commands (FNo 512, 513, 514) to a signal "single–pole trip"; the three–pole trip command gives the signal "three–pole trip".

For three–pole AR the general fault detection and tripping signals are, of course, sufficient.

Figure 4.3 shows a connection example for the interconnection between 7SD512 and an external AR–system using a program selector switch.

4.6.10 Control of the internal auto–reclose function by an external protective relay

The internal AR–function of 7SD512 can be controlled from an external protective device. This is applicable, for example, for line ends with duplicated protection or additional back–up protection, when a second protective device is used for the same line end and shall operate with the AR–function incorporated in 7SD512.

Signal exchange between 7SD512 and the external auto–reclose device be made via the binary input and outputs of the relay. The following list may be regarded as a recommendation.

The internal AR–function can be started via the binary inputs

2711 >Start AR general start signal for AR,

2712 >Trip L1 AR tripping command L1 for AR,

2713 >Trip L2 AR tripping command L2 for AR,

2714 >Trip L3 AR tripping command L3 for AR.

The general start signal is the criterion for the start of the action time. At the issue of the tripping command it is decided whether the dead time for single–pole AR or three–pole AR will be effected, or if, for three–pole tripping, the reclose will be blocked (dependent upon the set AR program). A possibility for three–pole AR coupling should be available externally.

It is also possible to use the single–pole and three–pole trip signals instead of the phase dedicated trip signals provided the external protection relay disposes of these outputs. That means, the following binary inputs of 7SD512 are used:

2711 >Start AR general start signal for AR,

2715 >Trip 1p AR tripping command single–pole for AR,

2716 >Trip 3p AR tripping command three–pole for AR.

If *only* three–pole AR is to be carried out, it is sufficient to use *any* convenient binary input for the tripping signal.

To couple the external relay three–pole and to release its overreach zone, the following output functions are suitable:

2864 1p Trip Perm. internal AR is ready for single–pole reclosure (logical inversion of three–pole coupling),

2817 RAR Zone Rel. internal AR is ready for an RAR cycle, i.e. releases RAR stages (if available) for the external protection relay,

2837 DAR Zone Rel. internal AR is ready for a DAR cycle, i.e. releases DAR stages (if available) for the external protection relay,

2815 RAR 1p Prog. internal RAR programmed to single–pole reclosure only, i.e. will reclose only after single–pole trip.

Depending on the requirements of the external protection relay and the used functions of the internal AR, one or the other input or output can be omitted. For example, for use of three–pole auto–reclose the following signal are sufficient: General start, general trip and "RAR Zone Rel", if used.

4.6.11 Two protection relays with two auto–reclose devices

If a feeder is equipped with duplicated protection and each protection relay should control its own auto–reclose device, certain exchange of information is necessary between the two combinations. This is shown, as an example, in Figure 4.4. Three–pole coupling should be arranged with an external coupling unit which interacts directly with the circuit breaker trip circuits. This ensures three–pole tripping under all circumstances of multi–pole faults.

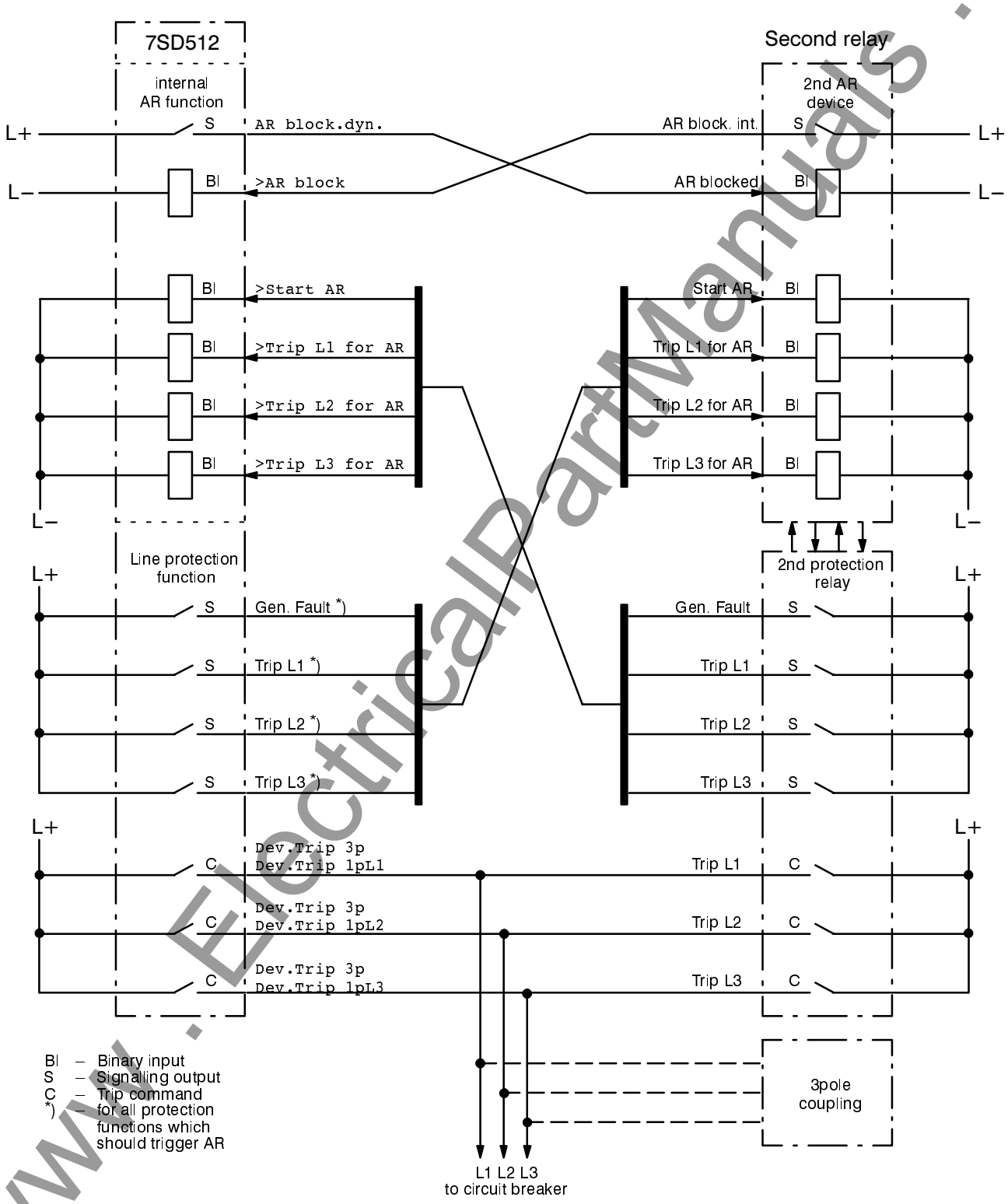


Figure 4.4 Connection example for 2 protection relays with 2 auto–reclosure devices

4.7 Circuit breaker trip test

Numerical current comparison protection 7SD512 allows simple checking of the tripping circuit and the circuit breaker. As the device incorporates an internal auto–reclose system, a TRIP–CLOSE test cycle is also possible when auto–reclosure is used (on overhead lines); the latter can also be performed with an external auto–reclose device.

Prerequisite for the start of a test cycle is that no protective function has picked up. If the circuit breaker auxiliary contacts advise the relay, through a binary input, of the circuit breaker position, the test cycle can only be started when the circuit breaker is closed. This additional security feature should not be omitted.

For starting a TRIP–CLOSE cycle a further condition is that the conditions for reclose (circuit breaker ready, AR not blocked) are fulfilled. This applies also for an external auto–reclose device (provided the exchange of the binary signals is performed).

Initiation of the test cycle can be given from the operator keyboard or via the front operator interface.

When a pure trip test is started, the relay issues a three–pole trip command.

A TRIP–CLOSE cycle can be performed three–pole or single–pole. Three–pole trip is initiated only when the AR function (internal or external) permits three–pole reclosure. Single–pole trip is initiated only when the AR function (internal or external) permits single–pole reclosure. Single–pole trip test can also be carried out with a sequence TRIP L1 – RECLOSE – TRIP L2 – RECLOSE – TRIP L3 – RECLOSE.

The test sequence is supervised by 7SD512 by means of the circuit breaker auxiliary contact position provided the auxiliary contacts are connected to binary inputs. If the breaker does not react correctly then the test sequence is aborted; a corresponding message is given in the display or on the PC screen.

Trip test can also be started by energization of a binary input. A pure trip test without reclosure (by internal or external auto–reclosure) is not recommended for safety reasons.

4.8 Ancillary functions

The ancillary functions of the current comparison protection 7SD512 include:

– Processing of annunciations,

– Storage of short circuit data for fault recording,

– Operational measurements and testing routines,

– Monitoring functions.

4.8.1 Processing of annunciations

After a fault in the protected object, information concerning the response of the protective device and knowledge of the measured values are of importance for an exact analysis of the history of the fault. For this purpose the device provides annunciation processing which is effective in three directions.

4.8.1.1 Indicators and binary outputs (signal relays)

Important events and conditions are indicated by optical indicators (LED) on the front plates. The modules also contain signal relays for remote signalling. Most of the signals and indications can be marshalled, i.e. they can be allocated meanings other than the factory settings. In Section 5.5 the delivered condition and the marshalling facilities are described in detail.

The output signal relays are not latched and automatically reset as soon as the originating signal disappears. The LEDs can be arranged to latch or to be self–resetting.

The memories of the LEDs can be safe against supply voltage failure (back–up battery available). They can be reset:

– locally, by operation of the reset button on the relay,

– remotely by energization of the remote reset input,

– via one of the interfaces,

– automatically, on occurrence of a new general pick–up signal.

Some indicators and relays indicate conditions; it is not appropriate that these should be stored. Equally they cannot be reset until the originating criterion has been removed. This mainly concerns disturbance indications such as ”auxiliary voltage fault”, etc.

A green LED indicates readiness for operation. This LED cannot be reset and remains illuminated when the microprocessor is working correctly and the unit is not faulty. The LED extinguishes when the self–checking function of the microprocessor detects a fault or when the auxiliary voltage is absent.

With the auxiliary voltage present but with an existing internal fault in the unit, a red LED illuminates (”Blocked”) and blocks the unit.

4.8.1.2 Information on the display panel or to a personal computer

Events and conditions can be read off in the display on the front plate of the device. Additionally, a personal computer, for example, can be connected via the operation interface, and all the informations can then be sent to it.

In the quiescent state, i.e. as long as no network faults are present, the display outputs selectable operating information (usually an operational measured value) in each of the two lines. In the event of a network fault, selectable information on the fault appears instead of the operating information, e.g. detected phase(s) and elapsed time from fault detection to trip command. The quiescent information is displayed again once these fault annunciations have been acknowledged. The acknowledgement is identical to resetting of the stored LED displays as in Section 4.8.1.1.

The device also provides several event buffers, e.g. for operating messages, circuit breaker operation statistics etc. (refer to Section 6.4) which are saved against supply voltage failure by a buffer battery (if available). These messages, as well as all available operating values, can be transferred into the front display at any time using the keyboard or to the personal computer via the operating interface.

After a fault, for example, important information concerning its history, such as pick–up and tripping, can be called up on the display of the device. The fault inception is indicated with the absolute time of the operating system provided this feature is available. The sequence of the events is tagged with the relative time referred to the moment at which the fault detector has picked up. Thus, the elapsed time until tripping is initiated and until the trip signal is reset can be read out. The resolution is 1 ms.

The events can also be read out with a personal computer by means of the appropriate program DIGSI®. This provides the comfort of a CRT screen and menu–guided operation. Additionally, the data can be documented on a printer or stored on a floppy disc for evaluation elsewhere.

The protection device stores the data of the last four network faults; if a fifth fault occurs the oldest fault is overwritten in the fault memory. The annunciations of the last three network fault can be read out in the local display.

A network fault begins with recognition of the fault by pick–up of any fault detector and ends with fault detector reset or expiry of the auto–reclose sequence so that non–successful auto–reclose attempts will also be stored as part of one network fault. Thus, one network fault can include different fault events (from pick–up until drop–off). This is particularly advantageous for allocation of time data.

4.8.1.3 Information to a central unit (optional)

In addition, all stored information can be transmitted via an optical fibre connector to a control centre, for example, the SIEMENS Localized Substation Automation System LSA 678. Transmission uses a standardized transmission protocol according to VDEW/ZVEI and IEC 60870–5–103. Alternatively the protocol is according to DIN 19244 (selectable).

4.8.2 Data storage and transmission for fault recording

The instantaneous values of the measured values

i_{L1}, i_{L2}, i_{L3}, i_E

are sampled at 1.67 ms intervals (for 50 Hz) and stored in a circulating shift register. In case of a fault, the data are stored over a selectable time period, but max. over 5 seconds. The maximum number of fault records within this time period is 8. These data are then available for fault analysis. For each renewed fault event, the actual new fault data are stored without acknowledgement of the old data.

The data can be transferred to a connected personal computer via the operating interface at the front and evaluated by the protection data evaluation program DIGSI®. The currents are referred to their maximum values, normalized to their rated values and prepared for graphic visualization. In addition, signals can be marked as binary traces, e.g. ”Pick–up” and ”Trip”.

Additionally, the fault record data can be transmitted to a control centre via the optional serial system interface. Evaluation of the data is made in the control centre, using appropriate software programs. The currents are referred to their maximum values, normalized to their rated values and prepared for graphic visualization. In addition, signals can be marked as binary traces, e.g. ”Pick–up” and ”Trip”.

When the data are transferred to a central unit, read–out can proceed automatically, optionally after each pick–up of the relay or after trip. The following then applies:

– The relay signals the availability of fault record data,

– The data remain available for recall until they are overwritten by new data.

– A transmission in progress can be aborted by the central unit.

4.8.3 Operating measurements and conversion

For local recall or transmission of data, the true r.m.s. values of the currents are always available as are the current of the remote end. Additionally, the temperature rise calculated from the r.m.s. currents are present.

The following is valid:

– I_{L1a}, I_{L2a}, I_{L3a}, I_{Ea}	Phase currents of the local line end in amps primary and in % of rated current
– I_{L1b}, I_{L2b}, I_{L3b}, I_{Eb}	Phase currents of the remote line end in amps primary and in % of rated current
– $\Theta/\Theta_{trip\ L1}$, $\Theta/\Theta_{trip\ L2}$, $\Theta/\Theta_{trip\ L3}$	Temperature rise related to the trip temperature rise; if available, for each phase.

Even the signal transmission time and the current phase relationship can be recalled upon request. These data are particularly useful during commissioning (refer to Sections 6.7.1 and 6.7.2).

4.8.4 Monitoring functions

The device incorporates comprehensive monitoring functions which cover both hardware and software; furthermore, the measured values are continuously checked for plausibility so that the current transformer circuits are also included in the monitoring system.

4.8.4.1 Hardware monitoring

The complete hardware is monitored for faults and inadmissible functions, from the measured value inputs to the output relays. In detail this is accomplished by monitoring:

– Auxiliary and reference voltages

  The processor monitors the offset and reference voltage of the ADC (analog/digital converter). The protection is blocked as soon as impermissible deviations occur. Permanent faults are annunciated.

  Failure or switch–off of the auxiliary voltage automatically puts the system out of operation; this status is indicated by a fail–safe contact. Transient dips in supply voltage of less than 50 ms will not disturb the function of the relay.

– Measured value acquisition

  The complete chain, from the input transformers up to and including the analog/digital converters are monitored by the plausibility check of the measured values.

  In the **current path**, there are four input converters; the digitized sum of the outputs of these must always be zero. A fault in the current path is recognized when

$$|i_{L1} + i_{L2} + i_{L3} + k_I \times i_E| > \text{SUM.Ithres} \times I_N + \text{SUM.Fact.I} \times I_{max}$$

  An adjustable factor k_I (parameter Ie/Iph) can be set to correct the different ratios of phase and earth current transformers (e.g. summation transformer). If the residual earth current is derived from the current transformer starpoint, $k_I = 1$. SUM.Ithres and SUM.Fact.I are setting parameters. The component SUM.Fact.I x I_{max} takes into account permissible current proportional transformation errors in the input converters which may particularly occur under conditions of high short circuit currents (Figure 4.5).

Note: Current sum monitoring can operate properly only when the residual current of the protected line is fed to the I_E input of the relay.

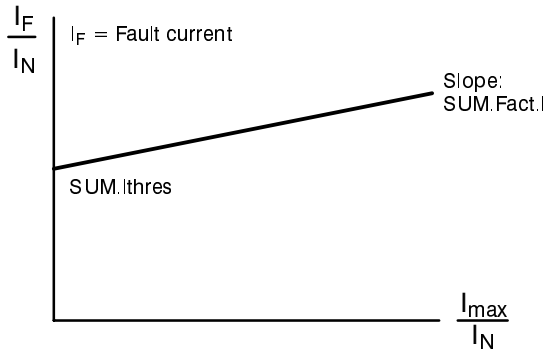


Figure 4.5 Current sum monitoring (current plausibility check)

– Command output channels:

The command relays for tripping and closing are controlled by two command and one additional release channels. As long as no pick–up condition exists, the central processor makes a cyclic check of these command output channel for availability, by exciting each channels one after the other and checking for change in the output signal level. Change of the feed–back signal to low level indicates a fault in one of the control channels or in the relay coil. Such a condition leads automatically to alarm and blocking of the command output.

– Memory modules:

The memory modules are periodically checked for fault by:

- Writing a data bit pattern for the working memory (RAM) and reading it,
- Formation of the modulus for the program memory (EPROM) and comparison of it with a reference program modulus stored there,
- Formation of the modulus of the values stored in the parameter store (EEPROM) then comparing it with the newly determined modulus after each parameter assignment process.

4.8.4.2 Software monitoring

For continuous monitoring of the program sequences, a watchdog timer is provided which will reset the processor in the event of processor failure or if a program falls out of step. Further, internal plausibility checks ensure that any fault in processing of the programs, caused by interference, will be recognized. Such faults lead to reset and restart of the processor.

If such a fault is not eliminated by restarting, further restarts are initiated. If the fault is still present after three restart attempts the protective system will switch itself out of service and indicate this condition by drop–off of the availability relay, thus indicating ”equipment fault” and simultaneously the LED ”Blocked” comes on.

4.8.4.3 Monitoring of external measuring transformer circuits

To detect interruptions or short circuits in the external measuring transformer circuits or faults in the connections (an important commissioning aid) the measured values are checked at cyclic intervals, as long as no pick–up condition exists:

– Current symmetry

In healthy operation it can be expected that the currents will be approximately symmetrical. The following applies:

$$|I_{min}| / |I_{max}| < \text{SYM.Fact.I}$$
if
$$I_{max} / I_N > \text{SYM.Ithres} / I_N$$

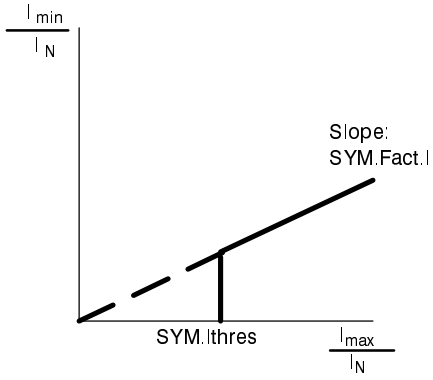


Figure 4.6 Current symmetry monitoring

I_{max} is always the largest of the three phase currents and I_{min} always the smallest. The symmetry factor SYM.Fact.I represents the magnitude of asymmetry of the phase currents, and the threshold SYM.Ithres is the lower limit of the processing area of this monitoring function (see Figure 4.6). Both parameters can be set (see Section 6.3.10).

Table 4.2 gives a survey of the functions of the measured value monitoring system.

Monitoring	Failure covered, reaction
1. Plausibility check of currents $\lvert i_{L1} + i_{L2} + i_{L3} + \mathbf{Ie/Iph} \times i_E \rvert >$ **SUM.Ithres** x I_N + **SUM.Fact.I** x I_{max}	Relay failures in the signal acquisition circuits i_{L1}, i_{L2}, i_{L3}, i_E Alarm
2. Current unbalance $\frac{\lvert I_{min} \rvert}{\lvert I_{max} \rvert} <$ **SYM.Fact.I** and $\lvert I_{max} \rvert >$ **SYM.Ithres**	Single, or phase–to–phase short circuits or broken conductors in the c.t. circuits i_{L1}, i_{L2}, i_{L3} or Unbalanced load Alarm

Bolted figures are setting values.

Table 4.2 Summary of the measured value monitoring functions

5 Installation instructions

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.

5.1 Unpacking and repacking

When dispatched from the factory, the equipment is packed in accordance with the guidelines laid down in IEC 60255–21, 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. The storage packing of the individual relays is not suited to transport. If alternative packing is used, this must also provide the same degree of protection against mechanical shock, as laid down in IEC 60255–21–1 class 2 and IEC 60255–21–2 class 1.

Before initial energization with supply voltage, the relay shall be situated in the operating area for at least two hours in order to ensure temperature equalization and to avoid humidity influences and condensation.

5.2 Preparations

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 **e**lectrostatically **e**ndangered **c**omponents (EEC) must be observed.

In installed conditions, the modules are in no danger.

5.2.1 Mounting and connections

5.2.1.1 Model 7SD512⋆–⋆B⋆⋆⋆ for panel surface mounting

– Secure the unit with four screws to the panel. For dimensions refer to Figure 2.2).

– Connect earthing terminal (Terminal 26) of the unit to the protective earth of the panel.

– 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, e.g. Order–No. 15284 of Messrs Druseidt, Remscheid, Germany.

– Make connections via screwed terminals.

5.2.1.2 Model 7SD512⋆–⋆C⋆⋆⋆ for panel flush mounting or –⋆E⋆⋆⋆ for cubicle installation

– 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 Figure 2.3.

– 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, e.g. Order–No. 15284 of Messrs Druseidt, Remscheid, Germany.

– 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; observe the max. permissible conductor cross–sections. The use of the screwed terminals is recommended; snap–in connection requires special tools and must not be used for field wiring unless proper strain relief and and the permissible bending radius are observed.

– The screw–type terminals can be used *without* wire end ferrules. Pin–end connectors generally must not be used. Care has to be taken for a sufficiently long bare wire: approx. 15 mm (6/10 inch), at least 10 mm (4/10 inch).

5.2.1.3 Optical fibre link for protection data

– Unscrew the protective caps at the two F–SMA connectors of the device.

– Plug on the optical fibre cable terminal carefully; observe the designation of transmitter and receiver end; the transmitter terminal of one device must be connected to the receiver terminal of the other and vice versa.

– Tighten the cap nuts without force and without use of tools.

– Observe the permissible bending radius.

5.2.2 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.

If the current transformer sets at the two line ends have different secondary currents, then all that must be checked is that the rated secondary current of the respective current transformers complies with the rated current fo the connected unit.

5.2.2.1 Control d.c. voltage of binary inputs

When delivered from factory, the binary inputs are designed to operate with a control voltage which corresponds with the rated voltage of the power supply of the relay. In order to optimize the operation of the inputs, they should be matched to the real control voltage. It depends on the hard–ware state (production series) of the relay how this is carried out. This state is found on the name plate behind the complete order designation.

The following is valid for production series /**DD**:

The binary inputs react on control d.c. voltages in the total voltage range from 19 V to 288 V. The pick–up threshold lies near 17 V. If the rated control voltage for binary inputs is 110 V or higher, it is advisable to fit a higher pick–up threshold to these inputs to increase stability against stray voltages in the d.c. circuits.

To fit a higher pick–up threshold of approximately 65 V to a binary input a solder bridge must be removed. Figure 5.1 shows the assignment of these solder bridges for the inputs BI 1 to BI 4, and their location on the basic p.c.b. of the basic input/output module GEA–1. Figure 5.2 shows the assignment of these solder bridges for the inputs BI 5 to BI 10 and their location on the additional input/output module ZEA–1.

The following is valid for production series /**EE** or later:

Table 5.1 shows the assignment of the presettings of the control voltage of the binary inputs against the rated supply voltage of the relay. If the control voltage of a binary input is of the same magnitude as the supply voltage of the relay, no matching is necessary. Even with higher control voltage the binary input will operate. But it is advisable to fit a higher pick–up threshold to increase stability against stray voltages. Refer to Table 5.2 for possibilities. If a binary input is to be controlled by a lower voltage, then the pick–up threshold must be matched! Otherwise it cannot be energized.

Order code 7SD512★–	Rated auxiliary voltage range	Presetting of binary inputs
2★★★★–★★★★	24/48 Vdc	24 Vdc
4★★★★–★★★★	60/110/125 Vdc	60 Vdc
5★★★★–★★★★	220/250 V–	220 Vdc

Table 5.1 Presetting of control voltage for binary inputs for production series /EE or later

Table 5.2 shows the setting possibilities for the binary inputs BI 1 to BI 4 on the basic p.c.b. of the basic input/output module GEA–2, Table 5.3 for the inputs BI 5 to BI 10 on the additional input/output module ZEA–1. The figures 5.3 and 5.4 show the printed circuits boards, viewed from the component side, with the setting plugs for the control voltage of the binary inputs. They are valid for relays from production series /EE. If the actual control voltage is not found on the p.c.b., select the setting for the next lower voltage. The figures show further plugs, which must not be changed.

Binary input on GEA–2	Settings for rated control voltage			
	24/48 Vdc	60 Vdc	110/125 Vdc	220/250 Vdc
BI 1	plug X50–X51	plug X52–X53	plug X54–X55	no plug [1])
BI 2	plug X56–X57	plug X58–X59	plug X60–X61	no plug [1])
BI 3	plug X44–X45	plug X47–X48	plug X49–X62	no plug [1])
BI 4	plug X75–X76	plug X77–X78	plug X79–X80	no plug [1])

[1]) Unused plugs may be parked on the pins X36 to X43

Table 5.2 Checking for control voltages of binary inputs 1 to 4 on the basic module GEA–2, valid from production series /EE

Binary input on ZEA–2	Settings for rated control voltage			
	24/48 Vdc	60 Vdc	110/125 Vdc	220/250 Vdc
BI 5	plug 24 V	plug 60 V	plug 110 V	plug 220 V
BI 6	plug 24 V	plug 60 V	plug 110 V	plug 220 V
BI 7	plug 24 V	plug 60 V	plug 110 V	plug 220 V
BI 8	plug 24 V	plug 60 V	plug 110 V	plug 220 V
BI 9	plug 24 V	plug 60 V	plug 110 V	plug 220 V
BI 10	plug 24 V	plug 60 V	plug 110 V	plug 220 V

Table 5.3 Checking for control voltages of binary inputs 5 to 10 on the additional module ZEA–2, valid from production series /EE

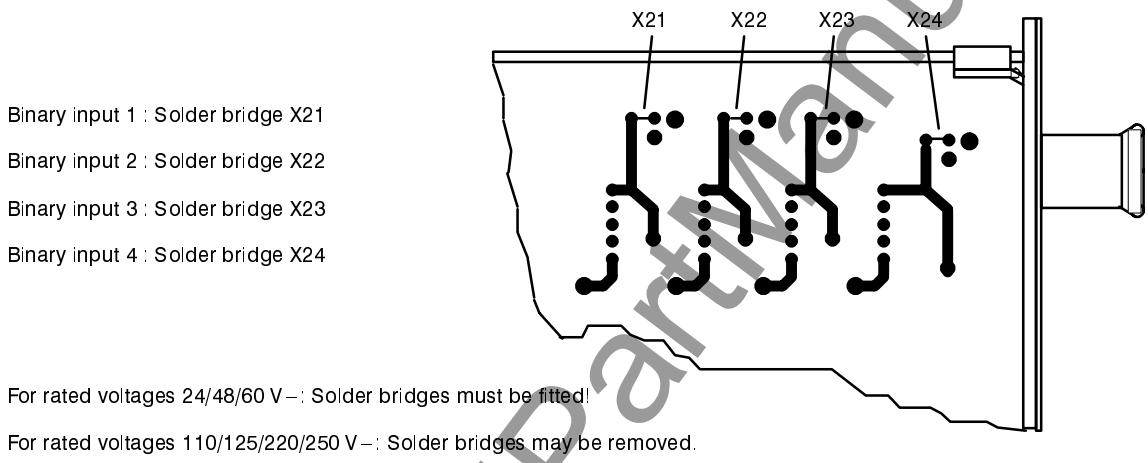


Figure 5.1 Checking for control voltages for binary inputs 1 to 4 on basic module GEA–1, up to production series /DD

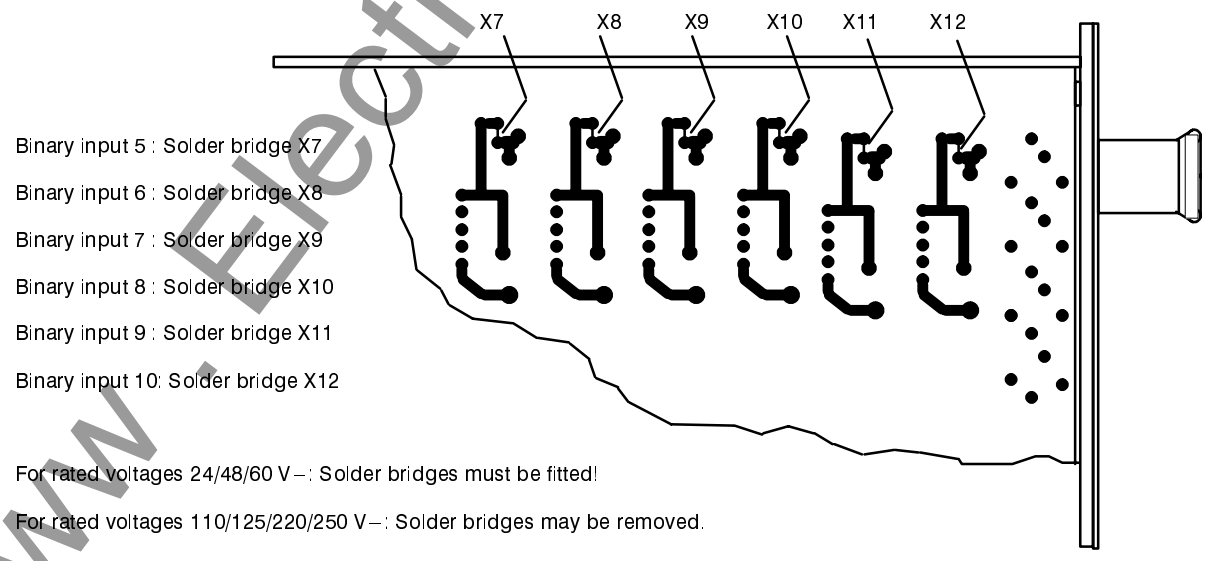


Figure 5.2 Checking for control voltages for binary inputs 5 to 10 on additional module ZEA–1, up to production series /DD

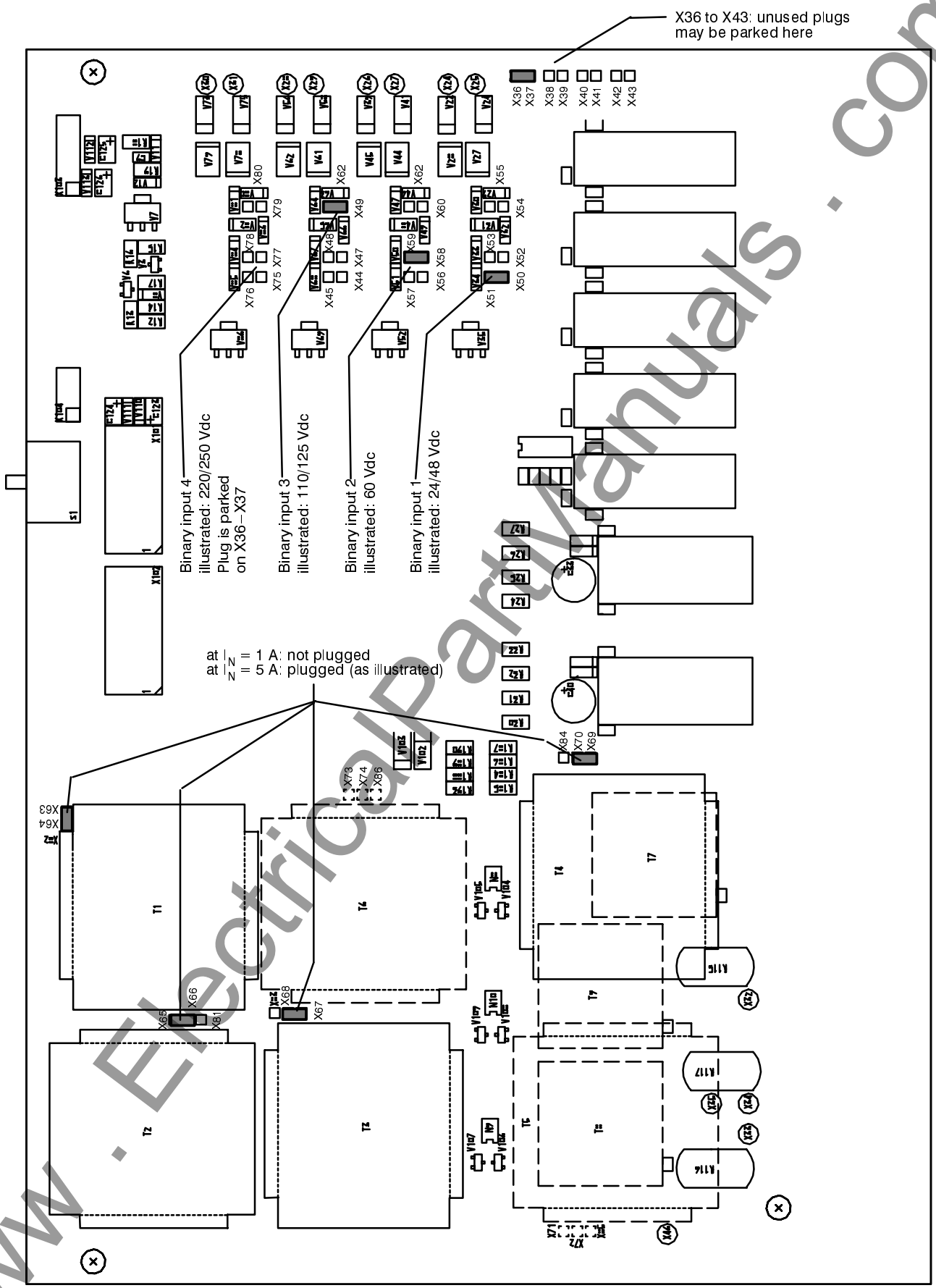


Figure 5.3 Setting plugs on basic input/output module GEA–2, from production series /EE

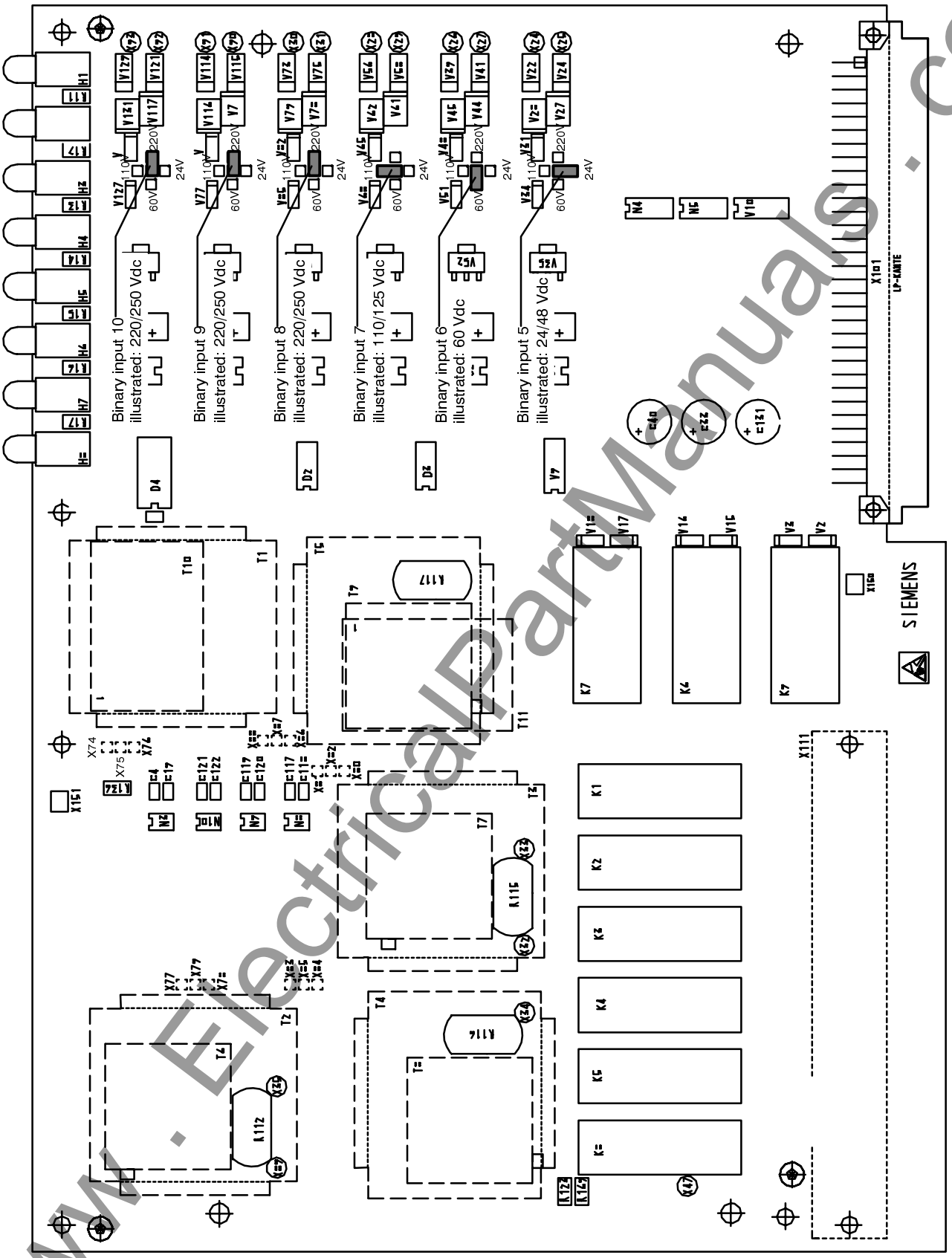


Figure 5.4 Setting plugs on additional input/output module ZEA−2, from production series /EE

– Open housing cover.

– Loosen the basic module using the pulling aids provided at the top and bottom.

> **Caution!**
>
> Electrostatic discharges via the component connections, the PCB tracks or the connecting pins of the modules must be avoided under all circumstances by previously touching an earthed metal surface.

– Pull out basic module and place onto a conductive surface.

– For production series up to /DD: check the solder bridges according to Figure 5.1, remove bridges where necessary.
For production series from /EE: check the plugs according to Figure 5.3.

– Insert basic module into the housing; ensure that the releasing lever is pushed fully to the left before the module is pressed in.

– Firmly push in the module using the releasing lever.

– Similarly check on the additional input/output module ZEA–2.
For production series up to /DD: check solder bridges according to Figure 5.2.
For production series from /EE: check the plugs according to Figure 5.4.

– Close housing cover.

5.2.3 Inserting the back–up battery

The device annunciations are stored in NV–RAMs. A back–up battery is available so that they are retained even with a longer failure of the d.c. supply voltage. The back–up battery is also required for the internal system clock with calender to continue in the event of a power supply failure.

The battery is supplied separately with relays of production series up to /DD. It should be inserted before the relay is installed. Section 7.2 explains in detail how to replace the back–up battery. Join this section accordingly when inserting the battery for the first time.

When the production series of the relay is /EE or later, the battery is installed at delivery so that no activities are necessary here.

5.2.4 Checking the protection data transmission link

Since the data transmission link between the units at either end of the line forms an essential and integral part of the comparison protection system, these connections must also be checked. The procedure is highly dependent on the chosen transmission medium and thus cannot be described in detail at this point. It is important to visually check the allocation of the transmitter and receiver channels including the associated frame reference connections. The connections are marked in sympathy with ISO 2110 and DIN 66020:

TXD	Transmit line of the respective unit
MT	Frame reference for the transmit line
RXD	Receive line of the respective unit
MR	Frame reference for the receive line

Since each connection is used for one transmission direction, the transmit connection of one unit must be connected to the receive connection of the other unit and vice versa.

Transmission via optical fibre is recommended. It is particularly insensitive against disturbances and automatically provides galvanic isolation.

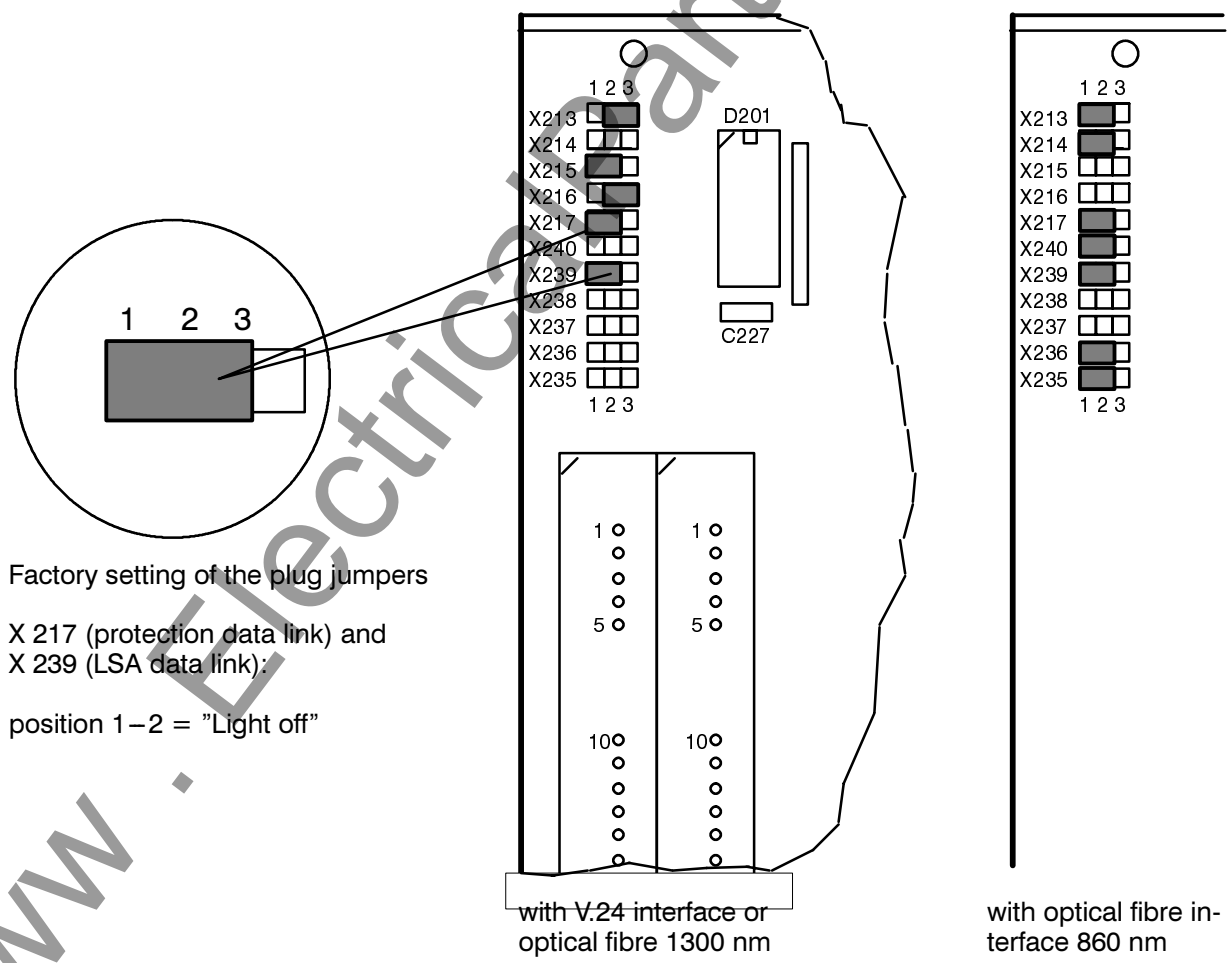
If data wire connection is used to a local optical fibre transmission device then the data cable screens are earthed at one cable end only.

If data transmission between the two units is by direct wire connection, then the conductor screen and the common overall screen must be earthed at one line end only. This prevents circulating currents from flowing via the screen in case of potential differences. This connection mode is generally not recommended because it could be influenced during line faults in spite of the screens. When using it nevertheless, it must be ensured that the longitudinal voltage which is induced into the transmission cable during short–circuits in the high voltage network does not exceed 60 % of the cable test voltage. The upper limit is 1200 V, which corresponds to 60 % of the test voltage for the interface of the 7SD512 for the protection signal transmission.

The normal signal position for the protection signal transmission is ”light off”. In models for 820 nm optical fibre, the normal signal position can be changed by means of a plug jumper X217 which is accessible when the plug–in module is removed from the case. The jumper is situated in the rear area of the upper part of the centre PCB (Figure 5.5).

Jumper	Position	Normal signal position
X217	1 – 2	”Light off”
X217	2 – 3	”Light on”

If optical fibre transmission units are used then they must be commissioned according to the respective operating instructions.



Factory setting of the plug jumpers

X 217 (protection data link) and
X 239 (LSA data link):

position 1–2 = ”Light off”

with V.24 interface or
optical fibre 1300 nm

with optical fibre interface 860 nm

Figure 5.5 Position of the jumpers X217 and X239 on the power supply board

5.2.5 Checking the transmission link to LSA

For models with interface for a central data processing station (e.g. LSA) these connections must also be checked. It is important to visually check the allocation of the transmitter and receiver channels. Since each connection is used for one transmission direction, the transmit connection of the relay must be connected to the receive connection of the central unit and vice versa.

Transmission via optical fibre is particularly insensitive against disturbances and automatically provides galvanic isolation. Transmit and receive connector are designated with the symbols ⟶● for transmit output and ●⟶ for receive input.

The normal signal position for the data transmission is factory preset as "light off". This can be changed by means of a plug jumper X239 which is accessible when the plug–in module is removed from the case. The jumper is situated in the upper rear area of the center board (power supply p.c.b.) (Figure 5.5).

Jumper	Position	Normal signal position
X239	1 – 2	"Light off"
X239	2 – 3	"Light on"

5.2.6 Connections

General and connection diagrams are shown in Appendix A and B. The marshalling possibilities of the binary inputs and outputs are described in Section 5.5. If, in networks with unearthed neutrals, only two current transformers are available, then the phase without a current transformer remains unconnected. In the event of a double earth fault, the footpoint in this phase will not be detected by the comparison protection. This must be in accordance with the double earth fault preference of the network.

5.2.6.1 Current transformer connections

If the current transformers at both line ends have different primary currents, then current matching is performed by entering the current transformer data to the device during parameterization (refer Section 6.3.3). If, for exceptional reasons (e.g. strongly differing c.t. ratios), matching is performed with intermediate c.t.s, the following should be noted:

Matching is performed at the end where the current transformers have the lower primary current. Since the current inputs of the 7SD51 are galvanically isolated from one another, auto–transformers can be used. The intermediate transformer output is then better utilized and the smaller model 4AM5170–7AA is sufficient.

The transformation ratio of the intermediate transformers is calculated as follows:

$$TR_I = \frac{I_{primary}\ \text{for the higher rated current}}{I_{primary}\ \text{for the lower rated current}}$$

The turn number ratio is thus:

$$\frac{N_1}{N_2} = \frac{I_{primary}\ \text{for the lower rated current}}{I_{primary}\ \text{for the higher rated current}}$$

whereby

N_1 – Turns number at the side facing the main current transformers,

N_2 – Turns number at the side facing the 7SD51

Example:

Current transformers at line end I: 500 A/5 A
Current transformers at line end II: 200 A/1 A

Matching is performed at line end II:

$$\frac{N_1}{N_2} = \frac{I_{primary}\ \text{for the lower rated current}}{I_{primary}\ \text{for the higher rated current}}$$

$$= \frac{200\ A}{500\ A} = 0.4 \text{ which corresponds to 20 / 50 winding turns}$$

5.2.6.2 Connections for circuit breaker auxiliary contacts

The circuit breaker live trip function can supervise the reaction of the breaker during the test sequence.

Binary inputs are provided to be connected to the auxiliary contact(s) of the circuit breaker in order to inform the relay about the breaker position. Various possibilities exist.

If the circuit breaker is switched only three–pole, its auxiliary contact is connected to a binary input module which is assigned to the input function ">CB Aux.1p cl" (FNo 355). The input function must be activated when the breaker is in the closed position. Function numbers 351, 352, 353, and 354 are not used.

If the circuit breaker poles can be switched individually but only the parallel connected auxiliary contacts are available, then the binary input for this connection must be assigned exclusively to the input function ">CB Aux.1p cl" (FNo 355). Function numbers 351, 352, 353, and 354 are not used.

If the circuit breaker poles can be switched individually and each individual auxiliary contact is available then it is recommended to connect the auxiliary contact of each individual pole to an individual binary input (example in Figure 5.6). The assignment of the binary inputs is as follows:

– auxiliary contact of pole L1 assigned to input function ">CB Aux. L1" (FNo 351),

– auxiliary contact of pole L2 assigned to input function ">CB Aux. L2" (FNo 352),

– auxiliary contact of pole L3 assigned to input function ">CB Aux. L3" (FNo 353).

Function numbers 354 and 355 are not used. This connection allows maximum information to be processed in the relay, i.e. to supervise each breaker pole.

If the circuit breaker poles can be switched individually but only two binary inputs can be used, one can connect the parallel connection of one set of auxiliary contacts to a binary input and the series connection to another. The inputs are assigned to the function ">CB Aux.1p cl" (FNo 355) for the parallel connection and to ">CB Aux.3p cl" (FNo 354) for the series connection (Figure 5.7).

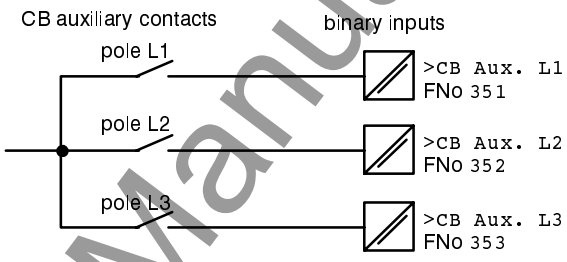


Figure 5.6 Connection example for CB auxiliary contacts

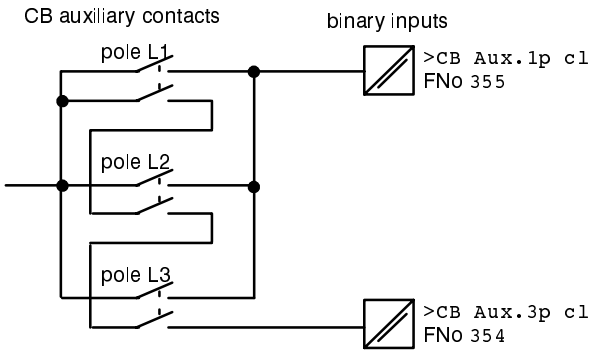


Figure 5.7 Connection example for CB auxiliary contacts

5.2.7 Checking the connections

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.

Before initial energization with supply voltage, the relay shall be situated in the operating area for at least two hours in order to ensure temperature equalization and to avoid humidity influences and condensation.

– Switch off the circuit breakers for the d.c. supply!

– Check the continuity of all the current transformer circuits against the plant and connection diagrams:

  - Are the current transformers correctly earthed?
  - Are the polarities of the current transformer connections consistent?
  - Is the phase relationship of the current transformers correct?
  - Is the polarity of the summation current transformer correct (if used)?
  - Is the polarity and transformation ratio of the matching current transformers correct (if used)?

– If test switches have been fitted in the secondary circuits, check their function, particularly that in the ”test” position the current transformer secondary circuits are automatically short–circuited.

– Ensure that the miniature slide switch on the front plate is in the ”OFF” ◯· position. (refer Figure 6.1).

– Fit a d.c. 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, the red LED gets off after at last 7 sec.

– Open the circuit breaker for the d.c. power supply.

– Remove d.c. 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.

5.3 Configuration of operation and memory functions

5.3.1 Operational preconditions and general

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 operation language, configuration of the interfaces and the device functions,

– allocation or marshalling of annunciation signals, binary inputs, optical indications, and trip relays,

– settings for 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. Operation via the integrated keyboard is described in detail in Section 6.2.

To indicate authorized operator use, press key **CW**, enter the six figure code **0 0 0 0 0 0** and confirm with **E**. Codeword entry can also be made retrospectively after paging or direct addressing to any setting address.

```
E N T E R   C O D E W O R D :
@ @ @ @ @ @
```

```
C W   A C C E P T E D
```

```
C O D E W O R D   W R O N G
```

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.

Address blocks 70 to 79 are provided for configuration of the software operating system. These settings concern the operation of the relay, communication with external operating and processing devices via the serial interfaces, and the interaction of the device functions.

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 7000 appears, which forms the heading of the configuration blocks:

```
⇑ 7 0 0 0 ▌ O P .  S Y S T E M
⇓ C O N F I G U R A T I O N
```

Beginning of the block ”Operating system configuration”

The double arrow key ⇑ switches over to the first configuration block (see below). Use the key ↑ to find the next address. The display shows the four–digit 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 presented 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!**

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 ?". Now you can confirm with **J**/**Y** or abort with **N**, as above.

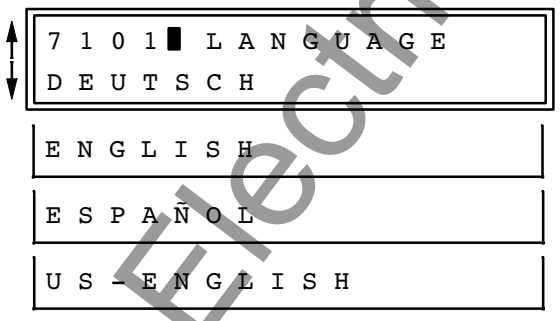
When one exits the setting program, the altered parameters, which until then have been stored in buffer stores, are permanently secured in EEPROMs and protected against power outage. If configuration parameters have been changed the processor system will reset and re – start. During re – start the device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

5.3.2 Settings for the integrated operation – address block 71

Operating parameters can be set in address block 71. This block allows the operator language to be changed. The date format can be selected. Messages on the front display can be selected here for the quiescent state of the unit or after a fault event. To change any of these parameters, codeword entry is necessary.

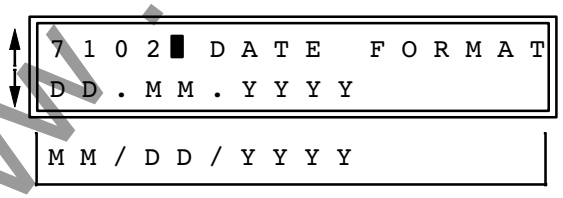
When the relay is delivered from the factory, the device is programmed to give function names and outputs in the German language. This can be changed under address 7101. The operator languages available at present are shown in the boxes below. The date is displayed in the European format when the relay is delivered.

Beginning of the block "Integrated operation"



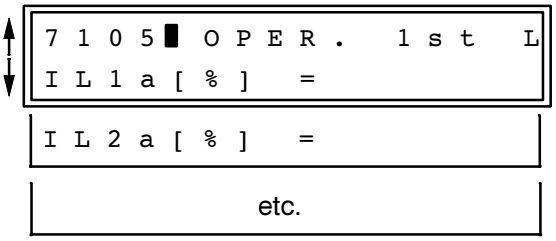
The available languages can be called up by repeatedly pressing the "No" – key **N**. Each language is spelled in the corresponding national language. If you don't understand a language, you should find your own language.

The required language is chosen with the enter key **E**.

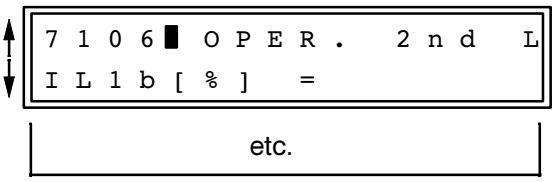


The date in the display is preset to the European format Day.Month.Year. Switch – over to the American format Month/Day/Year is achieved by depressing the "No" – key **N**; then confirm with the entry key **E**.

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

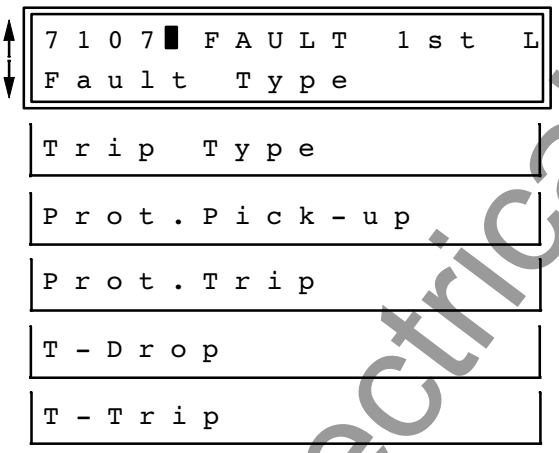


Message to be displayed in the **1st** display line during operation. Any of the operational measured values according to Section 6.4.5 can be selected as messages in the the quiescent state of the relay by repeatedly depressing the "No"–key **N**; The value selected by the entry key **E** under address 7105 will appear in the **first** line of the display.



Message to be displayed in the **2nd** display line during operation. The value selected by the entry key **E** under address 7106 will appear in the **second** line of the display.

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.



After a fault event, the **first** line of the display shows:

type of fault (faulty phases),

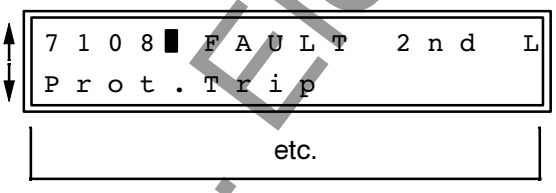
type of trip command (tripped breaker pole or three–pole trip),

protection function which has picked up,

protection function, which has tripped,

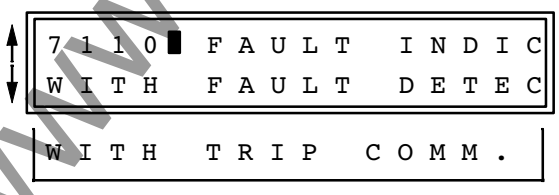
the elapsed time from pick–up to drop–off,

the elapsed time from pick–up to trip command,



After a fault event, the **second** line of the display shows:

the possibilities are the same as under address 7107.



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**.

5.3.3 Configuration of the serial interfaces – address block 72

The device provides 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.

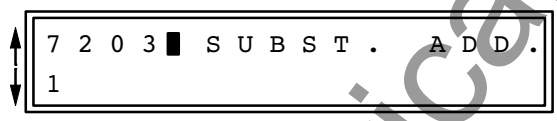
These data are entered to the relay in address block 72. Codeword input is necessary (refer to Section 5.3.1). The data must be coordinated with the connected devices.

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

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**



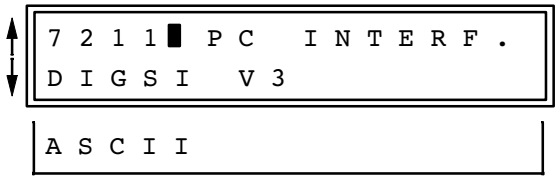
Identification number of the substation, in case more than one substation can be connected to a central device
Smallest permissible number: **1**
Largest permissible number: **254**

Function type in accordance with VDEW/ZVEI; for current comparison protection no. 192.
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 7SD512 V3 no. 29.
This address is only for information, it cannot be changed.

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

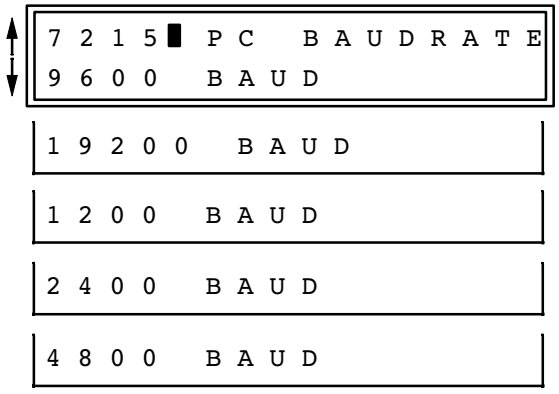
Note: For operator panel 7XR5, the PC–interface format (address 7211) must be *ASCII*, the PC Baud–rate (address 7215) must be *1200 BAUD*, the PC parity (address 7216) must be *NO 2 STOP*.



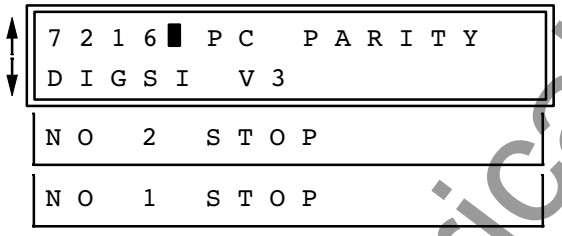
Data format for the PC (operating) interface:

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

ASCII format



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**.



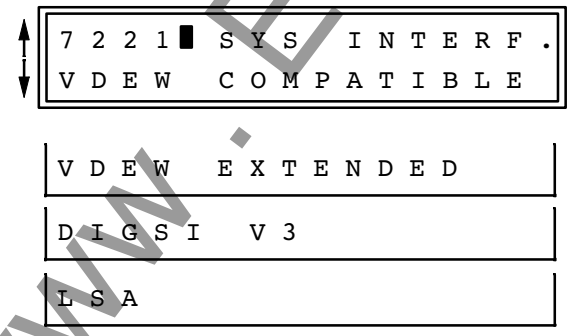
Parity and stop–bits for the PC (operating) interface:

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. for modem

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



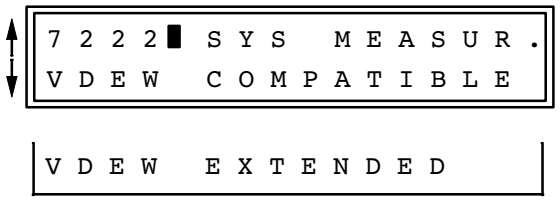
Format of annunciations and fault records for the system (LSA) interface:

only data in accordance with *VDEW*/ZVEI (IEC 60870–5–103)

data in accordance with *VDEW*/ZVEI (IEC 60870–5–103), *extended* by Siemens specified data

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

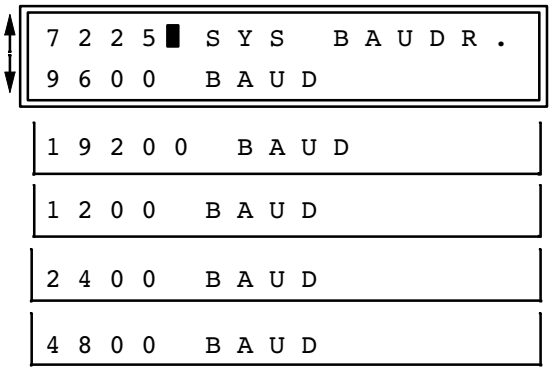
format of the former Siemens *LSA* version



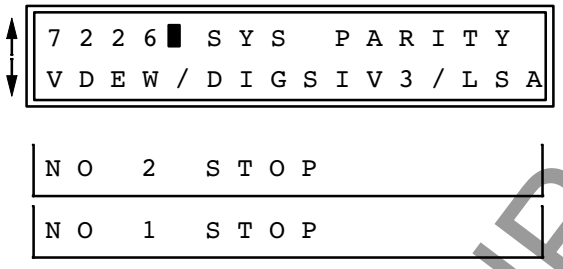
Format of measured values for the system (LSA) interface:

only data in accordance with *VDEW*/ZVEI (IEC 60870–5–103)

data in accordance with *VDEW*/ZVEI (IEC 60870–5–103), *extended* by Siemens specified data



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:

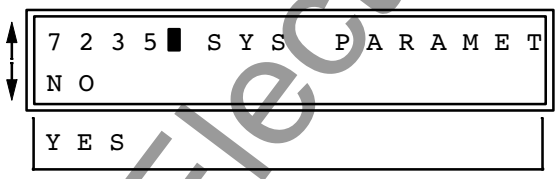
format for *VDEW*–protocol (IEC 60870–5–103) or Siemens protection data processing program *DIGSI*® *Version 3* and former *LSA*

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

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

---

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



Remote parameterizing via the system interface

NO – is not permitted

YES – is permitted

5.3.4 Settings for fault recording – address block 74

The current comparison protection relay is equipped with a fault data store (see Section 4.8.2). 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 FD*), 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 function and ends with drop–off of the latest fault detection. The scope of a fault record is normally this fault event (address 7403). If auto–reclosure is carried out, the complete network fault sequence – with one or more reclosure attempts – can be recorded until final fault clearance. This shows the total time sequence of the fault but utilizes more memory space even during the dead time(s).

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 address 7410. Altogether 5 s are available for fault recording. In this time range up to 8 fault records can be stored.

Note: The max. times are referred to a system frequency of 50 Hz. They are to be matched, accordingly, for different frequency.

The fault recording 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 but not longer than T–MAX; 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).

```
7400
FAULT  RECORDINGS
```

Beginning of block ”Fault recordings”

```
7402 INITIATION
STORAGE  BY  FD.
```

```
STORAGE  BY  TRIP
```

```
START  WITH  TRIP
```

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

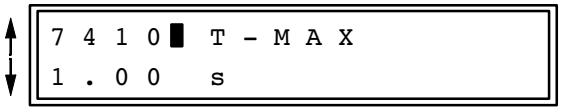
```
7403 SCOPE
FAULT  EVENT
```

```
FAULT  IN  POW.SYS
```

Scope of a fault record:

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

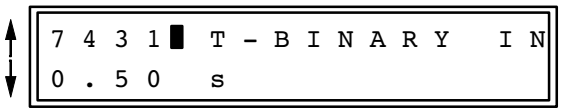
a fault record comprises the total *NETWORK FAULT* including auto–reclosure attempts



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

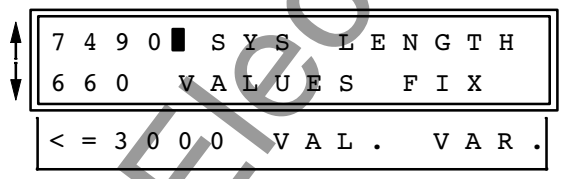
Post–fault time after the storage criterion disappears
Smallest setting value: **0.05** s
Largest setting value: **0.50** s



Storage time when fault recording is initiated via a binary input, pre–trigger and post–fault times 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 and post–fault times are additive
Smallest setting value: **0.10** s
Largest setting value: **5.00** s

Address 7490 is not relevant in case that the relay is connected to a control and storage processing system which operates with the protocol according to VDEW/ZVEI (IEC 60870–5–103). But, 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 or

variable length with a maximum of 3000 values

5.4 Configuration of the protective functions

5.4.1 Introduction

The **device** 7SD512 is capable of providing a series of **protection** and additional functions. 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.

1st example for configuration of the scope of the device:
Assume a network comprising overhead lines and cable sections. For reasons of uniformity, all devices have been specified with auto–reclose facilities. Since auto–reclose is only applicable for the overhead line sections, this function will be "de–configured" for the devices protecting the cable sections.

2nd example for the interaction of the functions:
The device includes current comparison protection and overcurrent time protection. The current comparison protection is required to operate with single–pole auto–reclose, the overcurrent time protection shall operate without auto–reclosure. The device will be "informed" of this condition during configuration.

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 Section 6.2. Alteration of the programmed parameters requires the input of the codeword (see Section 5.3.1). 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 bock 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. 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 configuration 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.

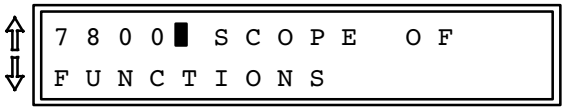
When one exits the setting program, the altered parameters, which until then have been stored in volatile memories, are then permanently secured in EEPROMs and protected against power outage. The processor system will reset and re–start. During re–start the device is not operational.

5.4.2 Programming the scope of functions – address 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.

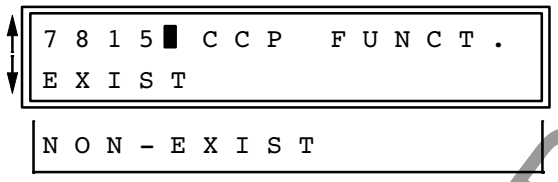
Functions which are **configured** as *NON EXIST* will not be processed in 7SD512: There will be no annunciations and the associated setting parameters (functions, limit values) will not be requested during setting (Section 6.3). In contrast, **switch–off** of a function means that the function will 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.

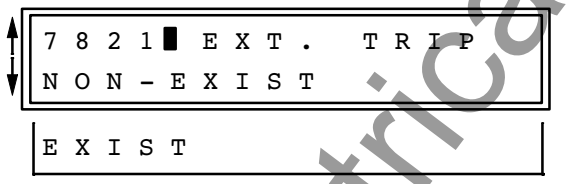


Beginning of the block "Scope of functions"

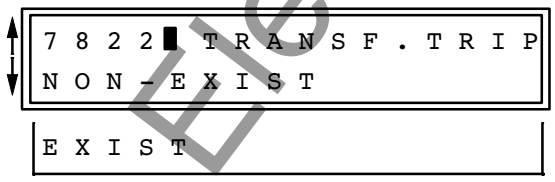
Current comparison protection:



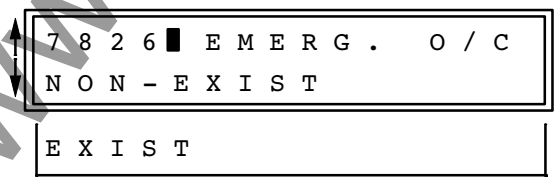
External local trip via binary input:



Transfer trip via binary input:

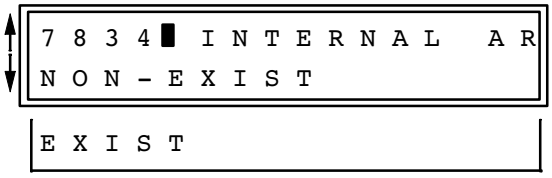


Emergency overcurrent time protection:

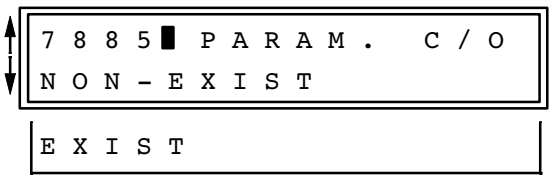


Thermal overload protection:

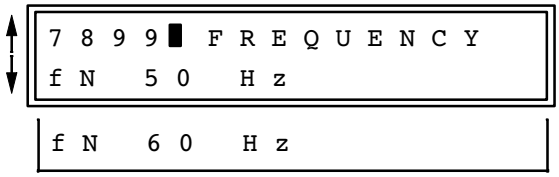
Internal auto–reclosure function:



Change–over of parameter sets:



The rated system frequency must comply with the setting under address 7899. If the system frequency is not 50 Hz, address 7899 must be changed.



Rated system frequency *50 Hz* or *60 Hz*

5.4.3 Setting the device configuration – address block 79

The configuration affects the interaction of the protective and additional functions, above all, for 7SD512, the interaction of the auto–reclosing system with the protection functions. This enables to connect a 7SD512 with firmware version V3 with a 7SD512 V2 or 7SD511 V2 at the opposite line end.

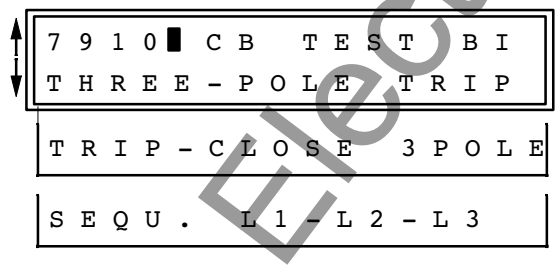
Beginning of the block "device configuration"

Auto–reclosing works together with current comparison protection or not

Back–up overcurrent time protection operation

NO – AR is blocked

YES – AR works in accordance with the setting but no auto–reclose when only I_E pick–up

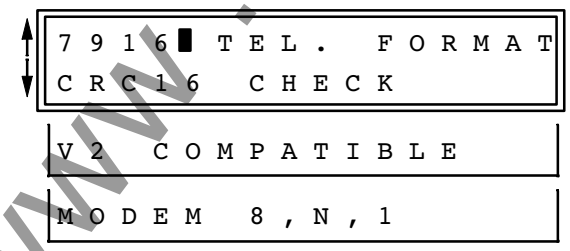


Circuit breaker test via binary input is carried out

THREE–POLE TRIP will be initiated (without reclose) or

TRIP–CLOSE 3POLE, that is three–pole AR cycle, or

each pole one after the other with a *SEQU. L1–L2–L3* open and close (this is only applicable when single–pole AR is used).



Telegram format of protection data transmission:

CRC 16 CHECK, i.e. telegram of version V3

COMPATIBLE with 7SD51 firmware version *V2*

MODEM with *8* bit, *N*o parity, and *1* stop–bit; the correct data transmission rate must be set under address 1602, see Section 6.3.5

5.5 Marshalling of binary inputs, binary outputs and LED indicators

5.5.1 Introduction

The functions of the binary inputs and outputs represented in the general diagrams (Appendix A) relate to the factory settings. 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 via the operating interface in the front. The operation of the operator panel is described in detail in Section 6.2. Marshalling begins at the parameter address 6000.

The input of the codeword is required for marshalling (refer Section 5.3.1). 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 configuration procedure, the solid bar in the display flashes.

When the firmware programs are running the specific logic functions will be allocated to the physical input and output modules or LEDs in accordance with the selection.

Example: Single–pole trip command is registered from the current comparison protection in phase L1. This event is generated in the device 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 "`Dev.Trip 1pL1`" 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. block current comparison protection) 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 element 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 function must not exceed a number of 10. If this number is tried to be exceeded, the display will show a corresponding message.

The marshalling procedure is set up such that for each (physical) binary input, each output relay, and for each marshallable LED, the operator will be asked which (logical) function should be allocated.

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**. When the required function appears press the execute key **E**. 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 execute key E**. Immediately the associated identification of the function appears for checking purposes. This can be altered either by entering another 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 execute 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 function numbers and designations are listed completely in Appendix C.

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 re–start. During re–start the device is not operational.

5.5.2 Marshalling of the binary inputs – address block 61

The unit contains 10 binary inputs which are designated INPUT 1 to INPUT 10. 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**. The selection procedure is carried out as described in Section 5.5.1.

A choice can be made for each individual input function as to whether the desired function should become operative in the "normally open" mode or in the "normally closed" mode, whereby:

NO – "normally open" mode: the input acts as a NO contact, i.e. the control voltage at the input terminals activates the function;

NC – "normally closed" mode: the input acts as a NC contact, i.e. control voltage present at the terminals turns off the function, control voltage absent activates the function.

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

Table 5.1 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 ("de–configured", refer Section 5.4.2).
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 means "normally open" mode, corresponds to "NO" as above.

.1 means "normally closed" mode, corresponds to "NC" as above.

If the extension with .0 or .1 is omitted the display first indicates the function designation in "normally open" mode NO. By pressing the "No"–key **N** the mode is changed to NC. 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 entry key **E**.

Note: One logical function must not be marshalled to two or more binary inputs, because an OR–logic of both signals can not be guaranteed!

The assignment of the binary inputs as delivered from factory is shown in the general diagrams in Appendix A. The following boxes show, as an example, the allocation for binary input 1. Table 5.2 shows all binary inputs as preset from the factory.

Beginning of block "Marshalling binary inputs"

The first binary input is reached with the key ↑:

Allocations for binary input 1

Change over to the selection level with **F** ↑:

Transfer trip command for the remote end circuit breaker, FNo 3306;
"normally open" operation: remote trip signal is sent when the input is energized

No further functions are initiated by binary input 1

Leave the selection level with key combination **F** ↑. You can go then to the next binary input with the arrow key ↑.

Marshalling binary input 1

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 (in conjunction with 8)
8	>ParamSelec.2	Parameter set selection 2 (in conjunction with 7)
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
351	>CB Aux. L1	Circuit breaker pole L1 is closed (from CB auxiliary contact)
352	>CB Aux. L2	Circuit breaker pole L2 is closed (from CB auxiliary contact)
353	>CB Aux. L3	Circuit breaker pole L3 is closed (from CB auxiliary contact)
354	>CB Aux.3p cl	Circuit breaker all 3 poles closed (series connection)
355	>CB Aux.1p cl	Circuit breaker any pole closed (parallel connection)
356	>Manual Close	Circuit breaker is manually closed (from discrepancy switch)
357	>CloseCmd.Blo	Block all closing commands
381	>1p Trip Perm	External AR ready for single-pole reclosure
382	>Only 1pole	External AR is programmed single-pole only
383	>RAR Release	Release of auto-reclose stages from external AR relay
1156	>CB Test	Trigger circuit breaker test
2010	>I>> block	Block I>> stage of emergency overcurrent time protection
2011	>IE>> block	Block I_E>> stage of emergency overcurrent time protection
2012	>I>/Ip block	Block I> or I_p stage of emergency overcurrent time protection
2013	>IE>IEp block	Block I_E> or I_{Ep} stage of emergency overcurrent time protection
2021	>Emer Ph on	Switch on emergency overcurrent time protection for phase currents
2022	>Emer Ph off	Switch off emergency overcurrent time protection for phase currents
2023	>Emer E on	Switch on emergency overcurrent time protection for earth current
2024	>Emer E off	Switch off emergency overcurrent time protection for earth current
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 statically
2704	>AR reset	Reset internal auto-reclose function (incl. lock-out)
2706	>1p RAR block	Block single-pole RAR
2707	>3p RAR block	Block tree-pole RAR
2708	>RAR block	Block complete RAR
2709	>DAR block	Block complete DAR
2711	>Start AR	Start signal from external protection for internal AR
2712	>Trip L1 AR	Trip signal L1 from external protection for internal AR
2713	>Trip L2 AR	Trip signal L2 from external protection for internal AR
2714	>Trip L3 AR	Trip signal L3 from external protection for internal AR
2715	>Trip 1p AR	Trip signal single-pole from external protection for internal AR
2716	>Trip 3p AR	Trip signal three-pole from external protection for internal AR
2721	>DAR aft. RAR	DAR is permitted only after unsuccessful RAR

Table 5.1 Marshalling possibilities for binary inputs (continued next page)

FNo	Abbreviation	Description
2730	>CB ready	Circuit breaker ready for AR cycle
3051	>CCP on	Switch on current comparison protection
3052	>CCP off	Switch off current comparison protection
3053	>CCP block	Block current comparison protection
3059	>CCP test	Test current comparison protection
3306	>Trans.Trip	Trigger transfer trip
3391	>Data block	Block transmission of protection data
3421	>Trans.Annu1	Transmit user definable remote annunciation 1
3422	>Trans.Annu2	Transmit user definable remote annunciation 2
3423	>Trans.Annu3	Transmit user definable remote annunciation 3
3424	>Trans.Annu4	Transmit user definable remote annunciation 4
4506	>Ext Trip	Trigger external trip

Table 5.1 Marshalling possibilities for binary inputs

Addr	1st display line	2nd display line	FNo	Remarks
6100	MARSHALLING	BINARY INPUTS		Heading of the address block
6101	BINARY INPUT 1	INPUT 1 >Trans.Trip NO	3306	Trigger transfer trip to remote line end
6102	BINARY INPUT 2	INPUT 2 >LED reset NO	5	Acknowledge and reset of stored LED and display indications, LED – test
6103	BINARY INPUT 3	INPUT 3 >CCP block NO	3053	Block current comparison protection
6104	BINARY INPUT 4	INPUT 4 >Ext Trip NO	4506	Trigger external local trip
6105	BINARY INPUT 5	INPUT 5 >CB Aux.1p cl NO	355	from circuit breaker auxiliary contacts: parallel connection
6106	BINARY INPUT 6	INPUT 6 >Manual Close NO	356	Manual close command from discrepancy switch
6107	BINARY INPUT 7	INPUT 7 >CB ready NO	2730	Binary inputs 7 to 10 are only effective when the internal auto – reclose function is configured as *EXIST* (refer to Section 5.4.2)
6108	BINARY INPUT 8	INPUT 8 >AR block NO	2703	
6109	BINARY INPUT 9	INPUT 9 >AR on NO	2701	
6110	BINARY INPUT 10	INPUT 10 >AR off NO	2702	

Table 5.2 Preset binary inputs

5.5.3 Marshalling of the signal output relays – address block 62

The unit contains 11 signal outputs (alarm relays). The signal relays are designated SIGNAL RELAY 1 to SIGNAL RELAY 11 and can be marshalled in address 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 Section 5.5.1. Multiple annunciations are possible, i.e. one logical annunciation function can be given to several physical signal relays (see also Section 5.5.1).

Table 5.3 gives a listing of all annunciation functions with the associated function numbers **FNo**. Annunciation functions are naturally not effective when the corresponding protection function has been programmed out ("de–configured" – refer Section 5.4.2).

The assignment of the output signal relays as delivered from factory is shown in the general diagrams in Appendix A. The following boxes show examples for marshalling of signal relay 1. Table 5.4 shows all signal relays as preset from the factory.

Note as to Table 5.3: Annunciations with a leading ">" sign are identical with those for binary inputs. They represent the direct confirmation of the binary input and are available as long as the corresponding binary input is energized.

Further information about annunciations see Section 6.4.

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

The first signal relay is reached with the key ↑:

Allocations for signal relay 1

Change over to the selection level with **F** ↑:

Signal relay 1 has been preset for:
General trip of the device, FNo 511

no further functions are preset for signal relay 1

Leave the selection level with key combination **F** ↑. You can go then to the next signal output relay with the arrow key ↑.

Allocations for signal relay 1

FNo	Abbreviation	Description
1	not allocated	Binary output is not allocated to any annunciation 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 (in connection with 8)
8	>ParamSelec.2	Parameter set selection 2 (in connection with 7)
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
51	Dev.operative	Protection relay operative
60	LED reset	Stored LED indicators are reset
95	Param.running	Parameters are being set
96	Param. Set A	Parameter Set A is activated
97	Param. Set B	Parameter Set B is activated
88	Param. Set C	Parameter Set C is activated
99	Param. Set D	Parameter Set D is activated
141	Failure 24V	Failure in 24 V internal dc supply circuit
143	Failure 15V	Failure in 15 V internal dc supply circuit
144	Failure 5V	Failure in 5 V internal dc supply circuit
145	Failure 0V	Failure 0 V for A/D converter
150	Failure I/O	Failure in basic input/output module (GEA)
151	Failure I/O 1	Failure in additional input/output module (ZEA)
161	I supervision	Failure current supervision, general
162	Failure ΣI	Failure detected by current sum monitor
163	Failure Isymm	Failure detected by current symmetry monitor
351	>CB Aux. L1	Circuit breaker pole L1 is closed (from CB auxiliary contact)
352	>CB Aux. L2	Circuit breaker pole L2 is closed (from CB auxiliary contact)
353	>CB Aux. L3	Circuit breaker pole L3 is closed (from CB auxiliary contact)
354	>CB Aux.3p cl	Circuit breaker all 3 poles closed (series connection)
355	>CB Aux.1p cl	Circuit breaker any pole closed (parallel connection)
356	>Manual Close	Circuit breaker is manually closed (from discrepancy switch)
357	>CloseCmd.Blo	Block all closing commands
381	>1p Trip Perm	External AR ready for single-pole reclosure
382	>Only 1pole	External AR is programmed single-pole only
383	>RAR Release	Release of auto-reclose stages from external AR relay
501	Device FltDet	General fault detection of the device
511	Device Trip	General trip of the device
512	Dev.Trip 1pL1	Trip by the device single-pole L1
513	Dev.Trip 1pL2	Trip by the device single-pole L2
514	Dev.Trip 1pL3	Trip by the device single-pole L3
515	Dev.Trip 3p	Three-pole trip of the device
561	Manual Close	Circuit breaker is manually closed (execution)
563	CB Alarm Supp	Circuit breaker operation alarm suppressed
1156	>CB Test	Trigger circuit breaker test
1174	CB in Test	Circuit breaker test is in progress
1181	CB Test Trip	Trip by internal circuit breaker test function
1182	CB Test 1pL1	Trip by internal circuit breaker test function single-pole L1
1183	CB Test 1pL2	Trip by internal circuit breaker test function single-pole L2
1184	CB Test 1pL3	Trip by internal circuit breaker test function single-pole L3
1185	CB Test 3p	Trip three-pole by internal circuit breaker test function

Table 5.3 Marshalling possibilities for signal relays and LEDs (continued next page)

FNo	Abbreviation	Description
1511	O/L Prot. off	Thermal overload protection is switched off
1513	O/L active	Thermal overload protection is active
1515	O/L Warn I	Thermal overload protection current warning stage picked up
1516	O/L Warn Θ	Thermal overload protection thermal warning stage picked up
1521	O/L Trip	Thermal overload protection trip command
2010	>I>> block	Block I>> stage of emergency overcurrent time protection
2011	>IE>> block	Block I_E>> stage of emergency overcurrent time protection
2012	>I>/Ip block	Block I> or I_p stage of emergency overcurrent time protection
2013	>IE>IEp block	Block I_E> or I_{Ep} stage of emergency overcurrent time protection
2021	>Emer Ph on	Switch on emergency overcurrent time protection for phase currents
2022	>Emer Ph off	Switch off emergency overcurrent time protection for phase currents
2023	>Emer E on	Switch on emergency overcurrent time protection for earth current
2024	>Emer E off	Switch off emergency overcurrent time protection for earth current
2053	Emer. active	Emergency overcurrent time protection is active
2054	Emer. mode	Emergency mode is in progress
2055	Emer.E/F off	Emergency earth fault overcurrent time protection is switched off
2056	Emer.Ph. off	Emergency phase fault overcurrent time protection is switched off
2061	Emer.Gen.Flt	General fault detection of emergency overcurrent protection
2062	Emer. Flt L1	Fault detection of emergency overcurrent protection in phase L1
2063	Emer. Flt L2	Fault detection of emergency overcurrent protection in phase L2
2064	Emer. Flt L3	Fault detection of emergency overcurrent protection in phase L3
2065	Emer. Flt E	Fault detection of emergency overcurrent protection earth fault
2091	Emer. I>>	I>> stage of emergency overcurrent protection picked up
2092	Emer. I>/Ip	I> or I_p stage of emergency overcurrent protection picked up
2095	Emer. IE>>	I_E>> stage of emergency overcurrent protection picked up
2096	Emer. IE>/IEp	I_E> or I_{Ep} stage of emergency overcurrent protection picked up
2121	Emer. TI>>	Delay time of I>> stage of overcurrent time protection expired
2122	Emer. TI>/Tp	Delay time of I> or I_p stage of overcurrent time protection expired
2125	Emer. TIE>>	Delay time of I_E>> stage of overcurrent time protection expired
2126	Emer. TIE>TEp	Delay time of I_E> or I_{Ep} stage of overcurrent time protection expired
2141	Emer.Gen.Trip	General trip by emergency overcurrent protection
2142	Emer.Trip1pL1	Trip single-pole L1 by emergency overcurrent protection
2143	Emer.Trip1pL2	Trip single-pole L2 by emergency overcurrent protection
2144	Emer.Trip1pL3	Trip single-pole L3 by emergency overcurrent protection
2145	Emer.Trip 3p	Three-pole 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
2704	>AR reset	Reset internal auto-reclose function
2706	>1p RAR block	Block single-pole rapid auto-reclosure (RAR, 1st shot)
2707	>3p RAR block	Block three-pole rapid auto-reclosure (RAR, 1st shot)
2708	>RAR block	Block complete rapid auto-reclosure (RAR, 1st shot)
2709	>DAR block	Block complete delayed auto-reclosure (DAR, further shots)
2711	>Start AR	Start signal from external protection for AR
2712	>Trip L1 AR	Trip signal L1 from external protection for AR
2713	>Trip L2 AR	Trip signal L2 from external protection for AR
2714	>Trip L3 AR	Trip signal L3 from external protection for AR
2715	>Trip 1p AR	Trip signal single-pole from external protection for AR
2716	>Trip 3p AR	Trip signal three-pole from external protection for AR
2721	>DAR aft. RAR	DAR is permitted only after unsuccessful RAR
2730	>CB ready	Circuit breaker ready for AR cycle

Table 5.3 Marshalling possibilities for signal relays and LEDs (continued next page)

FNo	Abbreviation	Description
2781	AR off	Internal auto-reclose function is switched off
2782	AR on	Internal auto-reclose function is switched on
2783	AR inoperativ	Internal auto-reclose function is not operative
2784	AR not ready	Internal auto-reclose function is not ready for reclose
2785	AR block.dyn.	Internal auto-reclose function is blocked dynamically
2787	CB not ready	Circuit breaker not ready for a trip/reclose cycle
2788	AR T-CB Exp.	Circuit breaker supervision time expired
2801	AR in prog.	Auto-reclose cycle is in progress
2811	RAR only	Internal AR function is programmed to perform only RAR cycle
2812	RAR T-act.run	Auto-reclose function action time for RAR is running
2813	RAR T-1p run.	Auto-reclose function single-pole dead time for RAR is running
2814	RAR T-3p run.	Auto-reclose function three-pole dead time for RAR is running
2815	RAR 1p Prog.	RAR function is programmed to perform only single-pole AR
2816	RAR 3p Prog.	RAR function is programmed to perform only three-pole AR
2817	RAR Zone Rel.	Internal AR function is ready to permit trip in RAR stage
2818	AR evolv.Flt.	Auto-reclose function evolving fault recognized during dead time
2831	DAR Only	Internal AR function is programmed to perform only DAR cycles
2832	DAR T-act.run	Auto-reclose function action time for DAR is running
2833	DAR T-3p1 run	Auto-reclose function dead time for first DAR is running
2834	DAR T-3p2 run	Auto-reclose function dead time for second DAR is running
2835	DAR T-3p3 run	Auto-reclose function dead time for further 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
2852	RAR 1p Close	Reclose command after single-pole RAR
2853	RAR 3p Close	Reclose command after three-pole RAR (rapid AR)
2854	DAR 3p Close	Reclose command after three-pole DAR (delayed AR)
2861	AR T-Recl.run	Auto-reclose function reclaim time is running
2862	AR successful	Auto-reclosure was successful
2863	Definit.Trip	Definitive (final) trip signal
2864	1p Trip Perm.	Internal AR function is ready to permit single pole trip
2871	AR Trip 3p	Internal AR function trips three-pole because blocked
3051	>CCP on	Switch on current comparison protection
3052	>CCP off	Switch off current comparison protection
3053	>CCP block	Block current comparison protection
3059	>CCP test	Test current comparison protection
3066	CCP off	Current comparison protection is switched off
3067	CCP block	Current comparison protection is blocked
3068	CCP active	Current comparison protection is active
3071	Itr.send off	Intertrip send signal is switched off
3072	Itr.rec. off	Intertrip reception is switched off
3073	I.Trip Send	Intertrip send signal
3074	I.Trip Rec.	Intertrip signal received
3075	CCP Test	Current comparison protection test procedure in progress
3076	CCP.Gen.Flt.	Current comparison protection general fault detection
3077	CCP.Fault L1	Current comparison protection fault detection phase L1
3078	CCP.Fault L2	Current comparison protection fault detection phase L2
3079	CCP.Fault L3	Current comparison protection fault detection phase L3
3080	Flt.I.Trip	Fault detection signal of intertrip function
3084	CCP.Gen.Trip	Current comparison protection general trip
3085	CCP.Trip L1	Current comparison protection trip single-pole L1
3086	CCP.Trip L2	Current comparison protection trip single-pole L2
3087	CCP.Trip L3	Current comparison protection trip single-pole L3
3088	CCP.Trip L123	Current comparison protection three-pole trip

Table 5.3 Marshalling possibilities for signal relays and LEDs (continued next page)

FNo	Abbreviation	Description
3090	Com.FltRec	Commissioning fault record is started
3306	>Trans.Trip	Trigger transfer trip
3311	TransTrip off	Transfer trip function is switched off
3316	TrTrip Send	Transfer trip transmission signal
3321	T.TripRec.off	Transfer trip reception is switched off
3322	T.Trip active	Transfer trip function is active
3323	T.Trip rec.	Transfer trip signal received from remote end
3324	Transfer Trip	Trip command by transfer trip reception
3391	>Data block	Block transmission of protection data
3401	TT.Corr.off	Automatic transmission time correction is switched off
3402	TT.corrected	Transmission time correction has been carried out
3403	TT Dev.>0.5ms	Transmission time deviation greater than 0.5 ms i.e. inadmissible
3404	TT blocks CCP	Current comp. prot. blocked by transmission time deviation
3405	Data Fault	Faulty data received
3406	Recep.Fail.	Total reception failure
3407	Wrong Version	Firmware version does not match with remote end relay
3408	Wrong Dev.ID	Device identification number does not match with remote end relay
3409	TR.Time Meas.	Fault recording released for commissioning
3410	Angle Meas.	Angle measurement is in progress
3421	>Trans.Annu1	Transmit user definable remote annunciation 1
3422	>Trans.Annu2	Transmit user definable remote annunciation 2
3423	>Trans.Annu3	Transmit user definable remote annunciation 3
3424	>Trans.Annu4	Transmit user definable remote annunciation 4
3431	Trans.Annu.1	User defined message 1 received from remote end
3432	Trans.Annu.2	User defined message 2 received from remote end
3433	Trans.Annu.3	User defined message 3 received from remote end
3434	Trans.Annu.4	User defined message 4 received from remote end
4506	>Ext Trip	Trigger external trip
4511	Ext off	External trip facility is switched off
4513	Ext active	External trip facility is active
4517	Ext Gen. Trip	General trip command by external trip facility

Table 5.3 Marshalling possibilities for signal relays and LEDs

Addr	1st display line	2nd display line	FNo	Remarks
6200	MARSHALLING	SIGNAL RELAYS		Heading of the address block
6201	SIGNAL RELAY 1	RELAY 1 Device Trip	511	Trip signal given from either protection function of the device
6202	SIGNAL RELAY 2	RELAY 2 I.Trip Rec.	3074	Intertrip signal received
6203	SIGNAL RELAY 3	RELAY 3 CCP Block.	3067	Current comparison protection is blocked
6204	SIGNAL RELAY 4	RELAY 4 Recep.Fail.	3406	Total reception failure
6205	SIGNAL RELAY 5	RELAY 5 Dev.operative	51	The NC contact of this relay indicates ”Device fault”
6206	SIGNAL RELAY 6	RELAY 6 AR inoperativ	2783	AR function is not operative
6207	SIGNAL RELAY 7	RELAY 7 Dev.Trip 1pL1 Dev.Trip 3p	512 515	Trip signal of the device with indication of the tripped breaker pole(s)
6208	SIGNAL RELAY 8	RELAY 8 Dev.Trip 1pL2 Dev.Trip 3p	513 515	
6209	SIGNAL RELAY 9	RELAY 9 Dev.Trip 1pL3 Dev.Trip 3p	514 515	
6210	SIGNAL RELAY 10	RELAY 10 not allocated	1	No function allocated
6211	SIGNAL RELAY 11	RELAY 11 CB Alarm Supp	563	Circuit breaker alarm suppression

Table 5.4 Preset annunciations for signal relays

5.5.4 Marshalling of the LED indicators – address block 63

The unit contains 16 LEDs for optical indications, 14 of which can be marshalled. They are designated LED 1 to LED 14 and can be marshalled in address block 63. The block is reached by paging in blocks with ⇑ ⇓ or by directly addressing with **DA 6 2 0 0 E**. The selection procedure is carried out as described in Section 5.5.1. Multiple annunciations are possible, i.e. one logical annunciation function can be given to several LEDs (see also Section 5.5.1).

Apart from the logical function, each LED can be marshalled to operate either in the stored mode (m for **m**emorized) or unstored mode (nm for "**n**ot **m**emorized"). Each annunciation function is displayed with the index m or nm when proceeding with the **N**–key.

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

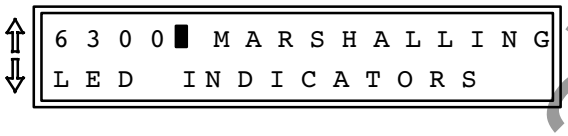
.0 unstored indication (not memorized) corresponds to "nm" as above,

.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 marshallable annunciation functions are the same as those listed in Table 5.3. 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).

The assignment of the LEDs as preset by the factory is shown in the front of the unit (Fig 6.1). The following boxes show, as an example, the assignment for LED 1. Table 5.5 shows all LED indicators as they are preset from the factory.



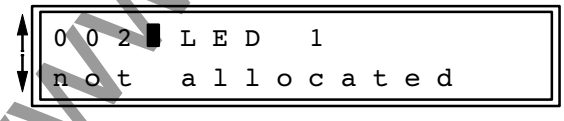
Beginning of the block "Marshalling of the LED indicators"

The first marshallable LED is reached with the key ↑:

Allocations for LED 1

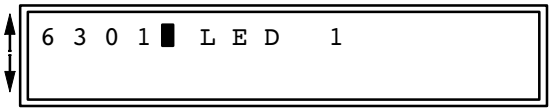
Change over to the selection level with **F** ↑:

LED 1 has been preset for:
General trip of the device, memorized, FNo 511



no further functions are preset for LED 1

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



Allocations for LED 1

Addr	1st display line	2nd display line	FNo	Remarks
6300	MARSHALLING	LEDs		Heading of the address block
6301	LED 1 LED 1	Device Trip m	511	Trip signal given from either protection function of the device
6302	LED 2 LED 2 LED 2	Dev.Trip 3p m Dev.Trip 1pL1 m	515 512	Trip signal of the device with indication of the tripped breaker pole
6303	LED 3 LED 3 LED 3	Dev.Trip 3p m Dev.Trip 1pL2 m	515 513	
6304	LED 4 LED 4 LED 4	Dev.Trip 3p m Dev.Trip 1pL3 m	515 514	
6305	LED 5 LED 5	I.Trip Rec. m	3074	Intertrip signal received
6306	LED 6 LED 6	Recep.Fail. m	3406	Total reception failure
6307	LED 7 LED 7	CCP.Trip L1 m	3085	Current comparison protection trip
6308	LED 8 LED 8	CCP.Trip L2 m	3086	
6309	LED 9 LED 9	CCP.Trip L3 m	3087	
6310	LED 10 LED 10 LED 10	Emer. IE>> m Emer. IE>/IEp m	2095 2096	Earth fault detection annunciation of emergency overcurrent time protection
6311	LED 11 LED 11	AR not ready nm	2784	Auto-reclose function momentarily not ready for operation
6312	LED 12 LED 12	Emer. Flt L1 m	2062	Fault detection annunciations of emergency overcurrent time protection
6313	LED 13 LED 13	Emer. Flt L2 m	2063	
6314	LED 14 LED 14	Emer. Flt L3 m	2064	

Table 5.5 Preset LED indicators

5.5.5 Marshalling of the command (trip) relays – address block 64

The unit contains 5 trip relays which are designated TRIP RELAY 1 to TRIP RELAY 5. Each trip relay can be controlled by up to 10 logical commands. 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 Section 5.5.1. Multiple commands are possible, i.e. one logical command function can be given to several trip relays (see also Section 5.5.1).

Most of the annunciation functions in accordance with Table 5.3, can be marshalled to output command relays. But those listed in Table 5.6 are particularly suitable for trip relay output. Regard the table as a recommended pre–selection. 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 assignment of the trip relays as delivered from factory is shown in the general diagrams in Appendix A. The following boxes show examples for marshalling of trip relay 1. Table 5.7 shows all trip relays as preset from the factory.

Important note: With single–pole auto–reclosure it is unavoidable that for each circuit breaker pole the corresponding phase segregated command, e.g. "CCP Trip L1" (FNo 3085) for pole L1, as also the three–pole command "CCP.Trip L123" (FNo 3088) is marshalled to the correct tripping relay. This is taken care of in the presetting of the relay but must also be considered if the allocation of the trip relays is altered.

If further protection functions shall trip the same breaker, each command relay must be triggered by the corresponding command functions.

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** ↑:

Trip relay 1 has been preset for:
Auto-reclose command from internal auto–reclose function, FNo 2851;

no further functions are preset for trip relay 1

Leave the selection level with key combination **F** ↑. You can go then to the next trip relay with the arrow key ↑.

Allocations for trip relay 1

FNo	Abbreviation	Logical command function
1	not allocated	no annunciation allocated to trip relay
501	Device FltDet	General fault detection of the device
511	Device Trip	General trip of the device
1182	CB Test 1pL1	Trip single-pole L1 by internal circuit breaker test function
1183	CB Test 1pL2	Trip single-pole L2 by internal circuit breaker test function
1184	CB Test 1pL3	Trip single-pole L3 by internal circuit breaker test function
1185	CB Test 3p	Trip three-pole by internal circuit breaker test function
1521	O/L Trip	Trip from thermal overload protection
2061	Emer.Gen.Flt	General fault detection of emergency overcurrent protection
2142	Emer.Trip1pL1	Trip single-pole L1 from emergency overcurrent protection
2143	Emer.Trip1pL2	Trip single-pole L2 from emergency overcurrent protection
2144	Emer.Trip1pL3	Trip single-pole L3 from emergency overcurrent protection
2145	Emer.Trip 3p	Trip three-pole from emergency overcurrent protection
2851	AR Close Cmd.	Reclose command from auto-reclose function
2871	AR Trip 3p	Internal AR function trips three-pole because blocked
3076	CCP.Gen.Flt.	General fault detection of current comparison protection
3085	CCP.Trip L1	Trip single-pole L1 from current comparison protection
3086	CCP.Trip L2	Trip single-pole L2 from current comparison protection
3087	CCP.Trip L3	Trip single-pole L3 from current comparison protection
3088	CCP.Trip L123	Trip three-pole from current comparison protection
3324	Transfer Trip	Trip command from remote transfer trip
4517	Ext Gen. Trip	Trip command from external local trip

Table 5.6 Command functions

Addr	1st display line	2nd display line	FNo	Remarks
6400	MARSHALLING	TRIP RELAYS		Heading of the address block
6401	TRIP TRIP REL. 1	RELAY 1 AR Close Cmd	 2851	only when internal auto-reclose function is available and configured as *EXIST*
6402	TRIP TRIP REL. 2 TRIP REL. 2 TRIP REL. 2 TRIP REL. 2 TRIP REL. 2 TRIP REL. 2 TRIP REL. 2	RELAY 2 CCP.Gen.Trip Emer.Gen.Trip O/L Trip CB Test Trip Ext Gen. Trip Transfer Trip AR Trip 3p	 3084 2141 1521 1181 4517 3324 2871	Group annunciation of all trip commands of the protection functions
6403	TRIP TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3 TRIP REL. 3	RELAY 3 CCP.Trip L1 CCP.Trip L123 Emer.Trip1pL1 Emer.Trip 3p O/L Trip CB Test 1pL1 CB Test 3p Ext Gen. Trip Transfer Trip AR Trip 3p	 3085 3088 2142 2145 1521 1182 1185 4517 3324 2871	Trip commands for circuit breaker pole L1
6404	TRIP TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4 TRIP REL. 4	RELAY 4 CCP.Trip L2 CCP.Trip L123 Emer.Trip1pL2 Emer.Trip 3p O/L Trip CB Test 1pL2 CB Test 3p Ext Gen. Trip Transfer Trip AR Trip 3p	 3086 3088 2143 2145 1521 1183 1185 4517 3324 2871	Trip commands for circuit breaker pole L2
6405	TRIP TRIP REL. 5 TRIP REL. 5 TRIP REL. 5 TRIP REL. 5 TRIP REL. 5 TRIP REL. 5 TRIP REL. 5 TRIP REL. 5 TRIP REL. 5	RELAY 5 CCP.Trip L3 CCP.Trip L123 Emer.Trip1pL3 Emer.Trip 3p O/L Trip CB Test 1pL3 CB Test 3p Ext Gen. Trip Transfer Trip AR Trip 3p	 3087 3088 2144 2145 1521 1184 1185 4517 3324 2871	Trip commands for circuit breaker pole L3

Table 5.7 Preset command functions for trip relays

6 Operating instructions

6.1 Safety precautions

Warning

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

Caution!

Connection of the device to a battery charger without connected battery may cause impermissibly high voltages which damage the device. See also Section 3.1.1 under Technical data for limits.

6.2 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.

6.2.1 Membrane keyboard and display panel

The membrane keyboard and display panel is externally arranged similar to a pocket calculator. Figure 6.1 illustrates the front view.

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 the 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 display:

↑	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 (refer Section 6.4)

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.

6.2.2 Operation with a personal computer

A personal computer 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. Note that the operating interface in the front of the relay is not galvanically isolated and that only adequate connection cables are applied (e.g. 7XV5100–2). Further information about facilities on request.

6.2.3 Operational preconditions

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

– setting of functional parameters (thresholds, functions),

– allocation or marshalling of trip relays, signals, binary inputs, LED indicators,

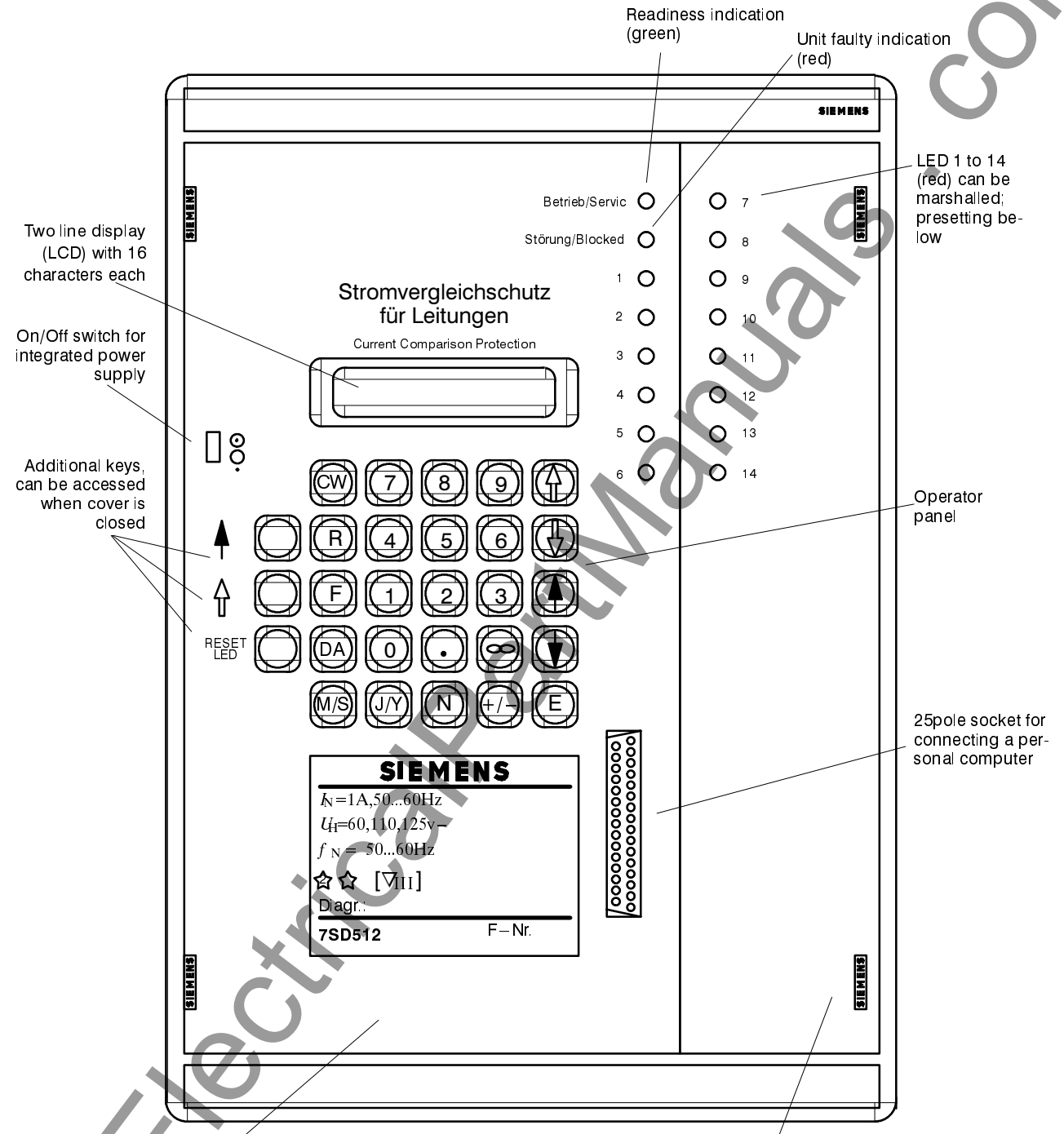
– configuration parameters for operation language and device configuration,

– 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 method of entry of the codeword is explained in detail in the installation instructions under Section 5.3.1.

6.2.4 Representation of the relay (front view)



Factory presetting LEDs:

1	General device trip	7	Trip comparison prot. L1
2	Device Trip L1	8	Trip comparison prot. L2
3	Device Trip L2	9	Trip comparison prot. L3
4	Device Trip L3	10	Pick–up emerg. O/C prot. I_E
5	Intertrip received	11	AR not ready
6	Protection data trans–mission link faulty	12	Pick–up emerg. O/C prot. L1
		13	Pick–up emerg. O/C prot. L2
		14	Pick–up emerg. O/C prot. L3

Figure 6.1 Front view of operating key board and display panel

6.3 Setting the functional parameters

6.3.1. Introduction

6.3.1.1 Parameterizing procedure

For setting the functional parameters it is necessary to enter the codeword (see 5.3.1). 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 request for operator input

  The address is identified by the block number followed by 00 as sequence number (e.g. **11**00 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. **1105** for block **11**, sequence number **5**). 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 overwritten 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. **1101** for block **11**, sequence number **1**). 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.** The changed parameters are only saved after termination of parameterizing (refer below).

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.

6.3.1.2 Selectable parameter sets

Up to 4 different sets of parameters can be selected for the functional parameters, i.e. the addresses above 1000 and below 4000. These parameter sets can be switched over during operation, locally using the operator panel or via the operating interface using a personal computer, or also remotely using binary inputs.

If this facility is not used then it is sufficient to set the parameters for the preselected set. The rest of this section is of no importance. Otherwise, the parameter change–over facility must be configured as *EXIST* under address 7885 (refer to Section 5.4.2). The first parameter set is identified as set A, the other sets are B, C and D. Each of these sets is adjusted one after the other.

If the switch–over facility is to be used, first set all parameters for the normal status of parameter set A. Then switch over to parameter set B:

– Fist complete the parameterizing procedure for set A as described in Section 6.3.1.1.

– Press key combination **F 2**, i.e. first the function key **F** and then the number key **2**. All following inputs then refer to parameter set B.

All parameter sets can be accessed in a similar manner:

- Key combination **F 1**:
  access to parameter set **A**
- Key combination **F 2**:
  access to parameter set **B**
- Key combination **F 3**:
  access to parameter set **C**
- Key combination **F 4**:
  access to parameter set **D**

Input of the codeword is again necessary for the setting of a new selected parameter set. Without input of the codeword, the settings can only be read but not modified.

Since only a few parameters will be different in most applications, it is possible to copy previously stored parameter sets into another parameter set.

It is additionally possible to select the original settings, i.e. the settings preset on delivery, for a modified and stored parameter set. This is done by copying the "ORIG.SET" to the desired parameter set.

It is finally still possible to define the active parameter set, i.e. the parameter set which is valid for the functions and threshold values of the unit. See Section 6.5.4 for more details.

The parameter sets are processed in address block 85. The most simple manner to come to this block is using direct addressing:

– press direct address key **DA**,
– enter address, e.g. **8 5 0 0**,
– press enter key **E**.

The heading of the block for processing the parameter sets then appears.

It is possible to scroll through the individual addresses using the ↑ key. The copying facilities are summarized in Table 6.1.

⇕ 8 5 0 0 ▮ P A R A M E T E R C H A N G E - O V E R	Beginning of the block "Parameter change–over"; processing of parameter sets

Addr.	Copy from	to
8510	ORIG.SET	SET A
8511	ORIG.SET	SET B
8512	ORIG.SET	SET C
8513	ORIG.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

Table 6.1 Copying parameter sets

Following copying, only such parameters need be changed which are to be different from the source parameter set.

Parameterizing must be terminated for each parameter set as described in Section 6.3.1.1.

6.3.1.3 Setting of date and time

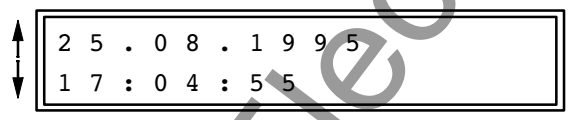
The date and time can be set if the unit is equipped with the real time clock. Setting is carried out in block 81 which is reached by direct addressing **DA 8 1 0 0 E** or by paging with ⇑ and ⇓. Input of the codeword is required to change the data.

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 ↑.

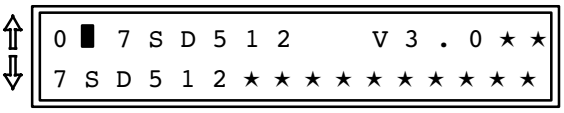
Enter the new date: 2 digits for day, 2 digits for month and 4 digits for year (including century); use the order as configured under address 7102 (Section 5.3.2), but always use a dot for separator:
DD.MM.YYYY or **MM.DD.YYYY**

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.

6.3.2 Initial displays – address blocks 0 and 10

When the relay is switched on, firstly the address 0 and the type identification of the relay appears. All Siemens relays have an MLFB (machine readable order 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.

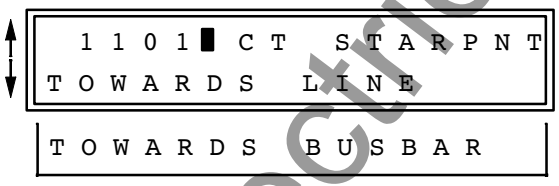
After address 1000, the functional parameters begin. Further address possibilities are listed under ”Annunciations” and ”Tests”.

Commencement of functional parameter blocks

6.3.3 Power system data – address block 11

The relay requests basic data of the power system and the switchgear. These data are used for matching the internal measured values to the current transformers, especially in case the primary rated currents are different at the two line ends, and to define the polarity of the currents.

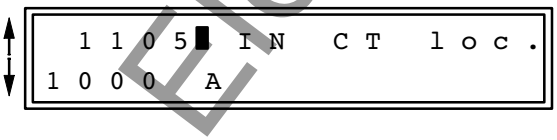
Beginning of the block ”Power system data”



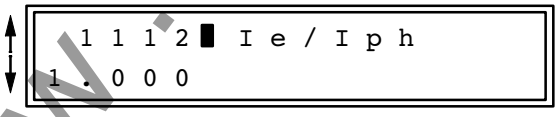
Current transformer polarity:

LINE – c.t. starpoint towards line

BUSBAR – c.t. starpoint towards bus–bar



Current transformer primary rated current (phases) at the local feeder end
Smallest setting value: **10** A
Largest setting value: **50000** A



Matching factor for earth current:

1 for connection in c.t. starpoint;

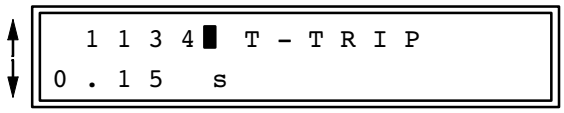
$$\frac{\text{earth c.t. ratio}}{\text{phase c.t. ratio}}$$

for connection to separate earth current transformer, e.g. summation transformer

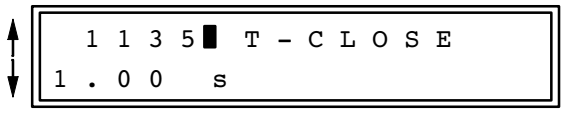
Smallest setting value: **0.000**
Largest setting value: **20.000**

In order to guarantee definite disconnection of the line by both circuit–breakers, the unit is equipped with an adjustable minimum trip signal duration. This should be sufficiently long to ensure proper execution of the trip command even with unfavourable short–circuit current distributions and different circuit breaker trip times. It must also ensure that the circuit–breaker auxiliary contact interrupts the current of the trip circuit.

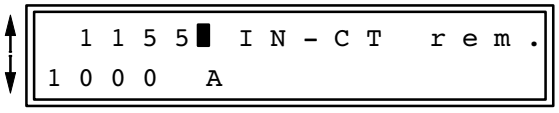
Under address 1135, the minimum close command duration can be set. It must be long enough to ensure reliable closure of the circuit breaker. An excessively long time does not present any danger, since the closing command will be interrupted at once on renewed pick–up of any of the protection functions. Finally, address 1155 requests the rated current of the remote end c.t.s.



Minimum duration of **trip** command
Smallest setting value: **0.01** s
Largest setting value: **32.00** s



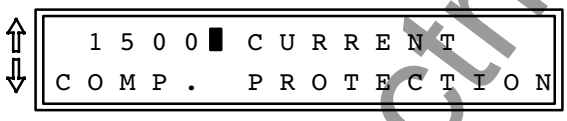
Maximum duration of **close** command
Smallest setting value: **0.01** s
Largest setting value: **32.00** s



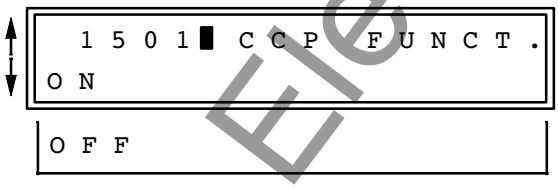
Current transformer primary rated current (phases) at the remote feeder end
Smallest setting value: **10** A
Largest setting value: **50000** A

6.3.4 Settings for the current comparison protection – address block 15

The comparison protection function can be set to be operative or inoperative. A precondition is that this function has been configured as CCP FUNCT = *EXIST* under address 7815 (refer to Section 5.4.2).



Beginning of block "Current comparison protection"



Comparison protection function is switched

ON or

OFF

The comparison protection includes a steady–state and a dynamic threshold.

The setting of the steady–state threshold is determined mainly by the maximum operational load current. Pick–up at this threshold for overloads should be excluded since this would simulate a continuous through–fault condition to the relay. The pick–up value I>ST–STATE (address 1503) must therefore be set to above the expected (over–) load current (at least 1.4 times).

The dynamic threshold I>DYN (address 1504) presents high sensitivity independent of the magnitude of the through–flowing current. This pick–up value should be set to at least 4 times the charging current

of the protected line. The preset value 0.33 · I_N is adequate for cables and overhead lines from 10 kV up to 110 kV with a length below 10 km provided this sensitivity is desired. For longer cables and overhead lines, or for higher voltage levels, the dynamic threshold setting should be checked by calculating the charging current of the line. The following formula can be used:

$$I_C = 3.63 \cdot 10^{-6} \cdot U_N \cdot f_N \cdot C' \cdot l$$

where

- I_C the charging current to be calculated in A primary
- U_N the rated voltage of the line in kV primary
- f_N the rated system frequency in Hz
- C' the operating capacitance per unit line length of the line in nF/km primary
- l the line length in km

The calculated charging current must be related on the primary rated current of the current transformers.

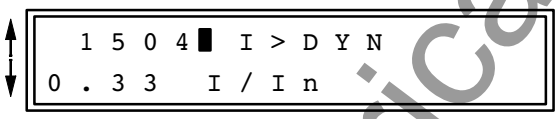
When long unloaded lines are switched on, a transient charging current of high magnitude and higher frequencies may occur. These inrush currents are damped in the input circuits of the protection relay. Nevertheless, pick–up of the dynamic stage by inrush currents when switching on cables should be avoided safely; for this, an additional pick–up threshold I>DYN CLOSe is provided (address 1505). This threshold replaces the dynamic threshold I>DYN (address 1504) for three or four a.c. periods when an unloaded line ($I/I_N < 0.05$) is energized. Normally, it is set to 10 times the steady–state charging current to achieve sufficient stability of the protection.

Final dynamic stability checks are carried out during commissioning (Section 6.7.3).

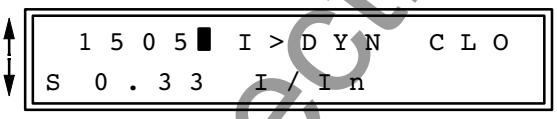
All currents are referred to the rated current of the relay. This must be considered when the primary rated currents of the c.t.s at the two line ends are different. The primary thresholds should be the same.

In special cases it can be advantageous to delay the trip signal of the protection. For this, an additional time delay can be set (address 1511). Under normal circumstances this time delay is set to zero.

Steady–state trip threshold
Setting range: **0.50** · I_N to **4.00** · I_N



Dynamic trip threshold
Setting range: **0.20** · I_N to **1.00** · I_N



Dynamic trip threshold during switch–on of the line
Setting range: **0.20** · I_N to **4.00** · I_N

Minimum operating current to allow measurement
Setting range: **0.10** s to **4.00** · I_N

Measurement repetition:
With setting *YES* a further a.c. period is evaluated before the protection trips. This is intended for difficult measuring conditions

Additional time delay for trip signal
Setting range: **0.00** s to **0.10** s

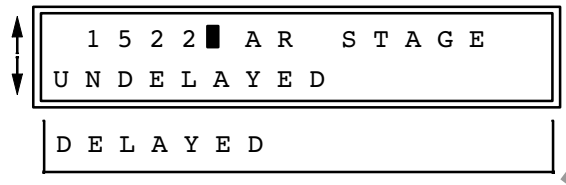
If a trip time delay has been set in address 1511 then, nevertheless, instantaneous trip is desired in case of switching onto a dead fault (e.g. when an earthing isolators has happened to remain closed). Address 1521 allows to pass a trip time delay by. A pre–requisite is, that the manual close command for the breaker is repeated via a binary input to the relay so that it is informed about manual closing of the breaker.

Instantaneous trip is often desired, if auto–reclosure is used on the protected line, before an auto–reclose attempt. Address 1522 determines whether a trip delay as set under address 1511 is effective before auto–reclosure (AR STAGE = *DELAYED*) or not (AR STAGE = *UNDELAYED*).

Trip reaction of the current comparison protection when the line is manually switched onto a dead fault:

UNDELAYED trip

DELAYED trip if a delay has been set under address 1511



Trip reaction of the current comparison protection before auto–reclosure:

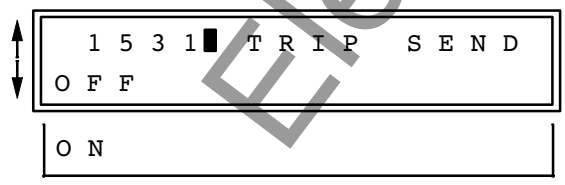
UNDELAYED trip

DELAYED trip if a delay has been set under address 1511

The 7SD51 includes an integrated intertrip function.

If there is no infeed or only weak infeed from one line end, a trip signal might not be initiated in the event of a short–circuit. In this case an intertrip signal can be transmitted by the other end, after the short–circuit has been recognized there, to the end with only weak infeed. Thus, immediate disconnection at both ends of the line is ensured even for these cases.

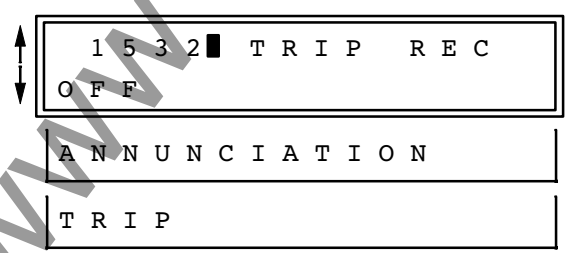
A received intertrip signal can initiate an alarm only (LED, or alarm relay or both), or give a trip command; depending on the marshalling (refer to Section 5.5).



Intertrip send condition:

OFF intertrip send function is switched off

ON intertrip send signal is transmitted in case of trip by current comparison protection



Reaction of the local protection if intertrip signal is received:

OFF intertrip reception switched off, i.e. no reaction

ANNUNCIATION of the received intertrip signal is signalled only

TRIP trip on received intertrip signal (incl. annunciation)

6.3.5 Data for the transmission of protection signals – address block 16

The transmission parameters for the transmission of data from one line end to the other must be set.

The external signal transmission time from one line end to the other must be compensated within the unit. The internal operating times are pre–configured in the 7SD51 and need not be considered during setting. The external signal transmission times are measured by the relay itself during commissioning (refer to Section 6.7.1) and then set in address 1603.

Automatic transmission time correction (address 1601) can be performed in the range $\pm$ 3.5 ms based on the value set under address 1603. It is assumed that greater deviations do not occur during service.

Deviations of more than 0.5 ms from the set signal transmission time or from the last automatic transmission time correction are signalled. When deviation of more than 1 ms from the set value occur (without auto–correction) or when the correction range is exceeded by more than 1 ms, current comparison protection is blocked; this condition is signalled. During blocking the device can be switched–over automatically to an ”emergency overcurrent time protection” mode.

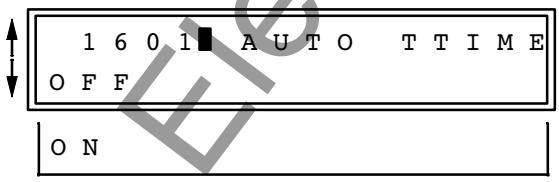
Automatic transmission time correction is not carried out as long as the line current is greater than 75 % of the parameterized steady–state trip threshold (address 1503) since protection data communication of the actual current comparison function has the highest priority in this case.

Address 1602 determines the transmission speed for the protection data transmission. This has nothing to do with the communication Baud rate for communication with a personal computer (address 7215) or LSA (address 7225) as set in Section 5.3.3.

The received data are continuously monitored. If the data transmission is interrupted, then the unit will not trip in the event of a short–circuit. This data interruption is annunciated by the 7SD51. The alarm is delayed to prevent every faulty reception telegram leading to an alarm. Usual time delays lie between 5 s and 10 s. During data failure the device can be switched–over automatically to an ”emergency overcurrent time protection” mode.

The device identification number of address 1606 is used internally to identify the pair of relays which operate together at the two line ends. This has nothing to do with the numbers which have been set under address 7201 (device address) to 7209 (refer to Section 5.3.3) for data transmission to LSA or a personal computer.

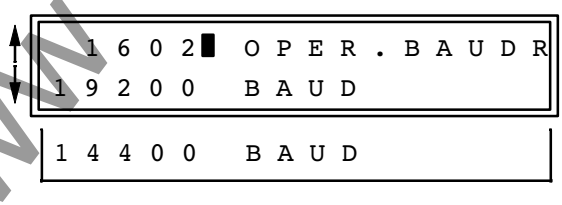
Beginning of block ”Protection data transmission”



Automatic transmission time correction, can be

OFF switched off or

ON switched on



Transmission Baud rate for protection data

19200 BAUD normal setting

14400 BAUD only for transmission via modem

Signal transmission time between station b (remote line end) and station a (local line end)
Setting range: **0.0** ms to **20.0** ms

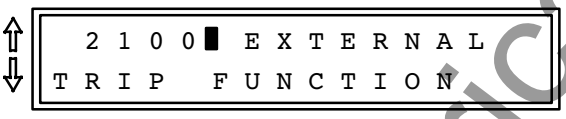
Time delay for the annunciation of a fault in the data transmission
Setting range: **1.0** s to **60.0** s

Identification of the device pair; both relays at the two line ends must have the same number
Setting range: **0** to **63**

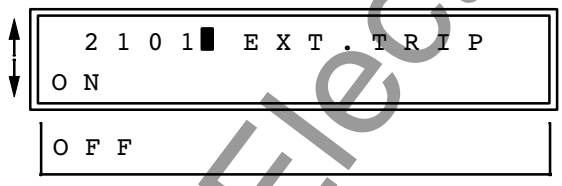
6.3.6 Settings for the external local trip facility – address block 21

Any desired signal can be coupled into the processing of annunciations and trip commands via a binary input of the relay from an external protective or supervisory device. Like the internal trip signals, it can be delayed and given to one or more of the trip relays.

A precondition is that this function has been set to EXT. TRIP = *EXIST* under address 7821 during configuration of the device functions (refer to Section 5.4.2).



Beginning of block "External local trip facility"



External local trip facility

ON switched on or

OFF switched off

Trip delay for external local trip facility
Setting range: **0.00** s to **60.00** s

Drop–off delay after external local trip command
Setting range: **0.00** s to **60.00** s

6.3.7 Settings for the transfer trip facility – address block 22

Current comparison protection relay 7SD512 comprises an integrated transfer trip function. This can be used to trip the circuit breaker at the remote line end by a command from an external source, e.g. a breaker failure protection. The transfer trip command is entered to the relay via a binary input.

Transmission of a transfer trip signal is possible for each direction independent of each other.

A precondition is that this function has been set to TRANSF.TRIP = *EXIST* under address 7822 during configuration of the device functions (refer to Section 5.4.2).

Do not mix up the remote trip facility with the intertrip function which is integral part of the comparison protection.

Beginning of block "Transfer trip facility"

Transfer trip send signal, can be

ON switched on or

OFF switched off

Send delay before transfer trip signal to the remote end
Setting range: **0.00** s to **60.00** s

Send signal prolongation before transfer trip to the remote end
Setting range: **0.00** s to **60.00** s

Transfer trip receiver, can be

OFF switched off or

ON switched on

Received signal prolongation for transfer trip from the remote end
Setting range: **0.10** s to **60.00** s

6.3.8 Settings for emergency overcurrent time protection – address block 26

When the data link to the remote end relay fails, the relay can still be operated as a definite time or inverse time overcurrent protection (emergency overcurrent function, refer to Section 4.4). A pre–condition is that the emergency protection has been configured under address 7826 as EMERG. O/C = *EXIST* (refer to Section 5.4.2).

The parameters of the emergency overcurrent time protection are set in block 26. Different stages are available for phase currents and earth current. Additionally, phase overcurrent and earth overcurrent time stages can be switched individually *ON* or *OFF* (addresses 2601 and 2631).

6.3.8.1 Phase fault overcurrent time protection

At first, the high–set overcurrent stage I>> is set under addresses 2602 and 2603. This stage is always a definite time stage, independent on which characteristic is set for the I> stage.

The emergency overcurrent stage can be used as definite time overcurrent protection or inverse time overcurrent protection. This function mode can be selected in address 2611. For inverse time, a choice can be made between three tripping time characteristics defined in IEC 60255–3.

The pick–up value I> (address 2612 for definite time) or I_p (address 2614 for inverse time) must be set above the maximum expected (over)load current (approximately 1.2 times).

Together with the high–current stage I>>, a two–stage overcurrent time protection is achieved. The corresponding delay times T–I>> (address 2603) and T–I> (address 2613 for definite time) or T–I_p (address 2615 for inverse time) are set in such a way that they allow the highest possible degree of selectivity. In a ring network, for example, one can set up a deliberate break point, with rapid interruption, to allow for emergency cases. The resultant radial networks can be protected in accordance with the conventional practice of grading of overcurrent time protection.

Generally, it must be noted that the set times are pure delay times which do not include the inherent operation time of the protection functions.

If a stage is not required the associated time is set at ∞.

```
  2 6 0 0 EMERGENCY
O V E R C U R R E N T  P R O T
```

Beginning of block
"Emergency overcurrent time protection"

```
  2 6 0 1 EMER. O/C  P
O N
```

```
O F F
```

Emergency overcurrent time protection for phase currents is

ON switched on

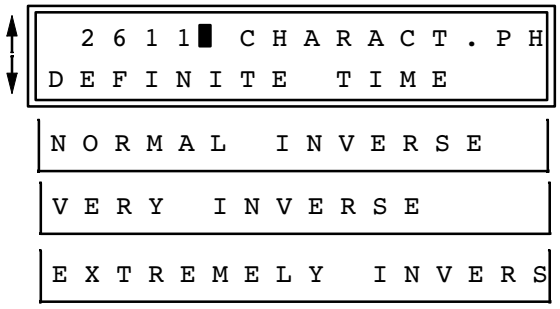
OFF switched off

```
  2 6 0 2 I >>
4 . 0 0  I / I n
```

High–current pick–up threshold I>> for phase currents
Smallest setting value: **0.10** · I_N
Largest setting value: **15.00** · I_N

```
  2 6 0 3 T - I >>
0 . 1 0  s
```

Time delay for the high–current stage I>> for phase currents
Smallest setting value: **0.00** s
Largest setting value: **32.00** s
and ∞ (no trip with I>> phases)



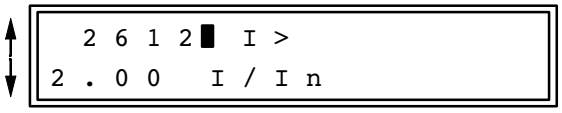
Characteristic of the overcurrent stage for phase currents

DEFINITE TIME characteristic

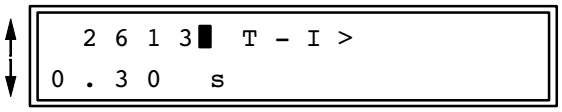
NORMAL INVERSE time (type A acc. IEC 60255–3)

VERY INVERSE time (type B acc. IEC 60255–3)

*EXTREMELY INVERS*e time (type C acc. IEC 60255–3)



Only for definite time protection:
Pick–up threshold I> for phase currents
Smallest setting value: **0.10** · I_N
Largest setting value: **15.00** · I_N



Delay time for I> stage for phase currents
Smallest setting value: **0.00** s
Largest setting value: **32.00** s
and ∞ (no trip with I> phases)

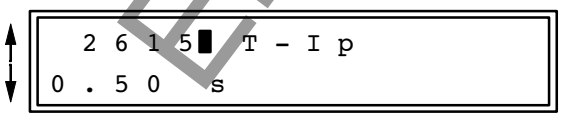
When setting the emergency function to **inverse time** overcurrent protection, it must be considered that, the protection picks up only when more than 1.05 (typically 1.07) times the set value is exceeded.

The time setting corresponds to 10 times the usual time multiplier TM, e.g.

T_p = 10 s means TM = 1,
thus for normal inverse
t_{trip} = 10 s tripping time at 2 times set value I_p

With the definite time characteristic the fundamental waves of the measured currents are evaluated for pick–up. When one of the **inverse time** characteristics is selected, a choice can be made whether the fundamental waves *WITHOUT HARMON*ics of the measured currents are formed for evaluation, or if the true r.m.s. values *WITH HARMONICS* are calculated. As the relay is used as short–circuit protection, the preset value is recommended. If the time grading is to be coordinated with conventional relays which operate with true r.m.s. values, then *WITH HARMONICS* can be advantageous.

Only for inverse time protection:
Pick–up threshold I_p for phase currents
Smallest setting value: **0.10** · I_N
Largest setting value: **4.00** · I_N



Time multiplier for phase currents
Smallest setting value: **0.50** s
Largest setting value: **32.00** s

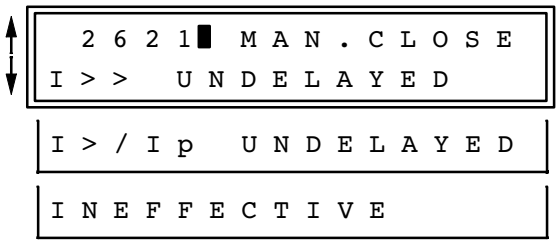
Only for inverse time protection:

The fundamental waves of the measured currents are evaluated *WITHOUT HARMON*ics

The true r.m.s. values of the measured currents are evaluated *WITH HARMONICS*

Address 2621 determines which stage is effective if the circuit breaker is manually closed. A pre–requisite is, that the manual close command for the breaker is repeated via a binary input to the relay so that it is informed about manual closing of the breaker. *INEFFECTIVE* means that the stages operate according to the settings in addresses 2602 to 2615.

It is also possible to carry out auto–reclosure in the overcurrent protection mode. This has to be entered into the device during configuration under address 7903 (refer to Section 5.4.3). In this case, the I>> stage is of interest because of its independent trip time: If reclosure is expected the protection will trip with the undelayed I>> stage, final disconnection is carried out via I> or Ip with T–I> or Tp delayed. I>> and I> should then be set to the same value. Address 2623 determines whether the I>> stage in effective only in conjunction with auto–reclosure or whether it operates independently.



Overcurrent stage which is effective during manual closing of the circuit breaker:
I>> i.e. I>> stage but without delay T–I>>

I>/Ip i.e. I> stage (definite time) or I_p stage (inverse time) but without delay

INEFFECTIVE, i.e. stages operate as parameterized

AR function operates with the I>>stage:
I>> WITH AR i.e. I>> is released only if AR is ready
I>> ALWAYS i.e. I>> stage operates always, inde–pendent of the AR function

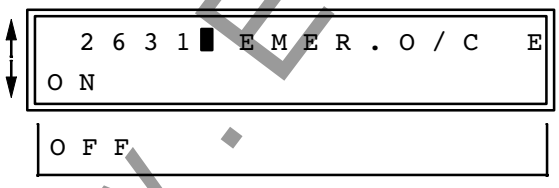
6.3.8.2 Earth fault overcurrent time protection

For earth faults, all parameters of the emergency overcurrent time protection can be set separately and independently. This allows separate time grading for earth faults with e.g. shorter times.

The setting possibilities are the same as for phase currents.

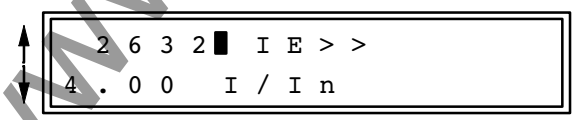
If a separate overcurrent time protection for earth faults is not required, the earth current stages can be switched of independent of the phase current stages in address 2631

If part functions are not required, then the corresponding delay times are set at ∞. This does not avoid the pick–up annunciation.

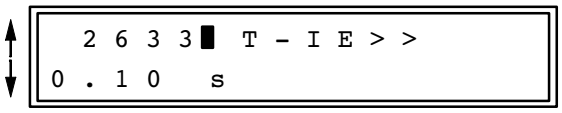


Emergency overcurrent time protection for earth currents is
ON switched on

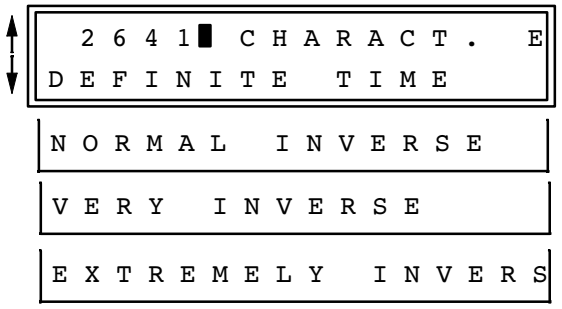
OFF switched off



High–current pick–up threshold I_E>> for earth currents
Smallest setting value: **0.10** · I_N
Largest setting value: **10.00** · I_N



Time delay for the stage I_E>> for earth currents
Smallest setting value: **0.00** s
Largest setting value: **32.00** s
and ∞ (no trip with I_E>> earth)



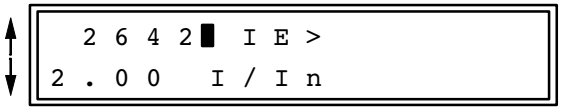
Characteristic of the overcurrent stage for earth currents

DEFINITE TIME characteristic

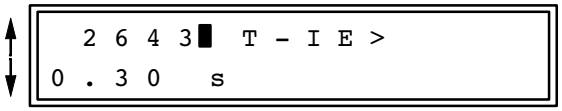
NORMAL INVERSE time (type A acc. IEC 60255–3)

VERY INVERSE time (type B acc. IEC 60255–3)

*EXTREMELY INVERS*e time (type C time acc. IEC ,60255–3255–3)



Only for definite time protection:
Pick–up threshold I_E> for earth currents
Smallest setting value: **0.10** · I_N
Largest setting value: **4.00** I_N



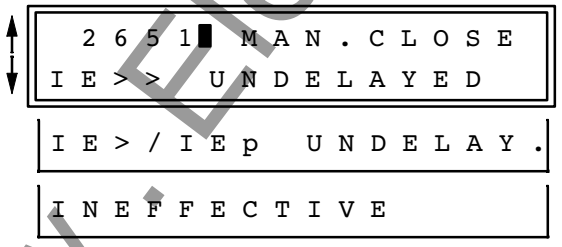
Delay time for I_E> stage for earth currents
Smallest setting value: **0.00** s
Largest setting value: **32.00** s
and ∞ (no trip with I_E> earth)

Only for inverse time protection:
Pick–up threshold I_{Ep} for earth currents
Smallest setting value: **0.10** · I_N
Largest setting value: **4.00** · I_N

Time multiplier for earth currents
Smallest setting value: **0.50** s
Largest setting value: **32.00** s

Only for inverse time protection:
The fundamental wave of the measured current is evaluated *WITHOUT HARMON*ics

The true r.m.s. value of the measured current is evaluated *WITH HARMONICS*

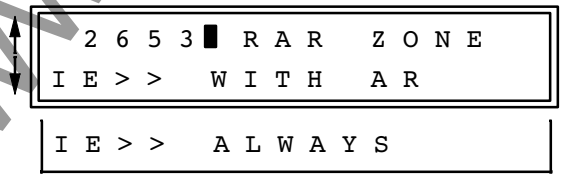


Overcurrent stage which is effective during manual closing of the circuit breaker:

IE>> i.e. I_E>> stage but without delay

IE>/IEp i.e. I_E> stage (definite time) or I_{Ep} stage (inverse time) but without delay

INEFFECTIVE, i.e. stages operate as parameterized



AR function operates with the I_E>>stage:

*IE>> WITH AR*i.e. I_E>> is released only if AR is ready
IE>> ALWAYS i.e. I_E>> stage operates always, independent on the AR function

6.3.9 Settings for thermal overload protection – address block 27

The relay includes a thermal overload protection function (refer to Section 4.5). This can operate only when it is configured to THERMAL O/L = *EXIST* under address 7827 during configuration of the device functions (refer to Section 5.4.2).

Cables are particularly endangered by overloads of longer duration. These overloads cannot and should not be detected by the short–circuit protection. An overcurrent time protection as back–up protection, for example, must be set sufficiently high so as to only detect short–circuits. Only short delays are permitted for short–circuit protection. These short time delays, however, do not permit measures to unload the overloaded cable nor to utilize its (limited) overload capacity.

The current comparison protection relay 7SD51 includes an overload function with a thermal trip characteristic which can be matched to the overload capacity of the protected cable. This function is usually not required for overhead lines as the current carrying capacity of overhead lines is generally not defined.

The overload protection function can be set to be inoperative or to initiate tripping (including alarm).

The rated current of the relay is used as the base current for the overload measurement. The setting factor k is determined by the ratio of the continuously permissible thermal current I_{max} to the rated current:

$$k = \frac{I_{max}}{I_N}$$

The permissible continuous current depends on cross–section, insulation material, type of construction and method of installation of the cable, etc. In general, the magnitude of the current can be taken from widely available tables or otherwise is to be stated by the manufacturer.

The heating–up time constant τ depends on the cable data and the cable surroundings. If the time constant is not readily available, it can be calculated from the short–term overload capacity of the cable. Frequently, the 1 s current, i.e. the maximum permissible current for 1 s duration, is known or can be taken from tables. The time constant can then be calculated according to the following formula:

$$\text{Setting value } \tau \text{ [min]} = \frac{1}{60} \cdot \left(\frac{\text{permissible 1 s current}}{\text{continuously permissible current}} \right)^2$$

If the short–time overload capacity is stated for a duration other than 1 s, then that short–term current is inserted into the above formula instead of the 1 s current. However, the result is then multiplied with the stated duration, i.e. in case of a 0.5 s current:

$$\frac{\mathbf{0.5}}{60} \cdot \left(\frac{\text{permissible } \mathbf{0.5} \text{ s current}}{\text{continuously permissible current}} \right)^2$$

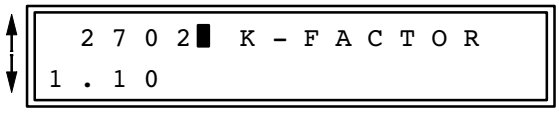
It should be noted that the result becomes more inaccurate the longer the duration of the current becomes.

Beginning of block ”Thermal overload protection”

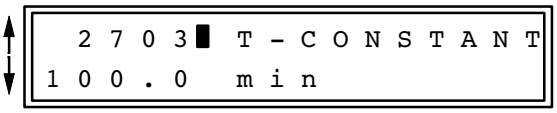
Thermal overload protection can be

ON switched on or

OFF switched off



Setting value of k–factor = I_{max}/I_N
Setting range: **0.10** to **4.00**



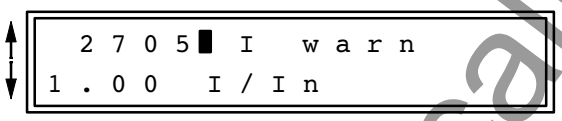
Time constant τ
Setting range: **1.0** min to **999.9** min

By setting a warning temperature rise, an alarm can be output before the trip temperature rise is reached, so that, for example, by prompt load shedding tripping may be prevented.

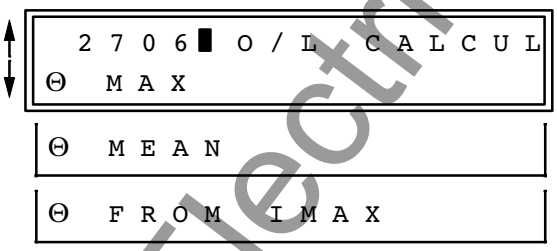
A further current warning stage is available. This can be set as a factor of the rated current and should be equal or less than the continuously admissible current. It can be used besides the temperature warning stage or instead of that. When setting $\Theta_{warn}/\Theta_{trip}$ to 100 %, the temperature warning is practically ineffective.

A choice can be made whether the temperature rise which is decisive for the threshold stages, is the maximum calculated temperature rise of the three conductors, the mean value of the calculated temperature rises of the three conductors, or the temperature rise calculated from the maximum current of the three conductors.

Warning temperature rise in %
of trip temperature rise $\Theta_{warn}/\Theta_{trip}$
Setting range: **50** % to **100** %



Current warn stage; set as a multiple of I_N
Setting range: **0.10** · I_N to **4.00** · I_N



Calculation mode decisive for thermal thresholds

*MAX*imum of the *temperature* rises of the three conductors

MEAN value of the *temperature* rises of the three conductors

temperature rise calculated *FROM* the *MAX*imum conductor *current*

6.3.10 Settings for measured value monitoring – address block 29

The different monitoring functions of the protective relay are described in Section 4.8.4. They partly monitor the relay itself, partly the steady–state measured values of the transformer circuits.

The sensitivity of the measured values monitoring can be changed in block 29. The factory settings are sufficient in most cases. If particularly high operational asymmetries of the currents are expected, or if, during operation, one or more monitoring functions react sporadically, then sensitivity should be reduced.

NOTE: Prerequisite for correct function of the measured value monitors is the proper setting of the general power system data (Section 6.3.3), especially the parameter concerning the earth current matching factor (address 1112).

Beginning of block
"Measured value supervision"

Current threshold above which the symmetry monitoring is effective (refer to Figure 4.6)
Smallest setting value: **0.10** · I_N
Largest setting value: **1.00** · I_N

Symmetry factor for the current symmetry = slope of the symmetry characteristic (see Figure 4.6)
Smallest setting value: **0.10**
Largest setting value: **0.95**

Current threshold above which the summation monitoring (refer to Figure 4.5) reacts (absolute content, related to I_N only)
Smallest setting value: **0.05** · I_N
Largest setting value: **2.00** · I_N

Relative content (related to the maximum conductor current) for operation of the current summation monitoring (refer to Figure 4.5)
Smallest setting value: **0.00**
Largest setting value: **0.95**

6.3.11 Settings for auto–reclosure – address block 34

Auto–reclose function (AR) is effective only if configured as *EXIST* under address 7834 (refer to Section 5.4.2).

When no auto–reclosure is to be carried out on the feeder which is protected by the current comparison protection relay (e.g. cables), then the internal AR function must be configured as *NON–EXIST* in address 7834 (refer to Section 5.4.2). The AR function is then not effective at all, i.e. 7SD512 does not process the AR function. No corresponding annunciations are given, binary inputs for auto–reclosure are ignored. All parameters in block 34 are irrelevant and unavailable. Tripping occurs three–pole with all kinds of fault.

If the relay is required to operate with an external AR device, the relevant binary inputs and outputs are to be used. Particularly, the corresponding control signals must be connected to 7SD512, e.g. release of RAR or DAR stages and single/three–pole tripping (if necessary); the fault detection and trip signal outputs of 7SD512 must be connected to the external AR device. The internal AR function must be set as *NON–EXIST* (Section 5.4.2, address 7834), in this case.

With the internal AR function, generally distinction is made between the first AR–cycle, identified in the following with RAR (rapid auto–reclosure), and further AR–cycles with multi–shot auto–reclosure, identified in the following with DAR (delayed auto–reclosure). The above identifications are regardless whether the dead times are really "rapid" or "delayed". Setting address 3401 to 3415 are common for all types of auto–reclosure.

When switching manually on a dead fault, it is normally desired that the short–circuit protection trips instantaneously, and the AR function is blocked. Thus, address 3403 should remain in position MC BLOCK = *YES*.

The reclaim time T–RECLAIM (address 3405) is the time period after which the network fault is supposed to be terminated after a successful auto–reclose cycle. A renewed trip of any protection function within this time increments the AR counter (when multi–shot AR is used) so that the next AR cycle starts; if no further AR is allowed the last AR is treated as unsuccessful.

The lock–out time T–LOCK (address 3406) is the time period during which after an unsuccessful auto–reclosure further reclosures by 7SD512 are blocked. If the manual close command is led via the 7SD512 then this will be blocked also. This time must be longer than the renewed readiness for operation of the circuit breaker unless the CB is supervised in the relay (see below, address 3415). If this time is set to ∞, breaker close commands are locked. In this case switching can be unlocked only when the binary input ">AR Reset" (FNo 2704) is energized.

The set time for T–BLOCK–MC (address 3407) must cover the time for safe closing and opening of the circuit breaker (0.5 s to 1 s). If any of the protection functions of 7SD512 detects a fault within this time, three–pole definitive trip command is issued and reclosure is blocked provided MC BLOCK (address 3403, see above) is switched *ON*.

The duration of the closing command has already been set when setting the general parameters of the device (address 1135, Section 6.3.3).

A prerequisite for initiation of the AR function is that the circuit breaker is ready for at least one trip–close cycle when any short–circuit protection function trips. This information has to be given to the relay via the binary input ">CB ready" (FNo 2730). In case such information is not available from the CB circuit, interrogation of ">CB ready" can be suppressed by setting the parameter CB? 1. TRIP = *NO* (i.e. CB interrogation 1st trip, address 3412); otherwise reclosure would not be possible at all.

Additionally it is possible to interrogate readiness of the circuit breaker before each further reclose command or before every other reclose command. Setting is made in address 3413:

CB? CLOSE = *CB? NEVER*; interrogation is not made or only at the moment of the first trip command as parameterized under address 3412,

CB? CLOSE= *CB WITH EACH AR*; interrogation is made before each reclose command,

CB? CLOSE = *CB? WITH 2nd AR*; interrogation is made before every other reclose command, i.e. before the 2nd, 4th, etc.; every trip–close cycle is valid regardless whether it is RAR or DAR.

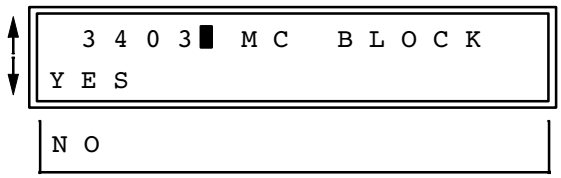
In order to monitor the regeneration time of the circuit breaker a special circuit breaker supervision time T–CB–SUPV can be set under address 3415. This time should be set slightly higher than the regeneration time of the breaker after a trip–close cycle. If the circuit breaker is not yet ready after this time, reclosure is suppressed.

Beginning of block
"Auto–reclose functions"

Auto–reclose function is

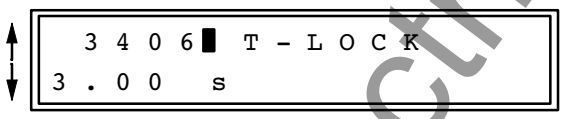
ON switched on

OFF switched off

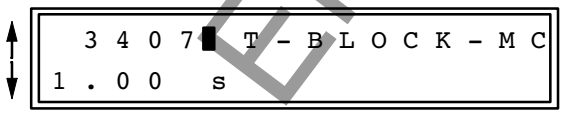


Blocking of reclosing after manual close of the circuit breaker
normal setting: *YES*

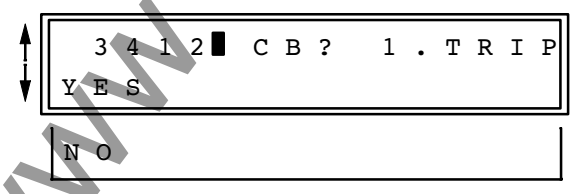
Reclaim time after successful AR cycle
Smallest setting value: **0.50** s
Largest setting value: **320.00** s



Lock–out time after unsuccessful AR; any close command is blocked
Smallest setting value: **0.50** s
Largest setting value: **320.00** s
and ∞ (locked until "`>AR Reset`" via binary input)



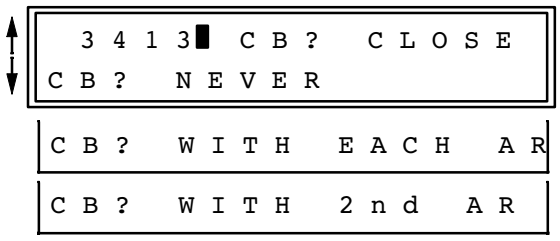
Reclaim time after manual closing of circuit breaker
Smallest setting value: **0.50** s
Largest setting value: **320.00** s



CB ready interrogation at the first trip command

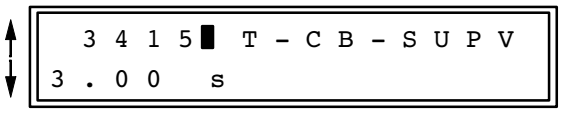
YES – normal setting

NO – only if there is no possibility to interrogate CB readiness



CB ready interrogation before reclosing

CB? NEVER	no CB ready interrogation before reclosing
CB? WITH EACH AR	CB ready interrogation before each reclosing
CB? WITH 2nd AR	CB ready interrogation before 2nd, 4th, 6th, etc. reclosing (RAR or DAR)



CB supervision time within which CB must be ready
Smallest setting value: **0.01** s
Largest setting value: **320.00** s

For RAR (first auto–reclose cycle), several programs are possible (address 3422): three–pole, single–pole, or single– and three–pole.

When setting the action time RAR T–ACT (address 3424), it must be ensured that this time is at least as long as the command time of the protective relay, including any possible signal transmission times (usually 0.2 s).

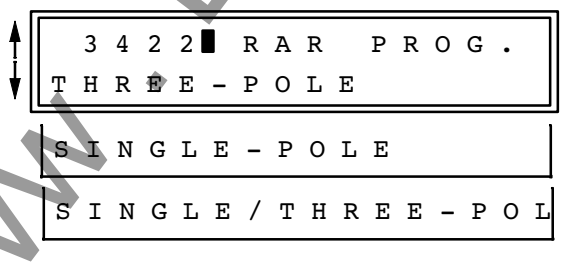
With single–pole auto–reclosure, the dead time RAR T–1POL (address 3426) must be long enough to ensure that the fault arc is extinguished and the air surrounding the arc is de–ionized, so that auto–reclosure can be successful. Because of the discharge and re–charge of the conductor capacitances, this time increases with the length of the line. Conventional values lie between 0.9 s and 1.5 s.

With three–pole auto–reclosure (address 3425), the stability of the network is the most important consideration. Since the disconnected line can no longer produce any synchronizing power, only a short dead time is permitted in most cases. Conventional values lie between 0.3 s and 0.6 s.

The possibilities for the treatment of multiple and evolving faults have been described in detail in Section 4.6.7. The reaction to evolving faults is set in address 3429: blocking in the case of an evolving fault either occurs *ALWAYS* (i.e. with each evolving fault) or *NEVER* at all, or blocking occurs only after the fault is detected after the discrimination time *>T–DISCRIM* which has to be set in address 3430. Blocking in these cases occurs even when three–pole auto–reclosure is permitted!

Also, for the treatment of evolving faults and for the discrimination time T–DISCRIM the stability of the network is of the utmost importance. In addition, the dynamic burden of the generators must be taken into account in the case of faults close to a power station. For the discrimination time T–DISCRIM (address 3430) it is only meaningful to chose a value which is smaller than the dead time for single–pole AR, RAR T–1POL (address 3426).

Finally, address 3431 determines whether the protection relay should issue a three–pole trip when, during the dead time of a single–pole auto–reclose cycle, reclosure is blocked (e.g. because of detection of an evolving fault).



Auto–reclose program for the first AR cycle (RAR)

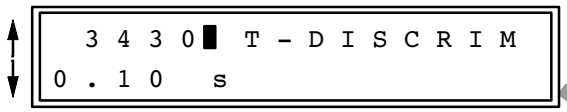
THREE–POLE	– for each type of fault three–pole auto–reclosure
SINGLE–POLE	– single–pole AR; for multi–phase faults no reclosure takes place (AR blocked)
*SINGLE/ THREE–POL*e	– for single–phase faults single–pole AR; for multi–phase faults three–pole AR

Action time for RAR (first AR–shot) (if trip signal is given after this time, AR is blocked)
Smallest setting value: **0.01** s
Largest setting value: **320.00** s

Dead time for first three–pole (RAR) cycle
Smallest setting value: **0.01** s
Largest setting value: **320.00** s

Dead time for first AR cycle (RAR) single–pole
Smallest setting value: **0.01** s
Largest setting value: **320.00** s

Treatment of evolving faults (only with 1–pole AR)
– each evolving fault results in final three–pole trip; reclosure is blocked
– no blocking of reclosure in the case of evolving faults; a change from single–pole AR to three–pole AR occurs (when permitted)
– before expiry of T–DISCRIM a change to three–pole AR (when permitted) occurs, after expiry of T–DISCRIM reclosure is blocked



Discrimination time for evolving faults (only with single–pole AR)
Smallest setting value: **0.01** s
Largest setting value: **32.00** s

Three–pole trip is given when the AR function is blocked during a single–pole dead time cycle (only with single–pole AR)
YES or
NO

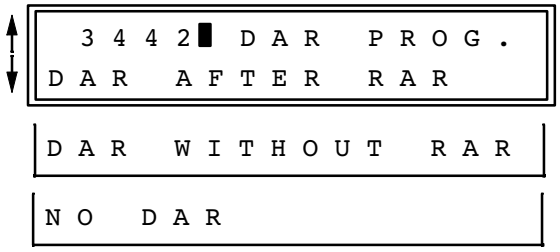
For DAR (further auto–reclose cycles), several programs are possible (address 3442). DAR can be permitted only after an unsuccessful RAR (DAR PROG = *DAR AFTER RAR*). DAR can be permitted also if no RAR has been preceded (DAR PROG = *DAR WITHOUT RAR*). DAR can be excluded (DAR PROG = *NO DAR*). DAR is always three–pole.

Multiple auto–reclosure with longer three–pole dead times are only permitted in networks in which no stability problems are to be expected (for example, due to a high degree of meshing), or in radial networks, or if synchronism check is used.

The number of DARs can be set differently after single–phase faults (address 3443) and after multi–phase faults (address 3444). Nevertheless, trip occurs always three–pole.

For DAR, a separate action time DAR T–ACT can be set (address 3445).

Different dead times can be set for the first, second and third trip–close cycle. The dead time for the first cycle (address 3446) is only valid if the DAR cycle is really the first cycle (i.e. RAR is suppressed). For the second (address 3447) and third (address 3448) cycle, a RAR counts only if it has occurred. Further cycles are treated as the third cycle.



Auto–reclose program for DAR cycles

WITHOUT DAR – no delayed AR

DAR WITHOUT RAR – DAR will be carried out also when no RAR has preceded

DAR AFTER RAR – DAR will be carried out only after an unsuccessful RAR cycle.

Number of permissible DAR cycles after single–phase faults; the RAR is not included in this number
Smallest setting value: **0**
Largest setting value: **9**

Number of permissible DAR cycles after multi–phase faults; the RAR is not included in this number
Smallest setting value: **0**
Largest setting value: **9**

Action time for DAR (if trip signal is given after this time, AR is blocked)
Smallest setting value: **0.01** s
Largest setting value: **320.00** s

Dead time for the first AR cycle if it is a DAR cycle
Smallest setting value: **0.01** s
Largest setting value: **1800.00** s

Dead time for the second AR cycle
Smallest setting value: **0.01** s
Largest setting value: **1800.00** s

Dead time for further AR cycles
Smallest setting value: **0.01** s
Largest setting value: **1800.00** s

6.4 Annunciations

6.4.1 Introduction

After a network fault, annunciations and messages provide a survey of important fault data and the function of the relay, and serve for checking sequences of functional steps during testing and commissioning. Further, they provide information about the condition of measured data and the relay itself during normal operation.

To read out recorded annunciations, no codeword input is necessary.

The annunciations generated in the relay are presented in various ways:

– LED indications in the front plate of the relay (Figure 6.1),

– Binary outputs (output relays) via the connections of the relay,

– Indications in the display on the front plate or on the screen of a personal computer, via the operating interface,

– Transmission via the serial interface to local or remote control facilities (if available).

Most of these annunciations can be relatively freely allocated to the LEDs and binary outputs (see Section 5.5). Also, within specific limitations, group and multiple indications can be formed.

To call up annunciations on the operator panel, the following possibilities exist:

– Block paging with the keys ⇑ forwards or ⇓ backwards up to address 5000,

– Direct selection with address code, using key **DA**, address **5 0 0 0** and execute with key **E**,

– Press key **M**/**S** (M stands for ”messages”, S for ”signals”); then the address 5000 appears automatically as the beginning of the annunciation blocks.

For configuration of the transfer of annunciations via the serial interfaces, the necessary data had been entered in address block 72 (see Section 5.3.3).

The annunciations are arranged as follows:

Block 51 Operational annunciations; these are messages which can appear during the operation of the relay: information about condition of relay functions, measurement data etc.

Block 52 Event annunciations for the last fault; pick–up, trip, AR, expired times, or similar. As defined, a network fault begins with pick–up of any fault detector. If auto–reclose is carried out, the network fault ends after expiry of the last reclaim time; thus an AR–shot (or all shots) occupy only one fault data store. Within a network fault, several fault events can occur, from pick–up of any fault detection until drop–off.

Block 53 Event annunciations for the previous network fault, as block 52.

Block 54 Event annunciations for the last but two network fault, as block 52.

Block 56 Annunciations for CB operation statistics, that is counters for first AR (RAR), second or further AR (DAR) and tripping commands, together with accumulated short circuit currents of each breaker pole.

Block 57 Indication of operational measured values (currents at the local line end).

Block 58 Indication of operational measured values (currents at the remote line end).

Block 59 Indication of operational measured values (overload protection data).

Commencement of ”annunciation blocks”

A comprehensive list of the possible annunciations and output functions with the associated function number FNo is given in Appendix C. It is also indicated to which device each annunciation can be routed.

6.4.2 Operational annunciations – address block 51

Operational and status annunciations contain information which the unit provides during operation and about the operation. They begin at address 5100. Important events and status changes are chronologically listed, starting with the most recent message. Time information is shown in hours and minutes. Up to 50 operational indications can be stored. If more occur, the oldest are erased in sequence.

Faults in the network are only indicated as "`System Flt`" together with the sequence number of the fault. Detailed information about the history of the fault is contained in blocks "Fault annunciations"; refer to Section 6.4.3.

The input of the codeword is not required.

After selection of the address 5100 (by direct selection with **DA 5100 E** and/or paging with ⇑ or ⇓ and further scrolling ↑ or ↓) the operational annunciations appear. The boxes below show all available operational annunciations. In each specific case, of course, only the associated annunciations appear in the display.

Next to the boxes below, the abbreviated forms are explained. It is indicated whether an event is announced on occurrence (**C** = "**C**oming") or a status is announced "**C**oming" and "**G**oing" (**C**/**G**).

The first listed message is, as example, assigned with date and time in the first line; the second line shows the beginning of a condition with the character **C** to indicate that this condition occurred at the displayed time.

5100 OPERATIONA LANNUNCIATIONS	Beginning of the block "Operational annunciations"
19.09.95 10:39 Emer. mode :C	1st line: Date and time of the event or status change 2nd line: Annunciation text, in the example **C**oming

If the real time clock is not available the date is replaced by ★★.★★.★★, the time is given as relative time from the last re–start of the processor system.

Direct response from binary inputs:

> Start FltRec	Fault recording started via binary input (C)
> Annunc. 1	User defined annunciation No 1 received via binary input (C/G)
> Annunc. 2	User defined annunciation No 2 received via binary input (C/G)
> Annunc. 3	User defined annunciation No 3 received via binary input (C/G)
> Annunc. 4	User defined annunciation No 4 received via binary input (C/G)
> CloseCmd.Blo	Block all closing commands (C)
> 1p Trip Perm	Single–pole tripping is permitted (from external AR device) (C/G)

> Only 1pole	External AR device is programmed for single–pole reclosure only (C/G)
> RAR Release	Release signal for AR stages of internal protection functions from an external AR device (C/G)
> I>> block	I>> stage of emergency overcurrent time protection is blocked from an external device (C/G)
> IE>> block	I_E>> stage of emergency overcurrent time protection is blocked from an external device (C/G)
> I> / Ip block	I> or Ip stage of emergency overcurrent time protection is blocked from an external device (C/G)
> IE> IEp block	I_E> or I_{Ep} stage of emergency overcurrent time protection is blocked from external (C/G)
> AR block	Block auto–reclosure statically via binary input (C/G)
> AR reset	Reset auto–reclosure function from external via binary input (C)
> 1p RAR block	Block single–pole RAR via binary input (C/G)
> 3p RAR block	Block three–pole RAR via binary input (C/G)
> RAR block	Block complete RAR via binary input (C/G)
> DAR block	Block complete DAR via binary input (C/G)
> Start AR	Starting signal from external protection for internal AR (C)
> Trip L1 AR	Trip signal pole L1 from external protection for internal AR (C)
> Trip L2 AR	Trip signal pole L2 from external protection for internal AR (C)
> Trip L3 AR	Trip signal pole L3 from external protection for internal AR (C)
> Trip 1p AR	Single–pole trip signal from external protection for internal AR (C)
> Trip 3p AR	Three–pole trip signal from external protection for internal AR (C)
> DAR aft. RAR	DAR permitted only after unsuccessful RAR (C/G)
> Trans. Trip	Trigger transfer trip command via binary input (C/G)
> Data block	Block transmission of data via binary input (C/G)
> Ext Trip	Trigger external local trip command via binary input (C/G)

General operational annunciations of the protection device:

Dev.operative	Device operative (C/G)
Initial start	Initial start of the processor system (C)
LED reset	Stored LED indications reset (C)
Param.running	Parameters are being set (C/G)
Param. Set A	Parameter set A is active (C/G)
Param. Set B	Parameter set B is active (C/G)
Param. Set C	Parameter set C is active (C/G)
Param. Set D	Parameter set D is active (C/G)
Syst.Flt	Network fault (C/G), detailed information in the fault annunciations
Manual Close	Manual close command registered (impulse) (C)
CB in Test	Circuit breaker test is in progress (C/G)
Flt.Rec.viaBI	Fault recording triggered via binary input (C)
Flt.Rec.viaKB	Fault recording triggered via the front keyboard (C)
Flt.Rec.viaPC	Fault recording triggered via operating (PC) interface (C)
Flt.RecDatDel	Fault recording data deleted (C)
Com.FltRec	Commissioning fault record triggered (C)

Annunciations of monitoring functions:

Wrong SW-vers	Wrong software version (C)
Wrong dev. ID	Wrong device identification number (C)
Annunc. lost	Annunciations lost (buffer overflow) (C)
Annu. PC lost	Annunciations for operating (PC) interface lost (C)
Oper.Ann.Inva	Operational annunciations invalid (C/G)
Flt.Ann.Inval	Fault annunciations invalid (C/G)

Stat.Buff.Inv	Buffer for operation statistics invalid (C/G)
LED Buff.Inva	Buffer for stored LEDs invalid (C/G)
VDEW-StateInv	State of VDEW/ZVEI compatible annunciations (IEC 60870–5–103) at the system interface invalid (C/G)
Chs.Error	Check–sum error detected (C/G)
Chs.A Error	Check–sum error detected for parameter set A: no operation possible with this set (C/G)
Chs.B Error	Check–sum error detected for parameter Set B: no operation possible with this set (C/G)
Chs.C Error	Check–sum error detected for parameter set C: no operation possible with this set (C/G)
Chs.D Error	Check–sum error detected for parameter set D: no operation possible with this set (C/G)
Failure 24V	Failure in internal supply voltage 24 V (C/G)
Failure 15V	Failure in internal supply voltage 15 V (C/G)
Failure 5V	Failure in internal supply voltage 5 V (C/G)
Failure 0V	Failure in offset voltage 0 V (C/G)
Failure I/O	Failure on base input/output module GEA (C/G)
Failure I/O 1	Failure on additional input/output module ZEA (C/G)
Failure RKA	Failure in trip relay control circuit (C/G)
LSA disrupted	Serial system link to LSA disrupted (C/G)
Failure Σ I	Failure detected by current plausibility monitor Σ I (C/G)
Failure Isymm	Failure detected by current symmetry monitor (C/G)

Operational annunciations of current comparison protection:

CCP off	Current comparison protection is switched off (C/G)
CCP blocked	Current comparison protection is blocked (C/G)
CCP active	Current comparison protection is active (C/G)
Itr.send off	Intertrip signal send circuit is switched off (C/G)

Itr.rec. off	Intertrip signal reception circuit is switched off (C/G)
I.Trip Send	Intertrip send signal transmitted to remote end (C)
I.Trip Rec.	Intertrip signal received from remote end (C)
CCP Test	Current comparison protection is in test (C/G)
>Data block	Block transmission of data via binary input (C/G)
TT Corr.off	Automatic transmission time correction is switched off (C/G)
TT Corrected	Transmission time has been corrected (C)
TT Dev.>0.5ms	Deviation in transmission time of more than 0.5 ms has been detected (C/G)
TT blocks CCP	Current comparison protection is blocked because of transmission time deviation > 1 ms (C/G)
Data Fault	Faulty protection data received (C/G)
Recep.Fail.	Total reception failure of comparison protection data (C/G)
Wrong Version	Wrong firmware version installed; does not match with version of remote end (C/G)
Wrong Dev.ID	Wrong device identification number; does not match with device ident of remote end (C/G)

Operational annunciations of external local trip and transfer trip/annunciation facilities:

Ext off	External local trip facility is switched off (C/G)
Ext active	External local trip facility is active (C/G)
>Ext Trip	Trigger external local trip command via binary input (C/G)
Ext Gen. Trip	External local trip command issued (C)
TransTrip off	Transfer trip transmitter is switched off (C/G)
T.TripRec.off	Transfer trip receiver is switched off (C/G)
T.Trip active	Transfer trip facility is active (C/G)
>Trans.Trip	Trigger transfer trip command via binary input (C/G)
TrTrip Send	Transfer trip send signal transmitted (C)

T.Trip rec.	Transfer trip signal received (C)
Transfer Trip	Trip command due to remote transfer trip signal issued (C)
Trans.Annu.1	User defined transfer annunciation No 1 received from remote end (C/G)
Trans.Annu.2	User defined transfer annunciation No 2 received from remote end (C/G)
Trans.Annu.3	User defined transfer annunciation No 3 received from remote end (C/G)
Trans.Annu.4	User defined transfer annunciation No 4 received from remote end (C/G)

Operational annunciations of emergency overcurrent time protection:

Emer.Ph.off	Emergency overcurrent time protection for phase currents is switched off (C/G)
Emer.E/F off	Emergency overcurrent time protection for earth current is switched off (C/G)
Emer. active	Emergency overcurrent time protection is active (C/G)
Emer. mode	Emergency overcurrent time mode is running (C/G)

Operational annunciations of the thermal overload protection:

O/L Prot. off	Thermal overload protection is switched off (C/G)
O/L active	Thermal overload protection is active (C/G)
O/L Warn I	Overload protection current warning stage (C/G)
O/L Warn Θ	Overload protection thermal warning stage (C/G)
O/L Trip	Trip by overload protection (C/G)

Operational annunciations of the internal auto–reclose function:

AR off	Auto–reclose function is switched off (C/G)
AR inoperativ	Auto–reclose function inoperative, i.e, cannot be initiated (C/G)

Further messages:

Table overflow	If more messages have been received the last valid message is `Table overflow`.
End of table	If not all memory places are used the last message is `End of table`.

6.4.3 Fault annunciations – address blocks 52 to 54

The annunciations which occurred during the last three network faults can be read off on the front panel or via the operating interface. The indications are recorded in the sequence from the youngest to the oldest under addresses 5200, 5300 and 5400. When a further fault occurs, the data relating to the oldest are erased. Each fault data buffer can contain up to 80 annunciations.

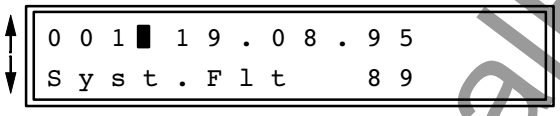
Input of the codeword is not required.

To call up the **last** fault data, one goes to address 5200 either by direct address **DA 5200 E** or by paging with the keys ⇑ or ⇓ . With the keys ↑ or ↓ one can page the individual annunciations forwards or backwards. Each annunciation is assigned with a sequence item number.

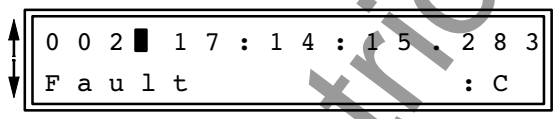
For these purposes, the term ”system fault” means the period from short circuit inception up to final clearance. If auto–reclose occurs, then the ”system fault” is finished on expiry of the last reclaim time, that is, after successful or unsuccessful AR. Thus the total fault clearance procedure inclusive AR–cycles occupies only one fault annunciation store. Within one system fault, several fault events can have occurred, i.e. from pick–up of any protection function until drop–off of the last pick–up of a protection function.

In the following clarification, all the available fault annunciations are indicated. In the case of a specific fault, of course, only the associated annunciations appear in the display. At first, an example is given for a system fault, and explained.

Beginning of the block ”Fault annunciations of the last system fault”



under item 1, the date of the system fault is indicated, in the second line the consecutive number of the system fault



under item 2, the time of recognition of the fault is given; time resolution is 1 ms

The following items indicate all fault annunciations which have occurred from fault detection until drop–off of the device, in chronological sequence. These annunciations are tagged with the relative time in milliseconds, starting with the fault detection.

etc.

General fault annunciations of the device:

Flt.Buff.Over	Buffer for fault annunciations overflow
Syst.Flt	System fault with consecutive number
Fault	Beginning of fault
>RAR Release	Release RAR stages from external AR device when occurred during a fault
IL1/In=	Interrupted fault current of phase L1
IL2/In=	Interrupted fault current of phase L2
IL3/In=	Interrupted fault current of phase L3
Dev. Drop-off	Drop–off of the device, general

Fault annunciations of current comparison protection:

CCP.Gen.Flt.	General fault detection of current comparison protection
CCP.Fault L1	Fault detection current comparison protection, phase L1
CCP.Fault L2	Fault detection current comparison protection, phase L2
CCP.Fault L3	Fault detection current comparison protection, phase L3
Flt.I.Trip	Fault detection of intertrip circuit (start)
CCP.Gen.Trip	General trip signal of current comparison protection
CCP.Trip L1	Trip single–pole L1 by current comparison protection
CCP.Trip L2	Trip single–pole L2 by current comparison protection
CCP.Trip L3	Trip single–pole L3 by current comparison protection
CCP.Trip L123	Trip three–pole by current comparison protection

Fault annunciations of emergency overcurrent time protection:

Emer. Flt E	Earth fault detection of emergency overcurrent time protection
Emer. Flt L1	Fault detection emergency overcurrent time protection, phase L1

Emer. Flt L1E	Fault detection emergency overcurrent time protection, phase L1–earth
Emer. Flt L2	Fault detection emergency overcurrent time protection, phase L2
Emer. Flt L2E	Fault detection emergency overcurrent time protection, phase L2–earth
Emer. Flt L12	Fault detection emergency overcurrent time protection, phases L1–L2
Emer.Flt L12E	Fault detection emergency overcurrent time protection, phases L1–L2–earth
Emer. Flt L3	Fault detection emergency overcurrent time protection, phase L3
Emer. Flt L3E	Fault detection emergency overcurrent time protection, phase L3–earth
Emer. Flt L13	Fault detection emergency overcurrent time protection, phases L1–L3
Emer.Flt L13E	Fault detection emergency overcurrent time protection, phases L1–L3–earth
Emer. Flt L23	Fault detection emergency overcurrent time protection, phases L2–L3
Emer.Flt L23E	Fault detection emergency overcurrent time protection, phases L2–L3–earth
Emer.Flt L123	Fault detection emergency overcurrent time protection, phases L1–L2–L3
Emer.Flt 123E	Fault detection emergency overcurrent time protection, phases L1–L2–L3–earth
Emer. I>>	Fault detection emergency overcurrent protection on high phase current I>>
Emer. I> / Ip	Fault detection emergency overcurrent protection phase stage I> (definite time) or I_p (inverse time)
Emer. IE>>	Fault detection emergency overcurrent protection on high earth current I_E>>
Emer. IE> / IEp	Fault detection emergency overcurrent protection earth stage I_E> (definite time) or I_{Ep} (inverse time)
Emer. TI>>	Time delay for high phase current stage of emergency overcurrent protection I>> expired
Emer. TI> / Tp	Time delay for phase current stage I> or I_p of emergency overcurrent protection I>> expired
Emer. TIE>>	Time delay for high earth current stage of emergency overcurrent protection I_E>> expired
Emer. TIE>TEp	Time delay for earth current stage I_E> or I_{Ep} of emergency overcurrent protection I>> expired
Emer.Trip1pL1	Trip single–pole L1 from emergency overcurrent time protection
Emer.Trip1pL2	Trip single–pole L2 from emergency overcurrent time protection
Emer.Trip1pL3	Trip single–pole L3 from emergency overcurrent time protection
Emer.Trip 3p	Trip three–pole from emergency overcurrent time protection

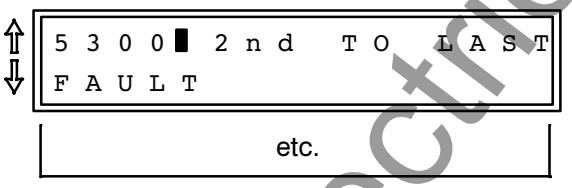
Fault annunciations of internal auto–reclose function:

AR in prog.	Auto–reclose cycle in progress
AR block.dyn.	AR function dynamically blocked (by internal cause)
AR Close Cmd	Reclose command from auto–reclose function issued
AR Trip 3p	Three–pole trip by internal auto–reclose function caused by blocking during single–pole AR cycle

Further messages:

Table empty	means that no fault event has been recorded
Table overflow	means that other fault data have occurred, however, memory is full
Table superceded	a new fault event has occurred during read–out: page on with ↑ or ↓; the display shows the first annunciation in the actualized order
End of table	If not all memory places are used the last message is End of table.

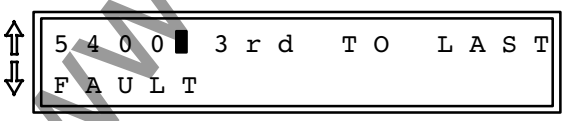
The data of the **second to last** system fault can be found under address 5300. The available annunciations are the same as for the last fault.



Beginning of the block ”Fault annunciations of the second to last system fault”

etc.

The data of the **third to last** system fault can be found under address 5400. The available annunciations are the same as for the last fault.



Beginning of the block ”Fault annunciations of the third to last system fault”

etc.

6.4.4 Circuit breaker operation statistics – address block 56

The number of trip commands initiated by 7SD512 is counted separately for each of the breaker poles. Also, the number of auto–reclose attempts is counted, separately for single–pole RAR, three–pole RAR (first shot) and three–pole DAR (further shots). Additionally, the interrupted currents are stated for each individual pole and given under the fault annunciations (refer to Section 6.4.3) following each trip command. These currents are accumulated and stored. Counter status and stores are secured against auxiliary voltage failure and can be read off under address 5600. The address can be reached by direct addressing **DA 5 6 0 0 E** or by paging with the keys ⇑ or ⇓ until address 5600 is reached. The counters can be called up using the key ↑ for forwards paging or ↓ for backwards paging.

Entry of the codeword is not required for read–off of counter states.

Beginning of the block "Circuit breaker operation statistics"

Number of auto–reclose attempts after single–pole trip, e.g. 14

Page on with key ↑ to get further counter states

Number of auto–reclose attempts after three–pole trip, 1st AR cycle (RAR)

Number of auto–reclose attempts after three–pole trip, further AR cycles (DAR)

Number of trip commands for circuit breaker pole L1

Number of trip commands for circuit breaker pole L2

Number of trip commands for circuit breaker pole L3

Accumulated interrupted currents for CB pole L1

Accumulated interrupted currents for CB pole L2

Accumulated interrupted currents for CB pole L3

The maximum values of the counters are:

– *RAR 1POLE, RAR 3POLE, DAR 3POLE*	9 digits
– *TRIP No L1, TRIP No L2, TRIP No L3*	9 digits
– *ΣIL1/In*, *ΣIL2/In*, *ΣIL3/In*	7 digits plus 1 decimal digit

The counters can be reset to 0 in block 82 (see Section 6.5.2).

6.4.5 Read–out of operational measured values – address blocks 57 to 59

The steady–state r.m.s. operating values of the local line end can be read out at any time under the address block 57. The address can be called–up directly using **DA 5 7 0 0 E** or by paging with ⇑ or ⇓. The individual measured values can be found by further paging with ↑ or ↓. Entry of the codeword is not necessary. The values will be updated in approximately 1 to 5 seconds intervals. The local measured values are identified by the index ”a”.

The measured values of the remote line end can be read out in address block 58; they carry the index ”b”.

The data are displayed in absolute primary values and in percent of the rated device values. To ensure correct primary values, the rated data must have been entered to the device under address block 11 as described in Section 6.3.3.

In the following example, some example values have been inserted. In practice the actual values appear.

Address block 59 shows further operational values: the calculated values of the overload protection. These values are available as long as the thermal overload protection is configured as THERMAL O/L = *EXIST* (address 7827) and switched on (address 2701).

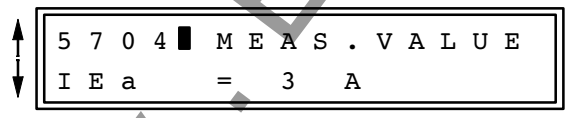
Beginning of the block ”Operational measured values of the local line end a”

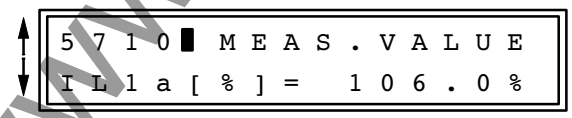
Use ↑ key to move to the next address with the next measured value:

Page on with the ↑ key to read off the next address with the next measured value, or page back with ↓.

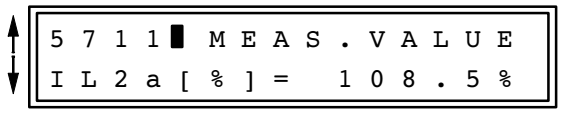
One address is available for each measured value. The values can be reached also by direct addressing using key **DA** followed by the address number and execute with **E**.

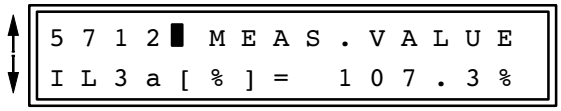
The primary values (addresses 5701 to 5704) are related to the primary rated values as parameterized under addresses 1105 (for phase currents) and 1112 (for earth current) (refer to Section 6.3.3).





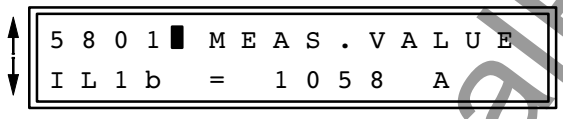
The percentage is related on rated current





Signal transmission time between remote end and local end

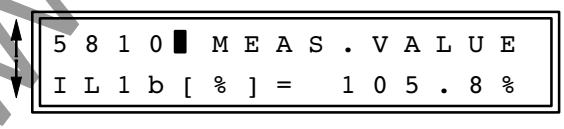
Beginning of the block "Operational measured values of the remote line end b"



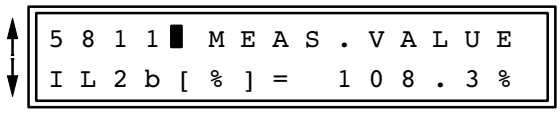
Page on with the ↑ key to read off the next address with the next measured value, or page back with ↓.

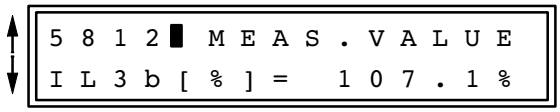
One address is available for each measured value. The values can be reached also by direct addressing using key **DA** followed by the address number and execute with **E**.

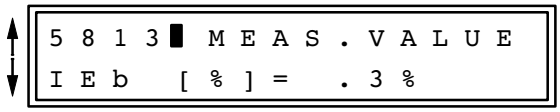
The primary values (addresses 5801 to 5804) are related to the primary rated values as parameterized under addresses 1155 (refer to Section 6.3.3).

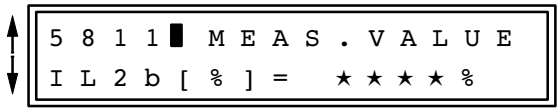


The percentage is referred to rated current



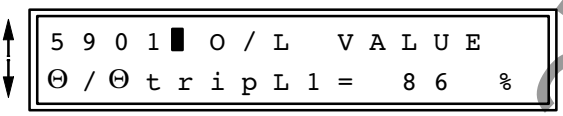




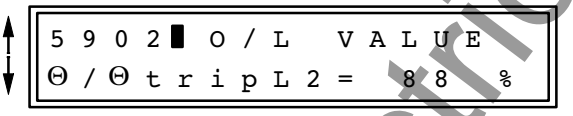


If the data link is faulty, no measured values can be received from the remote end; the values are replace by ★★★★ (example for current I_{L2b}).

Beginning of block "Overload measured values"

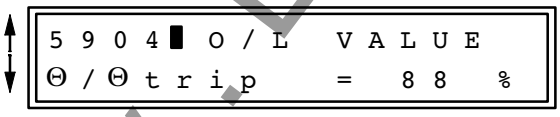


Page on with the ↑ key to read off the next address with the next measured value, or page back with ↓.



One address is available for each measured value. The values can be reached also by direct addressing using key **DA** followed by the address number and execute with **E**.

Addresses 5901 to 5903 show the calculated temperature rise for each phase; the phase dedicated values do not appear when the calculation method is Θ FROM IMAX (address 2706). The temperature rise which is decisive for warning and trip is given in address 5904;



If the thermal overload function is not available or switched off, no measured values can be displayed; the values are replace by ★★★★.

6.4.6 Statistics about data transmission faults – address block 92

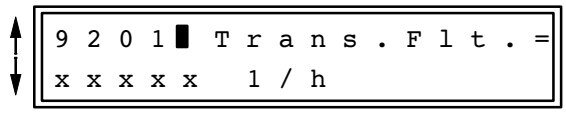
Errors in the protection data protocol may be caused by interferences during transmission from one line end to the other. Such events are recognized by the relay. The number of dips per hour is counted, stored, and secured against auxiliary voltage failure. It can be read off under address block 92.

The address can be reached by direct addressing **DA 9 2 0 0 E** or by paging with the keys ⇑ or ⇓ until address 9200 is reached. The counters can be called up using the key ↑.

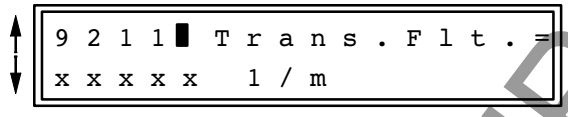
Entry of the codeword is not required for read–off of counter state.

Beginning of the block ”Data transmission fault statistics”

Use ↑ key to move to the next address:



Number of recognized transmission faults per hour (max. 65535)



Number of recognized transmission faults per minute (max. 65535)

6.5 Operational control facilities

During operation of the protection relay it may be desired to intervene in functions or annunciations manually or from system criteria. 7SD512 comprises facilities, e.g. to re–adjust the real time clock, to erase stored informations and event counters, to switch on or off partial functions under specific conditions, or to change over preselected sets of function parameters. The scope of operational control facilities depends on the ordered scope of functions of the device.

The functions can be controlled from the operating panel on the front of the device, via the operating or system (if available) interface as well as via binary inputs.

In order to control functions via binary inputs it is necessary that the binary inputs have been marshalled to the corresponding switching functions during configuration of the device and that they have been connected (refer to Section 5.5.2 Marshalling of the binary inputs).

The control facilities begin with address block 8000. This address is reached

– by block paging with the keys ⇑ forwards or ⇓ backwards up to address 8000, or

– by direct selection with address code, using key **DA**, address **8 0 0 0** and execute with key **E.**

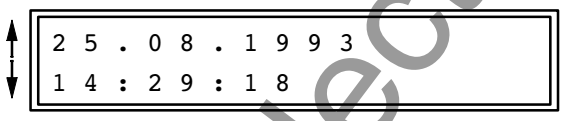
Beginning of the block "Device control"

6.5.1 Adjusting and synchronizing the real time clock – address block 81

The date and time can be adjusted at any time during operation as long as the real time clock is operative. 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**.

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 (Section 5.3.2), 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.

6.5.2 Erasing stored annunciations and counters – address block 82

The statistical indications (Section 6.4.4, address block 56) are stored in EEPROMs in the device. They are not therefore erased if the auxiliary power supply fails. Additionally, annunciations and the status of the LED memories are stored in NV–RAMs and thus saved provided the back–up battery is installed. These stores can be cleared in block 82. Block 82 is called up by paging with the keys ⇑ or ⇓ or directly by keying in the code **DA 8 2 0 0 E**.

With the exception of resetting the LED indications (address 8201), codeword entry is necessary to erase the stored items. Reset is separate for the different groups of counters, memories and annunciations. One reaches the individual items by paging ↑ ↓. Erasure requires confirmation with the key **J**/**Y**. The display then confirms the erasure. If erasure is not required, press key **N** or simply page on.

Beginning of block "Reset"

Request whether the LED memories should be reset

Request whether the operational annunciation buffer store should be erased

Request whether the fault annunciation buffer store should be erased

Request whether the CB operation counters should be set to zero

Request whether the total of switched short–circuit currents should be set to zero

During erasure of the stores (which may take some time) the display shows TASK IN PROGRESS. After erasure the relay acknowledges erasure, e.g.

6.5.3 Information to LSA during test operation – address block 83

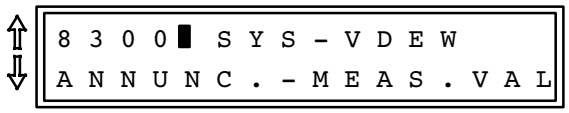
When the relay is connected to a central storage device or localized substation automation system and the protocol according VDEW/ZVEI (IEC 60870–5–103) is used, then the informations which are transmitted to the central computing system can be influenced.

Entry of the codeword is necessary for this (refer to Section 5.3.1).

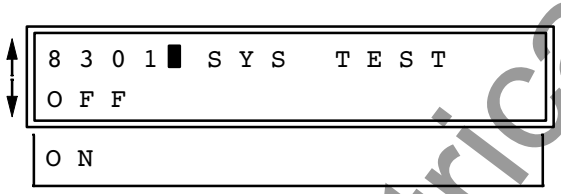
The standardized protocol allows all annunciations, messages, and measured values to be tagged with the origin "test operation", which occur while the relay is tested. Thus, these messages can be distinguished from those which occur during real operation.

In order to accomplish this switch–over, address block 83 is available provided the VDEW/ZVEI protocol (IEC 60870–5–103) has been chosen during configuration of the serial system interface (Section 5.3.3, address 7221 and/or 7222 *VDEW COMPATIBLE* or *VDEW EXTENDED*). The block is called up by paging with the keys ⇑ or ⇓ or directly by keying in the code **DA 8300 E**. Use key ↑ to scroll to address 8301. By pressing the "No"–key **N** the positions of this switch are changed. The desired position must be confirmed with the enter key **E**.

As with every settings of the device for which codeword input is necessary, codeword operation must be terminated. This is done by using 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.



Beginning of block "Annunciations and measured values for the system interface with VDEW/ZVEI compatible protocol (IEC 60870–5–103) "



Only for VDEW/ZVEI compatible protocol (IEC 60870–5–103):

in *ON* position, the VDEW/ZVEI–compatible (IEC 60870– 5–103) annunciations are assigned with the origin "test operation"

Do not forget to switch address 8301 back to SYS–TEST = *OFF* after having finished test operations!

6.5.4 Selection of parameter sets – address block 85

Up to 4 different sets of parameters can be selected for the functional parameters, i.e. the addresses above 1000 and below 4000. These parameter sets can be switched over during operation, locally using the operator panel or via the operating interface using a personal computer, or also remotely using binary inputs or the system interface.

The first parameter set is identified as set A, the other sets are B, C and D. Each of these sets has been set during parameterizing (Section 6.3.1.2) provided the switch–over facility is used.

6.5.4.1 Read–out of settings of a parameter set

In order to **look up** the settings of a parameter set **in the display** it is sufficient to go to any address of the function parameters (i.e. addresses above 1000 and below 4000), either by direct addressing using key **DA**, entering the four–figure address code and terminating with enter key **E**, or by paging through the display with ⇑ or ⇓. You can switch–over to look up a different parameter set, e.g.

– Press key combination **F 2**, i.e. first the function key **F** and then the number key **2**. All displayed parameters now refer to parameter set B.

The parameter set is indicated in the display by a leading character (A to D) before the address number indicating the parameter set identification.

The corresponding procedure is used for the other parameter sets:

- Key combination **F 1**: access to parameter set **A**
- Key combination **F 2**: access to parameter set **B**
- Key combination **F 3**: access to parameter set **C**
- Key combination **F 4**: access to parameter set **D**

The relay operates always with the active parameter set even during read–out of the parameters of any desired parameter set. The change–over procedure described here is, therefore, only valid for **read–out** of parameters **in the display**.

6.5.4.2 Change–over of the active parameter set from the operating panel

For **change over to a different parameter set**, i.e. if a different set shall be activated, the address block 85 is to be used. For this, codeword entry is required.

The block for processing parameter sets is reached by pressing the direct address key **DA** followed by the address **8 5 0 0** and enter key **E** or by paging through the display with ⇑ or ⇓. The heading of the block will appear:

Beginning of the block "Parameter change–over": processing of parameter sets

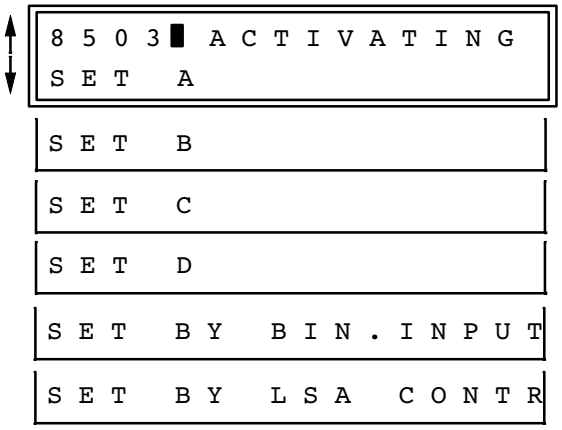
It is possible to scroll through the individual addresses using the ↑ key or to scroll backwards with ↓.

Address 8501 shows the actually active parameter set with which the relay operates.

In order to switch–over to a different parameter set scroll on with ↑ to address 8503. Using the "No"–key **N** you can change to any desired parameter set; alternatively, you can decide that the parameter sets are to be switched over from binary inputs or via the system interface using the VDEW/ZVEI–protocol (IEC 60870–5–103). If the desired set or possibility appears in the display, press the enter key **E**.

As with every settings of the device for which codeword input is necessary, codeword operation must be terminated. This is done by using 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.

Address 8501 shows the actually active parameter set



Use the "No"–key **N** to page through the alternative possibilities. The desired possibility is selected by pressing the enter key **E**.

If you select *SET BY BIN.INPUT*, then the parameter set can be changed–over via binary inputs (see Section 6.5.4.3).

If you select *SET BY LSA CONTR*, then the parameter set can be selected via the system interface using the VDEW/ZVEI protocol (IEC 60870–5–103)

6.5.4.3 Change–over of the active parameter set via binary inputs

If change–over of parameter sets is intended to be carried out via binary inputs, the following is to be heeded:

– Locally (i.e. from the operator panel or from PC via the operating interface), ACTIVATING must be switched to *SET BY BIN.INPUT* (refer to Section 6.5.4.2).

– 2 logical binary inputs are available for control of the 4 parameter sets. These binary inputs are designated ">Param.Selec.1" (FNo 7) and ">Param. Selec.2" (FNo 8).

– The logical binary inputs must be allocated to physical input modules (refer to Section 5.5.2) in order to allow control. An input is treated as not energized when it is not assigned to any physical input.

– The control input signals must be continuously present as long as the selected parameter set shall be active.

The active parameter sets are assigned to the logical binary inputs as shown in Table 6.2.

A simplified connection example is shown in Figure 6.2. Of course, the binary inputs must be declared in normally open ("NO") mode.

Binary input		causes
ParamSelec.1	ParamSelec.2	active set
no	no	Set A
yes	no	Set B
no	yes	Set C
yes	yes	Set D

no = input not energized
yes = input energized

Table 6.2 Parameter selection via binary input

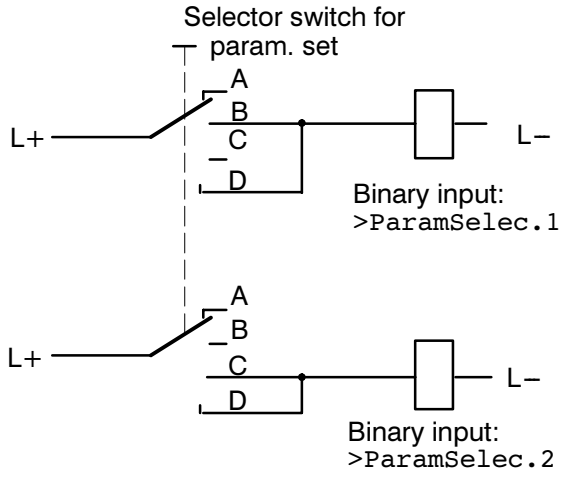


Figure 6.2 Connection scheme for parameter change–over via binary inputs

6.6 Testing and commissioning

6.6.1 General

Prerequisite for commissioning is the completion of the preparation procedures detailed in Chapter 5.

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.

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 (Section 3.1) 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 (refer to Section 5.2.7).

It is recommended that the actual settings for the relay be used for the testing procedure. If these values are not (yet) available, test the relay with the factory settings. In the following description of the test sequence the preset settings are assumed unless otherwise noted; for different setting values formulae are given, where necessary.

For the functional test a single–phase current source is sufficient. However, if unsymmetrical currents occur during the tests it is likely that the asymmetry monitoring will frequently operate. This is of no concern because the condition of steady–state measured values is monitored and, under normal operating conditions, these are symmetrical; under short circuit conditions these monitoring systems are not effective.

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 60255 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.

6.6.2 Testing the current comparison protection function

For testing the comparison protection, this function must have been parameterized as operative, i.e. CCP FUNCT = *ON* under address 1501 (condition as delivered from factory).

When testing an individual unit, the output of the protection transmission data to the opposite end must be directly connected to the input of the protection receive data from the opposite end. Testing is not possible without this feedback since the unit would be blocked due to transmission failure.

When testing two units, the data transmission output of each unit is connected to the data receive input of the other unit respectively. Both units must be connected to the auxiliary voltage. In this case the second unit can run without a test current (thus simulating a line short–circuit with single–ended infeed) or the test current is injected into both units either in phase (internal short–circuit) or in phase opposition (external short–circuit).

The following description refers to testing an individual unit with the protection data transmission output connected back into the protection data receive input.

Caution!

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

6.6.2.1 Testing the steady–state tripping threshold

The test current is gradually increased. Tripping is initiated when 1.33 x I_N is exceeded (factory setting). This is annunciated by LED 1 (factory setting). Furthermore, the trip of the tested phase(s) is annunciated (LED 2 and 7 or 3 and 8 or 4 and 9 as delivered from factory). The closing of the trip contacts and the signal contact must be checked.

The trip signal is reset approximately at 0.05 x I_N (factory setting).

For any other setting, tripping is initiated from approximately the set value for I>ST–STATE (address 1503).

6.6.2.2 Testing the dynamic tripping threshold

Adjust the test current to 0.3 x I_N. Increase current abruptly to 0.7 x I_N. Tripping is initiated and pick–up of the tested phase is annunciated (as under 6.6.2.1).

For the counter–check, the test current is increased from 0.3 x I_N to 0.55 x I_N. The unit should not pick–up.

For any other setting, the test current for the tripping test is adjusted to approximately I>DYN (address1504) and abruptly increased by 1.2 x set value for I>DYN. For the counter–check, the abrupt increase is from the set value I>DYN by 0.8 x set value for I>DYN.

If the test cannot be performed in the prescribed form, because the test current cannot be suddenly increased, then the test current is switched from 0 to 0.4 I_N (generally 1.2 x set value I>DYN CLOS address 1505).

6.6.2.3 Testing the time delay

If a time delay has been parameterized for tripping (address 1511), then an additional dynamic test can be performed. Usually, the test current is switched from 0 to 2 x pick–up value I>DYN CLOS for this test.

When measuring the time it must be considered that the parameterized value is the pure time delay. The measuring time and tripping time of the protection unit of approximately 35 ms are additive to the parameterized value.

6.6.3 Testing the emergency overcurrent time protection

For testing the emergency overcurrent time protection the protection data link is interrupted. Address 7826 EMERG. O/C must be switched to *EXIST*.

6.6.3.1 Testing the high–set overcurrent stages I>>, I_E>>

In order to test the phase current stages, this function must be switched on, i.e. address 2601 EMER.O/C P = *ON*, for earth current test, address 2631 EMER.O/C E = *ON*.

Testing can be performed with single–phase, two–phase or three–phase test current.

Caution!

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

For testing the I>> stages, therefore, measurement shall be performed dynamically. It should be stated that the relay picks up at 1.1 times setting value and does not at 0.9 times setting value.

When the test current is injected via one phase and the earth path and the set value for IE>> (address 2632) is exceeded the pick–up indication for I_E>> appears, with increase above the pick–up value of the phase current stage (address 2602 I>>) pick–up indication appears for the tested phase.

After expiry of the time delay (address 2633 T–IE>> for the earth current path, address 2603 T–I>> for the phase path) trip signal is given.

It must be noted that the set times are pure delay times; operating times of the measurement functions are not included.

6.6.3.2 Testing the definite time overcurrent stages I>, I_E>

For these tests the related functions must be switched on, furthermore, the *DEFINITE TIME* mode must be selected in addresses 2611 and/or address 2641.

Testing can be performed with single–phase, two–phase or three–phase test current.

When the test current is injected via one phase and the earth path and the set value for IE> (address 2642) is exceeded the pick–up indication for I_E> appears, with further increase above the pick–up value of the phase current stage (address 2612 I>) pick–up indication appears for the tested phase.

After expiry of the time delay (address 2643 T–IE> for the earth current path, address 2613 T–I> for the phase path), trip signal is given.

The reset value should lie at approximately 95% of the pick–up value.

It must be noted that the set times are pure delay times; operating times of the measurement functions are not included.

6.6.3.3 Testing the inverse time overcurrent stages I_p, I_{Ep}

For these tests the related functions must be switched on (address 2601 and/or 2631), furthermore, one of the *INVERSE* time modes must be selected in addresses 2611 and/or address 2641.

Testing can be performed with single–phase, two–phase or three–phase test current.

For test current below 4 x I_N, slowly increase the test current over one phase and earth until the protection picks up.

Caution!

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

When the test current is injected via one phase and the earth path and the set value for IEp (address 2644) is exceeded by approximately 1.1 times the pick–up value, indication for I_{Ep} appears, with further increase above 1.1 times the set value of the phase current stage (address 2614 Ip) pick–up indication appears for the tested phase.

The time delay depends on which characteristic has been selected in addresses 2641 and/or 2611 and the set time multiplier in addresses 2645 and/or 2615. The expected time delays can be calculated from the formula given in the technical data or read from the characteristic curves in Figure 3.2 (see Section 3.4).

6.6.4 Testing the thermal overload protection function

The overload function can only be tested if it has been configured as THERMAL OL = *EXIST* (address 7827, refer to Section 5.4.2) and parameterized as operative, under address 2701.

The basis current for the detection of overload is always the rated current of the device. Overload data are calculated for each individual phase.

When applying the rated current (factory settings) tripping must not occur. After an appropriate time (approximately 5 x τ) a steady–state temperature rise according to the following relationship is established:

$$\frac{\Theta}{\Theta_{trip}} = \frac{1}{k^2}$$

This value can be read out in address block 59 for each phase. For different setting values k, test current should be lower than k x I_N (e.g. 90%).

To check the time constant, the current input is simply subjected to 1.6 x the pick–up value, i. e. 1.6 x k x I_N. Tripping will then be initiated after a time interval which corresponds to half the time constant.

It is also possible to check the trip characteristic (Figure 3.3). It must be noted, that before each measurement, the temperature rise must be reduced to zero. This can be achieved by either de–activating and re–activating the overload function (address 2701) or by observing a current free period of at least 5 x τ.

Caution!

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

If testing with preload is performed, then it must be ensured that a condition of thermal equilibrium has been established before time measurement commences. This is the case, when the preload has been applied constantly for a period of at least 5 x τ.

6.6.5 Testing the auto–reclose functions

The internal AR function can be programmed to single–pole, three–pole or single/three–pole AR (address 3422), provided it is configured as INTERNAL AR = *EXIST* (Address 7834, refer to Section 5.4.2) and switched to AR FUNCT = *ON* (Address 3401).

The binary input "circuit breaker ready" must be simulated unless an open circuit contact has been programmed for this purpose (FNo 2730 "CB ready", refer also to Section 5.5.2).

Depending of the selected RAR program (address 3422 RAR PROG), a single–phase and/or two–phase short circuit should be simulated, each time once with successful and once with unsuccessful AR. Check the proper reaction of the relay according to the set AR program.

Note that each new test can begin only after the reclaim time for the previous test has expired; otherwise an auto–reclose cannot result: LED "AR not ready" (FNo 2784, LED 11, as delivered) must not be illuminated.

If the circuit breaker is not ready a reclose attempt must not result. However, a normal AR cycle must occur when the signal "circuit breaker ready" first disappears after the inception of the fault.

If multi–shot auto–reclosure is used, test the function sequence in accordance to the set DAR program and the number of desired shots.

6.7 Commissioning using primary tests

All secondary testing sets and equipment must be removed. Reconnect current transformers. For testing with primary values the line must be energized.

Warning

Primary tests shall be performed only by qualified personnel which is trained in commissioning of protection systems and familiar with the operation of the protected object as well as the rules and regulations (switching, earthing, etc.).

6.7.1 Measuring the signal transmission time

The internal processing times for the protection data have already been considered in the 7SD51 firmware. Therefore, the transmission time matching refers only to those delays which occur during signal transmission between the two units.

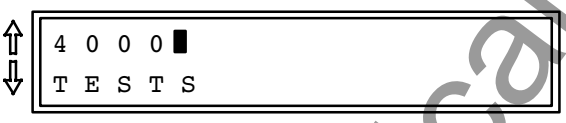
With direct optical fibre connection, transmission time compensation is not required, since the run times encountered with the maximum distances permissible for this application are far below permissible limits.

If other transmission methods are employed and the distance does not exceed 15 km, then only the time delay caused by the coupling devices and intermediate amplifiers (if applicable) need be considered. If the signal transmission time does not exceed 0.2 ms, compensation is not required. The transmission time can be measured by the relay itself.

Test facilities start at address 4000. Testing of the transmission time is at address 4100 and can be performed at any line end. The protection units at both ends of the line and the protection data transmission must be operational for testing. The address is reached:

– by pressing direct address key **DA** followed by the address number 4100, followed by the enter key **E**, or

– by paging through the blocks with key ⇑ or key ⇓ until address 4100 has been reached.



Commencement of the blocks for testing and commissioning aids.

Block ”Commission tests”

Transmission time measurement to be carried out?

To confirm transmission time measurement, press the ”Yes”–key **J/Y.** This starts transmission time measurement. The protection unit firstly checks whether the unit at the opposite end is ready. It then sends a measurement telegram via the protection data transmission link which is reflected at the opposite end. When the reflected telegram is received, the external transmission time of the protection data link can be determined. The protection function is blocked during the transmission time measurement.

Generally the transmission time is displayed immediately after transmission time testing has been initiated. If another testing procedure is in progress at the opposite end or if the protection data transmission link or the unit at the opposite end is not operational, then transmission time measurement can not proceed and a respective message is annunciated on the display.

Annunciation of measurement transmission time for protection data transmission link (resolution 0.1 ms)

FLT. IN PROGRESS	Network fault is in progress
DATA ABSENT	No data reception from the opposite end
MEAS. ABORTED	Measurement has been aborted

Testing stops automatically after the measurement telegram has been transmitted and received.

The measured transmission time of the protection data transmission link is then set under address ”1603 TDELAY b–a”.

6.7.2 Polarity check with load current

The correct connection of the current transformers is tested with load current. A load current of at least 0.1 x I_N is required for the test.

The line is connected at both ends. The load current can be read out under address block 57. If the protection data transmission link is operational, then the load currents at the opposite end are also indicated in address block 58 and can be compared with those at the local end.

For the current transformer connection check, the phase position of the currents at the local end can be compared with one another.

These tests begin at address 4110.

Block ”Angle measurement”

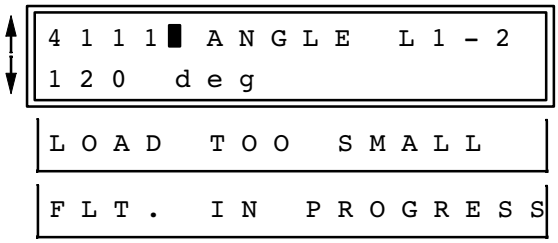
Testing of the various phase angles is selected with keys ↑ and ↓.

Phase angle measurement of phase currents L2 and L1 at the same line end ?

Testing is initiated by confirming with the ”Yes”–key **J/Y**.

Generally, the angle is displayed immediately after testing has been initiated. If the load current is too small or a network fault is being processed, angle measurement is not carried out and a corresponding message is displayed.

The phase position of the phase currents is indicated with 60 degrees increment in mathematical positive sequence.



Indication of phase angle between phase currents L1 and L2 at the same line end (expected value with correct connections: 120 deg.)

Load current in at least one of the phases absent or too small.

Network fault is in progress.

Indication of phase angle measurement between phase currents L2 and L3 at the same line end
(expected value with correct connections: 120 deg)

Indication of phase angle measurement between phase currents L3 and L1 at the same line end
(expected value with correct connections: 120 deg)

If the results of all three measurements show 240° instead of the expected 120°, either two phases are interchanged or the network rotation is counter–clockwise (this is permissible!)

If different angle values are displayed, connections of individual current transformers are wrong. Table 6.3 shows possible interchanges for clockwise phase sequence, Table 6.4 for counter–clockwise phase sequence.

Address	Angle	Error
4111 4112 4113	ANGLE L1→2 = 120° ANGLE L2→3 = 300° ANGLE L3→1 = 300°	Wrong polarity current L3
4111 4112 4113	ANGLE L1→2 = 300° ANGLE L2→3 = 120° ANGLE L3→1 = 300*	Wrong polarity current L1
4111 4112 4113	ANGLE L1→2 = 300° ANGLE L2→3 = 300° ANGLE L3→1 = 120°	Wrong polarity current L2

Table 6.3 Current connection errors with clockwise phase sequence

Address	Angle	Error
4111 4112 4113	ANGLE L1→2 = 240° ANGLE L2→3 = 60° ANGLE L3→1 = 60°	Wrong polarity current L3
4111 4112 4113	ANGLE L1→2 = 60° ANGLE L2→3 = 240° ANGLE L3→1 = 60°	Wrong polarity current L1
4111 4112 4113	ANGLE L1→2 = 60° ANGLE L2→3 = 60° ANGLE L3→1 = 240°	Wrong polarity current L2

Table 6.4 Current connection errors with counter–clockwise phase sequence

Switch off and earth the line.

Short–circuit the current transformers.

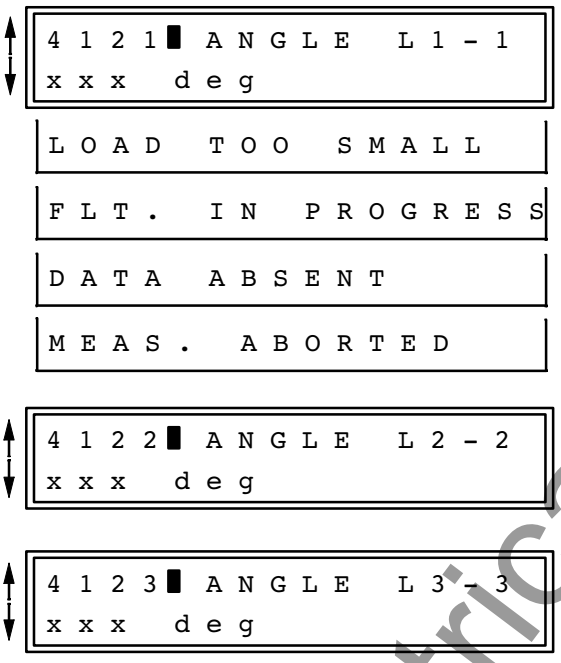
Correct the c.t. connections.

Re–check the phase angle measurement as described above.

Next, the phase position of the three phase–currents at the local end are to be compared with the phase position of the respective currents at the opposite end. If required, the transmission time of the protection data transmission link must have been compensated, e.g. by testing (address 4100) and, if required, setting (address 1603) of the protection data link transmission time.

Generally, the angle is displayed immediately after testing has been initiated. If a testing procedure is in progress at the opposite end, if the data transmission link or the unit is not ready for operation, or if the load current is too small a corresponding message is displayed

In order to determine the phase position of the currents, the phase currents at both ends of the line are assigned their polarity at each sampling point. The displacement of the change in polarity of the tested currents is evaluated under consideration of the current transformer star–point formation (address 1101).



Phase angle measurement of phase currents L1 at both line ends
(expected value with correct connections: 0 deg.)

Load current in at least one of the line ends absent or too small.

Network fault is in progress.

No data transmission from the other end.

Measurement has been aborted.

Phase angle measurement of phase currents L2 at both line ends
(expected value with correct connections: 0 deg).

Phase angle measurement of phase currents L3 at both line ends
(expected value with correct connections: 0 deg).

If the display shows 180˚ instead of the expected 0˚, for all three cases, the current polarity is wrong at one line end. Revert the polarity by changing the parameter in address 1101.

If the display shows 180˚ for at least one phase, revert the current polarity in address 1101 at one line end and repeat the check from address 4121 on.

If the three angles are equal, but different from 0˚, the three phases are cyclically interchanged.

If for at least one phase 0˚ is shown, the other two phases should be matched to this phase.

- 180° in one phase means wrong polarity in this phase at the opposite line end,
- with 120˚ or 240˚ phases are interchanged at the opposite line end,
- with 60˚ or 300˚ polarity and phase assignment are wrong at the opposite line end.

If angles are different, polarities and phases are wrong.

Switch off and earth the line.

Short–circuit the current transformers.

Correct the c.t. connections.

Re–check the phase angle measurement as described above.

6.7.3 Checking the stabilization

Stability checks should be made because of the high sensitivity of the current comparison protection. For this, the line is energized at <u>one</u> line end.

Read out the steady–state charging current in address block 57. Check that the dynamic threshold I>DYN (address 1504) is at least 4 times the charging current.

Switching tests are carried out in order to ensure that stability of the current comparison protection is sufficient even under switching conditions. the following procedure is suggested:

Set address 7402 (refer to Section 5.3.4) INITIATION = *STORAGE BY FD* (*FD* = fault detection) so that fault recording is initiated by internal dynamic fault detection signal. Note that codeword entry is necessary for alteration of a configuration parameter. Thus, a fault record can be produced automatically when the dynamic threshold of the current comparison protection is reached without any external trigger signal.

Test address 4131 allows to start one unique fault record. Codeword entry is necessary for this test initiation.

Allowance of a test fault record?

Confirm with the "Yes"–key **J**/**Y** that a test fault record is allowed.

When address 7402 is not set to INITIATION = *STORAGE BY FD* then the message *NOT POSSIBLE* is displayed.

Switch the line on several times. If a fault record has been stored then read it out and give renewed allowance of a test fault record before next closing.

If no fault record has been stored during several switching tests then the dynamic pick–up threshold has never been reached. The protection remained stable. Set address 7402 INITIATION back to the intended position. At the same instant test fault record allowance is erased when the position is *START WITH TRIP*.

If the dynamic pick–up threshold has been exceeded during one of the switching tests then a fault record will have been stored. It can be read out in order to find out the amplitude of the inrush currents. The dynamic threshold I>DYN CLOS (address 1505) should be set less sensitive, i.e. to a higher value. Repeat switching tests in this case.

6.7.4 Operational test facility

Possibility exists to carry out conventional test of the current comparison protection function during operation. In order to achieve this, a binary input must have been allocated to the function ">CCP Test" (FNo 3059). When this input is energized during operation, the relay at the opposite line end is switched over to emergency overcurrent time protection mode.

This test feature allows the relay to be tested without the need to inactivate the relay at the opposite line end.

The local relay can now be tested by an injected current without affection of the other relay. If local trip is not required, the trip command must be interrupted.

Attention! This test must only be carried out while the line is switched off or without current! Otherwise trip command may occur even after having finished the test.

6.7.5 Checking external local and transfer trip facility

If the external local trip or transfer trip facilities via binary inputs of the relay are used, these functions must be checked.

With external local trip energization of the accordingly allocated binary input (FNo 4506 ">Ext Trip") trips the local circuit breaker, influenced by the parameters of address block 21 (refer to Section 6.3.6). This function must be switched *ON* under address 2101. After the delay time T–DELAY (address 2102) following energization of the binary input, the breaker must be tripped.

With transfer trip, energization of the accordingly assigned binary input (FNo 3306 ">Trans. Trip") sends a transfer trip signal to the remote line end in order to trip the remote circuit breaker, influenced by the parameters of address block 22 (refer to Section 6.3.7). Transmission must be switched *ON* under address 2201 for the sending relay, reception must be switched *ON* under address 2204 for the receiving relay. After the delay time T–SEND–DEL (address 2202) following energization of the binary input, transfer trip signal is transmitted; the breaker of the receiving end must be tripped.

6.7.6 Tripping test including circuit breaker

Current comparison protection relay 7SD512 allows simple checking of the tripping circuit and the circuit breaker. With the integrated auto–reclose system, a TRIP–CLOSE test cycle is also possible.

6.7.6.1 TRIP–CLOSE test cycle – address block 43

Prerequisite for the start of a trip–close test cycle is that the integrated auto–reclose function is programmed as *EXIST* (address 7834) and it is switched *ON* (Address 3401).

A TRIP–CLOSE test cycle is also possible with an external auto–reclose system. Since in this case, however, 7SD512 only gives the tripping command, the procedure shall be followed as described in Section 6.7.6.2.

If the circuit breaker auxiliary contacts advise the relay, through binary inputs, of the circuit breaker position, the test cycle can only be started when the circuit breaker is closed. This additional security feature should not be omitted.

During marshalling of the binary inputs (refer to Section 5.5.2) the relay had been informed which binary inputs indicate the circuit breaker position. If auxiliary contact are assigned to binary inputs they must be connected, too. If none is assigned to any binary input then the device will perform tripping test without interrogation of the circuit breaker position!

DANGER!

A successfully started test cycle will lead to closing of the circuit breaker!

Initiation of the test cycle can be given from the operator keyboard or via the front operator interface. A codeword input is necessary. The procedure is started with address 4300 which can be reached by direct addressing **DA 4 3 0 0 E** or by paging with ⇓ or ⇑. In the addresses of this block there is a number of possibilities available which are shown in the following boxes. Single–pole trip–close–tests will only be carried out by the relay when single–pole AR is also permitted. Three–pole trip–close cycle will only be carried out when three–pole AR is permitted.

Further prerequisites for the start of test are that no protective function fault detector has picked up and that the conditions for reclose (circuit breaker ready, AR not blocked) are fulfilled.

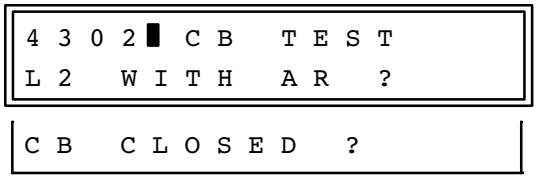
```
4 3 0 0 ■ C B   T E S T
T R I P - C L O S E   C Y C L E
```

Beginning of the block "Circuit breaker test, TRIP–CLOSE cycle"

Carry out test cycle with pole L1 of circuit breaker? Confirm with "**J**/**Y**"–key or abort with page–on key ↑

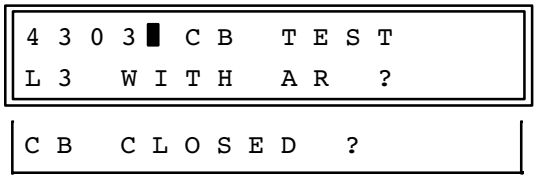
Confirm with "**J**/**Y**" key that circuit breaker is closed or abort by page–on ↑

After confirmation by the operator that the circuit breaker is closed, the test cycle proceeds. If the test is terminated successfully, this is annunciated in the display or on the PC screen. If, however, circuit breaker auxiliary contacts are assigned to binary inputs and connected, the relay rejects the test cycle as long as the auxiliary contacts indicate that the circuit breaker is not closed, even if the operator has confirmed that it is. Only when no circuit breaker auxiliary contact is assigned to any binary input, will the relay consider the operator's confirmation valid.



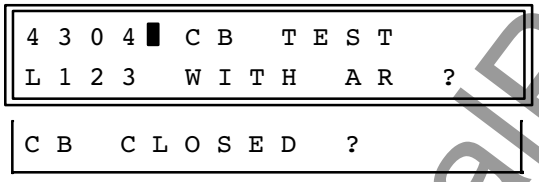
Carry out test cycle with pole L2 of circuit breaker? Confirm with "**J**/**Y**"–key or abort with page–on key ↑

Confirm with "**J**/**Y**" key that circuit breaker is closed or abort with page–on key ↑



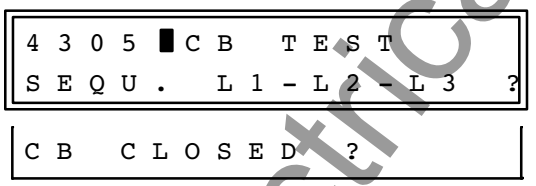
Carry out test cycle with pole L3 of circuit breaker? Confirm with "**J**/**Y**"–key or abort with page–on key ↑

Confirm with "**J**/**Y**"–key that circuit breaker is closed or abort with page–on key ↑



Carry out three–pole test cycle of circuit breaker? Confirm with "**J**/**Y**"–key or abort with page–on key ↑

Confirm with "**J**/**Y**"–key that circuit breaker is closed or abort with page–on key ↑



Carry out sequence of single–pole test cycles L1–L2–L3 of circuit breaker? Confirm with "**J**/**Y**"–key or abort with page–on key ↑

Confirm with "**J**/**Y**"–key that circuit breaker is closed or abort with page–on key ↑

6.7.6.2 Live tripping of the circuit breaker – address block 44

To check the tripping circuits, the circuit breaker can be tripped independently on whether an auto–reclosure will occur or not. However, this test can also be made with an external auto–reclose relay.

DANGER!

A successfully started test cycle can lead to closing of the circuit breaker, if an external auto–reclosure relay is connected!

If the circuit breaker auxiliary contacts advise the relay, through binary inputs, of the circuit breaker position, the test can only be started when the circuit breaker is closed. This additional security feature should not be omitted when an external auto–reclose relay is present.

During marshalling of the binary inputs (refer to Section 5.5.2) the relay had been informed which binary inputs indicate the circuit breaker position. If auxiliary contacts are assigned to binary inputs they must be connected, too. If none is assigned to any binary input then the device will perform tripping test without interrogation of the circuit breaker position!

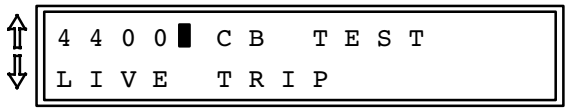
Initiation of the test can be given from the operator keyboard or from the front operator interface. A codeword input is necessary. The procedure is started with address 4400 which can be reached by direct dialling **DA 4 4 0 0 E** or by paging with ⇑ or ⇓. In the addresses of this block there is a number of possibilities available which are shown in the following boxes.

In order to trip the circuit breaker single–pole, it is necessary to permit single–pole tripping through the binary input ">1p Trip Perm" (FNo 381), with external single–pole AR: otherwise the single–pole test will not be carried out.

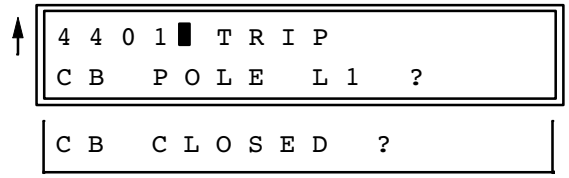
To trip all three poles of the circuit breaker, an external signal ">Only 1pole" must not be present from an external auto–reclose relay (FNo 382).

In the absence of auto–reclose, only the three–pole trip (address 4404) has any meaning.

Prerequisite for starting the test is that no protection function of the relay be picked–up.



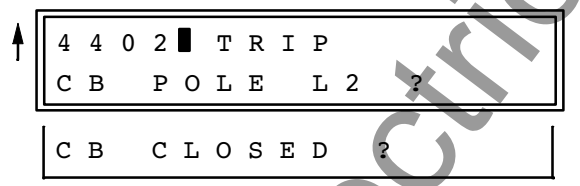
Beginning of the block "Circuit breaker trip test: live trip"



Trip circuit breaker pole L1? Confirm with "**J**/**Y**"–key or abort by paging on with ↑

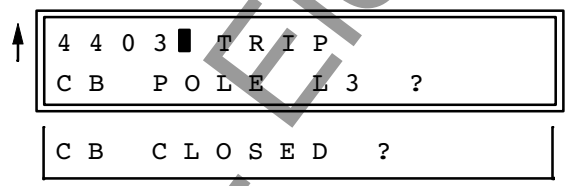
Confirm with "**J**/**Y**"– key that circuit breaker is closed or abort by paging on with ↑

After confirmation by the operator that the circuit breaker is closed, the test cycle proceeds. If the test is terminated successfully, this is annunciated in the display or on the PC screen. If, however, circuit breaker auxiliary contacts are assigned to binary inputs and connected, the relay rejects the test as long as the auxiliary contacts indicate that the circuit breaker is not closed, even if the operator has confirmed that it is. Only when no circuit breaker auxiliary contact is assigned to any binary input, will the relay consider the operator's confirmation valid.



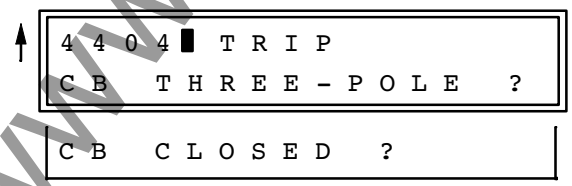
Trip circuit breaker pole L2? Confirm with "**J**/**Y**"–key or abort with page–on key ↑

Confirm with "**J**/**Y**"– key that circuit breaker is closed or abort with page–on key ↑



Trip circuit breaker pole L3? Confirm with **"J/Y"**–key or abort with page–on key ↑

Confirm with "**J**/**Y**"–key that circuit breaker is closed or abort with page–on key ↑



Trip circuit breaker three–pole? Confirm with "**J**/**Y**"–key or abort with page–on key ↑

Confirm with "**J**/**Y**"– key that circuit breaker is closed or abort with page–on Key ↑

6.7.7 Starting a test fault record – address block 49

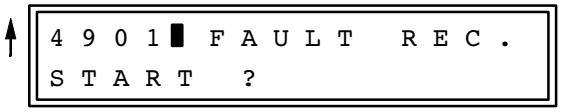
A fault record storage can be started at any time using the operating panel or via the operating interface. Starting a test fault record is also possible via a binary input provided this is accordingly allocated (FNo 4 ">Start FltRec").

The configuration parameters as set in address block 74 are decisive for this fault recording (refer to Section 5.3.4): address 7431 concerns triggering via binary input, address 7432 triggering via the operating keyboard or via the operating interface. The pre–trigger time was set under address 7411.

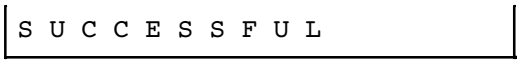
The fault record can be triggered via a binary input, for example at the instant of the breaker closing command.

Manual starting of a fault record can be carried out in address block 49, which can be reached by paging with ⇑ or ⇓, or by direct dialling with **DA 4 9 0 0 E**. The start address is reached with ↑:

Beginning of block "Test fault recording"
page on with ↑ to address 4901



Start fault recording? Confirm with "**J**/**Y**"– key or abort with page–on key ↑



The relay acknowledges successful completion of the test recording

6.8 Putting the relay into operation

All setting values should be checked again, in case they were altered during the tests. Particularly check that all desired protection functions have been programmed in the configuration parameters (address blocks 78 and 79, refer to Section 5.4) and all desired protection functions have been switched *ON*.

The counters for circuit breaker operation statistics should be erased (address block 82, refer to Section 6.5.2).

Push the key **M**/**S** on the front. The display shows the beginning of the annunciation blocks. Thus, it is possible that the measured values for the quiescent state of the relay can be displayed (see below). These values has been chosen during configuration (refer to Section 5.3.2) under the addresses 7105 and 7106.

Stored indications on the front plate should be reset by pressing the push–button "RESET LED" on the front so that from then on only real faults are indicated. From that moment the measured values of the quiescent state are displayed. During pushing the RESET button, the LEDs on the front will light–up (except the "Blocked"–LED); thus, a LED test is performed at the same time.

Check that the modules are properly inserted. The green LED must be on on the front; the red LED must not be on.

Close housing cover.

All terminal screws – even those not in use – must be tightened.

If a test switch is available, then this must be in the operating position.

The current comparison protection relay is now ready for operation.

7 Maintenance and fault tracing

Siemens digital protection relays are designed to require no special maintenance. All measurement and signal processing circuits are fully solid state and therefore completely maintenance free. Input modules are even static, relays are hermetically sealed or provided with protective covers.

If the device is equipped with a back–up battery for saving of stored annunciations and the internal time clock, the battery should be replaced after at the latest 10 years of operation (refer to Section 7.2). This recommendation is valid independent on whether the battery has been discharged by occasional supply voltage failures or not.

As the protection is almost completely self–monitored, from the measuring inputs to the command output relays, hardware and software faults are automatically annunciated. This ensures the high availability of the relay and allows a more corrective rather than preventive maintenance strategy. Tests at short intervals become, therefore, superfluous.

With detected hardware faults the relay blocks itself; drop–off of the availability relay signals "equipment fault". If there is a fault detected in the external measuring circuits, generally an alarm is given only.

Recognized software faults cause the processor to reset and restart. If such a fault is not eliminated by restarting, further restarts are initiated. If the fault is still present after three restart attempts the protective system will switch itself out of service and indicate this condition by the red LED "Blocked" on the front plate. Drop–off of the availability relay signals "equipment fault".

The reaction to defects and indications given by the relay can be individually and in chronological sequence read off as operational annunciations under the address 5100, for defect diagnosis (refer to Section 6.4.2).

If the relay is connected to a local substation automation system (LSA), defect indications will also be transferred via the serial interface to the central control system.

Warning

Ensure that the connection modules are not damaged when removing or inserting the device modules! Hazardous voltages may occur when the heavy current plugs are damaged!

7.1 Routine checks

Routine checks of characteristics or pick–up values are not necessary as they form part of the continuously supervised firmware programs. The planned maintenance intervals for checking and maintenance of the plant can be used to perform operational testing of the protection equipment. This maintenance serves mainly for checking the interfaces of the unit, i.e. the coupling with the plant. The following procedure is recommended:

– Read–out of operational values (address block 57) and comparison with the actual values for checking the analog interfaces.

– Simulation of an internal short–circuit with 4 x I_N for checking the analog input at high currents.

Warning

Hazardous voltages can be present on all circuits and components connected with the supply voltage or with the measuring and test quantities!

Caution!

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

– Circuit–breaker trip circuits are tested by actual live tripping. Respective notes are given in Section 6.7.6.

7.2 Replacing the back–up battery

The device annunciations are stored in NV–RAMs. A back–up battery is inserted so that they are retained even with a longer failure of the d.c. supply voltage. The back–up battery is also required for the internal system clock with calender to continue in the event of a power supply failure.

The back–up battery should be replaced at the latest after 10 years of operation. The way of displacement depends on the production series of the relay. This production series is found on the name plate behind the complete order designation.

Recommended battery:

Lithium battery 3 V/1 Ah, type CR 1/2 AA, e.g.
– VARTA Order No. 6127 501 501 for relays until production series /**DD**,
– VARTA Order No. 6127 101 501 for relays from production series /**EE** or later.

The battery is located at the rear edge of the processor board of the basic module GEA. The basic module must be removed from the housing in order to replace the battery.

– Prepare area of work: provide conductive surface for the basic module.

– Open housing cover.

– Read out device annunciations, i.e. all addresses which commence with 5 (5000 onwards). This is carried out most convenient using the front operating interface and a personal computer with the DIGSI® protection data processing program; the information is thus stored in the PC.

  Note: All configuration data and settings of the device are stored in EEPROMs protected against switching off of the power supply. They are stored independent of the back–up battery. They are, therefore, neither lost when the battery is replaced nor when the device is operated without a battery.

– **Only for relay until production series /DD**: Prepare the battery as in Figure 7.1:

Caution!

Do not short–circuit battery! Do not reverse battery polarities! Do not charge battery!

Shorten the legs to 15 mm (6/10 inch) each and bend over at a length of 40 mm (16/10 inch).

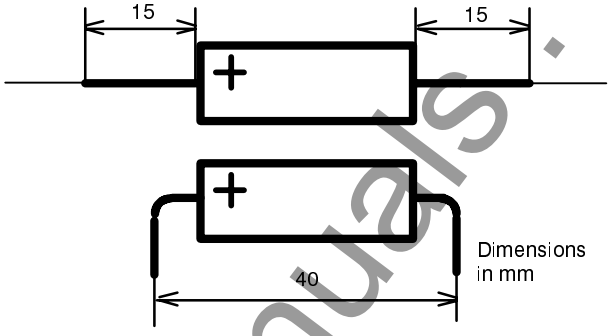


Figure 7.1 Bending the back–up battery (up to production series /DD

Relays from production series /**EE** or later have no axial legs.

– Loosen the basic module using the pulling aids provided at the top and bottom. (Figure 7.5).

Warning

Hazardous voltages can be present in the device even after disconnection of the supply voltage or after removal of the modules from the housing (storage capacitors)!

Caution!

Electrostatic discharges via the component connections, the PCB tracks or the connecting pins of the modules must be avoided under all circumstances by previously touching an earthed metal surface.

– Pull out basic module and place onto the conductive surface.

– Unscrew used battery from the terminals or remove it from the holder; **do not place on the conductive surface!** Refer to Figure 7.2 for relay until production series /**DD** and to Figure 7.3 from production series /**EE**.

– Insert the prepared battery into the terminals or holder as in Figure 7.2 (until production series /**DD**) and tighten the screws or as in Figure 7.3 (from production series /**EE**).

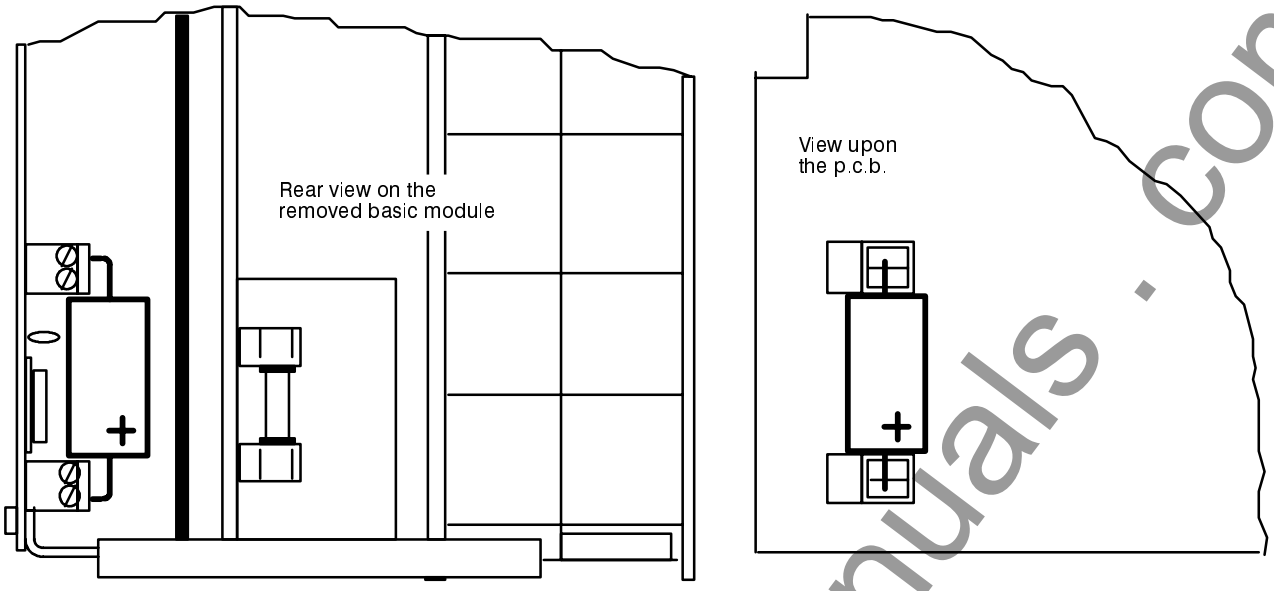


Figure 7.2 Installation of the back–up battery for relay until production series /DD

– Insert basic module into the housing; ensure that the releasing lever is pushed fully to the left before the module is pressed in.

– Firmly push in the module using the releasing lever. (Figure 7.5).

Warning

The discharged battery contains Lithium. It must only be disposed off in line with the applicable regulations!

Do not reverse polarities! Do not recharge! Do not throw into fire! Danger of explosion!

– Provided the internal system clock is not automatically synchronized via the LSA interface, it can now be set or synchronized as described in Section 6.5.1

– Close housing cover.

The replacement of the back–up battery has thus been completed.

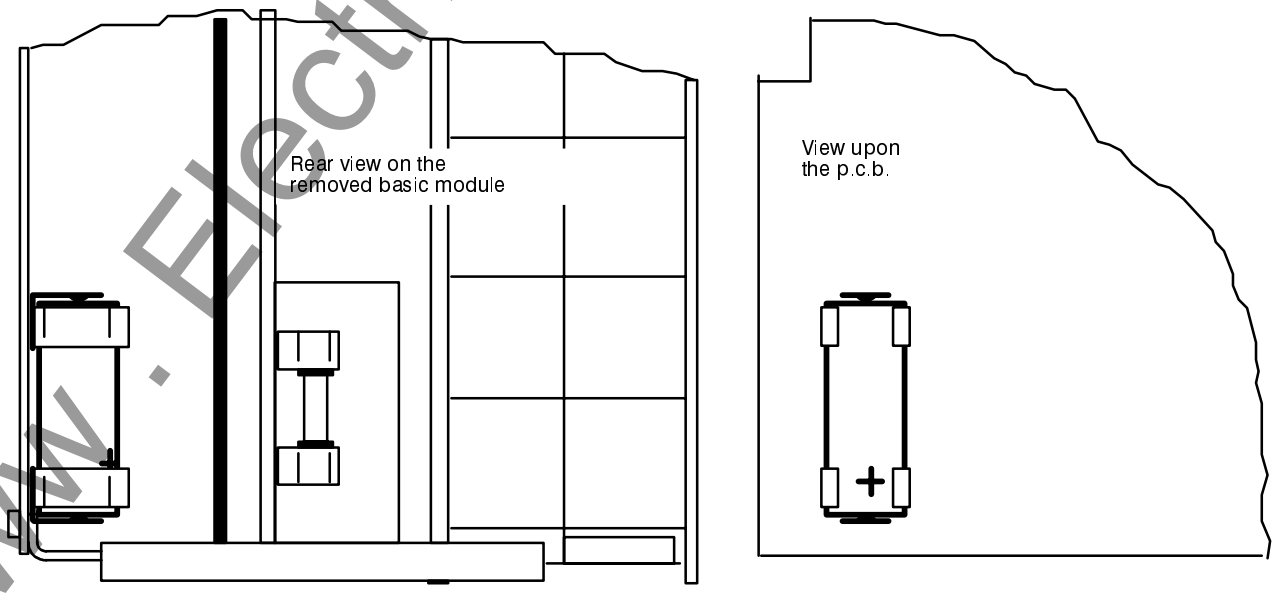


Figure 7.3 Installation of the back–up battery for relay from production series /EE

7.3 Fault tracing

If the protective device indicates a defect, the following procedure is suggested:

If none of the LEDs on the front plate of the module is on, then check:

– Have the modules been properly pushed–in and locked?

– Is the ON/OFF switch on the front plate in the ON position ⊙ ?

– Is the auxiliary voltage available with the correct polarity and of adequate magnitude, connected to the correct terminals (General diagrams in Appendix A)?

– Has the mini–fuse in the power supply section blown (see Figure 7.4)? If appropriate, replace the fuse according to Section 7.3.1.

If the red fault indicator "Blocked" on the front is on and the green ready LED remains dark, the device has recognized an internal fault. Re–initialization of the protection system could be tried by switching the d.c. auxiliary voltage off and on again. This, however, results in loss of fault data and messages if the relay is not equipped with a buffer battery, and, if a parameterizing process has not yet been completed, the last parameters are not stored.

7.3.1 Replacing the mini–fuse

– Select a replacement fuse 5 × 20 mm. Ensure that the rated value, time lag (medium slow) and code letters are correct. (Figure 7.4).

– Prepare area of work: provide conductive surface for the basic module.

– Open housing cover.

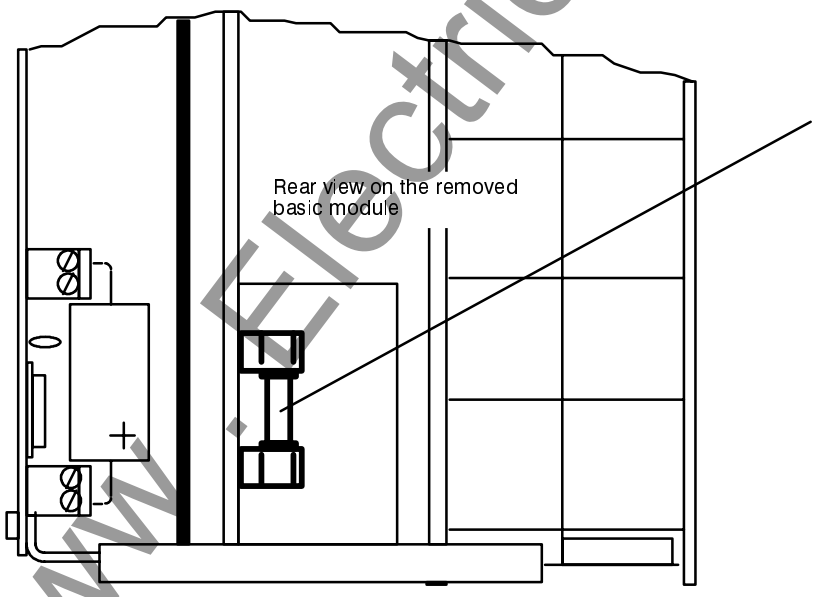
Warning

Hazardous voltages can be present in the device even after disconnection of the supply voltage or after removal of the modules from the housing (storage capacitors)!

– Loosen the basic module using the pulling aids provided at the top and bottom. (Figure 7.5).

Caution!

Electrostatic discharges via the component connections, the PCB tracks or the connecting pins of the modules must be avoided under all circumstances by previously touching an earthed metal surface.



at U_{HN}/V–	rated value
24/48	2 A/E
60/110/125	1,6 A/E
220/250	1 A/G

Figure 7.4 Mini–fuse of the power supply

– Pull out basic module and place onto the conductive surface.

– Remove blown fuse from the holder (Figure 7.4).

– Fit new fuse into the holder (Figure 7.4).

– Insert basic module into the housing; ensure that the releasing lever is pushed fully to the left before the module is pressed in (Figure 7.5).

– Firmly push in the module using the releasing lever. (Figure 7.5).

– Close housing cover.

Switch on the device again. If a power supply failure is still signalled, a fault or short–circuit is present in the internal power supply. The device should be returned to the factory (see Chapter 8).

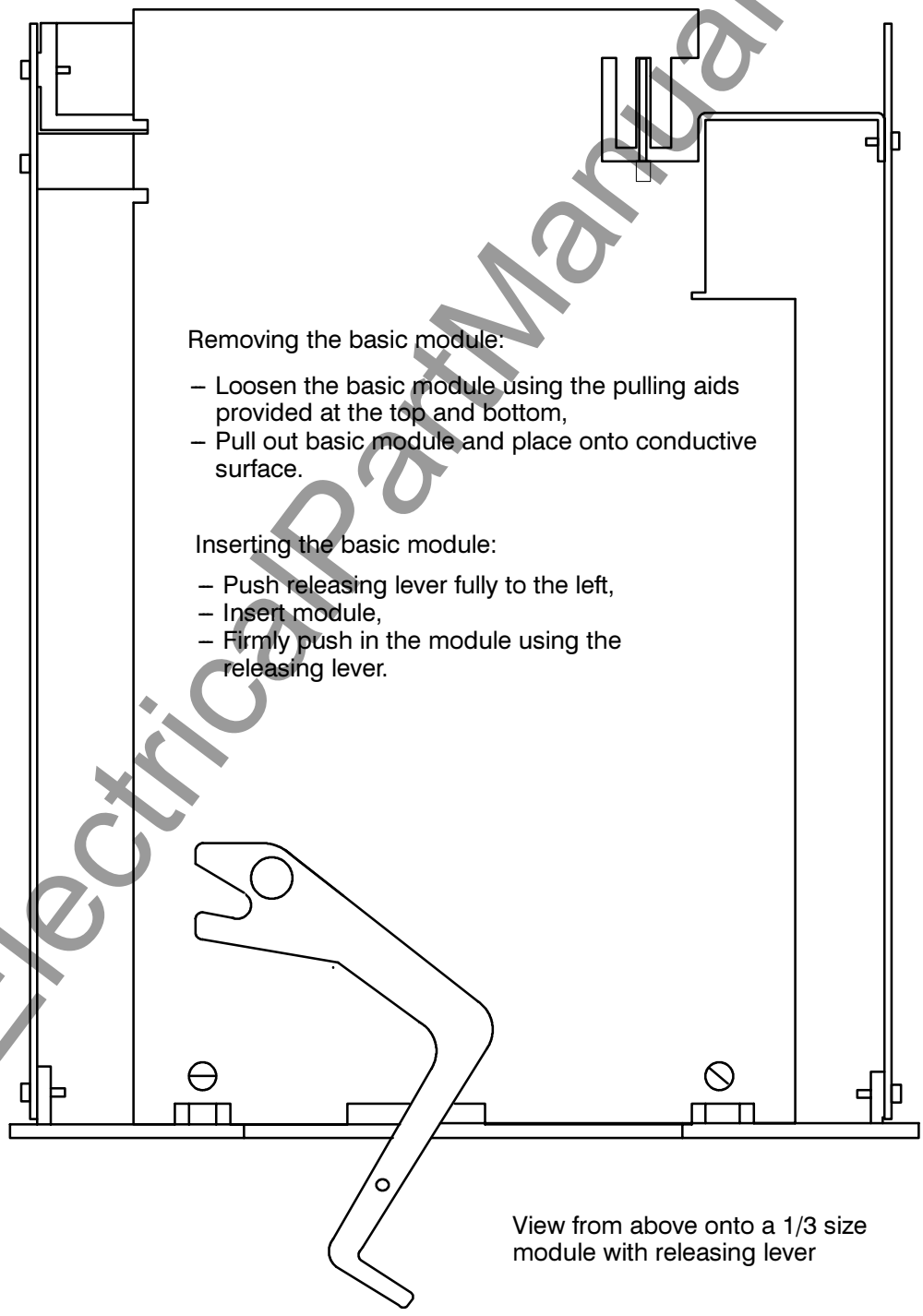


Figure 7.5 Aid for removing and inserting basic module

8 Repairs

Repair of defective modules is not recommended at all because specially selected electronic components are used which must be handled in accordance with the procedures required for **E**lectrostatically **E**ndangered **C**omponents (EEC). Furthermore, special manufacturing techniques are necessary for any work on the printed circuit boards in order to do not damage the bath-soldered multilayer boards, the sensitive components and the protective finish.

Therefore, if a defect cannot be corrected by operator procedures such as described in Chapter 7, it is recommended that the complete relay should be returned to the manufacturer. Use the original transport packaging for return. If alternative packing is used, this must provide the degree of protection against mechanical shock, as laid down in IEC 60255–21–1 class 2 and IEC 60255–21–2 class 1.

If it is unavoidable to replace individual modules, it is imperative that the standards related to the handling of **E**lectrostatically **E**ndangered **C**omponents are observed.

Warning

Hazardous voltages can be present in the device even after disconnection of the supply voltage or after removal of the module from the housing (storage capacitors)!

Caution!

Electrostatic discharges via the component connections, the PCB tracks or the connecting pins of the modules must be avoided under all circumstances by previously touching an earthed metal surface. This applies equally for the replacement of removable components, such as EPROM or EEPROM chips. For transport and returning of individual modules electrostatic protective packing material must be used.

Components and modules are not endangered as long as they are installed within the relay.

Should it become necessary to exchange any device or module, the complete parameter assignment should be repeated. Respective notes are contained in Chapter 5 and 6.

9 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 (refer Section 3.1.4 under the Technical data), 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.

Before initial energization with supply voltage, the relay shall be situated in the operating area for at least two hours in order to ensure temperature equalization and to avoid humidity influences and condensation.

Appendix

A General diagrams

B Connection diagrams

C Tables

A General diagrams

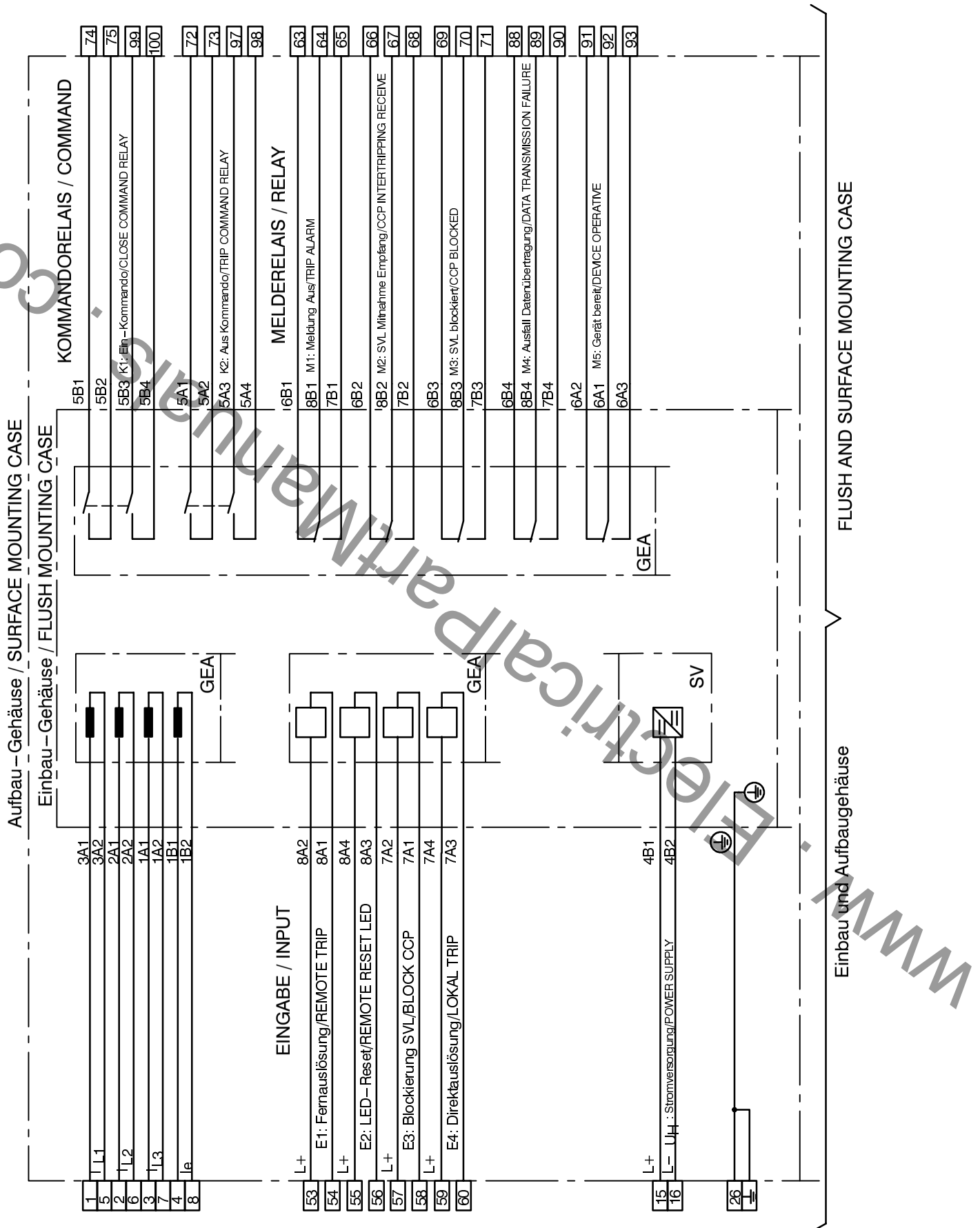


Figure A.1 General diagram of current comparison protection relay 7SD512 (sheet 1 of 4)

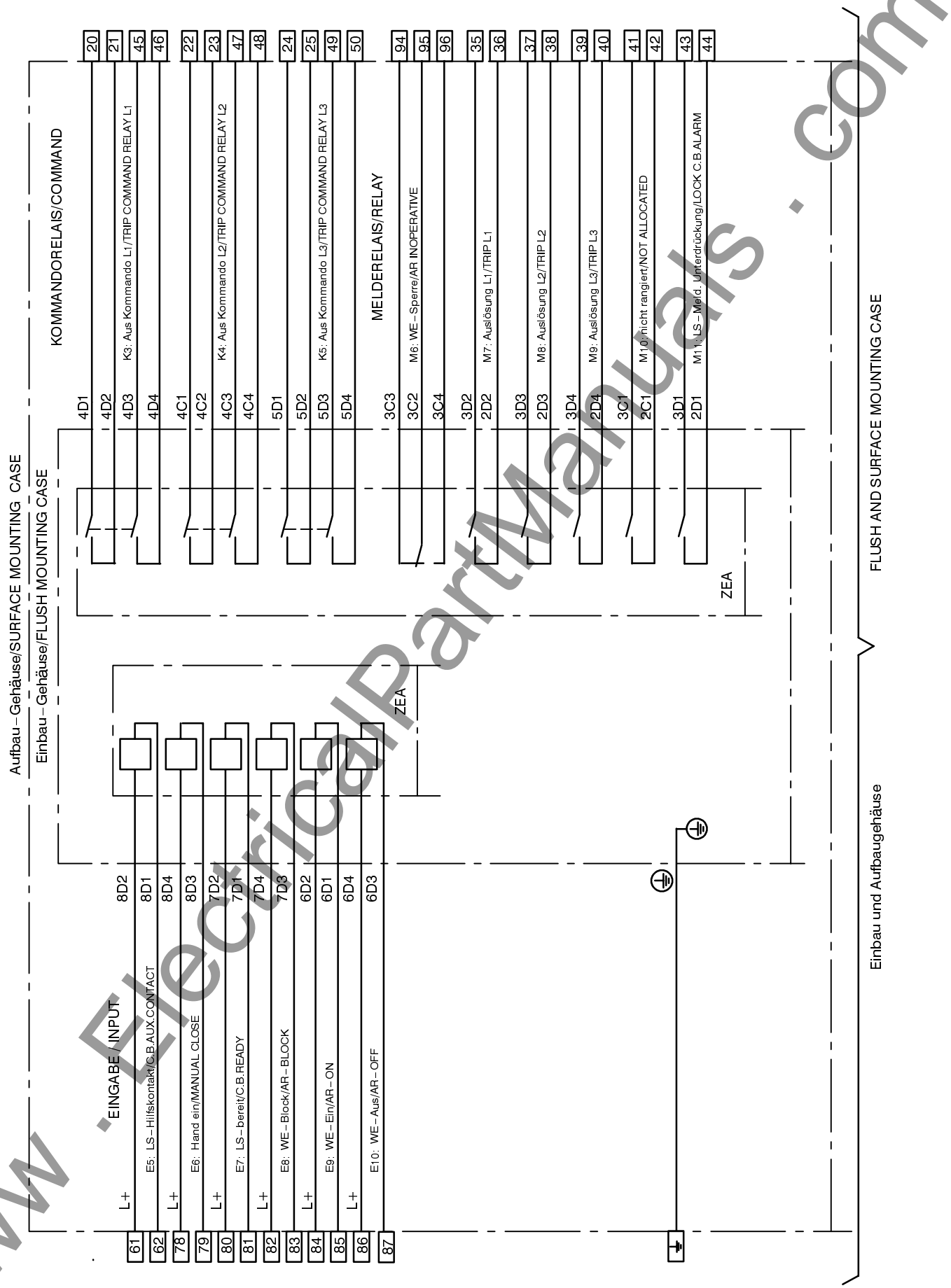


Figure A.2 General diagram of current comparison protection relay 7SD512 (sheet 2 of 4)

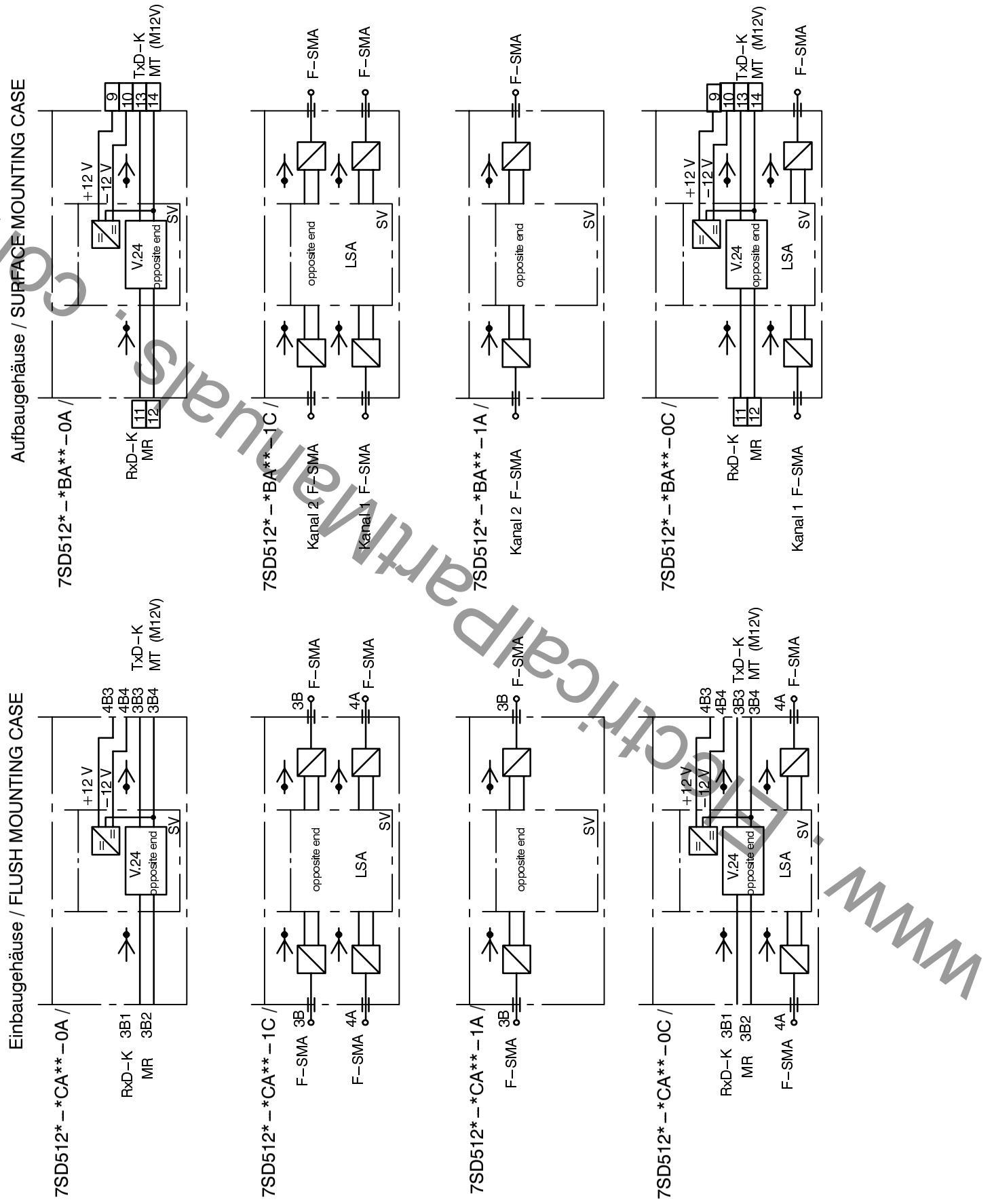


Figure A.3 General diagram of current comparison protection relay 7SD512 (sheet 3 of 4)

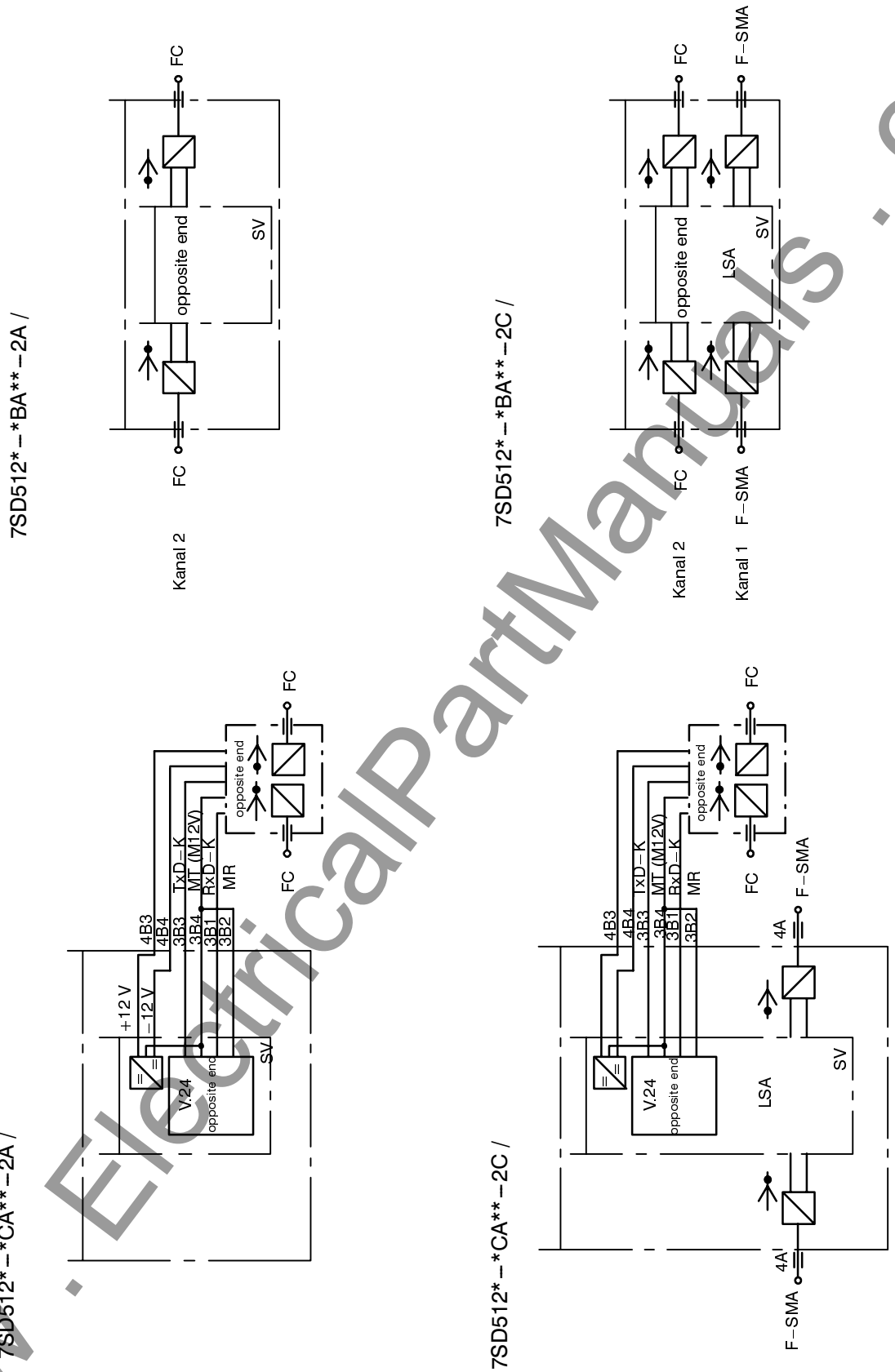


Figure A.4 General diagram of current comparison protection relay 7SD512 (sheet 4 of 4)

B Current transformer connections

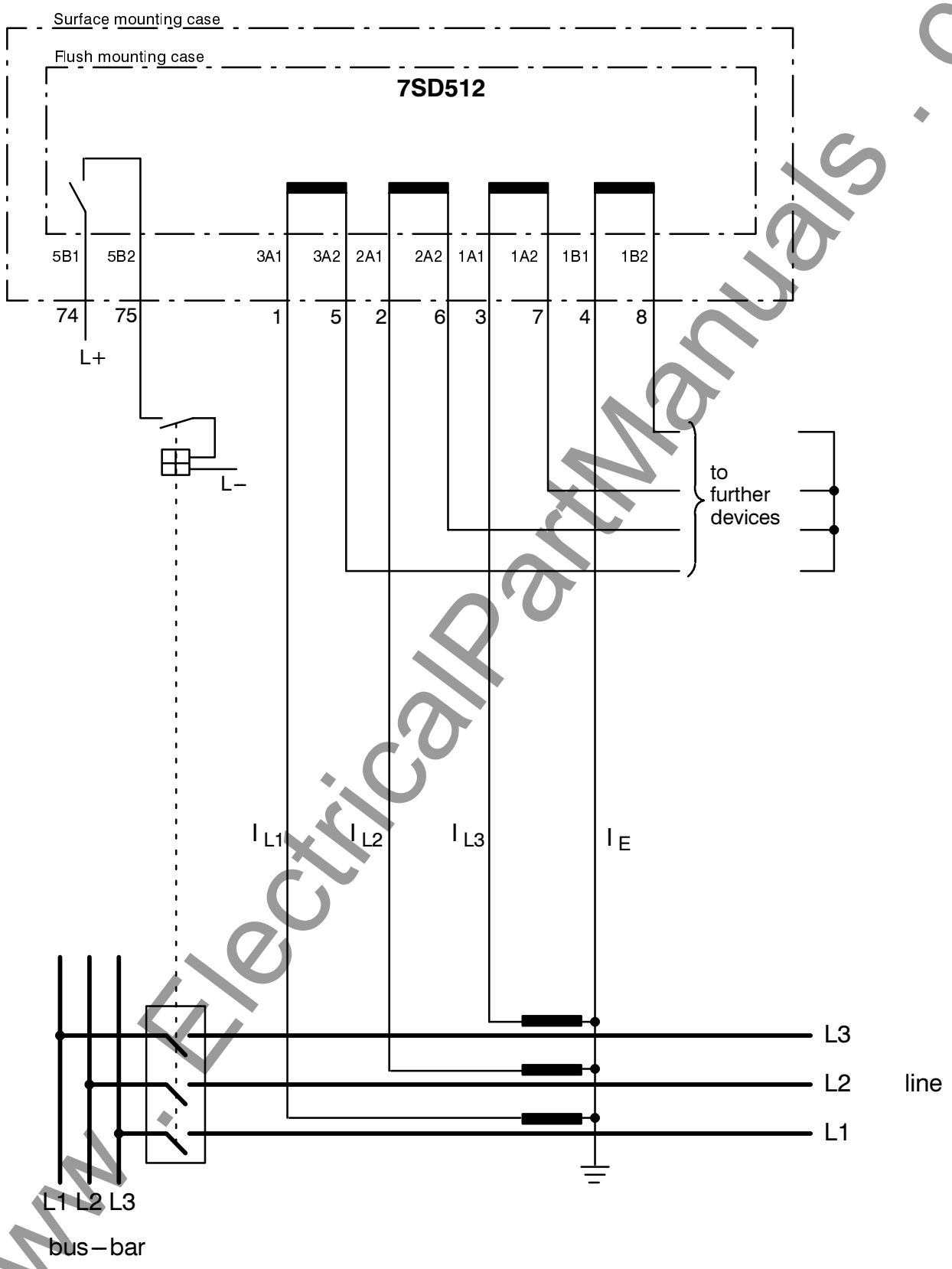


Figure B.1 Connection example for current transformer circuits

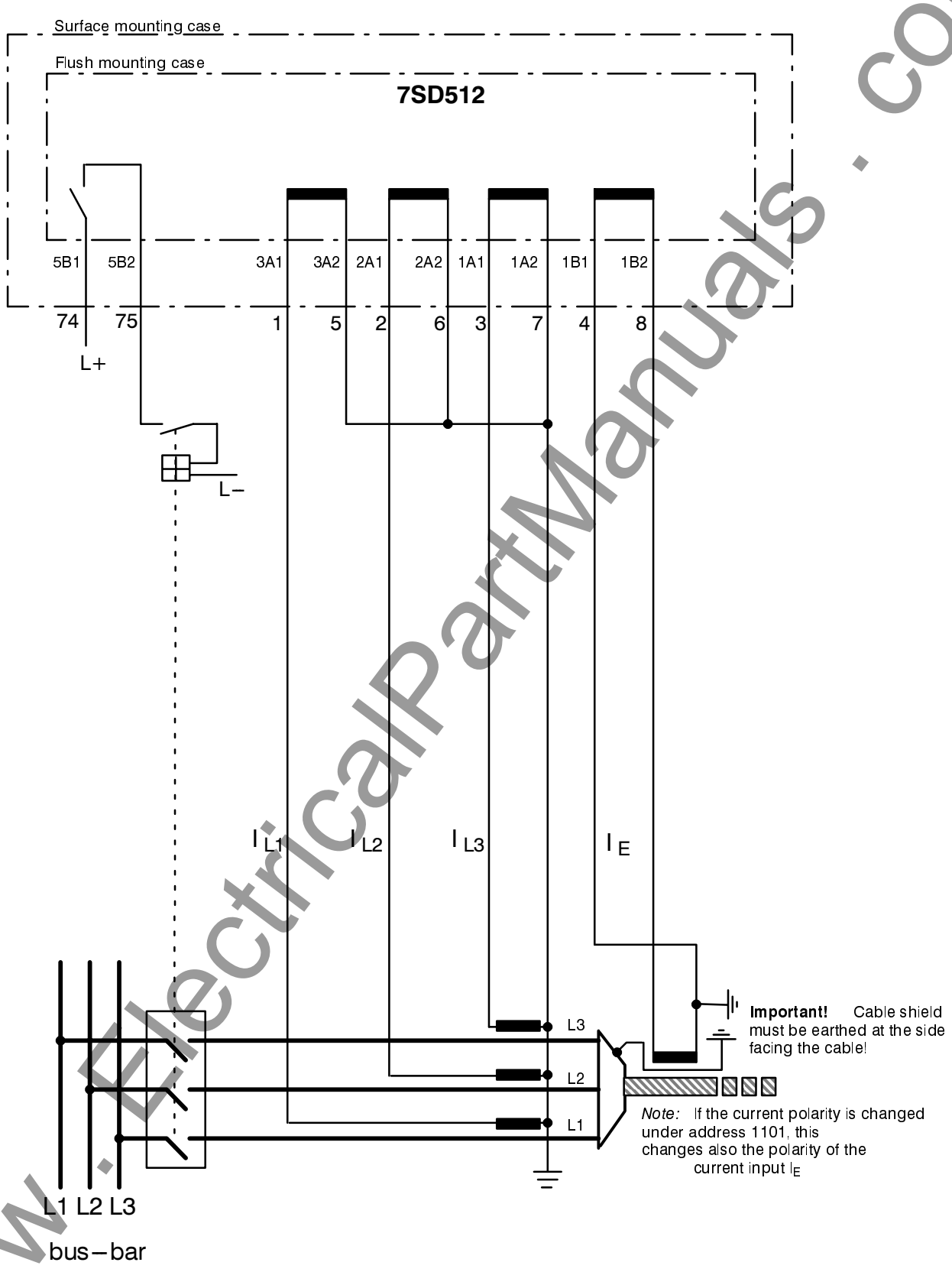


Figure B.2 Connection example with separate summation transformer

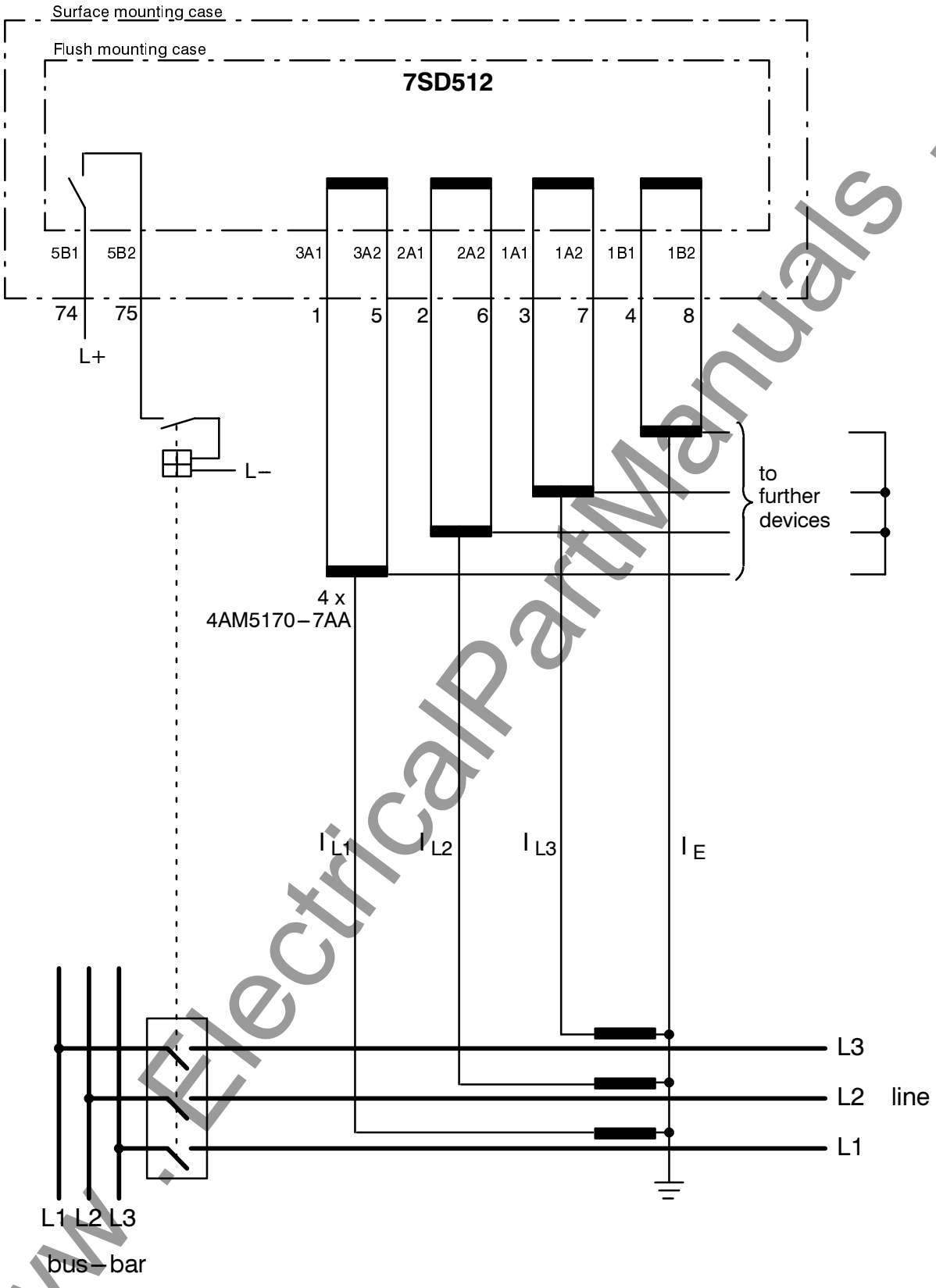


Figure B.3 Connection example with matching transformers 4AM51

C Tables

Table C.1 Annunciations for LSA 164

Table C.2 Annunciations for PC, LC–display, and binary inputs/outputs 167

Table C.3 Reference table for functional parameters (address blocks 11 to 39) 172

Table C.4 Tests and commissioning aids (address blocks 40 to 49) 179

Table C.5 Annunciations, measured values, etc. (address blocks 50 to 59) 180

Table C.6 Reference table for configuration parameters (address blocks 60 to 79) 182

Table C.7 Operational device control facilities (address blocks 80 to 89) 192

NOTE: The following tables list all data which are available in the maximum complement of the device. Dependent on the ordered model, only those data may be present which are valid for the individual version.

NOTE: The actual tables are attached to the purchased relay.

Annunciations 7SD512 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)
according 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

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	GI	BT	Typ	Inf
11	>User defined annunciation 1	CG		22	CA	GI	BT	p	27
12	>User defined annunciation 2	CG		23	CA	GI	BT	p	28
13	>User defined annunciation 3	CG		24	CA	GI	BT	p	29
14	>User defined annunciation 4	CG		25	CA	GI	BT	p	30
51	Device operative / healthy	CG		1		GI		135	81
52	Any protection operative	CG			CA	GI		p	18
55	Re-start of processor system	C		8	CA			p	4
56	Initial start of processor system	C			CA			p	5
59	Real time response to LSA	C		6					
60	LED Reset	C		30	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						135	83
95	Parameters are being set	CG		97	CA	GI		p	22
96	Parameter set A is active	CG			CA	GI		p	23
97	Parameter set B is active	CG			CA	GI		p	24
98	Parameter set C is active	CG			CA	GI		p	25
99	Parameter set D is active	CG			CA	GI		p	26
110	Annunciations lost (buffer overflow)	C		195				135	130
112	Annunciations for LSA lost	C		196				135	131
113	Fault tag lost						BT	135	136
140	General internal failure of device	CG			CA	GI		p	47
141	Failure of internal 24 VDC power supply	CG		88		GI		135	161
143	Failure of internal 15 VDC power supply	CG		83		GI		135	163
144	Failure of internal 5 VDC power supply	CG		89		GI		135	164
145	Failure of internal 0 VDC power supply	CG		84		GI		135	165
150	Failure in I/O module	CG		91		GI		135	170
151	Failure in I/O module 1	CG		92		GI		135	166
154	Failure in the RKA module	CG			CA	GI		p	36
160	Common alarm	CG			CA	GI		p	46
161	Measured value supervision of currents	CG			CA	GI		p	32
162	Failure: Current summation supervision	CG		104		GI		135	182
163	Failure: Current symmetry supervision	CG		107		GI		135	183
204	Fault recording initiated via bin.input						BT	135	204
205	Fault recording initiated via keyboard						BT	135	205
206	Fault recording initiated via PC interf						BT	135	206
301	Fault in the power system		CG	2				135	231
302	Fault event with consecutive number		C					135	232
501	General fault detection of device						BT	150	151
502	General drop-off of device		C	240				150	152
511	General trip of device		C				BT	150	161

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	VDEW/ZVEI GI	VDEW/ZVEI BT	VDEW/ZVEI Typ	VDEW/ZVEI Inf
512	General 1pole trip of device: Phase L1		C				BT	150	162
513	General 1pole trip of device: Phase L2		C				BT	150	163
514	General 1pole trip of device: Phase L3		C				BT	150	164
515	General 3pole trip of device		C				BT	150	165
521	Interrupted current: Phase L1 (I/In)		V	125				150	171
522	Interrupted current: Phase L2 (I/In)		V	126				150	172
523	Interrupted current: Phase L3 (I/In)		V	127				150	173
561	Circuit breaker manually closed (pulse)	C		18				150	211
601	Operational measurement: IL1a[%]=	M						134	131
602	Operational measurement: IL2a[%]=	M						134	131
603	Operational measurement: IL3a[%]=	M						134	131
604	Operational measurement: IEa[%]=	M						134	131
775	Time delay of transmission =	M						134	131
1174	Circuit breaker test in progress	CG		21		GI		151	74
1513	Thermal overload protection is active	CG				GI		167	13
1515	Thermal overload prot.: Current warning	CG		11		GI		167	15
1516	Thermal overload prot.: Thermal warning	CG		12		GI		167	16
1521	Thermal overload protection trip	CG		10		GI		167	21
2053	Emergency O/C protection is active	CG				GI		61	53
2054	Emergency O/C protection is running	CG		50		GI	BT	61	54
2055	Emergency O/C for earth switched OFF	CG		49		GI		61	55
2056	Emergency O/C for phases switched OFF	CG		48		GI		61	56
2061	Emerg. O/C prot.: General fault detect.		CG	210			BT	61	61
2062	Emerg. O/C prot.: Fault detection L1		CG	212			BT	61	62
2063	Emerg. O/C prot.: Fault detection L2		CG	213			BT	61	63
2064	Emerg. O/C prot.: Fault detection L3		CG	214			BT	61	64
2065	Emerg. O/C prot.: Earth fault detection		CG	216			BT	61	65
2071	Emerg. O/C earth fault detection only		C	221				61	71
2072	Emerg. O/C fault detection L1 only		C	222				61	72
2073	Emerg. O/C fault detection L1E		C	226				61	73
2074	Emerg. O/C fault detection L2 only		C	229				61	74
2075	Emerg. O/C fault detection L2E		C	232				61	75
2076	Emerg. O/C fault detection L12		C	235				61	76
2077	Emerg. O/C fault detection L12E		C	236				61	77
2078	Emerg. O/C fault detection L3 only		C	237				61	78
2079	Emerg. O/C fault detection L3E		C	238				61	79
2080	Emerg. O/C fault detection L13		C	239				61	80
2081	Emerg. O/C fault detection L13E		C	241				61	81
2082	Emerg. O/C fault detection L23		C	242				61	82
2083	Emerg. O/C fault detection L23E		C	243				61	83
2084	Emerg. O/C fault detection L123		C	244				61	84
2085	Emerg. O/C fault detection L123E		C	245				61	85
2091	Emerg. O/C phase fault detection I>>		C	246				61	91
2092	Emerg. O/C phase fault detection I>/Ip		C	247				61	92
2095	Emerg. O/C earth fault detection IE>>		C	249				61	95
2096	Emerg. O/C earth fault det. IE>/IEp		C	250				61	96
2121	Emerg. O/C prot.: Time TI>> expired		C	217				61	121
2122	Emerg. O/C prot.: Time TI>/Tp expired		C	218				61	122
2125	Emerg. O/C prot.: Time TIE>> expired		C	219				61	125
2126	Emerg. O/C prot.: Time TIE>/TEp expired		C	220				61	126
2141	Emerg. O/C protection: General Trip		C	251			BT	61	141
2142	Emerg. O/C protection: Trip 1pole L1		C	252				61	142
2143	Emerg. O/C protection: Trip 1pole L2		C	253				61	143
2144	Emerg. O/C protection: Trip 1pole L3		C	254				61	144
2145	Emerg. O/C protection: Trip 3pole		C	255				61	145
2709	>AR: Block delayed auto-reclose	CG		76		GI		40	9
2711	>AR: External start for internal AR	CG		41		GI		40	11

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	VDEW/ZVEI GI	VDEW/ZVEI BT	VDEW/ZVEI Typ	VDEW/ZVEI Inf
2712	>AR: Ext. Trip L1 for internal AR	CG		42		GI		40	12
2713	>AR: Ext. Trip L2 for internal AR	CG		43		GI		40	13
2714	>AR: Ext. Trip L3 for internal AR	CG		44		GI		40	14
2781	AR: Auto-reclose is switched off	CG		79		GI		40	81
2782	AR: Auto-reclose is switched on	CG			CA	GI		p	16
2783	AR: Auto-reclose is blocked	CG		72		GI		40	83
2784	AR: Auto-reclose is not ready	CG			CA	GI	BT	p	130
2785	AR: Auto-reclose is dynamically blocked	CG		233		GI		40	85
2787	AR: Circuit breaker not ready	CG		78		GI		40	87
2801	AR: Auto-reclose in progress	CG	CG	228		GI		40	101
2813	AR: 1 pole dead time for RAR is running	CG	CG	234		GI		40	113
2814	AR: 3 pole dead time for RAR is running	CG	CG	234		GI		40	114
2833	AR: 3 pole dead time 1 for DAR running	CG	CG	234		GI		40	133
2834	AR: 3 pole dead time 2 for DAR running	CG	CG	234		GI		40	134
2835	AR: 3 pole dead time 3 for DAR running	CG	CG	234		GI		40	135
2851	AR: Close command from auto-reclose	C	C	248	CA		BT	p	128
2854	AR: Close command after 3pole DAR cycle	C			CA			p	129
2863	AR: Definitive trip		C					40	163
2871	AR: Trip during 1pole AR cycle		C					40	171
3066	current comparison protec.switched off	CG		20		GI		92	66
3068	Current comparison protection is active	CG				GI		92	68
3073	Intertrip send signal	C		37				92	73
3074	Intertrip signal received	C		36				92	74
3075	Current comparison protection in test	CG				GI		92	75
3076	Fault detection of current compar.prot	CG	CG	3	CA	GI	BT	p	84
3077	Fault detection phase L1 of CCP		CG	209	CA	GI	BT	p	64
3078	Fault detection phase L2 of CCP		CG	211	CA	GI	BT	p	65
3079	Fault detection phase L3 of CCP		CG	215	CA	GI	BT	p	66
3080	Fault detection of intertrip circuit		C	223			BT	92	80
3084	General trip signal of current comp.pr		C	231	CA		BT	p	68
3085	Trip L1 (1-pole) of current comp.prot.		C	224	CA		BT	p	69
3086	Trip L2 (1-pole) of current comp.prot.		C	225	CA		BT	p	70
3087	Trip L3 (1-pole) of current comp.prot.		C	227	CA		BT	p	71
3088	Trip 3-pole of current comparison prot.		C	230			BT	92	88
3306	>Transfer trip signal input	C		39				93	6
3311	Trans. trip transmitter is switched off	CG		57		GI		93	11
3321	Switch OFF: Receiving a transfer trip	CG		58		GI		93	21
3322	Transfer trip function is active	CG				GI		93	22
3324	Trip command by transfer trip	C		59				93	24
3391	Block transmission of data	CG				GI		93	91
3401	Transmission time correction off	CG		111		GI		93	101
3402	Transmission time correction okay	C		112				93	102
3403	Transmission time deviation > 0.5 ms	CG		113		GI		93	103
3404	CCP blocked by time deviation > 1 ms	CG		114		GI		93	104
3405	Reception of faulty data	CG		95		GI		93	105
3406	Total reception failure	CG		94	CA	GI		p	39
3409	Transmission time measurm. in progress	CG		98		GI		93	109
3410	Angle measurement in progress	CG		99		GI		93	110
3431	User defined remote message 1 received	CG				GI		93	131
3432	User defined remote message 2 received	CG				GI		93	132
3433	User defined remote message 3 received	CG				GI		93	133
3434	User defined remote message 4 received	CG				GI		93	134
4506	>External trip	CG		51		GI		51	106
4511	External trip is switched off	CG		53		GI		51	111
4513	External trip is active	CG				GI		51	113
4517	External trip: General trip	C		52				51	117

Annunciations 7SD512 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
E - Earth fault annunciation
IOT - I: can be marshalled to binary input
O: can be marshalled to binary output (LED, signal relay)
T: can be marshalled to trip relay

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
3	>Time Synchro	>Time synchronization				IO
4	>Start FltRec	>Start fault recording	C			IO
5	>LED reset	>LED reset				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
51	Dev.operative	Device operative / healthy	CG			O
56	Initial start	Initial start of processor system	C			
60	LED reset	LED Reset	C			
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		
116	E/F Buff.Over	E/F buffer overflow			E	
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			
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			
141	Failure 24V	Failure of internal 24 VDC power supply	CG			OT
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
150	Failure I/O	Failure in I/O module	CG			OT
151	Failure I/O 1	Failure in I/O module 1	CG			OT
154	Failure RKA	Failure in the RKA module	CG			
159	LSA disrupted	LSA (system interface) disrupted	CG			
161	I supervision	Measured value supervision of currents				O
162	Failure ∑I	Failure: Current summation supervision	CG			OT
163	Failure Isymm	Failure: Current symmetry supervision	CG			OT
203	Flt.RecDatDel	Fault recording data deleted	C			

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
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=	Difference time of clock synchronism	M			
301	Syst.Flt	Fault in the power system	CG	C		
302	Fault	Fault event with consecutive number		C		
351	>CB Aux. L1	>Circuit breaker aux. contact: Phase L1				IOT
352	>CB Aux. L2	>Circuit breaker aux. contact: Phase L2				IOT
353	>CB Aux. L3	>Circuit breaker aux. contact: Phase L3				IOT
354	>CB Aux.3p cl	>CB aux. contact:3poles closed (series)				IOT
355	>CB Aux.1p cl	>CB aux. contact:1pole closed(parallel)				IOT
356	>Manual Close	>Manual close				IOT
357	>CloseCmd.Blo	>Block all close commands from external	C			IOT
381	>1p Trip Perm	>External auto-reclose ready for 1pole	CG			IOT
382	>Only 1pole	>External AR programmed for 1pole only	CG			IOT
383	>RAR Release	>Release overreach zones RAR	CG	CG		IOT
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
512	Dev.Trip 1pL1	General 1pole trip of device: Phase L1				OT
513	Dev.Trip 1pL2	General 1pole trip of device: Phase L2				OT
514	Dev.Trip 1pL3	General 1pole trip of device: Phase L3				OT
515	Dev.Trip 3p	General 3pole trip of device				OT
521	IL1/In=	Interrupted current: Phase L1 (I/In)		C		
522	IL2/In=	Interrupted current: Phase L2 (I/In)		C		
523	IL3/In=	Interrupted current: Phase L3 (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
601	IL1a[%]=	Operational measurement: IL1a[%]=	M			
602	IL2a[%]=	Operational measurement: IL2a[%]=	M			
603	IL3a[%]=	Operational measurement: IL3a[%]=	M			
604	IEa [%]=	Operational measurement: IEa[%]=	M			
614	IL1b[%]=	Operational measurement: IL1b[%]=	M			
615	IL2b[%]=	Operational measurement: IL2b[%]=	M			
616	IL3b[%]=	Operational measurement: IL3b[%]=	M			
617	IEb [%]=	Operational measurement: IEb[%]=	M			
651	IL1a =	Operational measurement: IL1a=	M			
652	IL2a =	Operational measurement: IL2a=	M			
653	IL3a =	Operational measurement: IL3a=	M			
654	IEa =	Operational measurement: IEa=	M			
664	IL1b =	Operational measurement: IL1b=	M			
665	IL2b =	Operational measurement: IL2b=	M			
666	IL3b =	Operational measurement: IL3b=	M			
667	IEb =	Operational measurement: IEb=	M			
775	TT =	Time delay of transmission =	M			
776	TTK=	Setting of time delay [ms] =	M			
777	OVERRUN 1/min	UART-overrun errors per minute =	M			
778	FRAMING 1/min	UART-framing errors per minute =	M			
779	PARITY 1/min	UART-parity errors per minute =	M			
780	FORMAT 1/min	UART-format errors per minute =	M			
781	CHECKS 1/min	UART-checksumme errors per minute =	M			
782	CLOCK 1/min	UART-receive clock errors per minute =	M			
783	Trans.Flt.1/m	UART-errors per minute =	M			

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
790	Trans.Flt.1/h	UART-errors per hour =	M			
801	Θ/Θtrip =	Temperature rise for warning and trip	M			
802	Θ/ΘtripL1=	Temperature rise for phase L1	M			
803	Θ/ΘtripL2=	Temperature rise for phase L2	M			
804	Θ/ΘtripL3=	Temperature rise for phase L3	M			
1001	TripNo L1=	Number of trip commands: Phase L1	M			
1002	TripNo L2=	Number of trip commands: Phase L2	M			
1003	TripNo L3=	Number of trip commands: Phase L3	M			
1004	∑IL1/In=	Summated current tripped IL1/In	M			
1005	∑IL2/In=	Summated current tripped IL2/In	M			
1006	∑IL3/In=	Summated current tripped IL3/In	M			
1011	AR 1pole=	Number of auto-reclose commands: 1p RAR	M			
1012	AR 3pole=	Number of auto-reclose commands: 3p RAR	M			
1013	DAR 3pol=	Number of auto-reclose commands: 3p DAR	M			
1156	>CB Test	>CB test start				IOT
1174	CB in Test	Circuit breaker test in progress	CG			OT
1181	CB Test Trip	Circuit breaker test: General trip				OT
1182	CB Test 1pL1	Circuit breaker test: Trip 1pole L1				OT
1183	CB Test 1pL2	Circuit breaker test: Trip 1pole L2				OT
1184	CB Test 1pL3	Circuit breaker test: Trip 1pole L3				OT
1185	CB Test 3p	Circuit breaker test: Trip 3pole				OT
1511	O/L Prot. off	Thermal overload prot. is switched off	CG			OT
1513	O/L active	Thermal overload protection is active	CG			OT
1515	O/L Warn I	Thermal overload prot.: Current warning	CG			OT
1516	O/L Warn Θ	Thermal overload prot.: Thermal warning	CG			OT
1521	O/L Trip	Thermal overload protection trip	CG			OT
2010	>I>> block	>Block I>> stage of emerg. O/C protec.	CG			IOT
2011	>IE>> block	>Block emerg. highset overc. (earth)	CG			IOT
2012	>I>/IP block	>Block emerg. overcurrent I>/Ip	CG			IOT
2013	>IE>IEP block	>Block emerg. overcurrent IE>/Ip	CG			IOT
2021	>Emer PH ON	>Switch ON emerg. overcurrent prot.				IOT
2022	>Emer PH OFF	>Switch OFF emerg. overcurrent prot.				IOT
2023	>Emer E ON	>Switch ON emerg. earth fault prot.				IOT
2024	>Emer E OFF	>Switch OFF emerg. earth fault prot.				IOT
2053	Emer. active	Emergency O/C protection is active	CG			OT
2054	Emer. mode	Emergency O/C protection is running	CG			OT
2055	Emer.E/F off	Emergency O/C for earth switched OFF	CG			OT
2056	Emer.Ph.off	Emergency O/C for phases switched OFF	CG			OT
2061	Emer.Gen.Flt	Emerg. O/C prot.: General fault detect.				OT
2062	Emer. Flt L1	Emerg. O/C prot.: Fault detection L1				OT
2063	Emer. Flt L2	Emerg. O/C prot.: Fault detection L2				OT
2064	Emer. Flt L3	Emerg. O/C prot.: Fault detection L3				OT
2065	Emer. Flt E	Emerg. O/C prot.: Earth fault detection				OT
2071	Emer. Flt E	Emerg. O/C earth fault detection only		C		
2072	Emer. Flt L1	Emerg. O/C fault detection L1 only		C		
2073	Emer. Flt L1E	Emerg. O/C fault detection L1E		C		
2074	Emer. Flt L2	Emerg. O/C fault detection L2 only		C		
2075	Emer. Flt L2E	Emerg. O/C fault detection L2E		C		
2076	Emer. Flt L12	Emerg. O/C fault detection L12		C		
2077	Emer.Flt L12E	Emerg. O/C fault detection L12E		C		
2078	Emer. Flt L3	Emerg. O/C fault detection L3 only		C		
2079	Emer. Flt L3E	Emerg. O/C fault detection L3E		C		
2080	Emer. Flt L13	Emerg. O/C fault detection L13		C		
2081	Emer.Flt L13E	Emerg. O/C fault detection L13E		C		
2082	Emer. Flt L23	Emerg. O/C fault detection L23		C		

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
2083	Emer.Flt L23E	Emerg. O/C fault detection L23E		C		
2084	Emer.Flt L123	Emerg. O/C fault detection L123		C		
2085	Emer.Flt 123E	Emerg. O/C fault detection L123E		C		
2091	Emer. I>>	Emerg. O/C phase fault detection I>>		C		OT
2092	Emer. I>/Ip	Emerg. O/C phase fault detection I>/Ip		C		OT
2095	Emer. IE>>	Emerg. O/C earth fault detection IE>>		C		OT
2096	Emer. IE>/IEp	Emerg. O/C earth fault det. IE>/IEp		C		OT
2121	Emer. TI>>	Emerg. O/C prot.: Time TI>> expired		C		OT
2122	Emer. TI>/Tp	Emerg. O/C prot.: Time TI>/Tp expired		C		OT
2125	Emer. TIE>>	Emerg. O/C prot.: Time TIE>> expired		C		OT
2126	Emer. TIE>TEp	Emerg. O/C prot.: Time TIE>/TEp expired		C		OT
2141	Emer.Gen.Trip	Emerg. O/C protection: General Trip				OT
2142	Emer.Trip1pL1	Emerg. O/C protection: Trip 1pole L1		C		OT
2143	Emer.Trip1pL2	Emerg. O/C protection: Trip 1pole L2		C		OT
2144	Emer.Trip1pL3	Emerg. O/C protection: Trip 1pole L3		C		OT
2145	Emer.Trip 3p	Emerg. O/C protection: Trip 3pole		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
2704	>AR reset	>AR: Reset auto-reclose function	C			IOT
2706	>1p RAR block	>AR: Block 1pole rapid auto-reclose	CG			IOT
2707	>3p RAR block	>AR: Block 3pole rapid auto-reclose	CG			IOT
2708	>RAR block	>AR: Block rapid auto-reclose	CG			IOT
2709	>DAR block	>AR: Block delayed auto-reclose	CG			IOT
2711	>Start AR	>AR: External start for internal AR	C			IOT
2712	>Trip L1 AR	>AR: Ext. Trip L1 for internal AR	C			IOT
2713	>Trip L2 AR	>AR: Ext. Trip L2 for internal AR	C			IOT
2714	>Trip L3 AR	>AR: Ext. Trip L3 for internal AR	C			IOT
2715	>Trip 1p AR	>AR: Ext. 1pole trip for internal AR	C			IOT
2716	>Trip 3p AR	>AR: Ext. 3pole trip for internal AR	C			IOT
2721	>DAR aft. RAR	>AR: Delayed AR only after rapid AR	CG			IOT
2730	>CB ready	>AR: Circuit breaker ready for reclose				IOT
2781	AR off	AR: Auto-reclose is switched off	CG			OT
2782	AR on	AR: Auto-reclose is switched on				OT
2783	AR inoperativ	AR: Auto-reclose is blocked	CG			OT
2784	AR not ready	AR: Auto-reclose is not ready				OT
2785	AR block.dyn.	AR: Auto-reclose is dynamically blocked		C		OT
2787	CB not ready	AR: Circuit breaker not ready				OT
2788	AR T-CB Exp.	AR: CB supervision time expired				OT
2801	AR in prog.	AR: Auto-reclose in progress		C		OT
2811	RAR only	AR: Only rapid auto-reclosing allowed				OT
2812	RAR T-act.run	AR: Action time for RAR is running				OT
2813	RAR T-1p run.	AR: 1 pole dead time for RAR is running				OT
2814	RAR T-3p run.	AR: 3 pole dead time for RAR is running				OT
2815	RAR 1p Prog.	AR: 1 pole rapid auto-reclose program				OT
2816	RAR 3p Prog.	AR: 3 pole rapid auto-reclose program				OT
2817	RAR Zone Rel.	AR: Zone extension for rapid reclosing				OT
2818	AR evolv.Flt.	AR: Evolving fault recognition				OT
2831	DAR Only	AR: Only delayed auto-reclosing allowed				OT
2832	DAR T-act.run	AR: Action time for DAR is running				OT
2833	DAR T-3p1 run	AR: 3 pole dead time 1 for DAR running				OT
2834	DAR T-3p2 run	AR: 3 pole dead time 2 for DAR running				OT
2835	DAR T-3p3 run	AR: 3 pole dead time 3 for DAR 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
2852	RAR 1p Close	AR: Close command after 1pole RAR cycle				OT
2853	RAR 3p Close	AR: Close command after 3pole RAR cycle				OT
2854	DAR 3p Close	AR: Close command after 3pole DAR cycle				OT

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
2861	AR T-Recl.run	AR: Reclaim time is running				OT
2862	AR successful	AR: Auto-reclose cycle successful				OT
2863	Definit.Trip	AR: Definitive trip				OT
2864	1p Trip Perm.	AR: 1 pole trip allowed by internal AR				OT
2871	AR Trip 3p	AR: Trip during 1pole AR cycle		C		OT
3051	>CCP ON	>Switch ON current comparison protect.				IOT
3052	>CCP OFF	>Switch OFF current comparison protect.				IOT
3053	>CCP block.	>Block current comparison protection				IOT
3059	>CCP test	>Test current comparison protection				IOT
3066	CCP off	current comparison protec.switched off	CG			OT
3067	CCP Block.	current comparison protection blocked	CG			OT
3068	CCP active	Current comparison protection is active	CG			OT
3071	Itr.send off	Intertrip send signal switched off	CG			OT
3072	Itr.rec. off	Intertrip reception switched off	CG			OT
3073	I.Trip Send	Intertrip send signal	C			OT
3074	I.Trip Rec.	Intertrip signal received	C			OT
3075	CCP Test	Current comparison protection in test	CG			OT
3076	CCP.Gen.Flt	Fault detection of current compar.prot		C		OT
3077	CCP.Fault L1	Fault detection phase L1 of CCP		C		OT
3078	CCP.Fault L2	Fault detection phase L2 of CCP		C		OT
3079	CCP.Fault L3	Fault detection phase L3 of CCP		C		OT
3080	Flt.I.Trip	Fault detection of intertrip circuit		C		OT
3084	CCP.GEN.TRIP	General trip signal of current comp.pr		C		OT
3085	CCP.Trip L1	Trip L1 (1-pole) of current comp.prot.		C		OT
3086	CCP.Trip L2	Trip L2 (1-pole) of current comp.prot.		C		OT
3087	CCP.Trip L3	Trip L3 (1-pole) of current comp.prot.		C		OT
3088	CCP.Trip L123	Trip 3-pole of current comparison prot.		C		OT
3090	Com.FltRec	Commissioning fault record release	C			OT
3306	>Trans.Trip	>Transfer trip signal input	CG			IOT
3311	TransTrip off	Trans. trip transmitter is switched off	CG			OT
3316	TrTrip Send	Transfer trip transmission signal	C			OT
3321	T.TripRec.off	Switch OFF: Receiving a transfer trip	CG			OT
3322	T.Trip active	Transfer trip function is active	CG			OT
3323	T.Trip rec.	Receiving a transfer trip	C			OT
3324	Transfer Trip	Trip command by transfer trip	C			OT
3391	>DATA block	Block transmission of data	CG			IOT
3401	TT.Corr.off	Transmission time correction off	CG			OT
3402	TT.corrected	Transmission time correction okay	C			OT
3403	TT Dev.>0.5ms	Transmission time deviation > 0.5 ms	CG			OT
3404	TT blocks CCP	CCP blocked by time deviation > 1 ms	CG			OT
3405	Data Fault	Reception of faulty data	CG			OT
3406	Recep.Fail.	Total reception failure	CG			OT
3407	Wrong Version	Wrong firmware version installed	CG			OT
3408	Wrong Dev.ID	Wrong device identification no.	CG			OT
3409	TR.Time Meas.	Transmission time measurm. in progress				OT
3410	Angle Meas.	Angle measurement in progress				OT
3421	>Trans.Annu1	>User defined message 1 to remote end				IOT
3422	>Trans.Annu2	>User defined message 2 to remote end				IOT
3423	>Trans.Annu3	>User defined message 3 to remote end				IOT
3424	>Trans.Annu4	>User defined message 4 to remote end				IOT
3431	Trans.Annu.1	User defined remote message 1 received	CG			OT
3432	Trans.Annu.2	User defined remote message 2 received	CG			OT
3433	Trans.Annu.3	User defined remote message 3 received	CG			OT
3434	Trans.Annu.4	User defined remote message 4 received	CG			OT
4506	>Ext Trip	>External trip	CG			IOT
4511	Ext off	External trip is switched off	CG			OT
4513	Ext active	External trip is active	CG			OT
4517	Ext Gen. Trip	External trip: General trip	C			OT

Reference Table for Functional Parameters 7SD512

1000 PARAMETERS

1100 POWERSYSTEM DATA

1101	CT STARPNT		Current transformer polarity
	TOWARDS LINE	[ ]	Towards line
	TOWARDS BUSBAR	[ ]	Towards busbar
1105	IN-CT loc.		Nominal current of local current transformer
	min. 10		A
	max. 50000	____	
1112	Ie/Iph		Matching factor Ie/Iph for earth current
	min. 0.000		
	max. 20.000	____	
1134	T TRIP		Minimum trip command duration
	min. 0.01		s
	max. 32.00	____	
1135	T-CLOSE		Maximum close command duration
	min. 0.01		s
	max. 32.00	____	
1155	IN-CT rem.		Nominal current of far current transformer
	min. 10		A
	max. 50000	____	

1500 CURRENT COMPARISION PROT

1501	CCP FUNCT.		State of current comparison function
	ON	[ ]	on
	OFF	[ ]	off
1503	I>ST-STATE		Steady-state trip threshold
	min. 0.50		I/In
	max. 4.00	____	
1504	I>DYN		Dynamic trip threshold
	min. 0.20		I/In
	max. 1.00	____	
1505	I>DYN CLOS		Dynamic trip threshold during switch-on
	min. 0.20		I/In
	max. 4.00	____	
1508	I>ALLOW		Threshold which allows trip-command
	min. 0.10		I/In
	max. 4.00	____	
1510	MEAS.REPET		State of the measurement repetition
	OFF	[ ]	off
	ON	[ ]	on

```
1511 TRIP DELAY              Additional time delay for trip signal
     min. 0.00               s
     max. 0.10          ____

1521 MAN.CLOSE               Action w. manual close of the circuit breaker
     UNDELAYED          [ ] Undelayed
     DELAYED            [ ] Tdel. KDO

1522 AR STAGE                Trip reaction of CCP before auto-reclosure
     UNDELAYED          [ ] Undelayed
     DELAYED            [ ] Tdel. KDO

1531 TRIP SEND               State of transmitting the intertrip signal
     OFF                [ ] off
     ON                 [ ] on

1532 TRIP REC                Reaction if intertrip signal is received
     OFF                [ ] off
     ANNUNCIATION       [ ] Annunciation
     TRIP               [ ] Trip
```

```
1600 DATA TRANSMISSION

1601 AUTO TTIME              State of automatic transmit time correction
     OFF                [ ] off
     ON                 [ ] on

1602 OPER.BAUDR              Operator interface baud rate (f.e. to PC/PG)
     19200 BAUD         [ ] 19200 Baud
     14400 BAUD         [ ] 14400 Baud

1603 TDELAY b-a              Signal transmission time station a <-> b
     min. 0.0                ms
     max. 40.0          ____

1605 T-DATAFAIL              Time delay for failure of transmission
     min. 1.0                s
     max. 60.0          ____

1606 DEVICE ID               Device-Identification number
     min. 0
     max. 63            ____
```

```
2100 EXTERNAL TRIP FUNCTION

2101 EXT.TRIP                State of external trip function
     ON                 [ ] on
     OFF                [ ] off

2102 T-DELAY                 Time delay of external trip function
     min. 0.00               s
     max. 60.00         ____

2103 T-RESET                 Reset delay after trip has been initiated
     min. 0.00               s
     max. 60.00         ____
```

```
2200 TRANSFER TRIP

2201 TRIP SEND              State of transfer trip send function
     ON                [ ] on
     OFF               [ ] off

2202 T-SEND-DEL             Send signal delay for transfer trip
     min. 0.00              s
     max. 60.00        ____

2203 T-SEND-PRO             Send signal prolongation for transfer trip
     min. 0.00              s
     max. 60.00        ____

2204 TRANS REC.             Receiving the transfer-trip
     OFF               [ ] off
     ON                [ ] on

2205 T-REC-PROL             Prolong.-time for receiving a transfer-trip
     min. 0.10              s
     max. 60.00        ____
```

```
2600 EMERGENCY OVERCURRENT PROT

2601 EMER.O/C P             Emergency overcurrent prot.: phase
     ON                [ ] on
     OFF               [ ] off

2602 I>>                    Highset phase overcurrent threshold I>>
     min. 0.10              I/In
     max. 15.00        ____

2603 T-I>>                  Delay time for I>> TI>>
     min. 0.00              s
     max. 32.00/∞      ____

2611 CHARACT.PH             Emerg. phase overcurrent characteristic
     DEFINITE TIME     [ ] Definite time
     NORMAL INVERSE    [ ] Normal inverse
     VERY INVERSE      [ ] Very inverse
     EXTREMELY INVERS  [ ] Extremely inverse

2612 I>                     Phase overcurrent threshold I>
     min. 0.10              I/In
     max. 15.00        ____

2613 T-I>                   Delay time for I> TI>
     min. 0.00              s
     max. 32.00/∞      ____

2614 Ip                     Overcurrent threshold (inverse time IDMT) Ip
     min. 0.10              I/In
     max. 4.00         ____

2615 T-Ip                   Time multiplier for Ip (inverse time IDMT) Tp
     min. 0.50              s
     max. 32.00        ____
```

```
2616 MEAS. FORM              Phase current measurement format
     WITHOUT HARMON.   [ ] Without harmonics
     WITH HARMONICS    [ ] With harmonics

2621 MAN.CLOSE               Phase overcurrent stage effect.: Manual close
     I>> UNDELAYED     [ ] I>> undelayed
     I>/Ip UNDELAYED   [ ] I>/Ip undelayed
     INEFFECTIVE       [ ] Ineffective

2623 RAR ZONE                Phase overcurrent stage effect.: Auto reclose
     I>> WITH AR       [ ] I>> only with AR
     I>> ALWAYS        [ ] I>> always

2631 EMER.O/C E              Emergency overcurrent prot.: earth
     ON                [ ] on
     OFF               [ ] off

2632 IE>>                    Highset earth overcurrent threshold (DT) IE>>
     min. 0.10               I/In
     max. 10.00        ____

2633 T-IE>>                  Delay time for IE>> TIE>>
     min. 0.00               s
     max. 32.00/∞      ____

2641 CHARACT. E              Emergency earth overcurrent characteristic
     DEFINITE TIME     [ ] Definite time
     NORMAL INVERSE    [ ] Normal inverse
     VERY INVERSE      [ ] Very inverse
     EXTREMELY INVERS  [ ] Extremely inverse

2642 IE>                     Earth overcurrent threshold IE>
     min. 0.10               I/In
     max. 4.00         ____

2643 T-IE>                   Delay time for IE> TIE>
     min. 0.00               s
     max. 32.00/∞      ____

2644 IEp                     Earth o/c pick-up (inverse time IDMT) IEp
     min. 0.10               I/In
     max. 4.00         ____

2645 T-IEp                   Time multiplier for IEp (inv. time IDMT) TEp
     min. 0.50               s
     max. 32.00        ____

2646 MEAS. FORM              Earth current measurement format
     WITHOUT HARMON.   [ ] Without harmonics
     WITH HARMONICS    [ ] With harmonics

2651 MAN.CLOSE               Earth overcurrent stage effect: Manual close
     IE>> UNDELAYED    [ ] IE>> undelayed
     IE>/IEp UNDELAY.  [ ] IE>/IEp undelayed
     INEFFECTIVE       [ ] Ineffective

2653 RAR ZONE                Earth overcurrent stage effect: Auto reclose
     IE>> WITH RAR     [ ] Ie>> with RAR
     IE>> ALWAYS       [ ] Ie>> always
```

2700 THERMAL OVERLOAD PROT.

2701	THERMAL OL		State of thermal overload protection
	ON	[ ]	on
	OFF	[ ]	off
2702	K-FACTOR		K-factor for thermal overload protection
	min. 0.10		
	max. 4.00	____	
2703	T-CONSTANT		Time constant for thermal overload protection
	min. 1.0		min
	max. 999.9	____	
2704	Θ WARN		Thermal warning stage
	min. 50		%
	max. 100	____	
2705	I WARN		Current warning stage
	min. 0.10		I/In
	max. 4.00	____	
2706	O/L CALCUL		Calculation method for thermal stages
	Θ MAX	[ ]	Theta max
	Θ MEAN	[ ]	Theta mean
	Θ FROM IMAX	[ ]	Theta from Imax

2900 MEAS.VALUE SUPERVISION

2903	SYM.Ithres		Symmetry threshold for current monitoring
	min. 0.10		I/In
	max. 1.00	____	
2904	SYM.Fact.I		Symmetry factor for current monitoring
	min. 0.10		
	max. 0.95	____	
2905	SUM.Ithres		Summation threshold for current monitoring
	min. 0.10		I/In
	max. 2.00	____	
2906	SUM.Fact.I		Factor for current summation monitoring
	min. 0.00		
	max. 0.95	____	

3400 AUTORECLOSE FUNCTION

3401	AR FUNCT		Auto-reclose function
	ON	[ ]	on
	OFF	[ ]	off
3403	MC BLOCK		Auto-reclose block with manual close
	YES	[ ]	yes
	NO	[ ]	no
3405	T-RECLAIM		Reclaim time after successful AR
	min. 0.50		s
	max. 320.00	____	

```
3406 T-LOCK                 Lock-out time after unsuccessful AR
     min. 0.50              s
     max. 320.00/∞   ———

3407 T-BLOCK MC             Blocking duration with manual close
     min. 0.50              s
     max. 320.00     ———

3412 CB? 1.TRIP             CB ready interrogation at 1st trip command
     YES                [ ] yes
     NO                 [ ] no

3413 CB? CLOSE              CB ready interrogation before reclosing
     CB? NEVER          [ ] CB? never
     CB? WITH EACH AR   [ ] CB? with each AR
     CB? WITH 2nd AR    [ ] CB? with 2nd AR

3415 T-CB-SUPV              Circuit breaker supervision time
     min. 0.10              s
     max. 320.00     ———

3422 RAR PROG.              Rapid auto-reclose program
     THREE-POLE         [ ] Three-pole
     SINGLE-POLE        [ ] Single-pole
     SINGLE/THREE-POL   [ ] Single/three-pole

3424 RAR T-ACT.             Rapid auto-reclose action time
     min. 0.01              s
     max. 320.00     ———

3425 RAR T-3POL             RAR 3pole dead time
     min. 0.01              s
     max. 320.00     ———

3426 RAR T-1POL             RAR 1pole dead time
     min. 0.01              s
     max. 320.00     ———

3429 EV.F.BLOCK             Blocking with evolving faults
     ALWAYS             [ ] Always
     NEVER              [ ] Never
     >T-DISCR.          [ ] >T-discrimination

3430 T-DISCRIM              Discrimination time for evolving faults
     min. 0.01              s
     max. 32.00      ———

3431 AR TRIP 3P             3p trip when AR is blocked during 1p dead time
     YES                [ ] yes
     NO                 [ ] no

3442 DAR PROG.              Delayed auto-reclose program
     DAR AFTER RAR      [ ] DAR only after RAR
     DAR WITHOUT RAR    [ ] DAR without RAR
     NO DAR             [ ] No DAR

3443 DAR No.1PH             Number of DAR shots after 1 pole initiation
     min. 0
     max. 9          ———
```

3444	DAR No.3PH		Number of DAR shots after 3 pole initiation
	min. 0		
	max. 9	———	
3445	DAR T-ACT.		Delayed auto-reclose action time
	min. 0.01		s
	max. 320.00	———	
3446	DAR T3POL1		DAR 3pole dead time for 1st shot
	min. 0.01		s
	max. 1800.00	———	
3447	DAR T3POL2		DAR 3pole dead time for 2nd shot
	min. 0.01		s
	max. 1800.00	———	
3448	DAR T3POL3		DAR 3pole dead time for 3rd and further shots
	min. 0.01		s
	max. 1800.00	———	

Tests and Commissioning Aids 7SD512

4000 TESTS

4100 COMMISSION TESTS	
4101 TRANSM.TIME	Transm. time from local station to far station
4111 ANLGE L1-2	Phase angle between phase L1-L2 (local)
4112 ANGLE L2-3	Phase angle between phase L2-L3 (local)
4113 ANGLE L3-1	Phase angle between phase L3-L1 (local)
4121 ANGLE L1-1	Phase angle between phase L1-L1 (local<->far)
4122 ANGLE L2-2	Phase angle between phase L2-L2 (local<->far)
4123 ANGLE L3-3	Phase angle between phase L3-L3 (local<->far)
4131 TEST-F.REC.	Test fault-record with Iph>Idyn
4300 CB TEST TRIP-CLOSE CYCLE	
4301 CB TEST	Circuit breaker test with AR 1pole L1
4302 CB TEST	Circuit breaker test with AR 1pole L2
4303 CB TEST	Circuit breaker test with AR 1pole L3
4304 CB TEST	Circuit breaker test with AR 3pole
4305 CB TEST	Circuit breaker test with AR sequence L1-L2-L3
4400 CB TEST LIVE TRIP	
4401 CB TRIP	Circuit breaker trip test 1pole L1
4402 CB TRIP	Circuit breaker trip test 1pole L2
4403 CB TRIP	Circuit breaker trip test 1pole L3
4404 CB TRIP	Circuit breaker trip test 3pole
4900 TEST FAULT RECORDING	
4901 FAULT REC.	Initiation of fault recording

Annunciations, Measured Values etc. 7SD512

5000 ANNUNCIATIONS

5100 OPERATIONAL ANNUNCIATIONS

5200 LAST FAULT

5300 2nd TO LAST FAULT

5400 3rd TO LAST FAULT

5600 CB OPERAT STATISTICS

5601	AR 1pole=	Number of auto-reclose commands: 1p RAR
5602	AR 3pole=	Number of auto-reclose commands: 3p RAR
5603	DAR 3pol=	Number of auto-reclose commands: 3p DAR
5604	TripNo L1=	Number of trip commands: Phase L1
5605	TripNo L2=	Number of trip commands: Phase L2
5606	TripNo L3=	Number of trip commands: Phase L3
5607	∑IL1/In=	Summated current tripped IL1/In
5608	∑IL2/In=	Summated current tripped IL2/In
5609	∑IL3/In=	Summated current tripped IL3/In

5700 OPERATIONAL MEASURED VALUES

5701	IL1a =	Operational measurement: IL1a=
5702	IL2a =	Operational measurement: IL2a=
5703	IL3a =	Operational measurement: IL3a=
5704	IEa =	Operational measurement: IEa=
5710	IL1a[%]=	Operational measurement: IL1a[%]=
5711	IL2a[%]=	Operational measurement: IL2a[%]=
5712	IL3a[%]=	Operational measurement: IL3a[%]=
5713	IEa [%]=	Operational measurement: IEa[%]=
5720	TT =	Time delay of transmission =

5800 OPERATIONAL MEASURED VALUES

5801	IL1b =	Operational measurement: IL1b=
5802	IL2b =	Operational measurement: IL2b=
5803	IL3b =	Operational measurement: IL3b=
5804	IEb =	Operational measurement: IEb=
5810	IL1b[%]=	Operational measurement: IL1b[%]=
5811	IL2b[%]=	Operational measurement: IL2b[%]=
5812	IL3b[%]=	Operational measurement: IL3b[%]=
5813	IEb [%]=	Operational measurement: IEb[%]=

5900 OVERLOAD MEASURED VALUES

5901	Θ/ΘtripL1=	Temperature rise for phase L1
5902	Θ/ΘtripL2=	Temperature rise for phase L2
5903	Θ/ΘtripL3=	Temperature rise for phase L3
5904	Θ/Θtrip =	Temperature rise for warning and trip

Reference Table for Configuration Parameters 7SD512

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

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

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 COMMAND 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
     DEUTSCH           [ ] deutsch
     ENGLISH           [ ] english
     ESPANOL           [ ] espanol
     US-ENGLISH        [ ] us-english

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
```

```
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. 1
     max. 254          ____

7211 PC INTERF.              Data format for PC-interface
     DIGSI V3          [ ] DIGSI V3
     ASCII             [ ] ASCII
```

```
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

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

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

7815 CCP FUNCT.           Current comparison protection
     EXIST            [ ] Existant
     NON-EXIST        [ ] Non-existant

7821 EXT. TRIP            External trip function
     NON-EXIST        [ ] Non-existant
     EXIST            [ ] Existant

7822 TRANSF.TRIP          Transfer trip
     NON-EXIST        [ ] Non-existant
     EXIST            [ ] Existant

7826 EMERG. O/C           Emergency overcurrent protection
     NON-EXIST        [ ] Non-existant
     EXIST            [ ] Existant

7827 THERMAL OL           Thermal overload protection
     NON-EXIST        [ ] Non-existant
     EXIST            [ ] Existant

7834 INTERNAL AR          Internal auto-reclose function
     NON-EXIST        [ ] Non-existant
     EXIST            [ ] Existant

7885 PARAM. C/O           Parameter change-over
     NON-EXIST        [ ] Non-existant
     EXIST            [ ] Existant

7899 FREQUENCY            Rated system frequency
     fN 50 Hz         [ ] fN 50 Hz
     fN 60 Hz         [ ] fN 60 Hz
```

```
7900 DEVICE CONFIGURATION

7902 AR w/ CCP            Auto-reclose with current comparison prot.
     YES              [ ] yes
     NO               [ ] no

7903 AR w/ O/C            Auto-reclose with emerg.overcurrent prot.
     NO               [ ] no
     YES              [ ] yes
```

```
7910 CB TEST BI              CB test via binary input program
     THREE-POLE TRIP   [ ] Three-pole trip
     TRIP-CLOSE 3POLE  [ ] Trip-close 3pole
     SEQU. L1-L2-L3    [ ] Sequence L1-L2-L3

7916 TEL. FORMAT             Message format of the prot. data interface
     CRC16 CHECK       [ ] CRC16 check
     V2 COMPATIBLE     [ ] V2 compatible
     MODEM 8,N,1       [ ] Modem 8,N,1
```

Operational Device Control Facilities 7SD512

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

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
```

```
9200 DATA TRANS FAULT STATISTIC

9201 Trans.Flt.1/h        UART-errors per hour =
9211 Trans.Flt.1/m        UART-errors per minute =
```

To

SIEMENS AKTIENGESELLSCHAFT

Dept. EV S SUP 21

D – 13623 BERLIN

Germany

From

_____
Name

_____
Company/Dept.

_____
Address

_____
Telephone no.

_____

Dear reader,

printing errors can never be entirely eliminated: therefore, should you come across any when reading this manual, kindly enter them in this form together with any comments or suggestions for improvement that you may have.

Corrections/Suggestions

Substantial alterations against previous issue:

Data corrected in Section 3.2 (optical fibre connections)

Subject to technical alteration

Siemens Aktiengesellschaft

Order No. C53000–G1176–C105–4
Available from: LZF Fürth–Bislohe
Printed in the Federal Republic of Germany
AG 0500 0.2 FO 196 En