

Numerical Current Comparison Protection

for overhead lines and cables

7SD511 v3.0

Instruction Manual

Order No. C53000–G1176–C104–7



Figure 1 Illustration of the numerical current comparison protection relay 7SD511 (in flush mounting case)

SIEMENS



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 50081–2 and EN 50082–2 (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).

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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 7SD511 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 7SD511 or 7SD512 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.

If data transmission fails, or if faulty data are received, the relay will switch over automatically to an emergency mode. During this emergency period the relay operates as an overcurrent time protection which can be used as a definite time or inverse time overcurrent protection.

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 7SD51 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.

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 IEC 60870-5-103 is used, as well as according to DIN 19244. The device can therefore be incorporated in Localized Substation Automation networks (LSA).

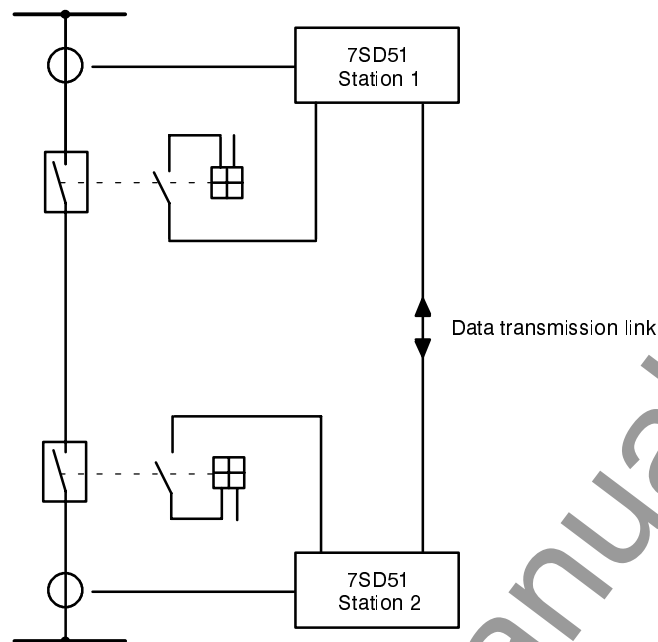


Figure 1.1 Current comparison protection for lines and cables 7SD51, scheme

1.2 Features

- Processor system with powerful 16-bit-micro-processor;
- 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;
- 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, during a fault for fault recording;
- communication with central control and storage devices via serial interfaces is possible with connection of optical fibre (optional);
- continuous monitoring of the measured values and the hardware and software of the relay.

1.3 Implemented functions

Current comparison protection

- phase-segregated measurement, thus pick-up sensitivity independent of the type of fault;
- adjustable steady state pick-up level together with high dynamic sensitivity;
- insensitive to d.c. components and transformation errors of current transformers;
- insensitive to inrush and charging currents as well as to high-frequency transients;
- high stability even with differing current transformer saturation;
- data exchange with opposite station via optical fibre for data transmission;
- continuous supervision of data link.

Circuit breaker intertripping and trip signal transfer possible.

Emergency overcurrent time protection

- during faulty data transmission, optionally definite time or inverse time overcurrent protection.

Integrated thermal overload protection.

2 Design

2.1 Arrangements

All protection functions including d.c./d.c. converter are accommodated on one plug-in module of Double Europa Format. This module is installed in a housing 7XP20. Two different types of housings can be delivered:

- **7SD511★–★B★★–** in housing 7XP2030–1 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 the 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 16 is connected to the case.

All external signals are connected to 60 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 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, an additional coupling facility has been provided. For optical fibre connection (model 7SD511★–★B★★–★C), two F–SMA connectors have been provided.

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

- **7SD511★–★C★★–** in housing 7XP2030–2 for **panel flush mounting** or **7SD511★–★E★★–** for **cubicle installation**

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 the 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 (7SD511★–★B★★–★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. 1A2). The individual connections within a module are numbered consecutively from left to right (when viewed from the rear), (e.g. 1A2); 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.

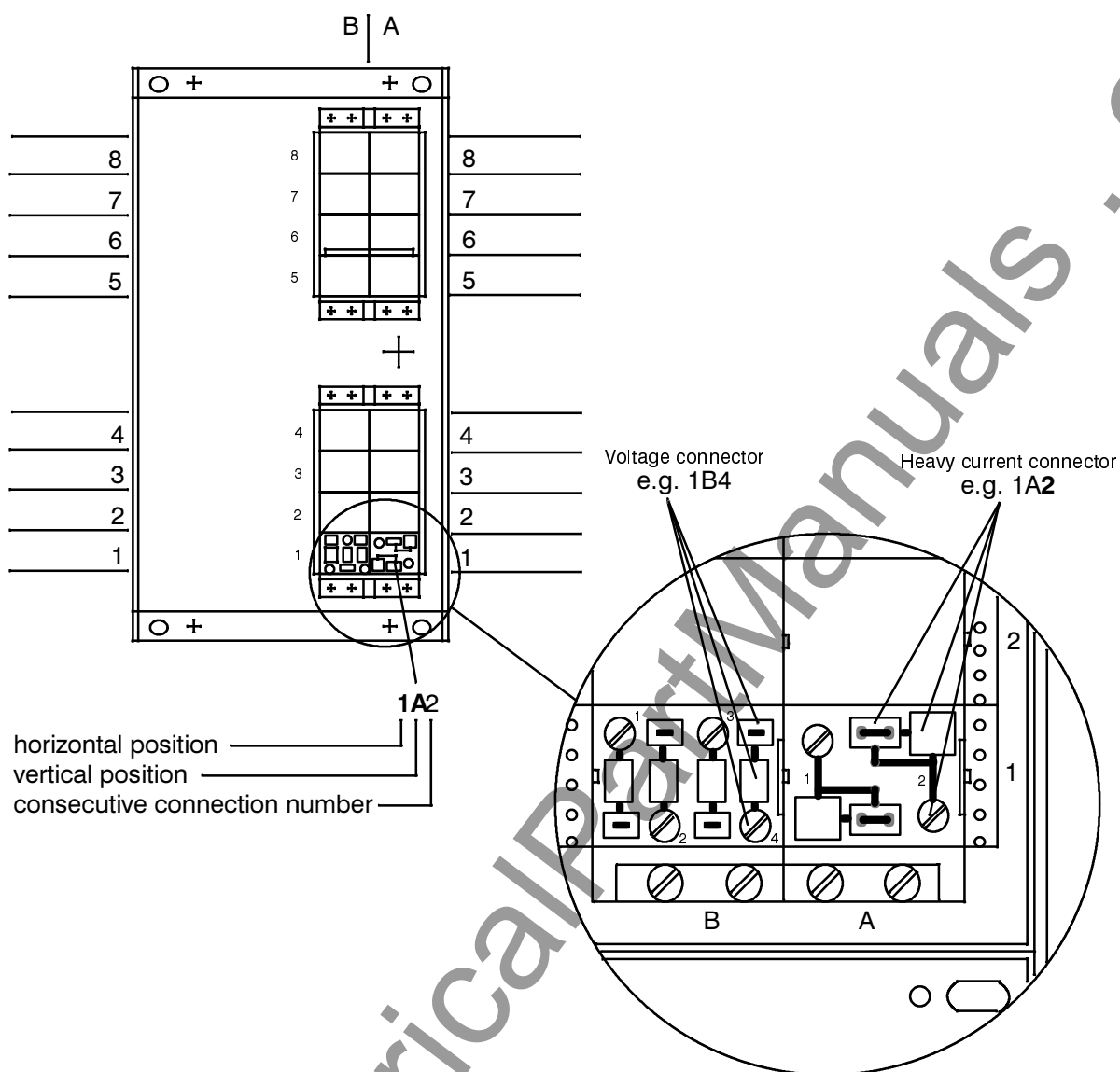
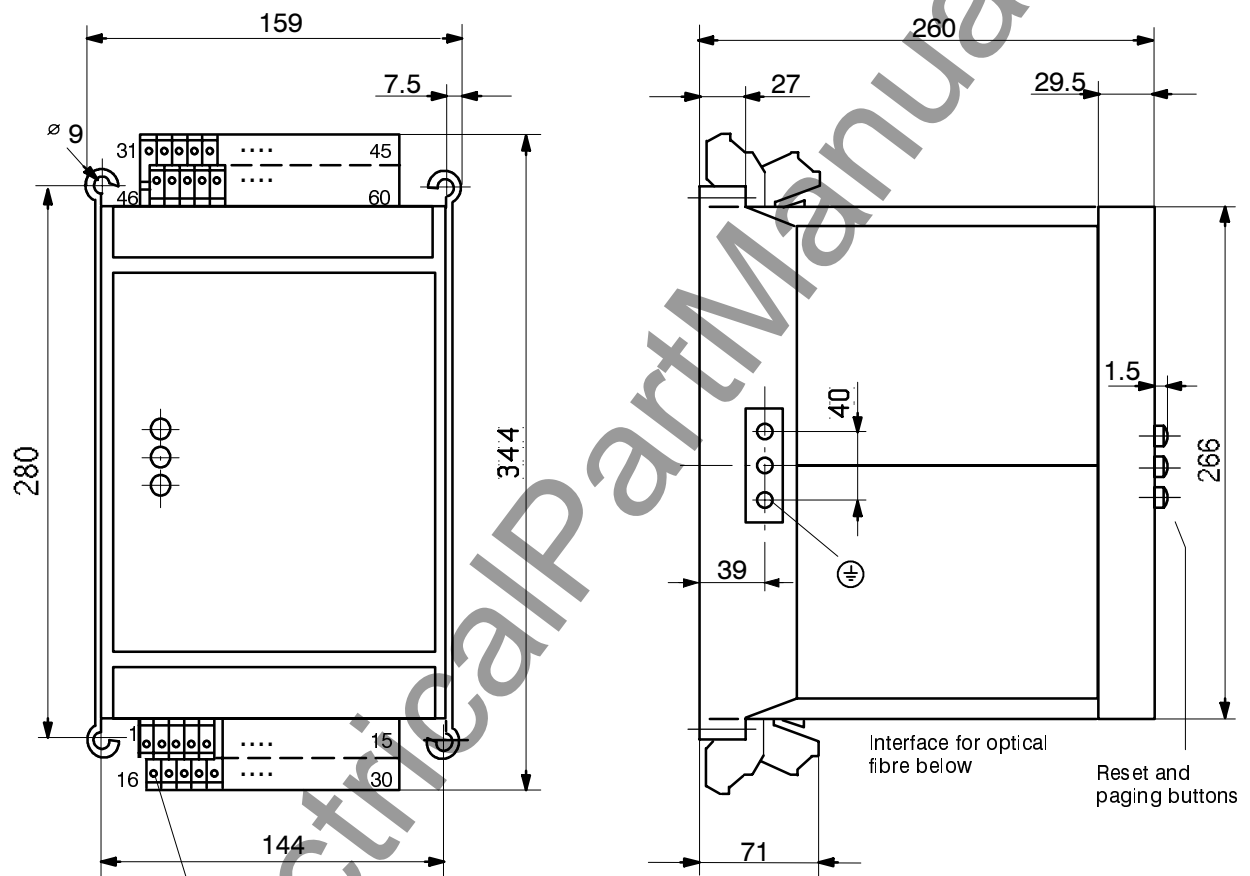


Figure 2.1 Connection plugs (rear view) – housing for flush mounting – example

2.2 Dimensions

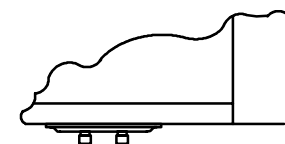
Figures 2.2 and 2.3 show the dimensions of the various types of housings available.

7SD511 Housing for panel surface mounting 7XP2030–1



Max. 60 terminals for cross-section max. 7 mm²

Dimensions in mm



optical fibre connectors
integrated F-SMA connector,
with ceramic post,
e.g for glass fibre 62.5/125 μ m

Figure 2.2 Dimensions for housing 7XP2030–1 for panel surface mounting

7SD511 Housing for panel flush mounting or cubicle installation 7XP2030-2

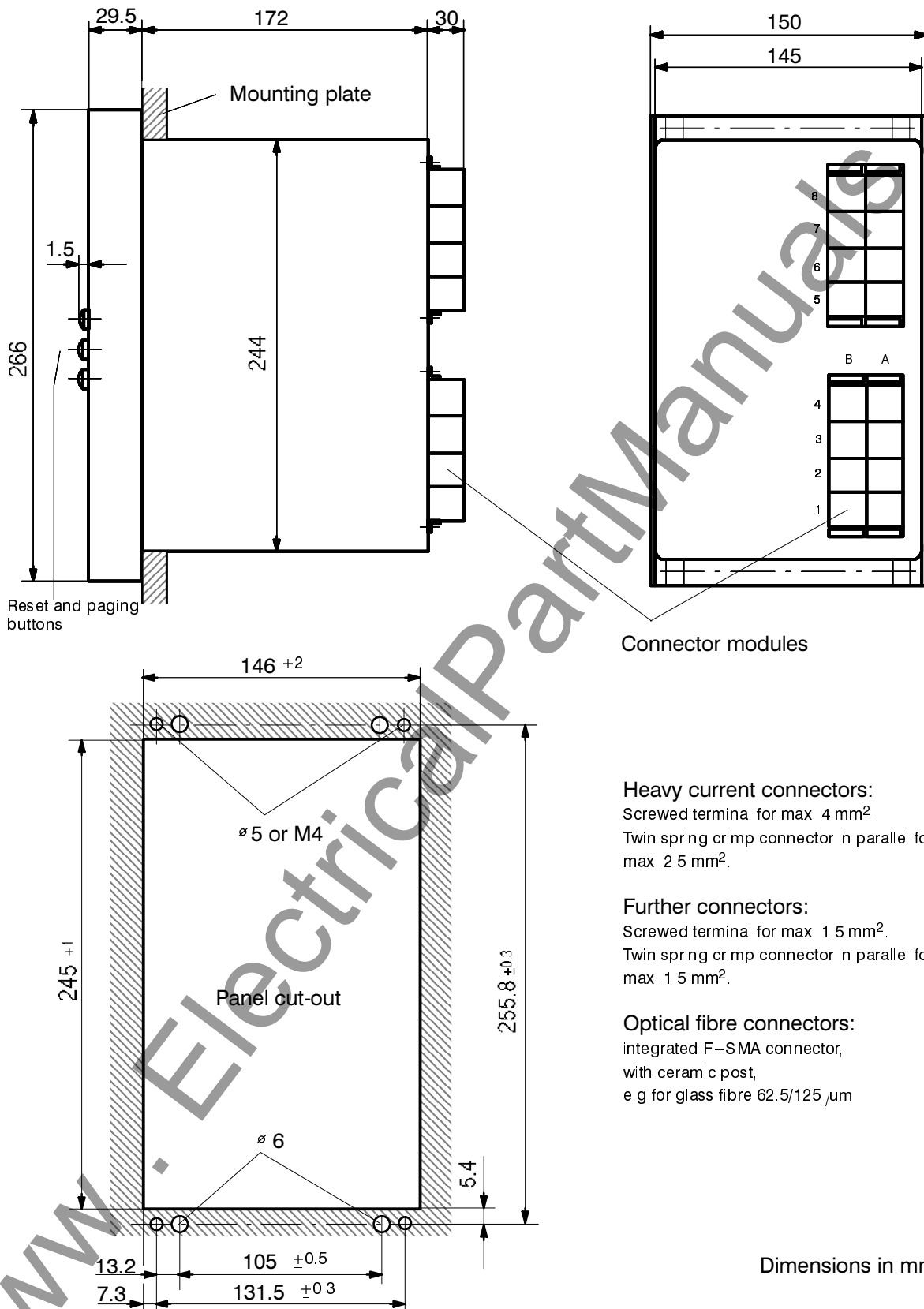


Figure 2.3 Dimensions for housing 7XP2030-2 for panel flush mounting or cubicle installation

2.3 Ordering data

Numerical Current Comparison

Protection Relay

7 S D 5 1 1

7.

8.

9.

10.

11.

12.

13.

14.

15.

16.

-

-

Rated current; rated frequency

1 A; 50/60 Hz 1

5 A; 50/60 Hz 5

Auxiliary voltage

24/48 V dc 2

60/110/125 V dc 4

220/250 V dc 5

Construction

in housing 7XP2030 for panel surface mounting B

in housing 7XP2030 for panel flush mounting C

in housing 7XP2030 for cubicle installation
(without glass front) E

Serial interface for protection data transfer

– with isolated serial interface (V.24 or RS 232 C) 0

– with serial interface for optical fibre connection 820 nm 1

– with serial interface for optical fibre connection 1300 nm 2

Serial interface for coupling to a control centre

without serial interface A

with serial interface for optical fibre connection C

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 current path at $I_N = 5$ A
	approx 0.1 VA per phase and earth current approx 0.5 VA per phase and earth current
Overload capability	current path, phases and earth
– thermal (rms)	100 $\times I_N$ for ≤ 1 s 20 $\times I_N$ for ≤ 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 energized	approx 10 W approx 15 W	
Bridging time during failure/short-circuit of auxiliary voltage	≥ 50 ms at $U_{dc} \geq 110$ Vdc		

Heavy duty (command) contacts

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

Signal contacts

Signal/alarm relays	5
Contact per relays	1 CO
Switching capacity	20 W/VA
Switching voltage	250 V
Permissible current	1 A

Binary inputs

Number	4								
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	<table><tr><td>24/48 Vdc</td><td>60 Vdc</td><td>110/125 Vdc</td><td>220/250 Vdc</td></tr><tr><td>16 Vdc</td><td>44 Vdc</td><td>80 Vdc</td><td>160 Vdc</td></tr></table>	24/48 Vdc	60 Vdc	110/125 Vdc	220/250 Vdc	16 Vdc	44 Vdc	80 Vdc	160 Vdc
24/48 Vdc	60 Vdc	110/125 Vdc	220/250 Vdc						
16 Vdc	44 Vdc	80 Vdc	160 Vdc						
pick-up value, approx.									
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
– Transmission speed	for connection of a personal computer or similar as delivered 9600 Baud min 1200 Baud, max 19200 Baud
Floating interface for data transfer to the remote line end	isolated
– Standards	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. to VDEW/ZVEI and IEC 60870-5-103, or acc. to 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 60255–5
– 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 μ s; 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; $\tau = 15 \mu$ s; 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; $R_i = 330 \Omega$
– 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; $R_i = 50 \Omega$; 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 ≤ 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 (mass)	
– in housing for surface mounting	approx 8.0 kg
– in housing for flush mounting	approx 6.5 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 $I_{DYN} > /I_N$ 0.20 to 1.00 (steps 0.01)
(for abrupt current changes)

Pick-up characteristics

Reset value refer to Figure 3.1
0.15 · 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 (steady state) $\pm 5\%$ of should-be value $\pm 0.01 \cdot I_N$ (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
 $0^\circ\text{C} \leq \vartheta_{amb} \leq 40^\circ\text{C}$ $\leq 0.5\%/10\text{ K}$

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

– data cable

for surface mounted housing: at terminals above 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 mm²
 ≤ 0.23 UI (unit interval)
 ≤ 0.25 UI (unit interval)
max. 10 dB
approx. 1 km

max. signal jitter at transmission output
adm. signal jitter at receive input
– permissible line attenuation
– transmission distance

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
max. signal jitter at transmission output
adm. signal jitter at receive input
glass fibre type
permissible line attenuation
transmission distance (guide value)

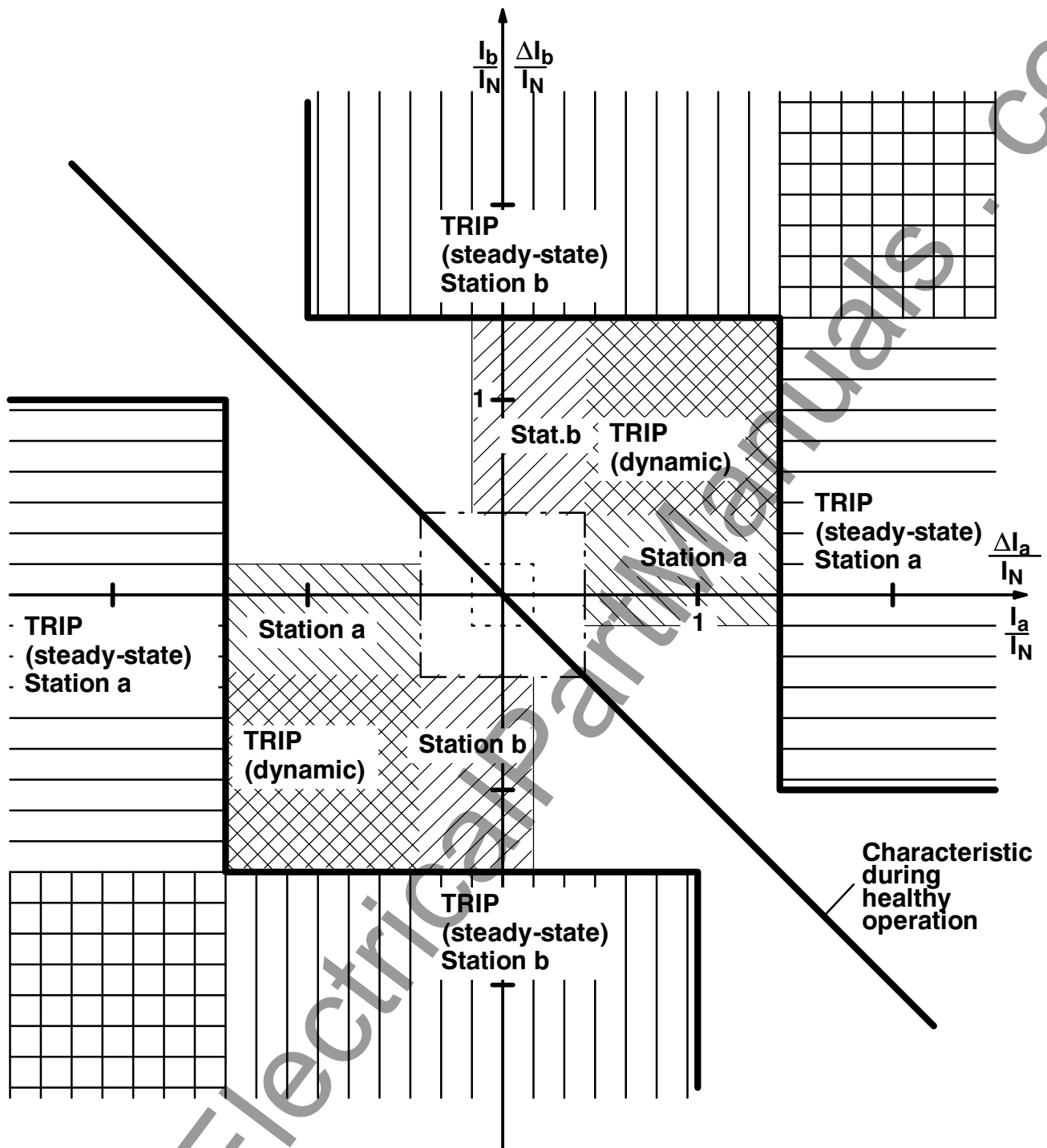
F–SMA plug	820 nm	FC plug	1300 nm
≤ 0.11 UI (unit interval)		≤ 0.11 UI (unit interval)	
≤ 0.43 UI (unit interval)		≤ 0.43 UI (unit interval)	
62.5/125 μm multi-mode		9/125 μm single mode	
typ. 8 dB		typ. 21.5 dB	
approx. 1.5 km		approx. 30 km	

normal signal position

"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	

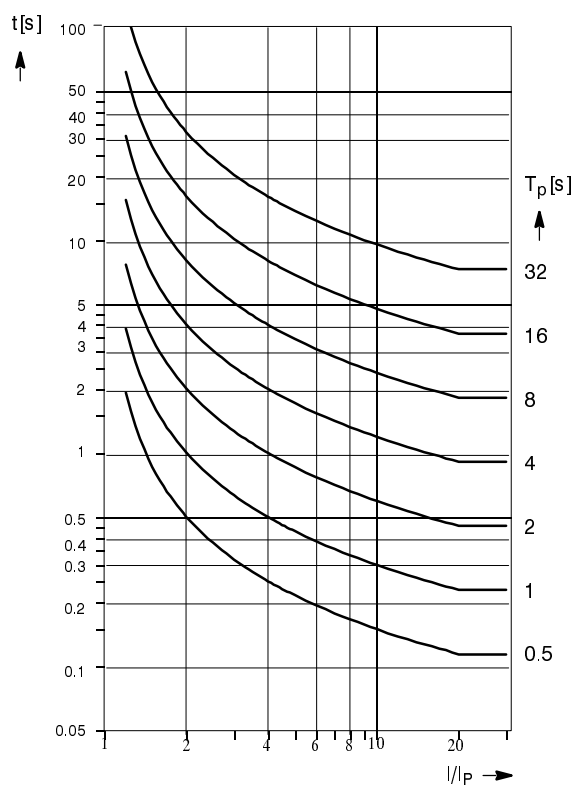
Operating times

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

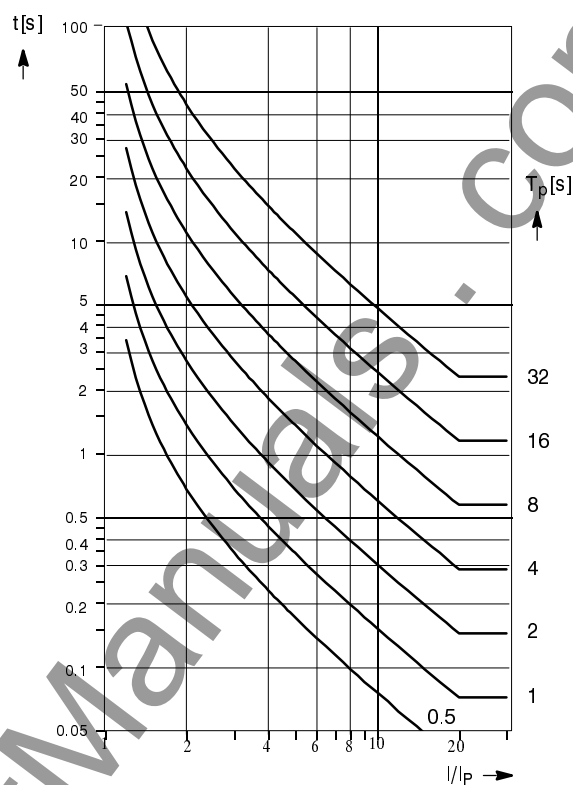
The set times are pure delay times.

3.4 Emergency overcurrent time protection

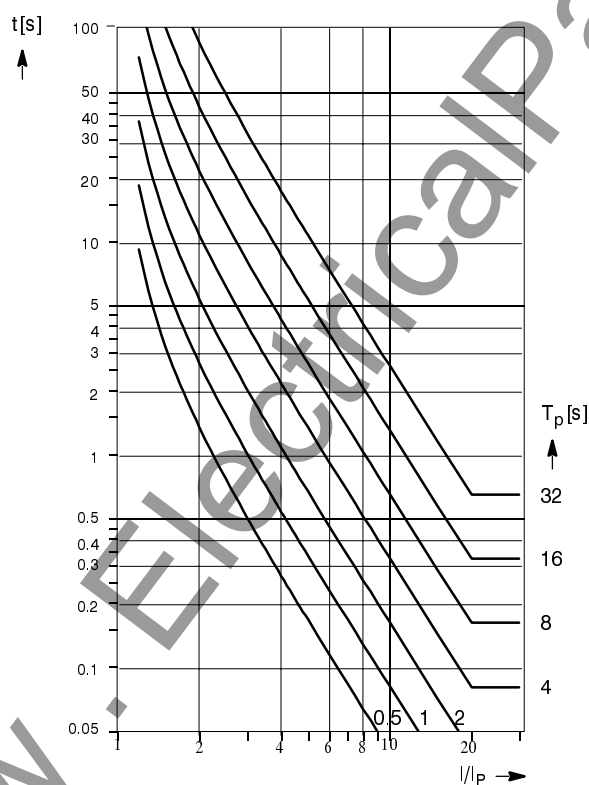
Emergency operation		during data transmission failure
operation modes		optionally definite time overcurrent protection or inverse time overcurrent protection; with definite time or instantaneous high current stage
Characteristics		
for definite time overcurrent protection – shortest trip time		approx. 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 times	$T_{I>} >$ and $T_{I_{E>} >}$	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	$T_{I_{E>} >}$	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_{Ep}	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, $I_{>} >$, $I_{E>} >$, $I_{>} >$, $I_{E>} >$		$\pm 3\%$ of set value
– for inverse time stages I_{p/I_N} , I_{Ep/I_N}		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		$\leq 5\% \pm 30$ ms for $2 \leq I/I_{(E)p} \leq 20$ $1 \leq T_{(E)p}/s \leq 20$



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



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



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

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	$\Theta_{\text{warn}}/\Theta_{\text{trip}}$	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

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

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

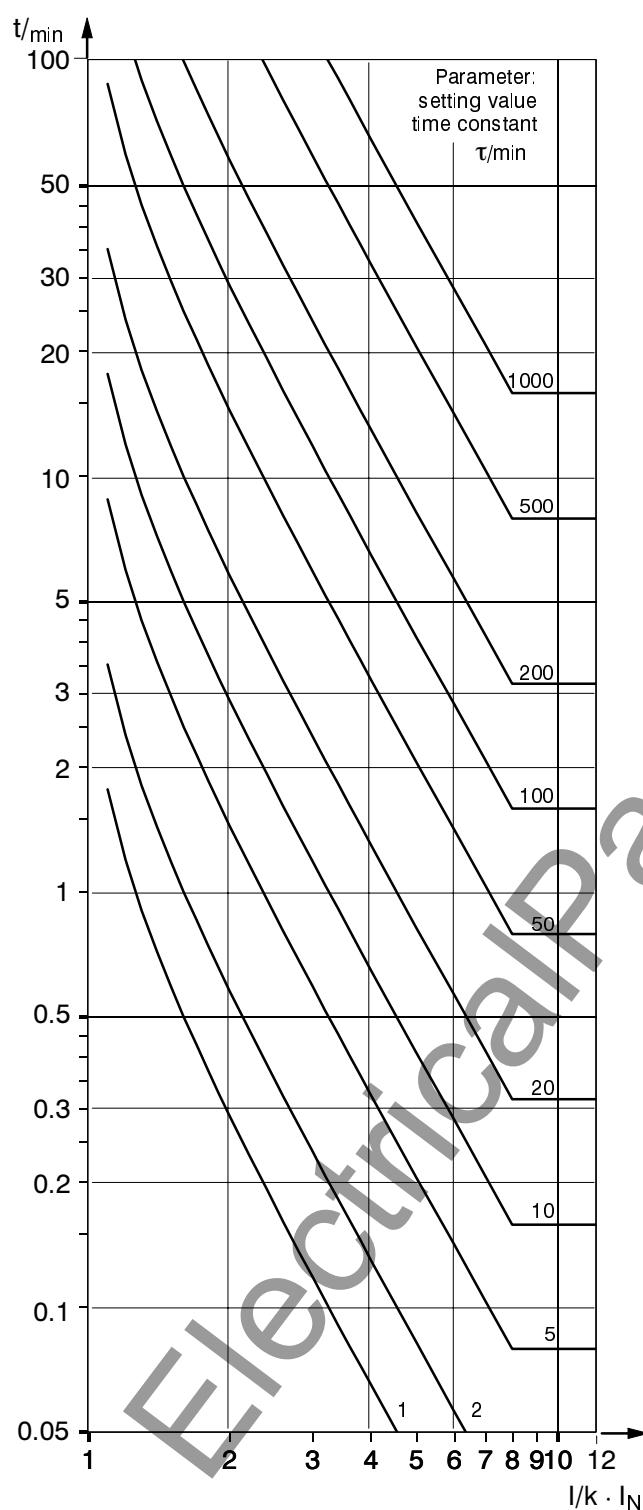
$\Theta/\Theta_{\text{trip}}$	approx. 0.99
$\Theta/\Theta_{\text{warn}}$	approx. 0.99
I/I_{warn}	approx. 0.97

Tolerances

– referring to $k \cdot I_N$	$\pm 10 \%$
– referring to trip time	$\pm 10 \% \pm 2 \text{ s}$

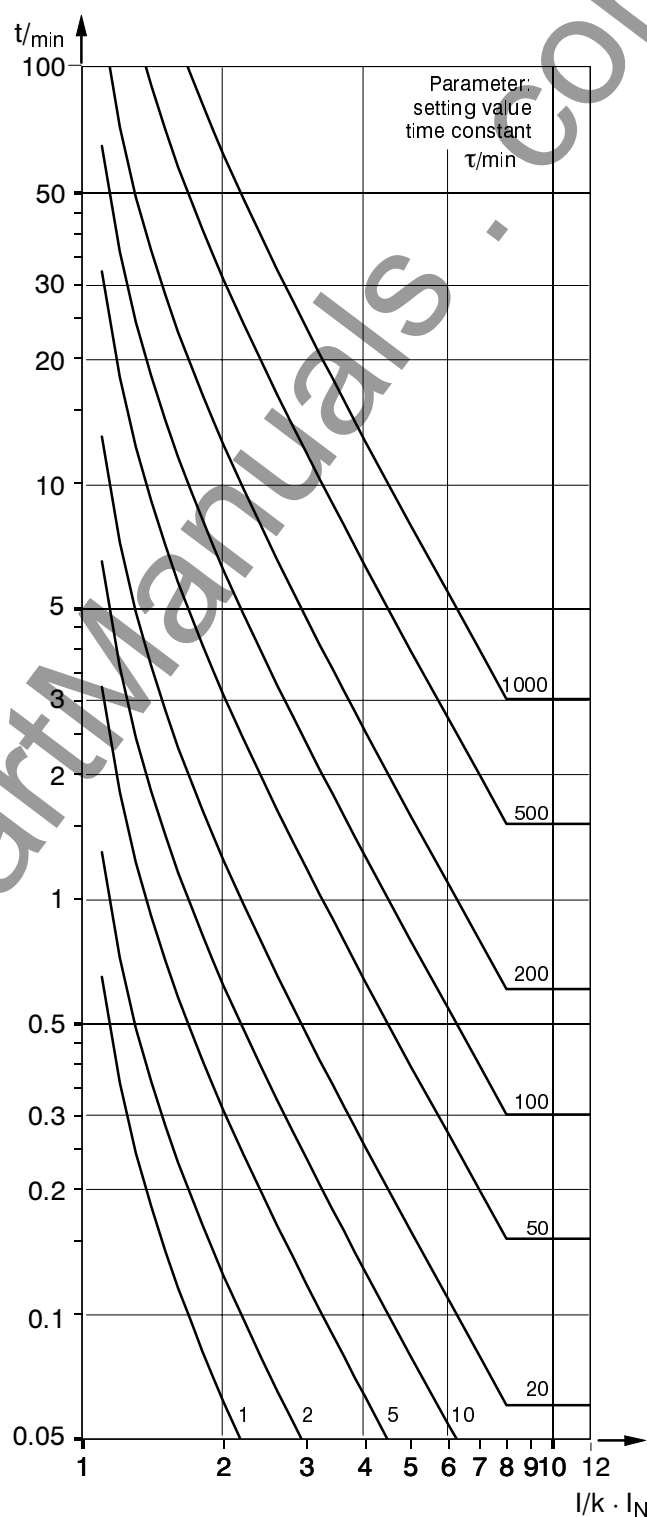
Influence variables referred to $k \cdot I_N$

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



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

Figure 3.3 Trip time characteristic of overload protection – without 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 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	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
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Steady-state measured value supervision

Current unbalance	$I_{max}/I_{min} > \text{symmetry factor}$ as long as $I > I_{limit}$
-------------------	--

Fault event data storage

Storage of annunciations of the last eight 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
Storage period	max 5 s per fault event, max. 20 s total, adjustable pre-fault and 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 I/I_N	max. 7 digits plus 1 decimal digit

4 Method of operation

4.1 Operation of complete unit

The numerical current comparison protection relay 7SD511 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 sec-

tion 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.

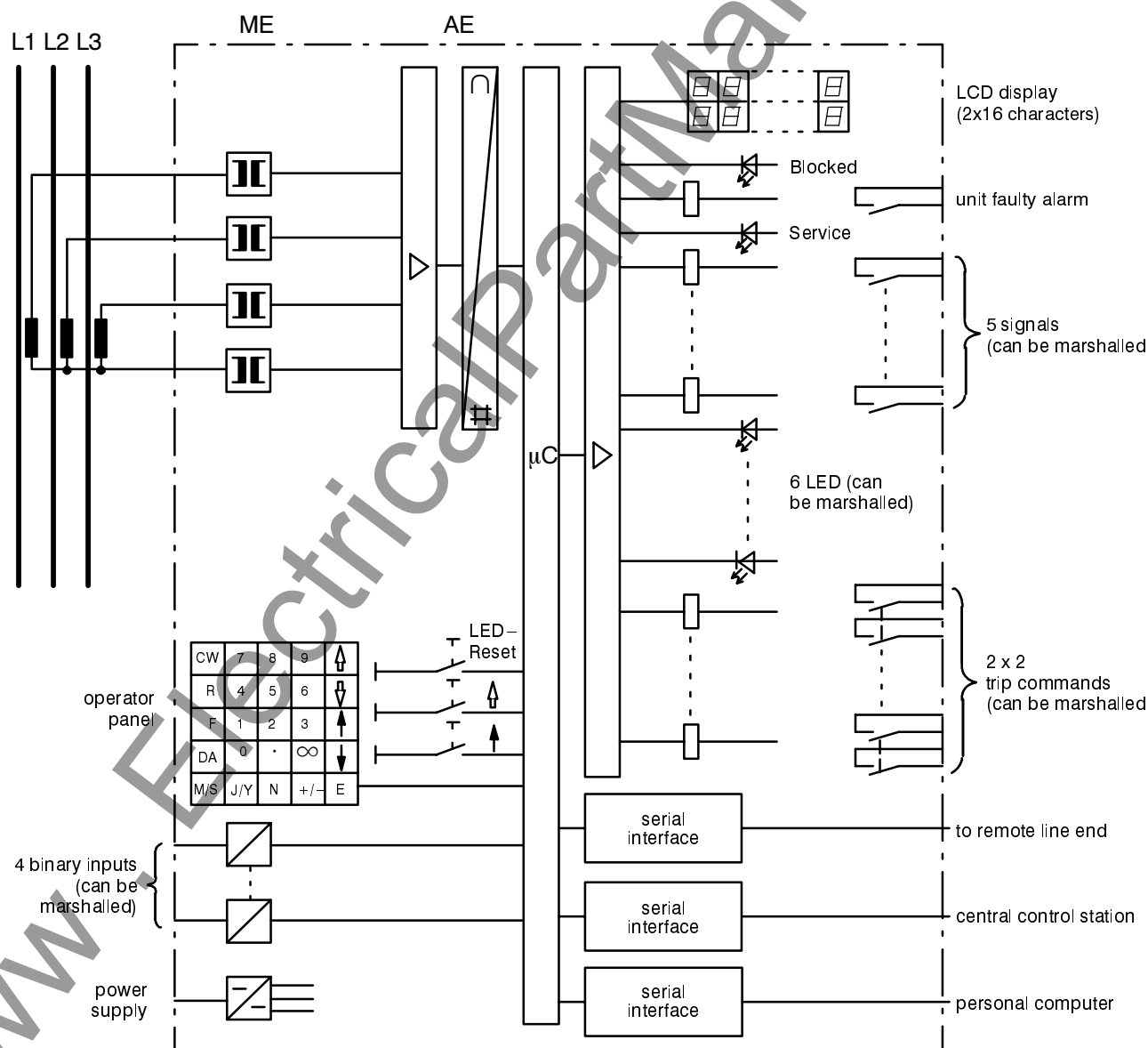


Figure 4.1 Hardware-structure of current comparison protection relay 7SD511

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 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 to 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 d.c. voltage storage element (rated auxiliary supply voltage ≥ 110 V).

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. 7SD511 V3 can operate with a 7SD512 V3 unit at the other line end. Additionally, it is possible to link 7SD51 V3 with relays of the former version 7SD51 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 star-point to be formed outside the unit or to include further devices in the current circuit.

If the current transformers' secondary rating is $I_N = 5 \text{ A}$ at one end of the line and $I_N = 1 \text{ A}$ 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 7SD511.

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.

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 7SD511. 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 inter-tripping 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 decoding 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 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 Band width at 820 nm Weight (mass) Operating temperature range Bending radius (without tensile stress) Tensile capability (short-time) Glass fibre Installation Order code (MLFB)	3.2 dB / km 200 MHz x km 18 kg / km -20 °C to +80 °C ≥ 30 mm 400 N 2 G 62.5/125 µm in pipes, cable tunnels, or for flexible application 6XV8100 – 0BC**	3.2 dB / km 200 MHz x km 57 kg / km -20 °C to +70 °C ≥ 255 mm 1600 N 2 G 62.5/125 µm directly in soil and in mechanically pro- tected environment 6XV8100 – 0BB**

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 7SD511 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 or other back-up functions.

The transfer 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.

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

Do not confuse the transfer trip facility and the inter-trip 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

7SD511 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 time multiplier.
- $I_{E>>}$ High current limit value threshold for earth currents,
 $T_{I_{E>>}}$ associated delay time.
- $I_{E>}$ Definite time limit value threshold,
 $T_{I_{E>}}$ associated delay time or
- I_{Ep} Inverse time base value for earth currents,
 T_{IEp} 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 bypassed for this condition.

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 (selectable).

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 rise 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 if the temperature rise has not yet reached the alarm or trip temperature rise values.

4.6 Circuit breaker trip test

Numerical current comparison protection 7SD511 allows simple checking of the tripping circuit and the circuit breaker.

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, especially when an external auto-reclosure device is installed.

Initiation of the test cycle can be given from the operator keyboard or via the front operator interface. The relay issues a three-pole trip command.

The test sequence is supervised by 7SD511 by means of the circuit breaker auxiliary contact position provided the auxiliary contact is connected to a binary input. 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.

4.7 Ancillary functions

The ancillary functions of the current comparison protection 7SD511 include:

- processing of annunciations,
- storage of short circuit data for fault recording,
- operational measurements and testing routines,
- monitoring functions.

4.7.1 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.

4.7.1.1 Indicators and binary outputs (signal relays)

Important events and conditions are indicated by optical indicators (LED) on the front plate. The module also contains 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 (models with non-volatile memories). 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 fault 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.

4.7.1.2 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 4.7.1.1.

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 fitted). 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 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 eight network faults; if a ninth fault occurs the oldest fault is overwritten in the fault memory. The last three network faults can be read out in the display.

A network fault begins with the first recognition of the fault by pick-up of any fault detector and ends with the last fault detector reset of any protection function.

4.7.1.3 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).

4.7.2 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.

4.7.3 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:

- $I_{L1}, I_{L2}, I_{L3}, I_E$ phase currents of local and remote line end in amps primary and in % of rated current
- Θ/Θ_{trip} temperature rise related to the trip temperature rise.

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

4.7.4 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.

4.7.4.1 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

$$|i_{L1} + i_{L2} + i_{L3} + k_I \times I_E| \geq$$

$$\text{SUM.lthres} \times I_N + \text{SUM.Fact.I} \times I_{\max}$$

An adjustable factor k_I (parameter I_e/I_{ph}) 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.lthres and SUM.Fact.I are setting parameters. The component $\text{SUM.Fact.I} \times I_{\max}$ takes into account permissible current proportional trans-

formation errors in the input converters which may particularly occur under conditions of high short circuit currents (Figure 4.2).

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.

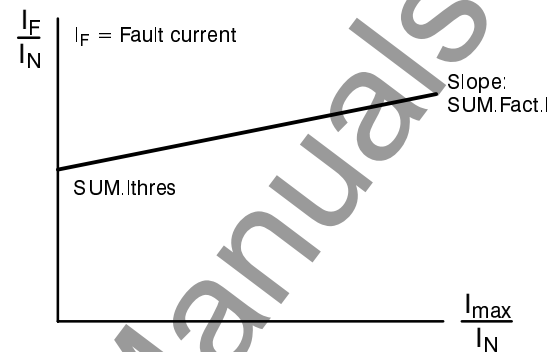


Figure 4.2 Current sum monitoring (current plausibility check)

– Command output channels:

The command relays for tripping 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.

4.7.4.2 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.

4.7.4.3 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:

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

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 4.3). Both parameters can be set (see Section 6.3.10).

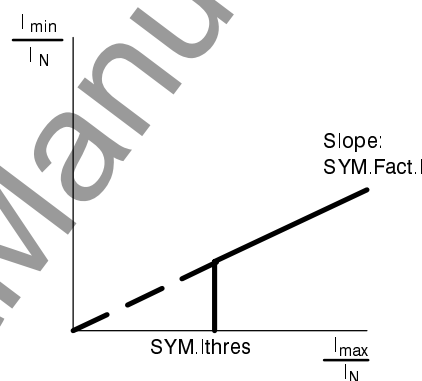


Figure 4.3 Current symmetry monitoring

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

Monitoring	Failure covered, reaction
1. Plausibility check of currents $ i_{L1} + i_{L2} + i_{L3} + i_E > \text{SUM.Ithres} \times I_N + \text{SUM.Fact.I} \times I_{\max}$	Relay failures in the signal acquisition circuits $i_{L1}, i_{L2}, i_{L3}, i_E$ Alarm
2. Current unbalance $\frac{ I_{\min} }{ I_{\max} } < \text{SYM.Fact.I}$ and $ I_{\max} > \text{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 electrostatically endangered components (EEC) must be observed.

In installed conditions, the modules are in no danger.

5.2.1 Mounting and connections

5.2.1.1 Model 7SD511★--★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 16) 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 7SD511★--★C★★ for panel flush mounting or 7SD511★--★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 stan-

dard 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 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 of 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 hardware 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 and their location on the basic p.c.b. of the basic input/output module GEA-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 Vdc	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. Figure 5.2 shows the printed circuits board, viewed from the component side, with the setting plugs for the control voltage of the binary inputs. It is 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 figure shows 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

- 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 5.2.

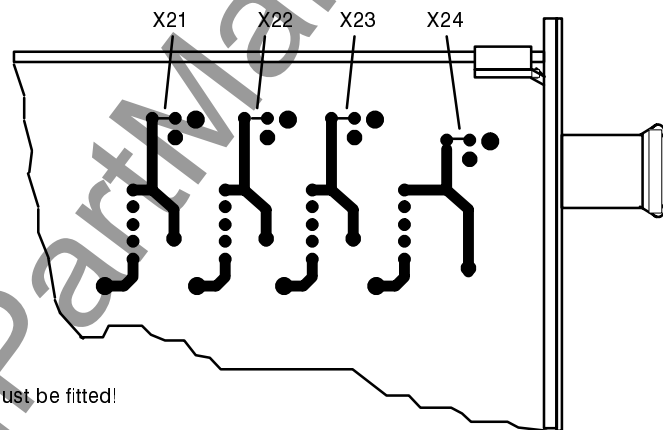
- Insert basic module into the housing; ensure that the releasing lever is pushed fully to the left before the module is pressed in.
- Firmly push in the module using the releasing lever.
- Close housing cover.

Binary input 1 : Solder bridge X21

Binary input 2 : Solder bridge X22

Binary input 3 : Solder bridge X23

Binary input 4 : Solder bridge X24



For rated voltages 24/48/60 Vdc: Solder bridges must be fitted!

For rated voltages 110/125/220/250 Vdc: Solder bridges may be removed.

Figure 5.1 Checking for control voltages for binary inputs 1 to 4

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 calendar 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.

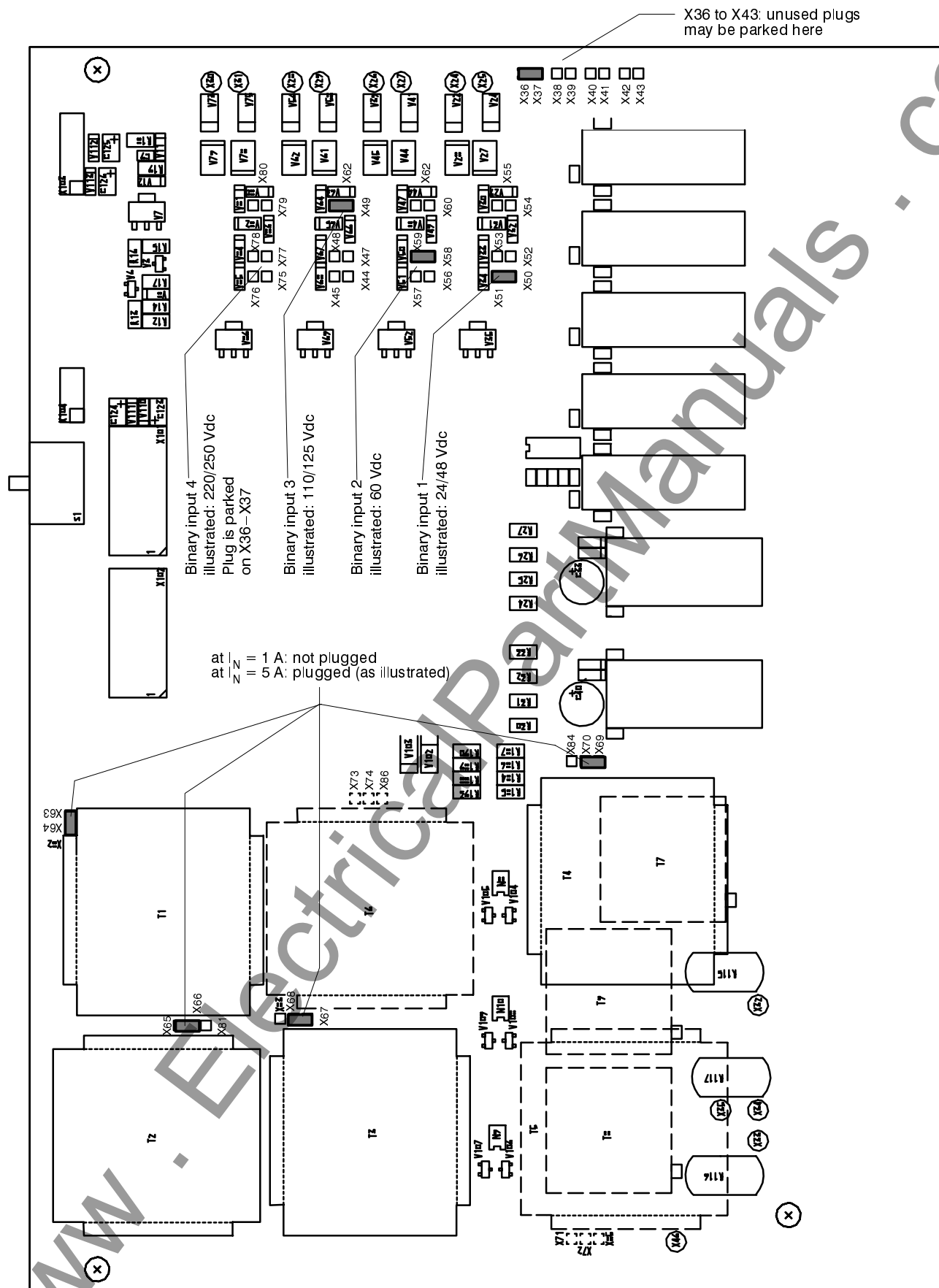


Figure 5.2 Setting plugs on basic input/output module GEA–2, from production series /EE

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 7SD511 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 5.3).

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.

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 $\bullet \rightarrow$ for transmit output and $\rightarrow \bullet$ 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 5.3).

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

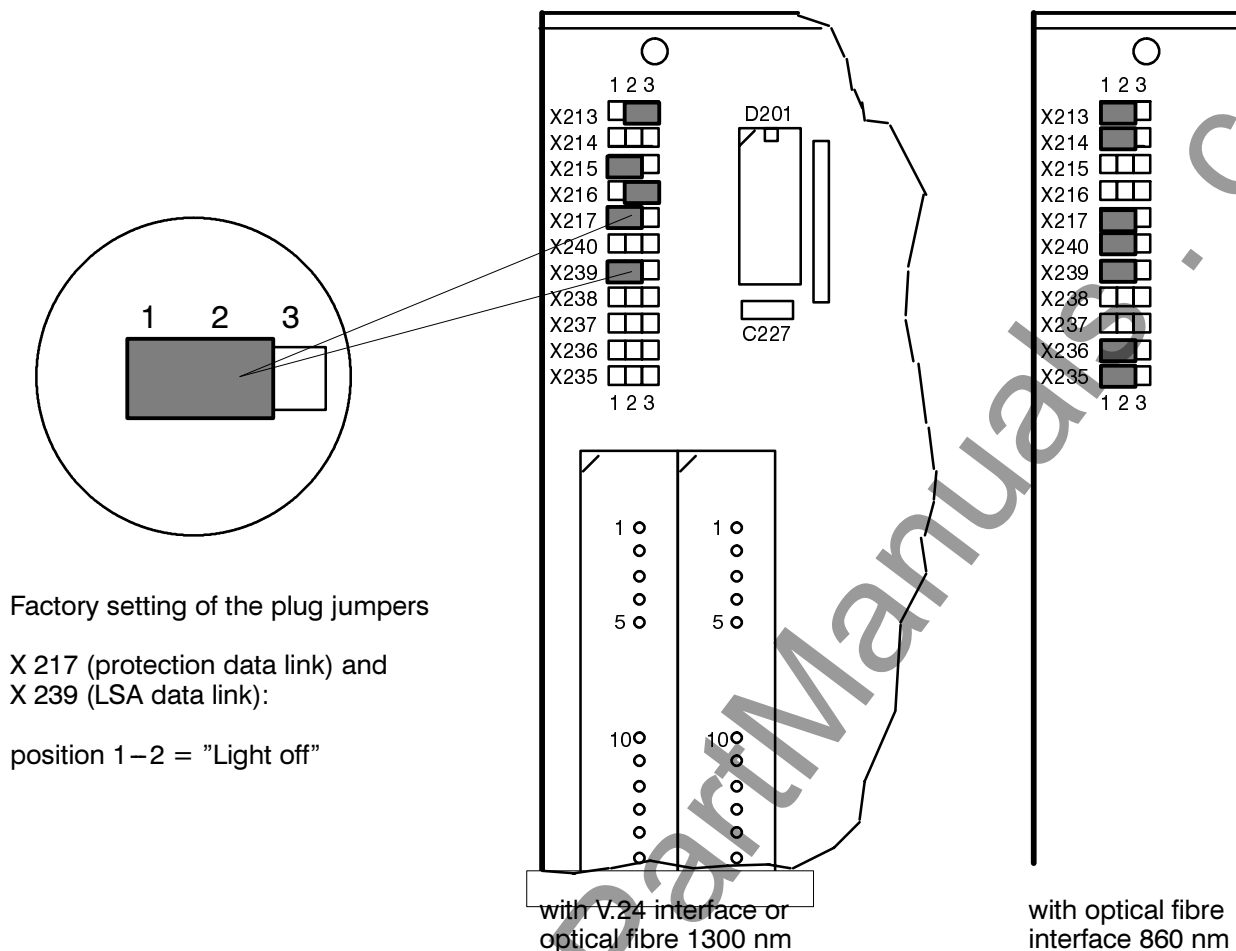


Figure 5.3 Position of the jumpers X217 and X239 on the power supply board

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 foot-point 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.

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:

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

The turn number ratio is thus:

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

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

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

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

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 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" \odot 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 \odot . 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 **000000** and confirm with **E**. Codeword entry can also be made retrospectively after paging or direct addressing to any setting address.

ENTER CODEWORD :
@ @ @ @ @ @
CW ACCEPTED
CODEWORD WRONG

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 **7000** and ENTER, key **E**. The address 7000 appears, which forms the heading of the configuration blocks:

↑	7000	OP. SYSTEM
↓	CONFIGURATION	

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 **FE**, i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS ?". Confirm

with the "Yes" – key **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 $\uparrow \downarrow$, 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.

$\uparrow \downarrow$ 7 1 0 0 ■ I N T E G R A T E D
O P E R A T I O N

Beginning of the block "Integrated operation"

$\uparrow \downarrow$ 7 1 0 1 ■ L A N G U A G E
D E U T S C H
E N G L I S H
E S P A N O L
U S - E N G L I S H

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**.

$\uparrow \downarrow$ 7 1 0 2 ■ D A T E F O R M A T
D D . M M . Y Y Y Y
M M / D D / Y Y Y Y

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)

7 1 0 5 ■ O P E R . 1 s t L
 I L 1 a [%] =
 I L 2 a [%] =
 etc.

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.

7 1 0 6 ■ O P E R . 2 n d L
 I L 1 b [%] =
 etc.

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.

7 1 0 7 ■ F A U L T 1 s t L
 F a u l t T y p e
 T r i p T y p e
 P r o t . P i c k - u p
 P r o t . T r i p
 T - D r o p
 T - T r i p

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,

7 1 0 8 ■ F A U L T 2 n d L
 P r o t . T r i p
 etc.

After a fault event, the **second** line of the display shows:
the possibilities are the same as under address 7107.

7 1 1 0 ■ F A U L T I N D I C
 W I T H F A U L T D E T E C
 W I T H T R I P C O M M .

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.

↑	7 2 0 0 ■ P C / S Y S T E M
↓	I N T E R F A C E S

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

↑	7 2 0 1 ■ D E V I C E A D D .
↓	1

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**

↑	7 2 0 2 ■ F E E D E R A D D .
↓	1

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

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

↑	7 2 0 3 ■ S U B S T . A D D .
↓	1

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**

↑	7 2 0 8 ■ F U N C T . T Y P E
↓	1 9 2

Function type in accordance with IEC 60870–5–103 or VDEW/ZVEI; for current comparison protection no. 192.

This address is mainly for information, it should not be changed.

↑	7 2 0 9 ■ D E V I C E T Y P E
↓	2 8

Device type for identification of the device in Siemens LSA 678 and program *DIGSI*®.

For 7SD511 V3 no. 28.

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*.

7	2	1	1	■	P	C	I	N	T	E	R	F	.
D	I	G	S	I	V	3							
A S C I I													

Data format for the PC (operating) interface:
format for Siemens protection data processing program
DIGSI® Version V3
ASCII format

7	2	1	5	■	P	C	B	A	U	D	R	A	T	E
9	6	0	0		B	A	U	D						
1 9 2 0 0 B A U D														
1 2 0 0 B A U D														
2 4 0 0 B A U D														
4 8 0 0 B A U D														

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**.

7	2	1	6	■	P	C	P	A	R	I	T	Y
D	I	G	S	I	V	3						
N O 2 S T O P												
N O 1 S T O P												

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).

7	2	2	1	■	S	Y	S	I	N	T	E	R	F	.
V	D	E	W		C	O	M	P	A	T	I	B	L	E
V D E W E X T E N D E D														
D I G S I V 3														
L S A														

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

7	2	2	2	■	S	Y	S	M	E	A	S	U	R	.
V	D	E	W		C	O	M	P	A	T	I	B	L	E

V	D	E	W		E	X	T	E	N	D	E	D	
---	---	---	---	--	---	---	---	---	---	---	---	---	--

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

7	2	2	5	■	S	Y	S	B	A	U	D	R	.
9	6	0	0		B	A	U	D					

1	9	2	0	0		B	A	U	D				
---	---	---	---	---	--	---	---	---	---	--	--	--	--

1	2	0	0		B	A	U	D					
---	---	---	---	--	---	---	---	---	--	--	--	--	--

2	4	0	0		B	A	U	D					
---	---	---	---	--	---	---	---	---	--	--	--	--	--

4	8	0	0		B	A	U	D					
---	---	---	---	--	---	---	---	---	--	--	--	--	--

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**.

7	2	2	6	■	S	Y	S	P	A	R	I	T	Y		
V	D	E	W	/	D	I	G	S	I	V	3	/	L	S	A

N	O		2		S	T	O	P					
---	---	--	---	--	---	---	---	---	--	--	--	--	--

N	O		1		S	T	O	P					
---	---	--	---	--	---	---	---	---	--	--	--	--	--

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.

7	2	3	5	■	S	Y	S	P	A	R	A	M	E	T
N	O													

Y	E	S												
---	---	---	--	--	--	--	--	--	--	--	--	--	--	--

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 4.7.2). 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. For current comparison protection, fault detection and trip command are the same instant, this distinction is useful only for the overcurrent time protection.

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 re-

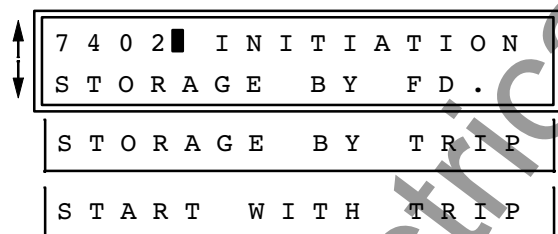
cord is set under address 7410. Altogether 5 s are available for fault recording. In this time range up to 8 fault records can be stored.

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).



Beginning of block "Fault recordings"



Data storage is initiated:

- fault detection is reference instant
fault detection is storage criterion
- fault detection is reference instant
trip command is storage criterion
- trip command is reference instant
trip command is storage criterion



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

7	4	1	2	■	T - P O S T
0	.	1	0	s	

Post-fault time after the storage criterion disappears

Smallest setting value: **0.05 s**

Largest setting value: **0.50 s**

7	4	3	1	■	T - B I N A R Y I N
0	.	5	0	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)

7	4	3	2	■	T - K E Y B O A R D
0	.	5	0	s	

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.

7	4	9	0	■	S Y S L E N G T H
6	6	0			V A L U E S F I X
<	=	3	0	0	0 V A L . V A R .

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** 7SD511 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.

Example for configuration of the scope of the functions:

Assume a network comprising overhead lines and cable sections. The overload protection is used only for the cable sections. Therefore, this function will be "de-configured" for the devices protecting the overhead line sections.

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 block 78 one can page forward with ↑ or back with ↓. Each paging action leads to a further address for the input of a configuration parameter. In the following sections, each address is shown in a box. In the upper line of the display, behind the number and the bar, stands the associated device func-

tion. 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 7SD511: There will be no announcements 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.

↑	7 8 0 0 ■ S C O P E O F
↓	F U N C T I O N S

Beginning of the block "Scope of functions"

Current comparison protection:

↑	7 8 1 5 ■ C C P F U N C T .
↓	E X I S T
	N O N - E X I S T

Emergency overcurrent time protection:

↑	7 8 2 6 ■ E M E R G . O / C
↓	N O N - E X I S T
	E X I S T

External local trip via binary input:

↑	7 8 2 1 ■ E X T . T R I P
↓	N O N - E X I S T
	E X I S T

Thermal overload protection:

↑	7 8 2 7 ■ T H E R M A L O L
↓	N O N - E X I S T
	E X I S T

Transfer trip via binary input:

↑	7 8 2 2 ■ T R A N S F . T R I P
↓	N O N - E X I S T
	E X I S T

Change-over of parameter sets:

↑	7 8 8 5 ■ P A R A M . C / O
↓	N O N - E X I S T
	E X I S T

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.

7	8	9	9	█	F	R	E	Q	U	E	N	C	Y
f	N	5	0		H								
f N 6 0 H z													

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, for 7SD511, mainly the telegram format of the protection data interface. This enables to connect a 7SD511 with firmware version V3 with a 7SD511 V2 or 7SD512 V2 at the opposite line end.

7	9	0	0	█	D	E	V	I	C	E		
C	O	N	F	I	G	U	R	A	T	I	O	N

Beginning of the block "device configuration"

7	9	1	0	█	C	B	T	E	S	T	B	I	
T	H	R	E	E	-	P	O	L	E	T	R	I	P

The program of circuit breaker test when initiated via binary input is always *THREE-POLE TRIP*

7	9	1	6	█	T	E	L	.	F	O	R	M	A	T
C	R	C	1	6	C	H	E	C	K					

Telegram format of protection data transmission:

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

V	2	C	O	M	P	A	T	I	B	L	E
---	---	---	---	---	---	---	---	---	---	---	---

COMPATIBLE with 7SD51 firmware version V2

M	O	D	E	M	8	,	N	,	1
---	---	---	---	---	---	---	---	---	---

MODEM with 8 bit, No 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 to 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: Trip command is registered from a protection function. 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 1, the processor must be advised that the logical signal "Device Trip" should be transmitted to the signal relay 1. 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 \uparrow or go back with the key \downarrow . Within a block, one goes forwards with \uparrow or backwards with \downarrow . 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** \uparrow , i.e. depressing the function key **F** followed by the arrow key \uparrow , 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 \uparrow 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 \uparrow . **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** \uparrow (i.e. depressing the function key **F** followed by the arrow key \uparrow). The display shows again the four digit address number of the physical input/output module. Now you can page with key \uparrow to the next input/output module or with \downarrow 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 $\uparrow\downarrow$ or $\uparrow\downarrow$ 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 \uparrow .

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 $\uparrow\downarrow$, 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 4 binary inputs which are designated INPUT 1 to INPUT 4. 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 to 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.

↑ ↓
6 1 0 0 ■ M A R S H A L L I N G
B I N A R Y I N P U T S

Beginning of block "Marshalling binary inputs"

The first binary input is reached with the key ↑:

↑ ↓
6 1 0 1 ■ B I N A R Y
I N P U T 1

Allocations for binary input 1

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

↑ ↓
0 0 1 ■ I N P U T 1
> T r a n s . T r i p N O

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

↑ ↓
0 0 2 ■ I N P U T 1
n o t a l l o c a t e d

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 **↑**.

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
354	>CB Aux.3p cl	Circuit breaker all 3 poles closed (from CB aux. contact)
356	>Manual Close	Circuit breaker is manually closed (from discrepancy switch)
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>/I _p block	Block I> or I _p stage of emergency overcurrent time protection
2013	>IE>IE _p block	Block I _E > or I _E _p 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
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

Table 5.2 Preset binary inputs

5.5.3 Marshalling of the signal output relays – address block 62

The unit contains 5 signal outputs (alarm relays). The signal relays are designated SIGNAL RELAY 1 to SIGNAL RELAY 5 and can be marshalled in address block 62. The block is reached by paging in blocks with $\uparrow \downarrow$ 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 to 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.

$\uparrow \downarrow$ 6 2 0 0 ■ M A R S H A L L I N G
S I G N A L R E L A Y S

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

The first signal relay is reached with the key \uparrow :

\uparrow 6 2 0 1 ■ S I G N A L
R E L A Y 1

Allocations for signal relay 1

Change over to the selection level with **F** \uparrow :

$\uparrow \downarrow$ 0 0 1 ■ R E L A Y 1
D e v i c e T r i p

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

$\uparrow \downarrow$ 0 0 2 ■ R E L A Y 1
n o t a l l o c a t e d

no further functions are preset for signal relay 1

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

\uparrow 6 2 0 1 ■ S I G N A L
R E L A Y 1

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 input/output module
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
354	>CB Aux.3p cl	Circuit breaker all 3 poles closed (from CB auxiliary contact)
356	>Manual Close	Circuit breaker is manually closed (from discrepancy switch)
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
515	Dev.Trip 3p	Three-pole trip of the device
561	Manual Close	Circuit breaker is manually closed (execution)
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
1185	CB Test 3p	Trip three-pole by internal circuit breaker test function
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>/I _p block	Block I> or I _p stage of emergency overcurrent time protection
2013	>IE>I _{Ep} 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

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

FNo	Abbreviation	Description
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 _E _p 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 _E _p stage of overcurrent time protection expired
2141	Emer.Gen.Trip	General trip by emergency overcurrent protection
2145	Emer.Trip 3p	Three-pole trip by emergency overcurrent protection
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
3088	CCP.Trip L123	Current comparison protection three-pole trip
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	Wrong firmware version installed
3408	Wrong Dev.ID	Wrong device identification number
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

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

FNo	Abbreviation	Description
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"

Table 5.4 Preset annunciations for signal relays

5.5.4 Marshalling of the LED indicators – address block 63

The unit contains 8 LEDs for optical indications, 6 of which can be marshalled. They are designated LED 1 to LED 6 and can be marshalled in address block 63. The block is reached by paging in blocks with $\uparrow\downarrow$ or by directly addressing with **DA 6200 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 memorized) or unstored mode (nm for "not memorized"). Each annunciation function is displayed with the index m or nm when proceeding with the **N**-key.

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 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 presettings.

$\uparrow\downarrow$ 6 3 0 0 ■ M A R S H A L L I N G
L E D I N D I C A T O R S

Beginning of the block "Marshalling of the LED indicators"

The first marshallable LED is reached with the key \uparrow :

\uparrow 6 3 0 1 ■ L E D 1

Allocations for LED 1

Change over to the selection level with **F** \uparrow :

$\uparrow\downarrow$ 0 0 1 ■ L E D 1
D e v i c e T r i p m

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

After input of all annunciations for LED 1, change-back to the marshalling level is carried out with **F** \uparrow .

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	Dev.Trip 3p m	515	Trip signal of the device
6303	LED 3 LED 3	Dev.Trip 3p m	515	
6304	LED 4 LED 4	Dev.Trip 3p m	515	
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

Table 5.5 Preset LED indicators

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

The unit contains 2 trip relays which are designated TRIP RELAY 1 and TRIP RELAY 2. 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 $\uparrow\downarrow$ 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 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 an example for marshalling of trip relays 1. Table 5.7 shows all trip relays as preset from the factory.

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

$\uparrow\downarrow$ 6 4 0 0 ■ M A R S H A L L I N G
T R I P R E L A Y S

Beginning of the block "Marshalling of the trip relays"

The first trip relay is reached with the key \uparrow :

F 6 4 0 1 ■ T R I P
R E L A Y 1

Allocations for trip relay 1

Change over to the selection level with **F** \uparrow :

$\uparrow\downarrow$ 0 0 1 ■ T R I P R E L . 1
C C P . G e n . T r i p

Trip relay 1 has been preset for:
1st: Trip by current comparison protection,
FNo 3084

$\uparrow\downarrow$ 0 0 2 ■ T R I P R E L . 1
E m e r . G e n . T r i p

Trip relay 1 has been preset for:
2nd: Trip by emergency overcurrent time protection, FNo 2141

$\uparrow\downarrow$ 0 0 3 ■ T R I P R E L . 1
O / L T r i p

Trip relay 1 has been preset for:
3rd: Trip by thermal overload protection,
FNo 1521

$\uparrow\downarrow$ 0 0 4 ■ T R I P R E L . 1
C B T e s t T r i p

Trip relay 1 has been preset for:
4th: Trip by internal circuit breaker test function,
FNo 1181

$\uparrow\downarrow$ 0 0 5 ■ T R I P R E L . 1
E x t G e n . T r i p

Trip relay 1 has been preset for:
5th: Trip by external direct local trip, FNo 4517

0 0 6 ■ T R I P R E L . 1
T r a n s f e r T r i p

Trip relay 1 has been preset for:
6th: Trip by transfer trip reception,
FNo 3324

0 0 7 ■ T R I P R E L . 1
n o t a l l o c a t e d

No further command function is 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 ↑.

6 4 0 1 ■ T R I P
R E L A Y 1

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
1181	CB Test Trip	General trip 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
2141	Emer.Gen.Trip	General trip from emergency overcurrent protection
2145	Emer.Trip 3p	Trip three-pole from emergency overcurrent protection
3076	CCP.Gen.Flt.	General fault detection of current comparison protection
3084	CCP.Gen.Trip	General trip 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 TRIP REL. 1 TRIP REL. 1 TRIP REL. 1 TRIP REL. 1 TRIP REL. 1	RELAY 1 CCP.Gen.Trip Emer.Gen,Trip O/L Trip CB Test Trip Ext Gen. Trip Transfer Trip	3084 2141 1521 1181 4517 3324	Group annunciation of all trip commands of the protection functions
6402	TRIP 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	3084 2141 1521 1181 4517 3324	

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:

	to		Digits 0 to 9 for numerical input
			Decimal point
			Infinity symbol
			Change of sign (input of negative numbers)

Yes/No keys for text parameters:

	Yes key: operator affirms the displayed question
	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:



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:



Codeword: prevents unauthorized access to setting programs (not necessary for call-up of annunciations or messages)



Backspace erasure of incorrect entries



Function key; explained when used



Direct addressing: if the address number is known, this key allows direct call-up of the address



Messages/Signals: interrogation of annunciations of fault and operating data (refer Section 6.4)

The three keys \uparrow ; $\uparrow\uparrow$; 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 $\uparrow\uparrow$ 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)

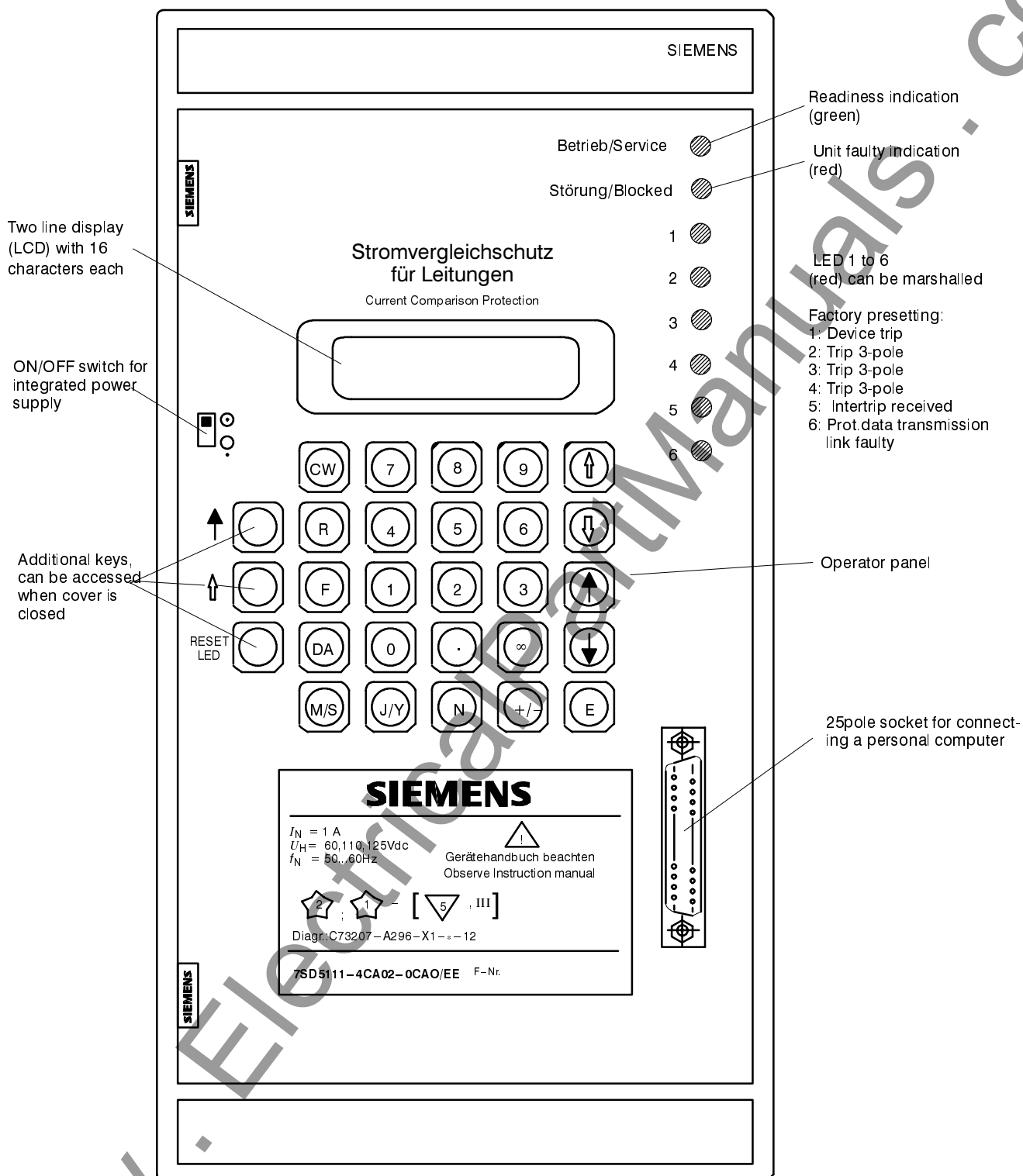


Figure 6.1 Front view of operating key board and display panel

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. **1100** for block **11**). Displayed text forms the heading of this block. No input is expected. By using keys \uparrow or \downarrow the next or the previous block can be selected. By using the keys \uparrow or \downarrow 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 $\uparrow\downarrow$ or $\uparrow\downarrow$ 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 $\uparrow\downarrow$ and keys $\uparrow\downarrow$ is possible.

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

If one tries to leave the setting range for the functional parameter blocks (i.e. address blocks 10 to 39) with keys $\uparrow \downarrow$, 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 *EX/ST* 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:

- First 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 \uparrow key. The copying facilities are summarized in Table 6.1.



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 8100 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.

↑ ↓
8 1 0 0 ■ S E T T I N G
R E A L T I M E C L O C K

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

↑ ↓
1 8 . 0 8 . 1 9 9 5
1 6 : 3 2 : 4 8

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

↑ ↓
8 1 0 2 ■ D A T E

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**

↑ ↓
8 1 0 3 ■ T I M E

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

↑ ↓
8 1 0 4 ■ D I F F . T I M E

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".



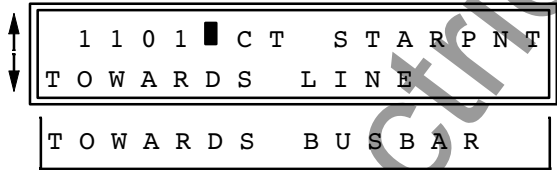
Commencement of functional parameter blocks

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.



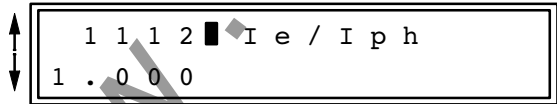
Beginning of the block "Power system data"



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;
earth c.t. ratio
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.

1	1	3	4	■	T	T	R	I	P
0	.	1	5		s				

Minimum duration of trip command

Smallest setting value:

0.01 s

Largest setting value:

32.00 s

1	1	5	5	■	I	N	-	C	T	r	e	m	.
1	0	0	0		A								

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 = EX/ST under address 7815 (refer to Section 5.4.2).

1	5	0	0	■	C	U	R	R	E	N	T		
C	O	M	P	A	R	I	S	O	N	P	R	O	T

Beginning of block "Current comparison protection"

1	5	0	1	■	C	C	P	F	U	N	C	T	.
O	N												
O	F	F											

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 $0.33 \cdot I_N$ 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 $I > \text{DYN CLOSE}$ is provided (address 1505). This threshold replaces the dynamic threshold $I > \text{DYN}$ (address 1504) for three or four a.c. periods when an unloaded line ($l/l_N < 0.05$) 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.

1 5 0 3 ■ I > S T - S T A T E
1 . 3 3 I / I_N

Steady-state trip threshold

Setting range: **0.50** · I_N to **4.00** · I_N

1 5 0 4 ■ I > D Y N
0 . 3 3 I / I_N

Dynamic trip threshold

Setting range: **0.20** · I_N to **1.00** · I_N

1 5 0 5 ■ I > D Y N C L O S E
0 . 3 3 I / I_N

Dynamic trip threshold during switch-on of the line

Setting range: **0.20** · I_N to **4.00** · I_N

1 5 0 8 ■ I > A L L O W
0 . 1 0 I / I_N

Minimum operating current to allow measurement

Setting range: **0.10** s to **4.00** · I_N

1 5 1 0 ■ M E A S . R E P E T
O F F
O N

Measurement repetition:

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

1 5 1 1 ■ T R I P D E L A Y
0 . 0 0 s

Additional time delay for trip signal

Setting range: **0.00** s to **0.10** s

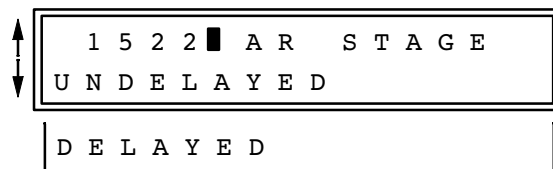
If a trip time delay has been set in address 1511 then, nevertheless, instantaneous trip is desired in case of switching onto a dead fault (e.g. when an earthing isolators has happened to remain closed). Address 1521 allows to pass a trip time delay by. A pre-requisite is, that the manual close command 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. When an external auto-reclosure device is present, 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*). The external AR device can inform the protection about its readiness via the binary input ">RAR Release"



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

UNDELAYED trip or
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

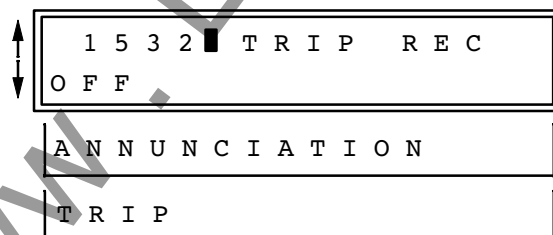
weak infeed. Thus, immediate disconnection at both ends of the line is ensured even for these cases.

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 ± 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.

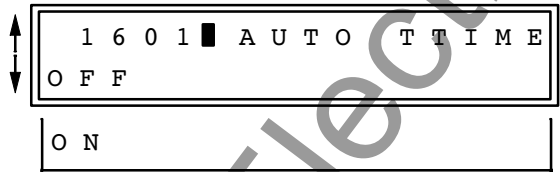
Address 1602 determines the transmission speed for the protection data transmission. This has nothing to do with the communication Baud rate for communication with a personal computer (address 7215) or LSA (address 7225) as set in Section 5.3.3.

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.



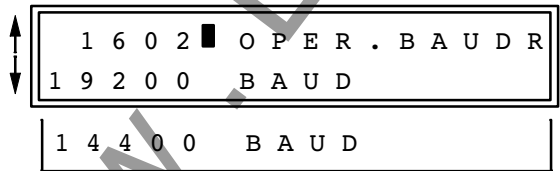
Beginning of block "Protection data transmission"



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 40.0 ms

1 6 0 5 ■ T - D A T A F A I L
8 . 0 s

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

1 6 0 6 ■ D E V I C E I D
0

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).

2 1 0 0 ■ E X T E R N A L
T R I P F U N C T I O N

Beginning of block "External local trip facility"

2 1 0 1 ■ E X T . T R I P
O N
O F F

External local trip facility

ON switched on or

OFF switched off

2 1 0 2 ■ T - D E L A Y
0 . 0 2 s

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

2 1 0 3 ■ T - R E S E T
0 . 2 0 s

Drop-off delay after external local trip
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 7SD511 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 on 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).

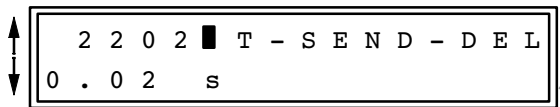
Do not confuse the transfer trip facility with the inter-trip function which is integral part of the comparison protection.



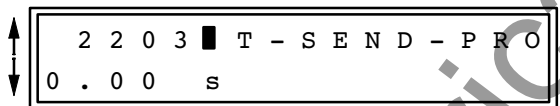
Beginning of block "Transfer trip facility"



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 for 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 overcurrent 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 definite 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 ∞ . This does not avoid pick-up annunciation.



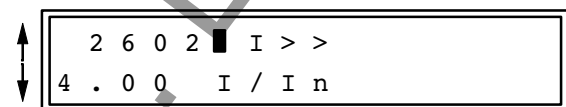
Beginning of block
"Emergency overcurrent time protection"



Emergency overcurrent time protection for phase currents is

ON switched on

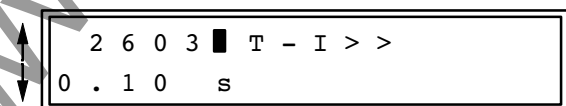
OFF switched off



High-current pick-up threshold $I > >$ for phase currents

Smallest setting value: $0.10 \cdot I_N$

Largest setting value: $15.00 \cdot I_N$



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)

2 6 1 1 █ C H A R A C T . P H

D E F I N I T E T I M E

N O R M A L I N V E R S E

V E R Y I N V E R S E

E X T R E M E L Y I N V E R S E

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 INVERSE time (type C acc. IEC 60255-3)

2 6 1 2 █ I >

2 . 0 0 I / I_n

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

2 6 1 3 █ T - I >

0 . 3 0 s

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, according to IEC 60255-3, 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.

$T_p = 10 \text{ s}$ means $TM = 1$,

thus for normal inverse tripping time at 2 times set value I_p
 $t_{trip} = 10 \text{ s}$

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 HARMONICS* 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.

2 6 1 4 █ I_p

0 . 2 0 I / I_N

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

2 6 1 5 █ T - I_p

0 . 5 0 s

Time multiplier for phase currents

Smallest setting value: **0.50** s

Largest setting value: **32.00** s

2 6 1 6 █ M E A S . F O R M

W I T H O U T H A R M O N .

W I T H H A R M O N I C S

Only for inverse time protection:

The fundamental waves of the measured currents are evaluated *WITHOUT HARMONICS*

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 with an external auto-reclosure device. 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 I_p with $T-I >$ or $T-I_p$ delayed. $I > >$ and $I >$ should then be set to the same value. Address 2623 determines whether the $I > >$ stage is effective only in conjunction with auto-reclosure or whether it operates independently.

2 6 2 1	MAN . C L O S E
$I > >$	U N D E L A Y E D
$I > / I_p$	U N D E L A Y E D
I N E F F E C T I V E	

2 6 2 3	R A R Z O N E
$I > >$	W I T H A R
$I > >$	A L W A Y S

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

$I > >$ i.e. $I > >$ stage but without delay $T-I > >$

$I > / I_p$ 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, independent 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 off 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.

2 6 3 1	E M E R . O / C E
ON	
OFF	

2 6 3 2	I E > >
4 . 0 0	I / I _N

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

Emergency overcurrent time protection for earth currents is

ON switched on

OFF switched off

High-current pick-up threshold $I > >$ for earth currents

Smallest setting value: $0.10 \cdot I_N$

Largest setting value: $10.00 \cdot I_N$

Time delay for the stage $I > >$ for earth currents

Smallest setting value: 0.00 s

Largest setting value: 32.00 s
and ∞ (no trip with $I > >$ earth)

2 6 4 1 ■ C H A R A C T . E
D E F I N I T E T I M E

N O R M A L I N V E R S E

V E R Y I N V E R S E

E X T R E M E L Y I N V E R S E

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 INVERSE time (type C acc. IEC 60255–3)

2 6 4 2 ■ I E >

2 . 0 0 I / I_n

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

2 6 4 3 ■ T - I E >

0 . 3 0 s

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)

2 6 4 4 ■ I E_p

2 . 0 0 I / I_n

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

2 6 4 5 ■ T - I E_p

0 . 5 0 s

Time multiplier for earth currents

Smallest setting value: **0.50** s

Largest setting value: **32.00** s

2 6 4 6 ■ M E A S . F O R M

W I T H O U T H A R M O N .

W I T H H A R M O N I C S

Only for inverse time protection:

The fundamental wave of the measured current is evaluated *WITHOUT HARMONICS*

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

2 6 5 1 ■ M A N . C L O S E

I E > > U N D E L A Y E D

I E > / I E_p U N D E L A Y .

I N E F F E C T I V E

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

$I_{E>>}$ i.e. $I_{E>>}$ stage but without delay

$I_{E>}/I_{Ep}$ i.e. $I_{E>}$ stage (definite time) or I_{Ep} stage (inverse time) but without delay

INEFFECTIVE, i.e. stages operate as parameterized

2 6 5 3 ■ R A R Z O N E

I E > > W I T H A R

I E > > A L W A Y S

AR function operates with the $I_{E>>}$ stage:

$I_{E>>}$ *WITH AR* i.e. $I_{E>>}$ is released only if AR is ready

$I_{E>>}$ *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:

Setting value τ [min] =

$$\frac{1}{60} \cdot \left(\frac{\text{permissible 1 s current}}{\text{continuously permissible current}} \right)^2$$

If the short-term 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:

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

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

2 7 0 2

K - F A C T O R

1 . 1 0

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

2 7 0 3

T - C O N S T A N T

1 0 0 . 0 m i n

Time constant τ
 Setting range: **1.0 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 $\Theta_{\text{warn}}/\Theta_{\text{trip}}$

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.

2 7 0 4

Θ w a r n

9 0 %

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

2 7 0 5

I w a r n

1 . 0 0 I / I n

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

2 7 0 6

O / L C A L C U L

Θ M A X

Θ M E A N

Θ F R O M I M A X

Calculation mode decisive for thermal thresholds
MAXimum 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 4.7.4. 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).

↑↓ 2 9 0 0 ■ M E A S . V A L U E
S U P E R V I S I O N

Beginning of block
"Measured value supervision"

↑↓ 2 9 0 3 ■ S Y M . I t h r e s
0 . 5 0 I / I_N

Current threshold above which the symmetry monitoring is effective (refer Figure 4.3)

Smallest setting value: $0.10 \cdot I_N$

Largest setting value: $1.00 \cdot I_N$

↑↓ 2 9 0 4 ■ S Y M . F a c t . I
0 . 5 0

Symmetry factor for the current symmetry = slope of the symmetry characteristic (see Figure 4.3)

Smallest setting value: 0.10

Largest setting value: 0.95

↑↓ 2 9 0 5 ■ S U M . I t h r e s
0 . 1 0 I / I_N

Current threshold above which the summation monitoring (refer Figure 4.2) reacts (absolute content, related to I_N only)

Smallest setting value: $0.10 \cdot I_N$

Largest setting value: $2.00 \cdot I_N$

↑↓ 2 9 0 6 ■ S U M . F a c t . I
0 . 1 0

Relative content (related to the maximum conductor current) for operation of the current summation monitoring (refer Figure 4.2)

Smallest setting value: 0.00

Largest setting value: 0.95

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, expired times, or similar. As defined, a network fault begins with pick-up of any fault detector and ends after drop-off of the last protection function.
- 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 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 "Syst. Flt" together with the sequence number of the fault. Detailed information about the history of the fault is contained in blocks "Fault annunciations"; refer 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** = "Coming") or a status is announced "Coming" and "Going" (**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.

↑ ↓
5 1 0 0 ■ O P E R A T I O N A
L A N N U N C I A T I O N S

Beginning of the block "Operational annunciations"

↑ ↓
1 9 . 0 8 . 9 5 1 0 : 0 8
E m e r . m o d e : 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:

> S t a r t F l t R e c
> A n n u n c . 1
> A n n u n c . 2
> A n n u n c . 3
> A n n u n c . 4
> R A R R e l e a s e
> I > > b l o c k

Fault recording started via binary input (C)

User defined annunciation No 1 received via binary input (C/G)

User defined annunciation No 2 received via binary input (C/G)

User defined annunciation No 3 received via binary input (C/G)

User defined annunciation No 4 received via binary input (C/G)

Release signal for AR stages of internal protection functions from an external auto-reclose device (C/G)

I > > stage of emergency overcurrent time protection is blocked from an external device (C/G)

> I E > > b l o c k	$I_E > >$ stage of emergency overcurrent time protection is blocked from an external device (C/G)
> I > / I p b l o c k	$I >$ or I_p stage of emergency overcurrent time protection is blocked from an external device (C/G)
> I E > I E p b l o c k	$I_E >$ or I_{Ep} stage of emergency overcurrent time protection is blocked from external (C/G)
> T r a n s . T r i p	Trigger transfer trip command via binary input (C/G)
> D a t a b l o c k	Block transmission of data via binary input (C/G)
> E x t T r i p	Trigger external local trip command via binary input (C/G)

General operational annunciations of the protection device:

D e v . o p e r a t i v e	Protection device is operative (C/G)
I n i t i a l s t a r t	Initial start of the processor system (e.g. after switching on the auxiliary voltage) (C)
L E D r e s e t	Stored LED indications reset (C)
P a r a m . R u n n i n g	Parameters are being set (C/G)
P a r a m . S e t A	Parameter set A is active (C/G)
P a r a m . S e t B	Parameter set B is active (C/G)
P a r a m . S e t C	Parameter set C is active (C/G)
P a r a m . S e t D	Parameter set D is active (C/G)
S y s t . F l t	Network fault (C/G), detailed information in the fault annunciations
M a n u a l C l o s e	Manual close command registered (impulse) (C)
C B i n T e s t	Internal circuit breaker test in progress (C/G)
F l t . R e c . v i a B I	Fault recording started via binary input (C)
F l t . R e c . v i a K B	Fault recording started via front keyboard (C)
F l t . R e c . v i a P C	Fault recording started via operating (PC) interface (C)
F l t . R e c D a t D e l	Fault recording data deleted (C)
C o m . F l t R e c	Commissioning fault record triggered (C)

Annunciations of monitoring functions:

W r o n g S W - v e r s	Wrong software version (C)
W r o n g d e v . I D	Wrong device identification number (C)
A n n u n c . l o s t	Annunciations lost (buffer overflow) (C)
A n n u . P C l o s t	Annunciations for operating (PC) interface lost (C)
O p e r . A n n . I n v a	Operational annunciations invalid (C/G)
F l t . A n n . I n v a l	Fault annunciations invalid (C/G)
S t a t . B u f f . I n v	Buffer for operation statistics invalid (C/G)
L E D B u f f . I n v a	Buffer for stored LEDs invalid (C/G)
V D E W - S t a t e I n v	State of VDEW/ZVEI compatible annunciations (IEC 60870-5-103) at the system interface invalid (C/G)
C h s E r r o r	Check-sum error detected (C/G)
C h s A E r r o r	Check-sum error detected for parameter set A: no operation possible with this set (C/G)
C h s B E r r o r	Check-sum error detected for parameter Set B: no operation possible with this set (C/G)
C h s C E r r o r	Check-sum error detected for parameter set C: no operation possible with this set (C/G)
C h s D E r r o r	Check-sum error detected for parameter set D: no operation possible with this set (C/G)
F a i l u r e 2 4 V	Failure in internal supply voltage 24 V (C/G)
F a i l u r e 1 5 V	Failure in internal supply voltage 15 V (C/G)
F a i l u r e 5 V	Failure in internal supply voltage 5 V (C/G)
F a i l u r e 0 V	Failure in offset voltage 0 V (C/G)
F a i l u r e I / O	Failure on base input/output p.c.b. (C/G)
F a i l u r e R K A	Failure in trip relay control circuit (C/G)
L S A d i s r u p t e d	Serial system link to LSA disrupted (C/G)
F a i l u r e Σ I	Failure detected by current plausibility monitor Σ I (C/G)
F a i l u r e I s y m m	Failure detected by current symmetry monitor (C/G)

Operational annunciations of current comparison protection:

C C P o f f	Current comparison protection is switched off (C/G)
C C P b l o c k e d	Current comparison protection is blocked (C/G)
C C P a c t i v e	Current comparison protection is active (C/G)
I t r . s e n d o f f	Intertrip signal send circuit is switched off (C/G)
I t r . r e c . o f f	Intertrip signal reception circuit is switched off (C/G)
I . T r i p S e n d	Intertrip send signal transmitted to remote end (C)
I . T r i p R e c .	Intertrip signal received from remote end (C)
C C P T e s t	Current comparison protection is in test (C/G)
> D a t a b l o c k	Block transmission of data via binary input (C/G)
T T C o r r . o f f	Automatic transmission time correction is switched off (C/G)
T T C o r r e c t e d	Transmission time has been corrected (C)
T T D e v . > 0 . 5 m s	Deviation in transmission time of more than 0.5 ms has been detected (C/G)
T T b l o c k s C C P	Current comparison protection is blocked because of transmission time deviation > 1 ms (C/G)
D a t a F a u l t	Faulty protection data received (C/G)
R e c e p . F a i l .	Total reception failure of comparison protection data (C/G)
W r o n g V e r s i o n	Wrong firmware version installed (C/G)
W r o n g D e v . I D	Wrong device identification number; does not correspond with device ident of remote end (C/G)

Operational annunciations of external local trip and transfer trip/annunciation facilities:

E x t o f f	External local trip facility is switched off (C/G)
E x t a c t i v e	External local trip facility is active (C/G)
> E x t T r i p	Trigger external local trip command via binary input (C/G)
E x t G e n . T r i p	External local trip command issued (C)
T r a n s T r i p o f f	Transfer trip transmitter is switched off (C/G)
T . T r i p R e c . o f f	Transfer trip receiver is switched off (C/G)
T . T r i p a c t i v e	Transfer trip facility is active (C/G)
> T r a n s . T r i p	Trigger transfer trip command via binary input (C/G)
T r T r i p S e n d	Transfer trip send signal transmitted (C)
T . T r i p r e c .	Transfer trip signal received (C)
T r a n s f e r T r i p	Trip command due to remote transfer trip signal issued (C)
T r a n s . A n n u . 1	User defined transfer annunciation No 1 received from remote end (C/G)
T r a n s . A n n u . 2	User defined transfer annunciation No 2 received from remote end (C/G)
T r a n s . A n n u . 3	User defined transfer annunciation No 3 received from remote end (C/G)
T r a n s . A n n u . 4	User defined transfer annunciation No 4 received from remote end (C/G)

Operational annunciations of emergency overcurrent time protection:

E m e r . P h . o f f	Emergency overcurrent time protection for phase currents is switched off (C/G)
E m e r . E / F o f f	Emergency overcurrent time protection for earth current is switched off (C/G)
E m e r . a c t i v e	Emergency overcurrent time protection is active (C/G)
E m e r . m o d e	Emergency overcurrent time mode is running (C/G)

Operational annunciations of the thermal overload protection:

O / L P r o t . o f f	Thermal overload protection is switched off (C/G)
O / L a c t i v e	Thermal overload protection is active (C/G)
O / L W a r n I	Overload protection current warning stage (C/G)
O / L W a r n Θ	Overload protection thermal warning stage (C/G)
O / L T r i p	Trip by overload protection (C/G)

Further messages:

T a b l e o v e r f l o w	If more messages have been received the last valid message is Table overflow.
E n d o f t a b l e	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 \uparrow or \downarrow . With the keys \uparrow or \downarrow one can page the individual annunciations forwards or backwards. Each annunciation is assigned with a sequence item number.

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.

5 2 0 0 ■ L A S T
F A U L T

Beginning of the block "Fault annunciations of the last system fault"

0 0 1 ■ 1 9 . 0 8 . 9 5
S y s t . F l t 8 9

under item 1, the date of the system fault is indicated, in the second line the consecutive number of the system fault

0 0 2 ■ 1 7 : 1 4 : 1 5 . 2 8 3
F a u l t : C

under item 2, the time of recognition of the fault is given; time resolution is 1 ms

0 0 3 ■ 0 m s
C C P . F l t . L 1 : C

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.

0 0 4 ■ 6 m s
C C P T r i p L 1 2 3 : C

0 0 5 ■ 1 1 5 m s
D e v . D r o p - o f f : C

etc.

General fault annunciations of the device:

S y s t . F l t	System fault with consecutive number
F a u l t	Beginning of fault
F l t . B u f f . O v e r	Buffer for fault annunciations overflow
> R A R R e l e a s e	Release signal for AR stages of internal protection functions from an external auto-reclose device (only when during a fault)
I L 1 / I n =	Interrupted fault current of phase L1
I L 2 / I n =	Interrupted fault current of phase L2
I L 3 / I n =	Interrupted fault current of phase L3
D e v . D r o p - o f f	Drop-off of the device, general

Fault annunciations of current comparison protection:

C C P . G e n . F l t .	General fault detection of current comparison protection
C C P . F a u l t L 1	Fault detection current comparison protection, phase L1
C C P . F a u l t L 2	Fault detection current comparison protection, phase L2
C C P . F a u l t L 3	Fault detection current comparison protection, phase L3
F l t . I . T r i p	Fault detection of intertrip circuit (start)
C C P . G e n . T r i p	General trip signal of current comparison protection
C C P . T r i p L 1 2 3	Trip three-pole by current comparison protection

Fault annunciations of emergency overcurrent time protection:

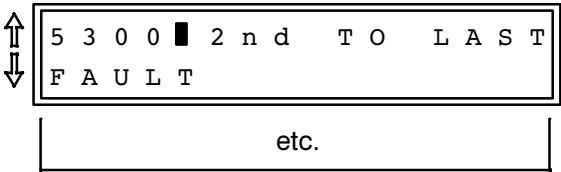
E m e r . F l t E	Earth fault detection of emergency overcurrent time protection
E m e r . F l t L 1	Fault detection emergency overcurrent time protection, phase L1
E m e r . F l t L 1 E	Fault detection emergency overcurrent time protection, phase L1 – earth
E m e r . F l t L 2	Fault detection emergency overcurrent time protection, phase L2
E m e r . F l t L 2 E	Fault detection emergency overcurrent time protection, phase L2 – earth

E m e r . F l t L 1 2	Fault detection emergency overcurrent time protection, phases L1–L2
E m e r . F l t L 1 2 E	Fault detection emergency overcurrent time protection, phases L1–L2–earth
E m e r . F l t L 3	Fault detection emergency overcurrent time protection, phase L3
E m e r . F l t L 3 E	Fault detection emergency overcurrent time protection, phase L3–earth
E m e r . F l t L 1 3	Fault detection emergency overcurrent time protection, phases L1–L3
E m e r . F l t L 1 3 E	Fault detection emergency overcurrent time protection, phases L1–L3–earth
E m e r . F l t L 2 3	Fault detection emergency overcurrent time protection, phases L2–L3
E m e r . F l t L 2 3 E	Fault detection emergency overcurrent time protection, phases L2–L3–earth
E m e r . F l t L 1 2 3	Fault detection emergency overcurrent time protection, phases L1–L2–L3
E m e r . F l t 1 2 3 E	Fault detection emergency overcurrent time protection, phases L1–L2–L3–earth
E m e r . I > >	Fault detection emergency overcurrent protection on high phase current $I > >$
E m e r . I > / I p	Fault detection emergency overcurrent protection phase stage $I >$ (definite time) or I_p (inverse time)
E m e r . I E > >	Fault detection emergency overcurrent protection on high earth current $I_E > >$
E m e r . I E > / I E p	Fault detection emergency overcurrent protection earth stage $I_E >$ (definite time) or I_{Ep} (inverse time)
E m e r . T I > >	Time delay for high phase current stage of emergency overcurrent protection $I > >$ expired
E m e r . T I > / T p	Time delay for phase current stage $I >$ or I_p of emergency overcurrent protection $I > >$ expired
E m e r . T I E > >	Time delay for high earth current stage of emergency overcurrent protection $I_E > >$ expired
E m e r . T I E > T E p	Time delay for earth current stage $I_E >$ or I_{Ep} of emergency overcurrent protection $I > >$ expired
E m e r . T r i p 3 p	Trip three-pole from emergency overcurrent time protection

Further messages:

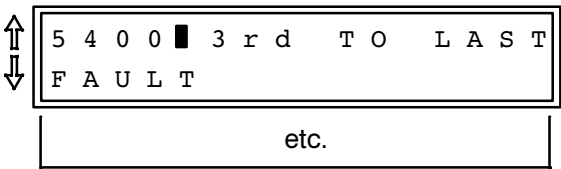
T a b l e e m p t y	means that no fault event has been recorded
T a b l e o v e r f l o w	means that other fault data have occurred, however, memory is full
T a b l e s u p e r c e d e d	a new fault event has occurred during read-out: page on with ↑ or ↓; the display shows the first annunciation in the actualized order
E n d o f t a b l e	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"

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"

6.4.4 Circuit breaker operation statistics – address block 56

The number of trip commands initiated by 7SD511 is counted separately for each of the breaker poles. Also, the interrupted currents are stated for each individual pole and given under the fault annunciations (refer 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 ad-

dress 5600. The address can be reached by direct addressing **DA 5600 E** or by paging with the keys \uparrow or \downarrow until address 5600 is reached. The counters can be called up using the key \uparrow for forwards paging or \downarrow for backwards paging.

Entry of the codeword is not required for read-off of counter states.

$\uparrow \downarrow$ 5 6 0 0 ■ C B O P E R A T .
S T A T I S T I C S

Beginning of the block "Circuit breaker operation statistics"

$\uparrow \downarrow$ 5 6 0 4 ■ T r i p N o L 1 =
4

Number of trip commands for circuit breaker pole L1, e.g. 4

Page on with key \uparrow to get further counter states:

\uparrow 5 6 0 5 ■ T r i p N o L 2 =

Number of trip commands for circuit breaker pole L2

\uparrow 5 6 0 6 ■ T r i p N o L 3 =

Number of trip commands for circuit breaker pole L3

\uparrow 5 6 0 7 ■ $\Sigma I L 1 / I n =$

Accumulated interrupted currents for CB pole L1

\uparrow 5 6 0 8 ■ $\Sigma I L 2 / I n =$

Accumulated interrupted currents for CB pole L2

\uparrow 5 6 0 9 ■ $\Sigma I L 3 / I n =$

Accumulated interrupted currents for CB pole L3

The maximum values of the counters are:

- TripNo L1, TripNo L2, TripNo L3
- $\Sigma I L 1 / I n$, $\Sigma I L 2 / I n$, $\Sigma I L 3 / I n$

9 digits

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 5700 E** or by paging with \uparrow or \downarrow . The individual measured values can be found by further paging with \uparrow or \downarrow . 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).

5700 ■ OPERATIONAL
MEAS. VALUES a

Beginning of the block "Operational measured values of the local line end a"

Use \uparrow key to move to the next address with the next measured value:

5701 ■ MEAS. VALUE
IL1a = 1060 A

Page on with the \uparrow key to read off the next address with the next measured value, or page back with \downarrow .

5702 ■ MEAS. VALUE
IL2a = 1085 A

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**.

5703 ■ MEAS. VALUE
IL3a = 1073 A

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 Section 6.3.3).

5704 ■ MEAS. VALUE
IEa = 3 A

5710 ■ MEAS. VALUE
IL1a [%] = 106.0 %

The percentage is related on rated current

5 7 1 1 ■ MEAS . VALUE
I L 2 a [%] = 1 0 8 . 5 %

5 7 1 2 ■ MEAS . VALUE
I L 3 a [%] = 1 0 7 . 3 %

5 7 1 3 ■ MEAS . VALUE
I E a [%] = 0 . 3 %

5 7 2 0 ■ MEAS . VALUE
T T = 0 . 3 m s

Signal transmission time between remote end and local end

5 8 0 0 ■ OPERATIONAL
MEAS . VALUES b

Beginning of the block "Operational measured values of the remote line end b"

5 8 0 1 ■ MEAS . VALUE
I L 1 b = 1 0 5 8 A

Page on with the ↑ key to read off the next address with the next measured value, or page back with ↓.

5 8 0 2 ■ MEAS . VALUE
I L 2 b = 1 0 8 3 A

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**.

5 8 0 3 ■ MEAS . VALUE
I L 3 b = 1 0 7 1 A

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).

5 8 0 4 ■ MEAS . VALUE
I E b = 3 A

5 8 1 0 ■ MEAS . VALUE
I L 1 b [%] = 1 0 5 . 8 %

The percentage is related on rated current

5 8 1 1 ■ M E A S . V A L U E
I L 2 b [%] = 1 0 8 . 3 %

5 8 1 2 ■ M E A S . V A L U E
I L 3 b [%] = 1 0 7 . 1 %

5 8 1 3 ■ M E A S . V A L U E
I E b [%] = 2 . 3 %

5 8 1 1 ■ M E A S . V A L U E
I L 2 b [%] = ★ ★ ★ ★ %

If the data link is faulty, no measured values can be received from the remote end; the values are replaced by ★★ (example for current I_{L2b}).

5 9 0 0 ■ O V E R L O A D
M E A S U R E D V A L U E S

Beginning of block "Overload measured values"

5 9 0 1 ■ O / L V A L U E
Θ / Θ t r i p L 1 = 8 6 %

Page on with the ↑ key to read off the next address with the next measured value, or page back with ↓.

5 9 0 2 ■ O / L V A L U E
Θ / Θ t r i p L 2 = 8 8 %

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**.

5 9 0 3 ■ O / L V A L U E
Θ / Θ t r i p L 3 = 8 7 %

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;

5 9 0 4 ■ O / L V A L U E
Θ / Θ t r i p = 8 8 %

If the thermal overload function is not available or switched off, no measured values can be displayed; the values are replaced 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.

↑ ↓
 9 2 0 0 ■ D A T A T R A N S
 F A U L T S T A T I S T I C

Beginning of the block "Data transmission fault statistics"

Use ↑ key to move to the next address:

↑ ↓
 9 2 0 1 ■ T r a n s . F l t . =
 x x x x x 1 / h

Number of recognized transmission faults per hour
 (max. 65535)

↑ ↓
 9 2 1 1 ■ T r a n s . F l t . =
 x x x x x 1 / m

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. 7SD511 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.

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 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 \uparrow forwards or \downarrow 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"

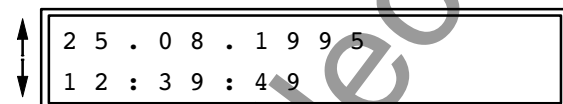
6.5.1 Adjusting and synchronizing the real time clock – address block 81

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 \uparrow and \downarrow . Input of the codeword is required to change the data.

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



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



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



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 \pm 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 \uparrow or \downarrow or directly by keying in the code **DA 8200 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 \uparrow \downarrow . 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.

\uparrow
8 2 0 0 ■
 \downarrow
R E S E T

Beginning of block "Reset"

\uparrow
8 2 0 1 ■ R E S E T
 \downarrow
L E D ?

Request whether the LED memories should be reset

\uparrow
8 2 0 2 ■ R E S E T
 \downarrow
O P E R A T . A N N U N C . ?

Request whether the operational annunciation buffer store should be erased

\uparrow
8 2 0 3 ■ R E S E T
 \downarrow
F A U L T A N N U N C . ?

Request whether the fault annunciation buffer store should be erased

\uparrow
8 2 0 4 ■ R E S E T
 \downarrow
C O U N T E R S ?

Request whether the CB operation counters should be set to zero

\uparrow
8 2 0 5 ■ R E S E T
 \downarrow
T O T A L I s c ?

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.

8 2 0 2 ■ R E S E T
S U C C E S S F U L

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.

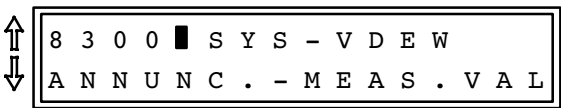
Entry of the codeword is necessary for this (refer to Section 5.3.1).

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.

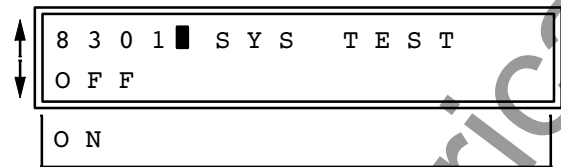
In order to accomplish this switch-over, address block 83 is available provided the VDEW/ZVEI protocol (IEC 60870–5–103) has been chosen during configuration of the serial system interface (Section

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 annunciations (IEC 60870–5–103) 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 \uparrow or \downarrow . 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 \uparrow or \downarrow . 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 \uparrow key or to scroll backwards with \downarrow .

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 \uparrow 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. If the desired set or possibility appears in the display, press the enter key **E**.

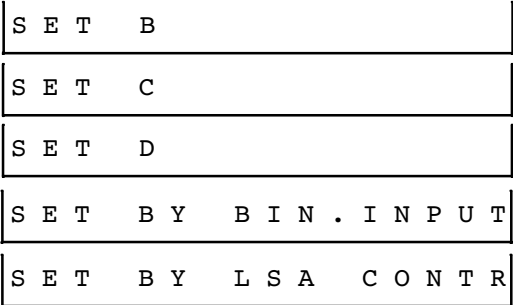
As with every settings of the device for which codeword input is necessary, codeword operation must be terminated. This is done by using the key combination **F E**, i.e. depressing the function key **F** followed by the entry key **E**. The display shows the question "SAVE NEW SETTINGS ?". Confirm with 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 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 2 physical input modules (refer 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 active set
ParamSelec.1	ParamSelec.2	
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

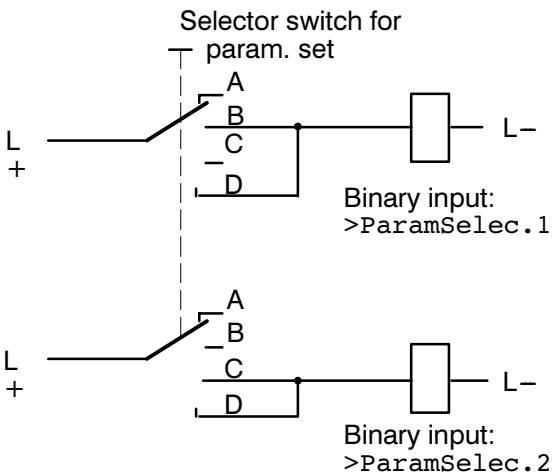


Figure 6.2 Connection scheme for parameter change-over via binary inputs

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

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 $1.33 \times I_N$ is exceeded (factory setting). This is annunciated by LED 1 (factory setting). Furthermore, the trip is annunciated (LED 2 and 3 and 4 as delivered from factory). The closing of the trip contacts and the signal contact must be checked.

The trip signal is reset approximately at $0.05 \times I_N$ (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 $0.3 \times I_N$. Increase current abruptly to $0.7 \times I_N$. 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 $0.3 \times I_N$ to $0.55 \times I_N$. The unit should not pick-up.

For any other setting, the test current for the tripping test is adjusted to approximately $I > DYN$ (address 1504) and abruptly increased by $1.2 \times$ set value for $I > DYN$. For the counter-check, the abrupt increase is from the set value $I > DYN$ by $0.8 \times$ 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 $1.2 \times$ 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 $2 \times$ 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 $I_{E>>}$ (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- $I_{E>>}$ 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, as above, 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 $I_{E>}$ (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- $I_{E>}$ 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 $4 \times I_N$, 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 I_{Ep} (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 I_p) 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

The overload protection 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 $5 \times \tau$) a steady-state temperature rise according to the following relationship is established:

$$\frac{\Theta}{\Theta_{\text{trip}}} = \frac{1}{k^2}$$

This value can be read out in address block 59 for each phase. For different setting values k , test current should be lower than $k \times I_N$ (e.g. 90%).

To check the time constant, the current input is simply subjected to 1.6 times the pick-up value, i. e. $1.6 \times k \times I_N$. 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 $5 \times \tau$.



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 $5 \times \tau$.

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.).

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.

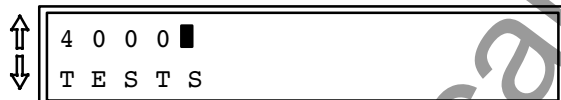
If other transmission methods are employed and the distance does not exceed 15 km, then only the time delay caused by the coupling devices and intermediate amplifiers (if applicable) need be considered. If the signal transmission time does not exceed 0.2 ms, compensation is not required. The transmission 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.

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.



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 cannot proceed and a respective message is annunciated on the display.

4 1 0 1 ■ T R A N S M . T I M E x x x . x m s	Annunciation of measurement transmission time for protection data transmission link (resolution 0.1 ms)
F L T . I N P R O G R E S S	Network fault is in progress
D A T A A B S E N T	No data reception from the opposite end
M E A S . A B O R T E D	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 $0.1 \times I_N$ 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 indi-

cated 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.

4 1 1 0 ■ A N G L E M E A S U R E M E N T	Block "Angle measurement"
--	---------------------------

Testing of the various phase angles is selected with keys ↑ and ↓.

4 1 1 1 ■ A N G L E L 1 - 2 M E A S U R E M E N T ?	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.

4 1 1 1	■	A N G L E	L 1 - 2
1 2 0		d e g	
L O A D T O O S M A L L			
F L T . I N P R O G R E S S			

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.

4 1 1 2	■	A N G L E	L 2 - 3
1 2 0		d e g	

Indication of phase angle measurement between phase currents L2 and L3 at the same line end (expected value with correct connections: 120 deg)

4 1 1 3	■	A N G L E	L 3 - 1
1 2 0		d e g	

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).

4 1 2 1	ANGLE	L 1 - 1
x x x	deg	

L O A D	T O O	S M A L L
---------	-------	-----------

F L T .	I N	P R O G R E S S
---------	-----	-----------------

D A T A	A B S E N T
---------	-------------

M E A S .	A B O R T E D
-----------	---------------

4 1 2 2	ANGLE	L 2 - 2
x x x	deg	

4 1 2 3	ANGLE	L 3 - 3
x x x	deg	

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 one line end.

Read out the steady-state charging current in address block 57. Check that the dynamic threshold $I > \text{DYN}$ (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 $I > \text{DYN CLOS}$ (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 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 – address block 44

Current comparison protection relay 7SD511 allows simple checking of the tripping circuit and the circuit breaker.



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 a binary input, 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 input indicates the circuit breaker position. If the auxiliary contact is assigned to a binary input it must be connected, too. If it is not 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.

Prerequisite for starting the test is that no protection function of the relay be picked up.

↑
↓

4 4 0 0 ■ C B T E S T
L I V E T R I P

Beginning of the block "Circuit breaker test: CB live trip"

↑

4 4 0 4 ■ T R I P
C B T H R E E - P O L E ?
C B C L O S E D ?

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 ↑

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, the circuit breaker auxiliary contact assigned to a binary input and connected, the relay rejects the test as long as

the auxiliary contact indicates 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.

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 ↑:

↑
↓
4 9 0 0 ■ T E S T
F A U L T R E C O R D I N G

Beginning of block "Test fault recording"
page on with ↑ to address 4901

↑
4 9 0 1 ■ F A U L T R E C .
S T A R T ?
S U C C E S S F U L

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 block 78, 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 have 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 module is 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 $4 \times I_N$ 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 calendar 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).

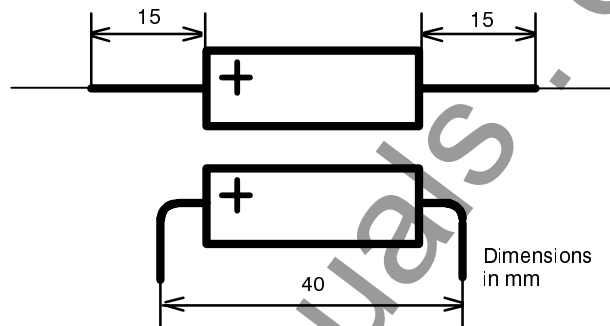


Figure 7.1 Bending the back-up battery (up to production series /DD)

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).

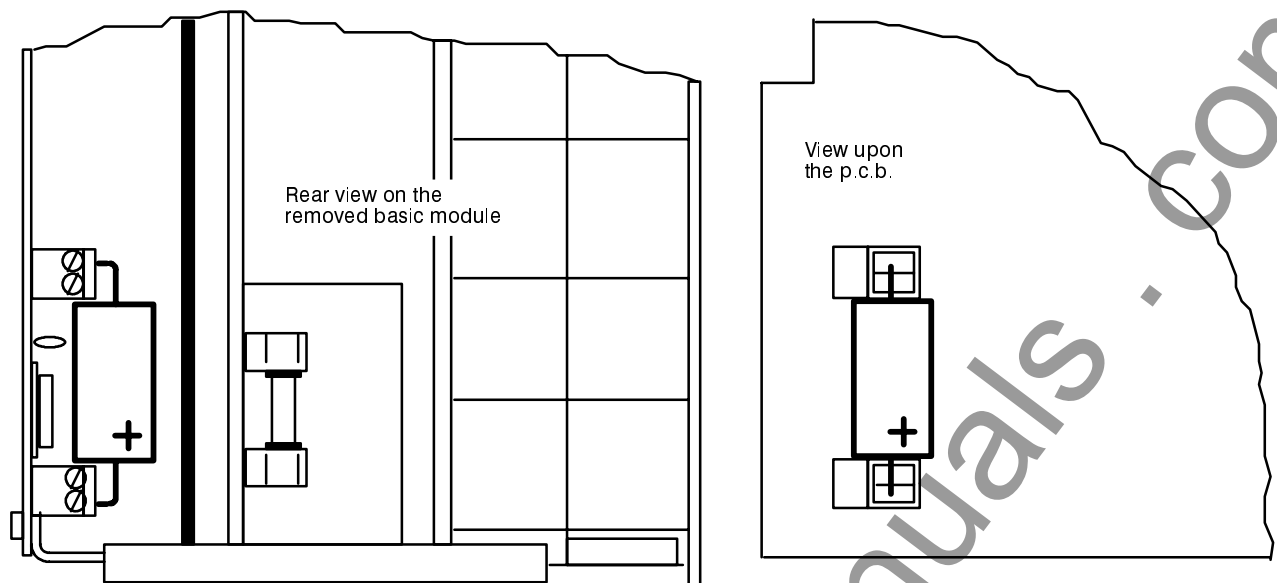


Figure 7.2 Installation of the back-up battery for relay until production series /DD

- 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).

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



Warning

The discharged battery contains Lithium. It must only be disposed off in line with the applicable regulations!

- Close housing cover.

The replacement of the back-up battery has thus been completed.

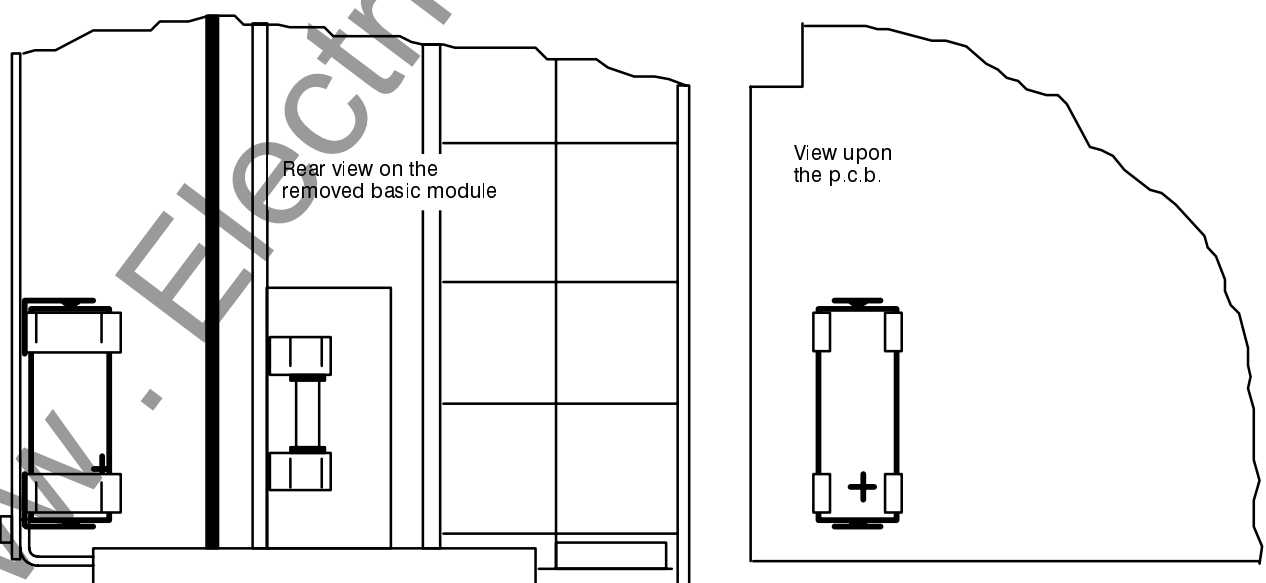


Figure 7.3 Installation of the back-up battery for relay from production series /EE

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.

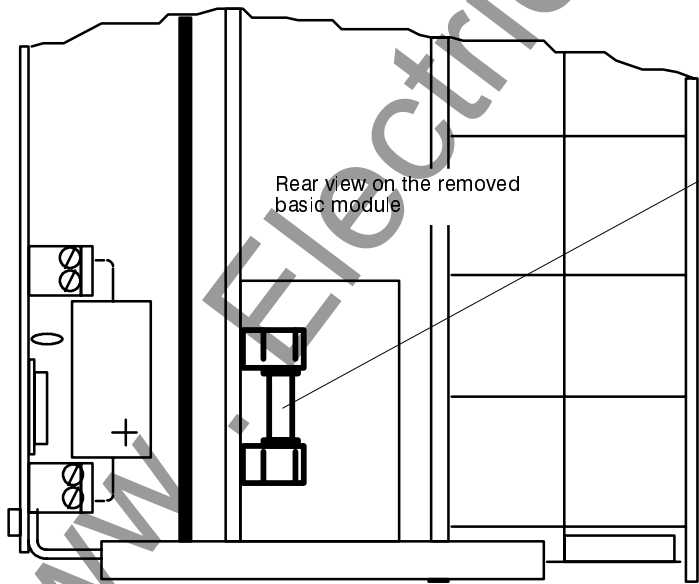


Figure 7.4 Mini-fuse of the power supply

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.

Mini-fuse of the power supply; medium slow (M)

at U _{HN} /V–	rated value
24/48	2 A/E
60/110/125	1,6 A/E
220/250	1 A/G

- 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).

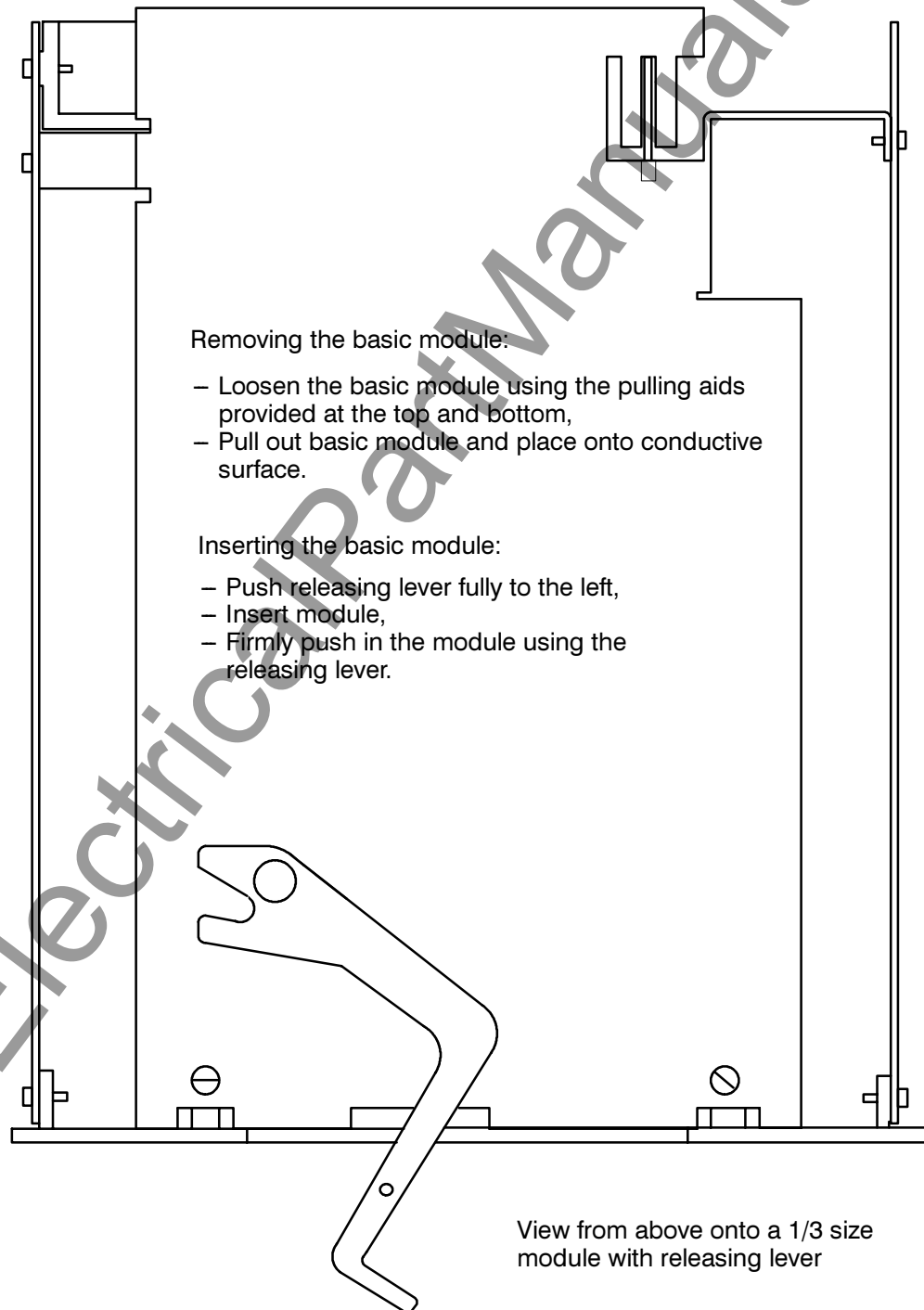


Figure 7.5 Aid for removing and inserting basic module

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 **Electrostatically Endangered Components (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 **Electrostatically Endangered Components** 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 $-25\text{ }^{\circ}\text{C}$ to $+55\text{ }^{\circ}\text{C}$ (refer Section 3.1.4 under the Technical data), corresponding to $-12\text{ }^{\circ}\text{F}$ to $130\text{ }^{\circ}\text{F}$.

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 $+10\text{ }^{\circ}\text{C}$ to $+35\text{ }^{\circ}\text{C}$ ($50\text{ }^{\circ}\text{F}$ to $95\text{ }^{\circ}\text{F}$); 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

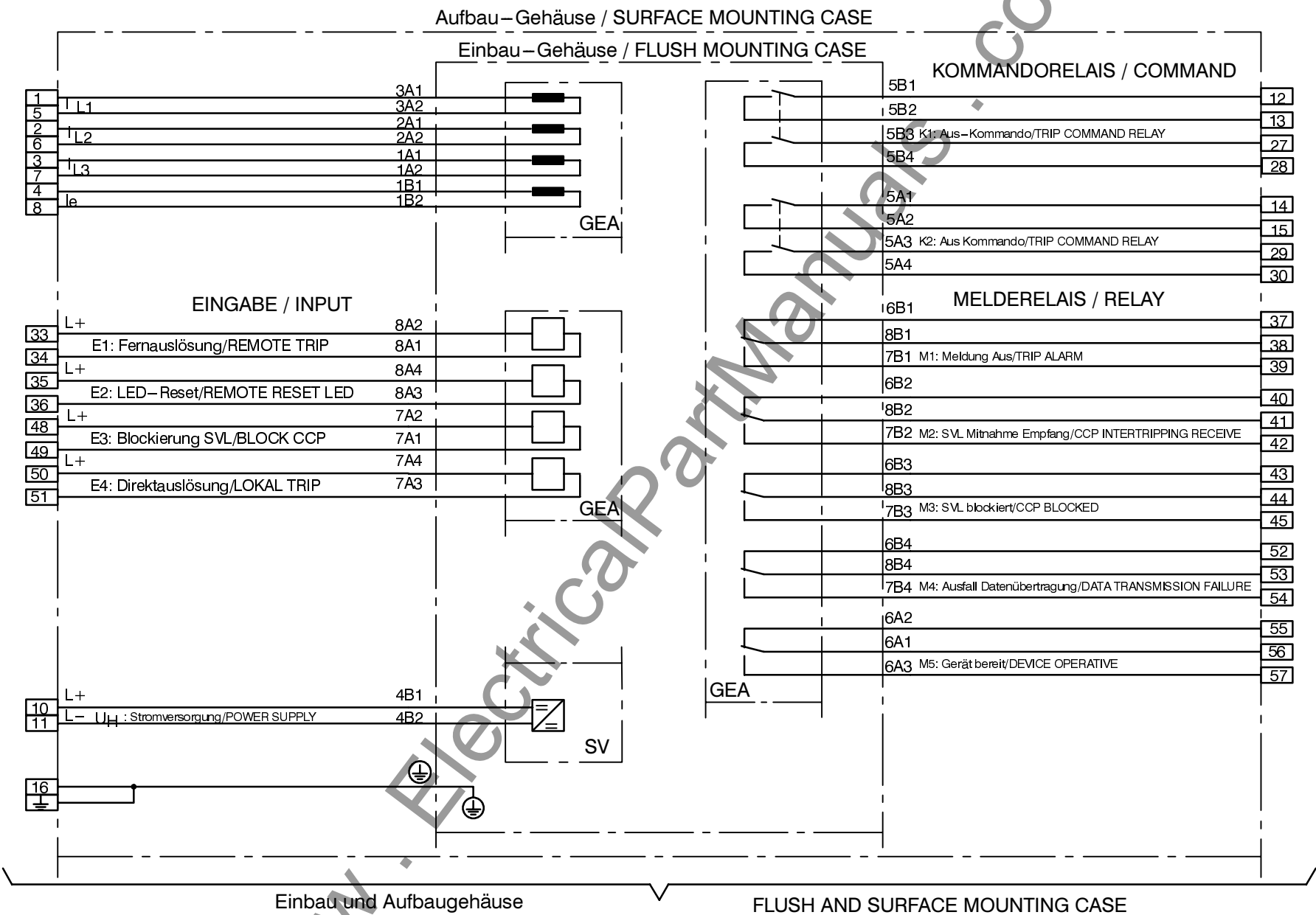
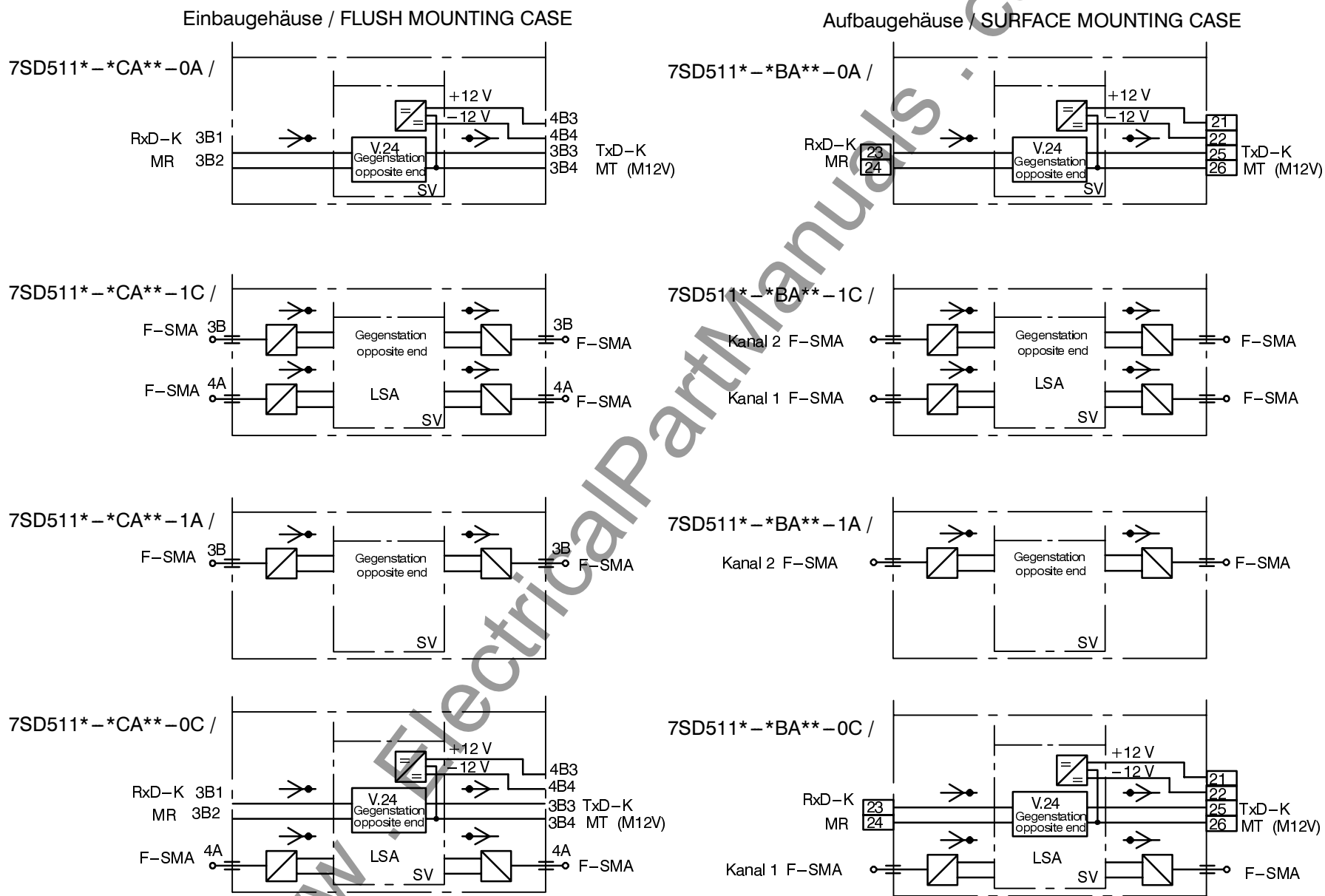
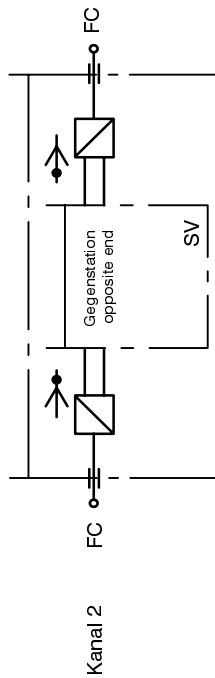


Figure A.1 General diagram of current comparison protection relay 7SD511 (sheet 1 of 3)

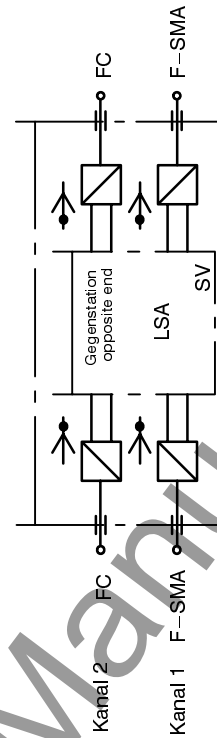
Figure A.2 General diagram of current comparison protection relay 7SD511 (sheet 2 of 3)



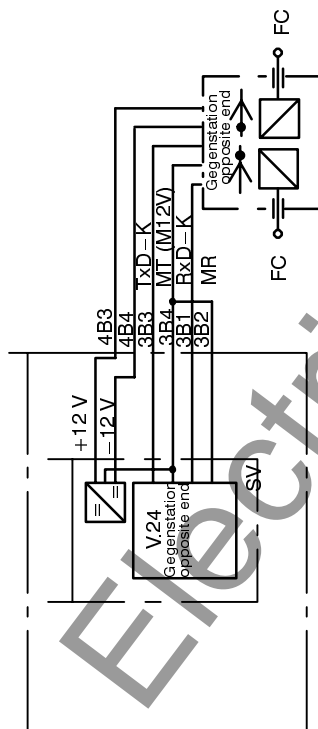
7SD511*-*BA**-2AA0 /



7SD511*-*BA**-2CA0 /



7SD511*-*CA**-2AA0 /



7SD511*-*CA**-2CA0 /

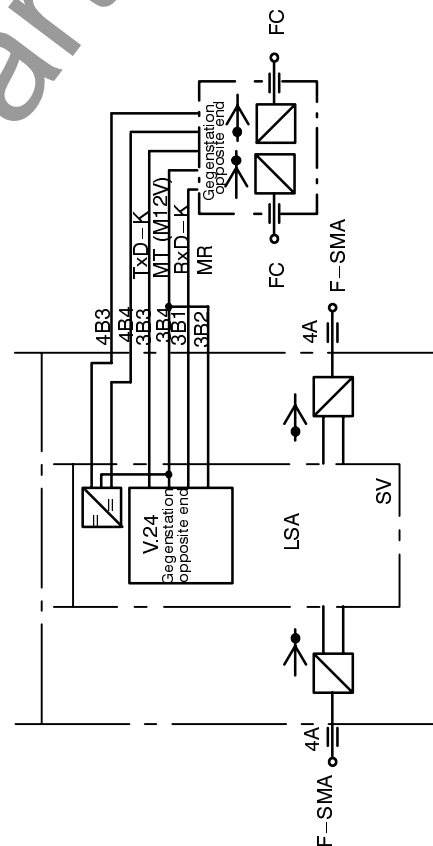


Figure A.3 General diagram of current comparison protection relay 7SD511 (sheet 3 of 3)

B Current transformer connections

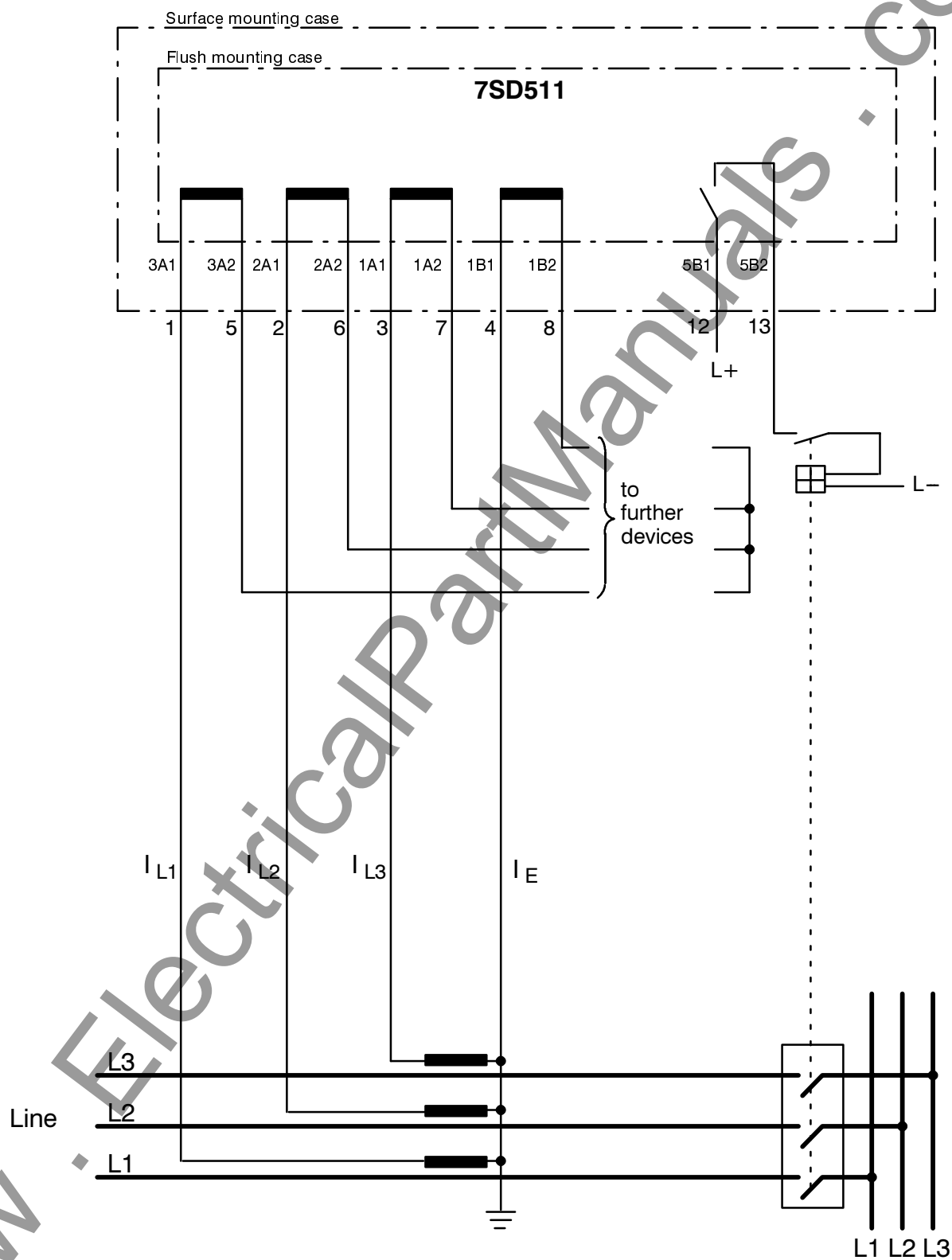


Figure B.1 Connection example for current transformer circuits

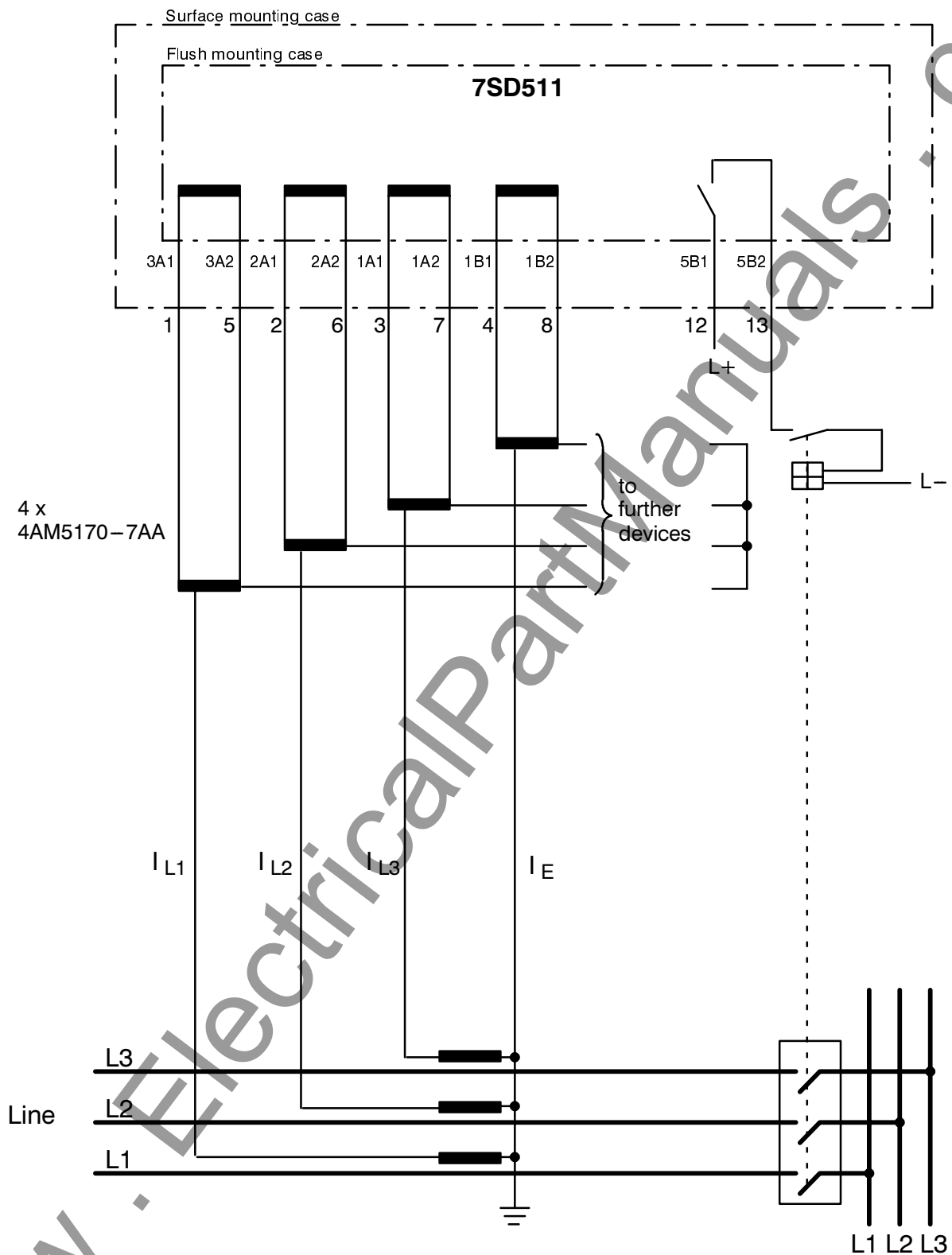


Figure B.2 Connection example with matching transformers 4AM51

C Tables

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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 7SD511 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.		LSA No.	VDEW/ZVEI				
		Op	Ft		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
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
515	General 3pole trip of device	C					BT	150	165

FNo.	Meaning	Ann.		LSA No.	VDEW/ZVEI				
		Op	Ft		CA	GI	BT	Typ	Inf
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
2145	Emerg. O/C protection: Trip 3pole	C		255				61	145
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	CG	209	CA	GI	BT	p	64
3078	Fault detection phase L2 of CCP	CG	CG	211	CA	GI	BT	p	65
3079	Fault detection phase L3 of CCP	CG	CG	215	CA	GI	BT	p	66

FNo.	Meaning	Ann.		LSA No.	VDEW/ZVEI				
		Op	Ft		CA	GI	BT	Typ	Inf
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
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 7SD511 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		
120	Oper.Ann.Inva	Operational annunciations invalid	CG			
121	Flt.Ann.Inval	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
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 Σ I	Failure: Current summation supervision	CG			OT
163	Failure Isymm	Failure: Current symmetry supervision	CG			OT
203	Flt.RecDatDel	Fault recording data deleted	C			
204	Flt.Rec.viaBI	Fault recording initiated via bin.input	C			

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
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		
354	>CB Aux.3p cl	>CB aux. contact:3poles closed (series)				IOT
356	>Manual Close	>Manual close				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
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-overflow 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		
790	Trans.Flt.1/h	UART-errors per hour =		M		
801	@/@trip =	Temperature rise for warning and trip		M		
802	@/@tripL1=	Temperature rise for phase L1		M		
803	@/@tripL2=	Temperature rise for phase L2		M		
804	@/@tripL3=	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		

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
1004	Σ IL1/In=	Summated current tripped IL1/In	M			
1005	Σ IL2/In=	Summated current tripped IL2/In	M			
1006	Σ IL3/In=	Summated current tripped IL3/In	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
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 @	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		
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 L123E	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
2145	Emer.Trip 3p	Emerg. O/C protection: Trip 3pole		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

FNo.	Abbreviation	Meaning	Op	Ft	E	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
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 7SD511

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	—	
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	<input type="checkbox"/>	on
	OFF	<input type="checkbox"/>	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	<input type="checkbox"/>	Theta max
	Θ MEAN	<input type="checkbox"/>	Theta mean
	Θ FROM IMAX	<input type="checkbox"/>	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	—	

Tests and Commissioning Aids 7SD511

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

4400 CB TEST LIVE TRIP

4404 CB TRIP	Circuit breaker trip test 3pole
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4900 TEST FAULT RECORDING

4901 FAULT REC.	Initiation of fault recording
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Annunciations, Measured Values etc. 7SD511

5000 ANNUNCIATIONS

5100 OPERATIONAL ANNUNCIATIONS

5200 LAST FAULT

5300 2nd TO LAST FAULT

5400 3rd TO LAST FAULT

5600 CB OPERAT STATISTICS

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 $\sum IL1/In$ =	Summated current tripped IL1/In
5608 $\sum IL2/In$ =	Summated current tripped IL2/In
5609 $\sum IL3/In$ =	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 @/@tripL1=	Temperature rise for phase L1
5902 @/@tripL2=	Temperature rise for phase L2
5903 @/@tripL3=	Temperature rise for phase L3
5904 @/@trip =	Temperature rise for warning and trip

Reference Table for Configuration Parameters 7SD511

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

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

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

6400 MARSHALLING COMMAND RELAYS

6401 TRIP RELAY 1

Trip relay 1

6402 TRIP RELAY 2

Trip relay 2

7000 OP. SYSTEM CONFIGURATION

7100 INTEGRATED OPERATION

7101 LANGUAGE

Language

DEUTSCH

[]

deutsch

ENGLISH

[]

english

ESPAÑOL

[]

español

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	<input type="checkbox"/>	With fault detection
	WITH TRIP COMM.	<input type="checkbox"/>	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	<input type="checkbox"/>	DIGSI V3
	ASCII	<input type="checkbox"/>	ASCII
7215	PC BAUDRATE		Transmission baud rate for PC-interface
	9600 BAUD	<input type="checkbox"/>	9600 Baud
	19200 BAUD	<input type="checkbox"/>	19200 Baud
	1200 BAUD	<input type="checkbox"/>	1200 Baud
	2400 BAUD	<input type="checkbox"/>	2400 Baud
	4800 BAUD	<input type="checkbox"/>	4800 Baud
7216	PC PARITY		Parity and stop-bits for PC-interface
	DIGSI V3	<input type="checkbox"/>	DIGSI V3
	NO 2 STOP	<input type="checkbox"/>	no parity, 2 stopbits
	NO 1 STOP	<input type="checkbox"/>	No parity, 1 stopbit
7221	SYS INTERF.		Data format for system-interface
	VDEW COMPATIBLE	<input type="checkbox"/>	VDEW compatible
	VDEW EXTENDED	<input type="checkbox"/>	VDEW extended
	DIGSI V3	<input type="checkbox"/>	DIGSI V3
	LSA	<input type="checkbox"/>	LSA
7222	SYS MEASUR.		Measurement format for system-interface
	VDEW COMPATIBLE	<input type="checkbox"/>	VDEW compatible
	VDEW EXTENDED	<input type="checkbox"/>	VDEW extended

7225	SYS BAUDR.		Transmission baud rate for system-interface
	9600 BAUD	<input type="checkbox"/>	9600 Baud
	19200 BAUD	<input type="checkbox"/>	19200 Baud
	1200 BAUD	<input type="checkbox"/>	1200 Baud
	2400 BAUD	<input type="checkbox"/>	2400 Baud
	4800 BAUD	<input type="checkbox"/>	4800 Baud
7226	SYS PARITY		Parity and stop-bits for system-interface.
	VDEW/DIGSIV3/LSA	<input type="checkbox"/>	VDEW/DIGSI V3/LSA
	NO 2 STOP	<input type="checkbox"/>	no parity,2 stopbits
	NO 1 STOP	<input type="checkbox"/>	No parity,1 stopbit
7235	SYS PARAMET		Parameterizing via system-interface
	NO	<input type="checkbox"/>	no
	YES	<input type="checkbox"/>	yes

7400 FAULT RECORDINGS

7402	INITIATION		Initiation of data storage
	STORAGE BY FD.	<input type="checkbox"/>	Storage by fault det
	STORAGE BY TRIP	<input type="checkbox"/>	Storage by trip
	START WITH TRIP	<input type="checkbox"/>	start with trip
7403	SCOPE		Scope of stored data
	FAULT EVENT	<input type="checkbox"/>	Fault event
	FAULT IN POW.SYS	<input type="checkbox"/>	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	<input type="checkbox"/>	660 values fix
	<=3000 VAL. VAR	<input type="checkbox"/>	<=3000 val. var

7800 SCOPE OF FUNCTIONS

7815	CCP FUNCT.		Current comparison protection
	EXIST	<input type="checkbox"/>	Existant
	NON-EXIST	<input type="checkbox"/>	Non-existant

7821	EXT. TRIP		External trip function
	NON-EXIST	[]	Non-existent
	EXIST	[]	Existant
7822	TRANSF.TRIP		Transfer trip
	NON-EXIST	[]	Non-existent
	EXIST	[]	Existant
7826	EMERG. O/C		Emergency overcurrent protection
	NON-EXIST	[]	Non-existent
	EXIST	[]	Existant
7827	THERMAL OL		Thermal overload protection
	NON-EXIST	[]	Non-existent
	EXIST	[]	Existant
7885	PARAM. C/O		Parameter change-over
	NON-EXIST	[]	Non-existent
	EXIST	[]	Existant
7899	FREQUENCY		Rated system frequency
	fN 50 Hz	[]	fN 50 Hz
	fN 60 Hz	[]	fN 60 Hz

7900 DEVICE CONFIGURATION

7910	CB TEST BI		CB test via binary input program
	THREE-POLE TRIP	[]	Three-pole trip
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 7SD511

 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 2

D–13623 BERLIN

Germany

Dear reader,

printing errors can never be entirely eliminated:
therefore, should you come across any when
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gestions for improvement that you may have.

From

Name

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Corrections/Suggestions

Substantial alterations against previous issue:

Data corrected in Section 3.2 (optical fibre connections)

Subject to technical alteration

Siemens Aktiengesellschaft

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