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Numerical Time Overcurrent Protection Relay

with Thermal Overload Protection, Earth Fault Protection, Auto–Reclosure, and Directional Option

7SJ512 V3.2

Instruction Manual Order No. C53000–G1176–C102–4

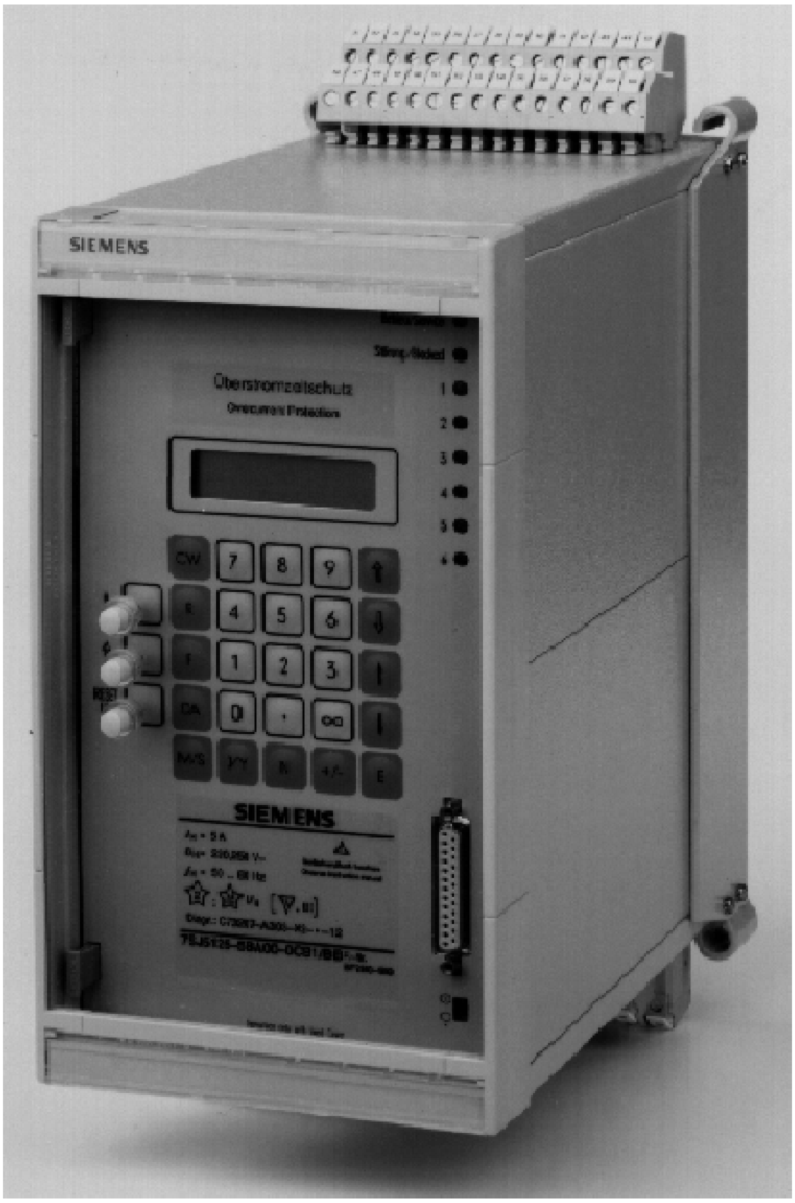

Figure 1 Illustration of the numerical overcurrent time protection 7SJ512 (in housing for surface mounting)

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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).

Contents

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 7SJ512 is used as definite time overcurrent protection or inverse time overcurrent protection for overhead lines, cables, transformers, and motors in high voltage distribution systems with infeed from one single end or radial feeders or open ring feeders. It is also used as back-up protection for comparison protection such as line, transformer, generator, motor, and busbar protection. The treatment of the system star point is of no concern.

For use in systems with infeed from both sides, on ring feeders as well as on parallel lines or transformers with infeed from one side, a directional measuring supplement for all types of faults can be ordered optionally.

The four stage time overcurrent protection (2 time current stages for each of phase currents and earth currents) is supplemented by additional functions such as single- and multi-shot automatic reclosure (for overhead lines), highly sensitive earth fault protection (for isolated or compensated networks as well as for high-resistance earth faults in earthed networks), inrush stabilization (for use on transformer feeders). An integrated thermal overload protection is incorporated for use in cable networks or on transformers or machines.

A special time stage is suitable for breaker failure detection.

Throughout a fault in the network the magnitudes of the instantaneous values are stored for a period of max. 5 seconds and are available for subsequent fault analysis.

Continuous monitoring of the measured values permits rapid annunciation of faults 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. For data transmission a standardized protocol according to IEC 60870–5–103 is used, as well as in accordance with DIN 19244 (selectable). The device can therefore be incorporated in Localized Substation Automation networks (LSA).

1.2 Features

- Processor system with powerful 16-bit-microprocessor;
- complete digital measured value processing and control from data acquisition and digitizing of the measured values up to the trip and close decisions for the circuit breaker;
- 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./d.c. converter;
- complete scope of functions required normally for the protection of a high voltage feeder circuit;
- insensitive against d.c. components, inrush or charging currents and high frequency transients in the measured currents;
- circuit breaker operation test facility by test trip or trip–close sequence;
- comprehensive supplementary functions (refer also to Section 1.3);
- continuous calculation of operational measured values and indication on the front display;
- simple setting and operation using the integrated operation panel or a connected personal computer with menu-guided operation software;
- selection of up to four different sets of functional parameters;
- storage of fault data, storage of instantaneous values during a fault for fault recording, trip current log;
- communication with central control and storage devices via serial interfaces is possible, with optional connection of data cables or optical fibre;
- continuous monitoring of the measured values and the hardware and software of the relay.

1.3 Implemented functions

The unit comprises the following functions:

Time overcurrent protection

– high-set phase current stage I>> with phase segregated fault detection and phase segregated delay timers;

– high-set earth current stage I_E>> with individual delay timer;

– inverse time phase overcurrent stage I_p with phase segregated fault detection and phase segregated time processing;

– alternatively definite time phase overcurrent stage I> with phase segregated fault detection and phase segregated delay timers;

– inverse time earth overcurrent stage I_{Ep} with individual time processing;

– alternatively definite time earth overcurrent stage I_E> with individual delay timer;

– different current time characteristics can be set for phase currents and earth current;

– selection can be made of three standardized characteristics of inverse time overcurrent protection for phase currents, four standardized characteristics of inverse time overcurrent protection for earth current;

– additionally, one user specified current time characteristic can be defined, which is preset with a residual dependent characteristic;

– an alternative set of pick-up values can be set for all current time stages, which can be changed over by external control signal via binary input – even during pick-up of the protection;

– further sets of delay times can be set for all current time stages which are controlled dependent of the internal auto-reclose programs;

– adjustable inrush stabilization for switching of power transformers, selectable for each individual phase or with cross-block function.

Directional time overcurrent protection (optional)

– additional direction-dependent time stages for I_p and I_{Ep} (inverse time) or I> and I_E> (definite time);

– characteristics and time delays can be set individually for each of these stages;

– operation direction individually selectable for each of these stages, forwards or reverse;

– the normal overcurrent time stages remain effective as back-up stages.

Instantaneous dead fault protection

– with selectable stages during switch-onto-fault of the circuit breaker.

Thermal overload protection

– provides thermal replica of the current heat losses;

– true r.m.s. measurement of each of the phase currents;

– adjustable warning stages.

High-sensitivity earth fault protection

– can be set independent of the time overcurrent protection stages for highly sensitive earth fault detection (smallest pick-up value 0.003 A);

– two-stage earth current detection: high-value stage I_{EE}>> and low-value stage I_{EE}>;

– low-value stage with inverse time lag or (selectable) definite time lag;

– selection can be made of four standardized current time characteristics and the user specified characteristic, for inverse time mode;

– each stage can be set directional forwards or reverse or non-directional;

– adjustable directional characteristic;

– can be set to trip or to alarm only;

– displacement voltage detection, optionally with indication or with additional delayed trip;

– discrimination of the earth-faulted phase when used in isolated or compensated systems (model with directional discrimination);

– compensation of current transformer angle error when used in compensated systems.

Intermittent earth fault protection (optional)

– can detect and accumulate intermittent earth faults, can be set to trip after a selectable accumulated time.

Automatic reclose function

– single or multi-shot (e.g. RAR and DAR);

– with separately allocated action times for RAR (rapid AR for first shot) and DAR (delayed AR for further shots);

– with separately allocated dead times for RAR (rapid AR for first shot) and DAR (delayed AR for further shots), individually after single-phase fault and after multi-phase faults;

– individual time stages for each of the phase overcurrent stages, earth overcurrent stages, and high-sensitivity earth fault stages can be controlled for trip before RAR, trip before DAR, and final trip after unsuccessful AR;

– selection can be made which of the overcurrent and earth fault stages do operate with AR, and which do not.

Time stage for breaker failure protection

– initiation by each of the integrated protection functions which lead to trip;

– initiation possible from external protection device via binary input.

User definable annunciations

– four annunciations can be coupled into the relay via binary input from external protection or supervision devices, and can be included into the annunciation processing;

– each user defined annunciation can be optionally delayed and/or allocated to trip relays.

The standard functions also include:

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

– measurement and test routines under normal load conditions:
measurement of load currents and operating voltages,
measurement of power and frequency,
directional and phase sequence check;

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

– storage of data of the last three earth faults in isolated or arc compensated systems;

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

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

– commissioning aids such as directional verification and circuit breaker live test.

2 Design

2.1 Arrangements

All protection functions including dc/dc 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:

– **7SJ512★–★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.

  Guide rails are built in for the support of plug-in modules. On the top and bottom plates of the housing, contact areas which are electrically connected to the housing are installed to mate with the earthing springs 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 module is withdrawn. This does not release from the care to be taken when c.t. secondary circuits are concerned.

  For the optional interface to a central control and storage unit, an additional coupling facility has been provided. For the hard-wired V.24 (RS232C) serial interface (7SJ512★–★★★★★–★**B**), 4 screwed terminals are provided. For the interface for optical fibre connection (model 7SJ512★–★★★★★–★**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.

– **7SJ512★–★C★★★–** in housing 7XP2030–2 for **panel flush mounting** or **7SJ512★–★E★★★–** for **cubicle installation**

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

  Guide rails are built in for the support of plug-in modules. On the top and bottom plates of the housing, contact areas which are electrically connected to the housing are installed to mate with the earthing springs 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 module is withdrawn. This does not release from the care to be taken when c.t. secondary circuits are concerned.

  The optional interface to a central control and storage unit (7SJ512★–★★★★★–★**B**) is led to a 4-pole connection module. In the interface for optical fibre connection (7SJ512★–★★★★★–★**C**), a module with 2 F–SMA connectors is provided instead.

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

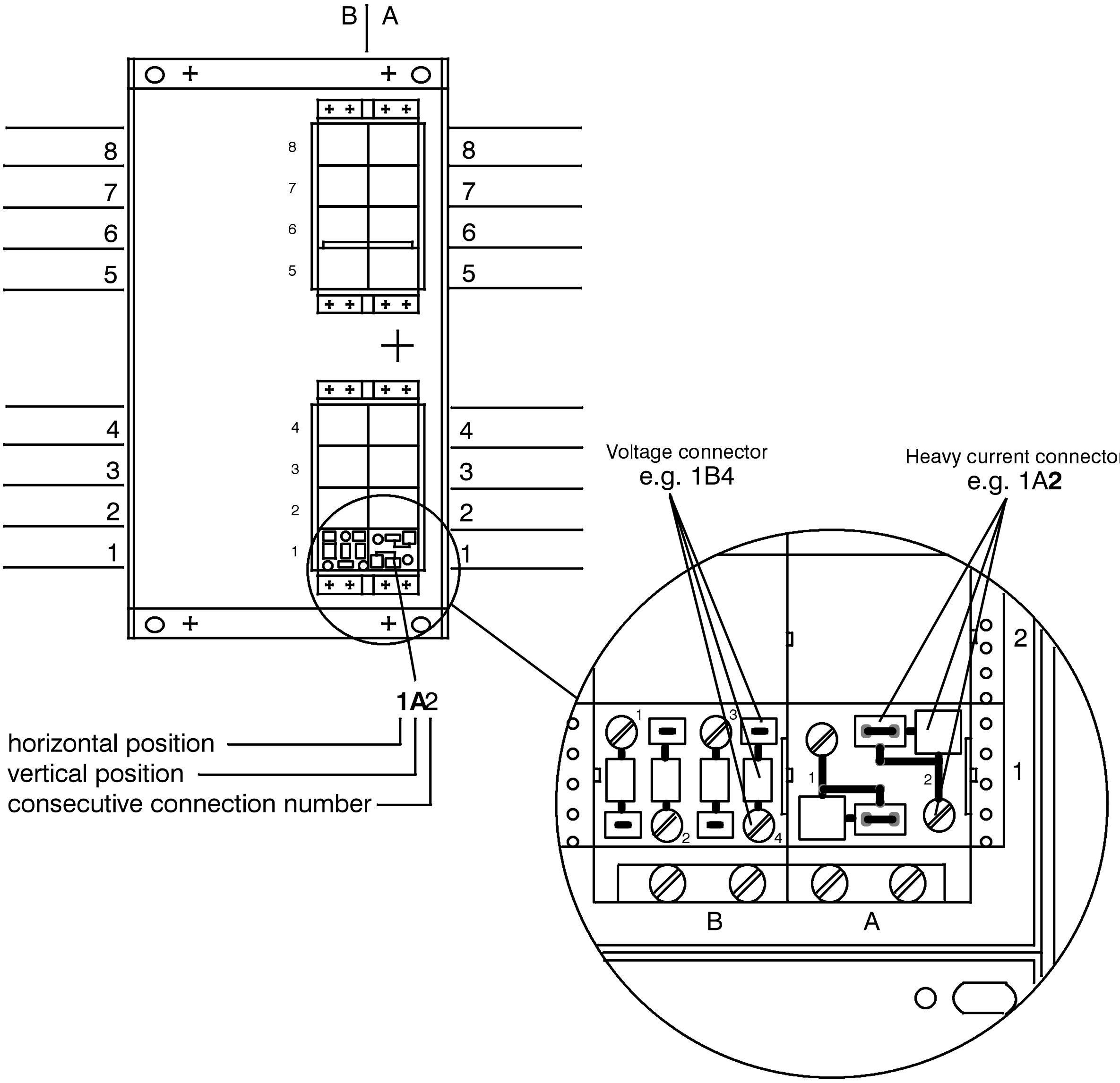
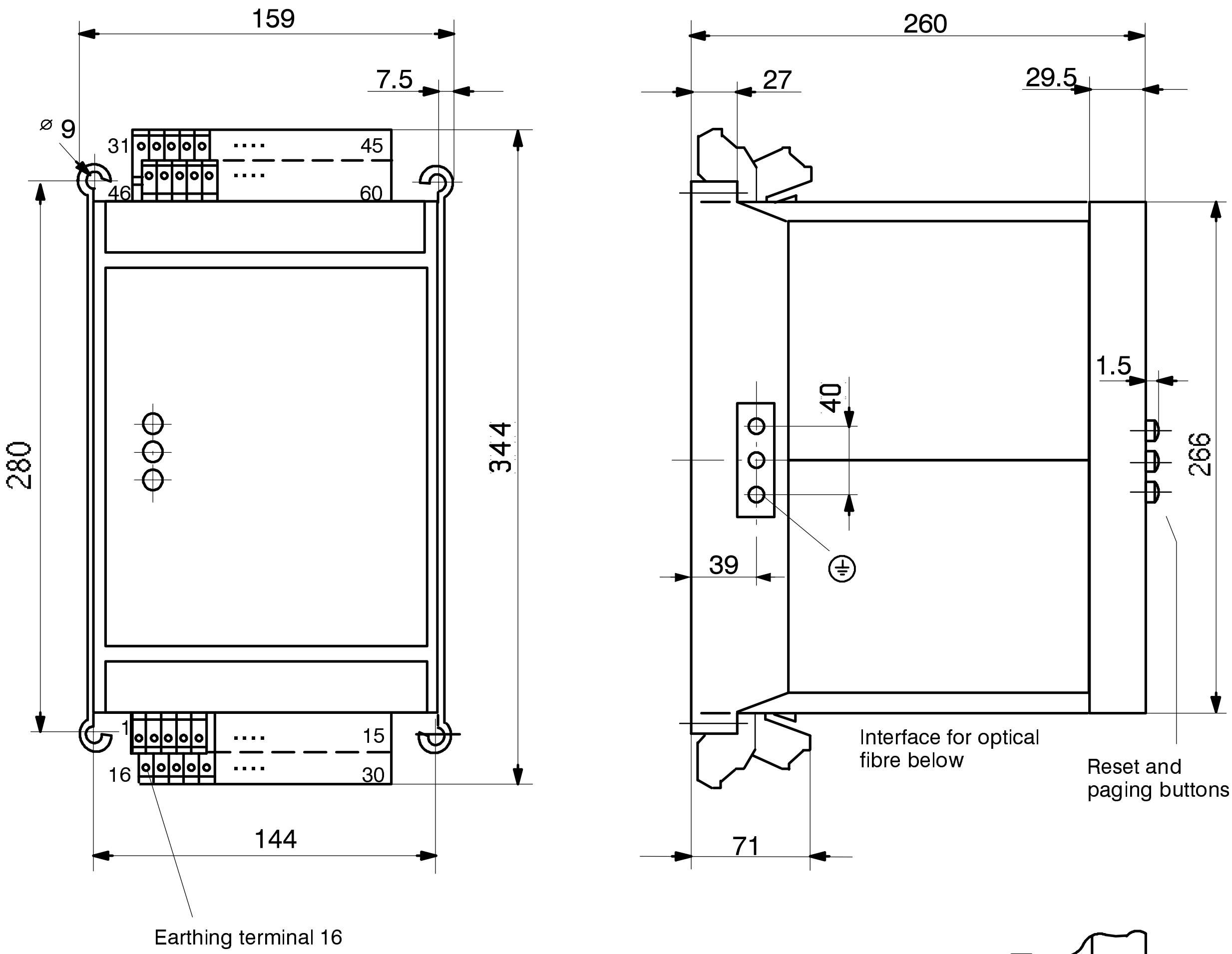


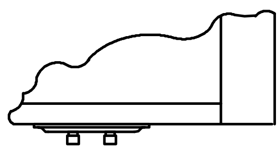
Figure 2.1 Connection plugs (rear view) – housing for flush mounting – example

2.2 Dimensions

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

7SJ512 Housing for **panel surface mounting** 7XP2030−1





Max. 60 terminals for cross-section max. 5 mm^2
Max. torque value 1.7 Nm or 15 in-lb

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

Dimensions in mm

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

7SJ512 Housing for **panel flush mounting** or **cubicle installation** 7XP2030−2

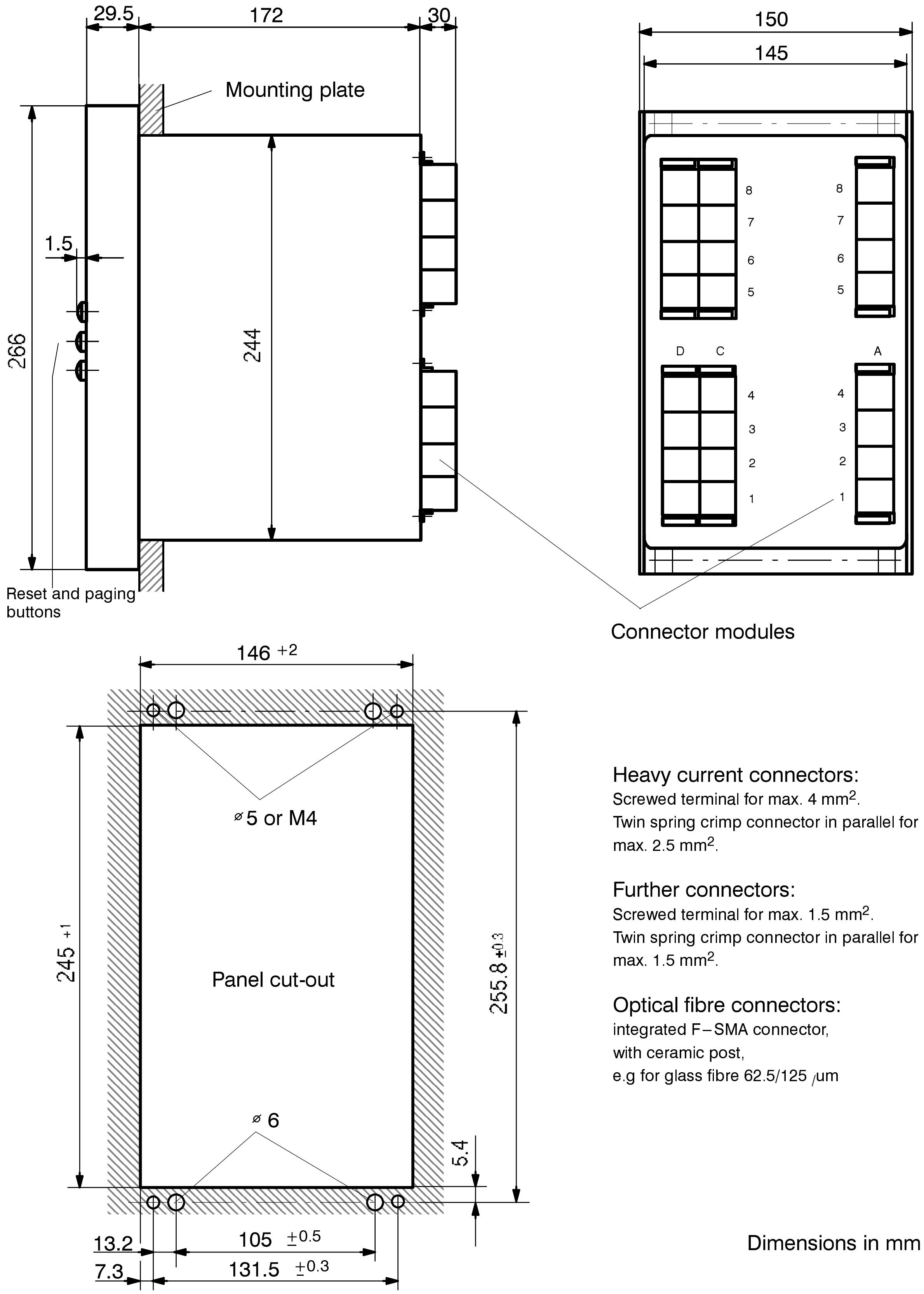


Figure 2.3 Dimensions for housing 7XP2030−2 for panel flush mounting or cubicle installation

2.3 Ordering data

Numerical Time Overcurrent Protection **7 S J 5 1 2** [7.] -- [8.] [9.] A 0 3 -- [13.] [14.] A 0

Position	7.		8.	9.	10.	11.	12.		13.	14.	15.	16.
7 S J 5 1 2	☐	--	☐	☐	A	0	3	--	☐	☐	A	0

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

Complement

Time overcurrent protection with thermal overload protection, auto-reclosure, and high-sensitivity earth fault protection 0

Time overcurrent protection with directional supplement and thermal overload protection, auto-reclosure, and high-sensitivity earth fault protection 1

Time overcurrent protection with thermal overload protection, auto-reclosure, high-sensitivity earth fault protection, and intermittent earth fault protection 2

Time overcurrent protection with directional supplement and thermal overload protection, auto-reclosure, high-sensitivity earth fault protection, and intermittent earth fault protection 3

Serial interface for coupling to a control centre

without serial interface . . . . A

with isolated serial interface (similar V.24 or RS 232 C) . . . . B

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 voltage U_N		100 V to 125 V (settable)
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 path approx 0.2 VA per phase and earth path
– for high-sensitivity earth fault detection at 1 A		approx 0.3 VA
Power consumption	voltage path at 100 V	approx 0.5 VA per phase
Overload capability	current path (phases and earth)	
– thermal (rms)		100 $\times I_N$ for $\leq$1 s 20 $\times I_N$ for $\leq$10 s 4 $\times I_N$ continuous
– dynamic (pulse current)		250 $\times I_N$ one half cycle
Overload capability ct circuit for high-sensitivity earth fault detection		
– thermal (rms)		300 A for 1 second 100 A for 10 seconds 15 A continuous
Overload capability	voltage paths	
– thermal (rms)		140 V continuous

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. 7 W approx. 13 W
Bridging time during failure/short-circuit of auxiliary voltage		$\geq$ 50 ms at $U_{rated} \geq$ 110 Vdc

Heavy duty (command) contacts

Command (trip) relays, number	4
Contacts per relays	2 NO or 1 NO
Switching capacity MAKE	1000 W/VA
BREAK	30 W/VA
Switching voltage	250 V
Permissible current	5 A continuous
	30 A for 0.5 s

Signal contacts

Signal relays, number	9
Contact per relays	1 CO or 1 NO
Switching capacity MAKE/BREAK	20 W/VA
Switching voltage	250 V
Permissible current	1 A

Binary inputs, number	5 or 8 (depending on model)
Operating voltage	24 to 250 Vdc
Current consumption	approx. 1.7 mA, independent of operating voltage

Serial interfaces

Operator terminal interface	non-isolated
– Connection	at the front, 25-pole subminiature connector acc. ISO 2110, for connection of a personal computer
– Transmission speed	as delivered 9600 Baud min. 1200 Baud; max. 9600 Baud
Interface for data transfer to a control centre	isolated (optional)
– Standards	similar V.24/V.28 to CCITT; RS 232 C to EIA protocol according to IEC 60870–5–103, or to DIN 19244
– Transmission speed	as delivered 9600 Baud min. 1200 Baud; max. 19200 Baud
– Transmission security	Hamming distance d = 4
– Connection directly	for flush mounted housing: 4-pole module connector; for surface mounted housing: 4 terminals 2 core pairs, with individual and common screening e.g. LI YCY–CY/2 x 2 x 0.25 mm^2
Transmission distance	max. 1000 m
Test voltage	2 kV; 50 Hz
– 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 μs; 0.5 J; 3 positive and 3 negative shots at intervals of 5 s

EMC tests; immunity (type tests)

Standards:	IEC 60255–6, IEC 60255–22 (product standards) EN 50082–2 (generic standard) VDE 0435 /part 303
– High frequency IEC 60255–22–1, class III	2.5 kV (peak); 1 MHz; τ =15 μs; 400 shots/s; duration 2 s
– Electrostatic discharge IEC 60255–22–2 class III and IEC 61000–4–2, class III	4 kV/6 kV contact discharge; 8 kV air discharge; both polarities; 150 pF; R_i = 330 Ω
– Radio-frequency electromagnetic field, non-modulated; IEC 60255–22–3 (report) class III	10 V/m; 27 MHz to 500 MHz
– Radio-frequency electromagnetic field, amplitude modulated; IEC 61000–4–3, class III	10 V/m; 80 MHz to 1000 MHz; 80 % AM; 1 kHz
– Radio-frequency electromagnetic field, pulse modulated; IEC 61000–4–3/ENV 50204, class III	10 V/m; 900 MHz; repetition frequency 200 Hz; duty cycle 50 %
– Fast transients IEC 60255–22–4 and IEC 61000–4–4, class III	2 kV; 5/50 ns; 5 kHz; burst length 15 ms; repetition rate 300 ms; both polarities; R_i = 50 Ω; duration 1 min
– Conducted disturbances induced by radio-frequency fields, amplitude modulated IEC 61000–4–6, class III	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
– Power frequency magnetic field IEC 61000–4–8, class IV IEC 60255–6	30 A/m continuous; 300 A/m for 3 s; 50 Hz 0.5 mT; 50 Hz

EMC tests; emission (type tests)

Standard:	EN 50081–★ (generic standard)
– Conducted interference voltage, aux. voltage CISPR 22, EN 55022, class B	150 kHz to 30 MHz
– Interference field strength CISPR 11, EN 55011, class A	30 MHz to 1000 MHz

3.1.3 Mechanical stress tests

Vibration and shock during operation	
Standards:	IEC 60255−21 and IEC 60068−2
– Vibration IEC 60255−21−1, class 1 IEC 60068−2−6	sinusoidal 10 Hz to 60 Hz: ± 0.035 mm amplitude; 60 Hz to 150 Hz: 0.5 g acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
– Shock IEC 60255−21−2, class 1	half sine acceleration 5 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
– Seismic vibration IEC 60255−21−3, class 1 IEC 60068−3−3	sinusoidal 1 Hz to 8 Hz: ± 3.5 mm amplitude (hor. axis) 1 Hz to 8 Hz: ± 1.5 mm amplitude (vert. axis) 8 Hz to 35 Hz: 1 g acceleration (hor. axis) 8 Hz to 35 Hz: 0.5 g acceleration (vert. axis) sweep rate 1 octave/min 1 cycle in 3 orthogonal axes
Vibration and shock during transport	
Standards:	IEC 60255−21 and IEC 60068−2
– Vibration IEC 60255−21−1, class 2 IEC 60068−2−6	sinusoidal 5 Hz to 8 Hz: ± 7.5 mm amplitude; 8 Hz to 150 Hz: 2 g acceleration sweep rate 1 octave/min 20 cycles in 3 orthogonal axes
– Shock IEC 60255−21−2, class 1 IEC 60068−2−27	half sine acceleration 15 g, duration 11 ms, 3 shocks in each direction of 3 orthogonal axes
– Continuous shock IEC 60255−21−2, class 1 IEC 60068−2−29	half sine acceleration 10 g, duration 16 ms, 1000 shocks each direction of 3 orthogonal axes

3.1.4 Climatic stress tests

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

Storage and transport with standard works packaging!

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

All units shall be 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

Design

Housing	7XP20; refer to Section 2.1
Dimensions	refer to Section 2.2
Weight	
– in housing for surface mounting	approx. 11.5 kg
– in housing for flush mounting	approx. 9.5 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 Definite time overcurrent protection

Setting range/steps

Overcurrent pick-up I> (phases)	I/I_N	0.05 to 25.00	(steps 0.01)
Overcurrent pick-up I_E> (earth)	I/I_N	0.05 to 25.00	(steps 0.01)
High current pick-up I>> (phases)	I/I_N	0.05 to 25.00	(steps 0.01)
High current pick-up I_E>> (earth)	I/I_N	0.05 to 25.00	(steps 0.01)
Delay times	T	0.00 s to 60.00 s	(steps 0.01 s) or infinite

The set times are pure delay times.

Times

Pick-up times for I>, I>>, I_E>, I_E>>	
– at 2 x setting value, without meas. repetition	approx 33 ms
– at 2 x setting value, with meas. repetition	approx 50 ms
– at 5 x setting value, without meas. repetition	approx 25 ms
– at 5 x setting value, with meas. repetition	approx 40 ms
Reset times for I>, I>>, I_E>, I_E>>	approx 35 ms
Overshot time	approx 35 ms
Reset ratios	approx 0.95

Tolerances

– Pick-up values I>, I>>, I_E>, I_E>>	3 % of setting value
– Delay times T	1 % of setting value or 10 ms

Influence variables

– Auxiliary voltage in range	
$0.8 \leq U_H/U_{HN} \leq 1.15$	$\leq$ 1 %
– Temperature in range	
$0\ °C \leq \vartheta_{amb} \leq 40\ °C$	$\leq$ 0.5 %/10 K
– Frequency in range	
$0.98 \leq f/f_N \leq 1.02$	$\leq$ 1.5 %
– Frequency in range	
$0.95 \leq f/f_N \leq 1.05$	$\leq$ 2.5 %
– Harmonics	
up to 10 % of 3rd harmonic	$\leq$ 1 %
up to 10 % of 5th harmonic	$\leq$ 1 %

3.3 Inverse time overcurrent protection

Setting range/steps

Overcurrent pick-up I_p> (phases)	I/I_N	0.10 to 4.00	(steps 0.01)
Overcurrent pick-up I_{Ep}> (earth)	I/I_N	0.10 to 4.00	(steps 0.01)
Time multiplier for I_p, I_{Ep}	T_p	0.05 to 10.00	(steps 0.01) or 0 or infinite
High current pick-up I>> (phases)	I/I_N	0.05 to 25.00	(steps 0.01)
High current pick-up I_E>> (earth)	I/I_N	0.05 to 25.00	(steps 0.01)
Delay time for I>>, I_E>>	T	0.00 s to 60.00 s	(steps 0.01 s) or infinite

Trip time characteristics

acc. IEC 60255−3 — refer to Figure 3.1

Normal inverse (IEC 60255−3 type A)

$$t = \frac{0.14}{(I/I_p)^{0.02} - 1} \cdot T_p$$

Very inverse (IEC 60255−3 type B)

$$t = \frac{13.5}{(I/I_p)^{1} - 1} \cdot T_p$$

Extremely inverse (IEC 60255−3 type C)

$$t = \frac{80}{(I/I_p)^{2} - 1} \cdot T_p$$

Additionally for earth current (refer Figure 3.2):

Long time inverse (IEC 60255−3 type B)

$$t = \frac{120}{(I/I_p)^{1} - 1} \cdot T_p$$

where:
t tripping time
T_p set time multiplier
I fault current
I_p set pickup value

One additional user specified characteristic can be set.

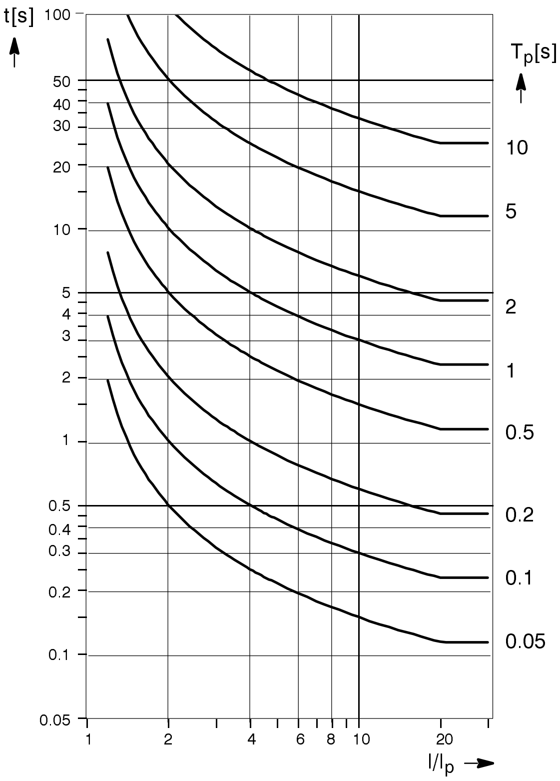
Pick-up threshold — approx. 1.1 · I_p

Tolerances

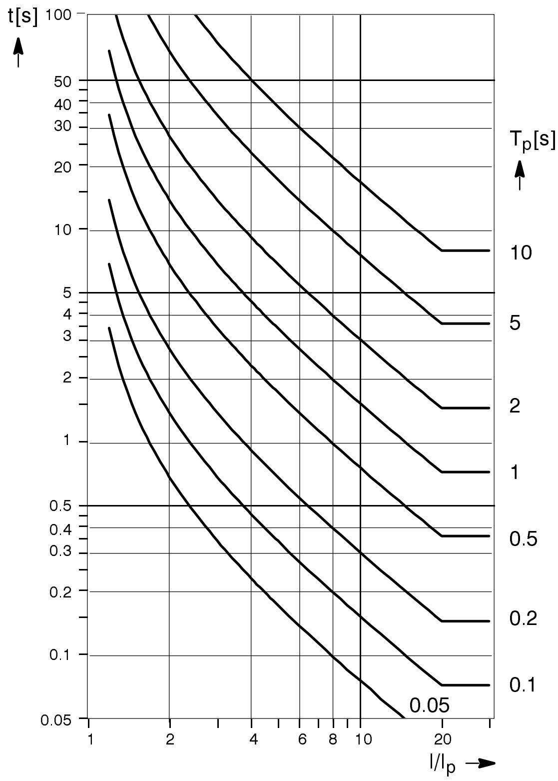
– Pick-up values I>>, I_E>>	3 % of setting value
– Delay time for $2 \leq I/I_p \leq 20$ and $T_p + 1$ fir $T_p \neq 1$	5 % of setting value additionally 2 % or 30 ms

Influence variables

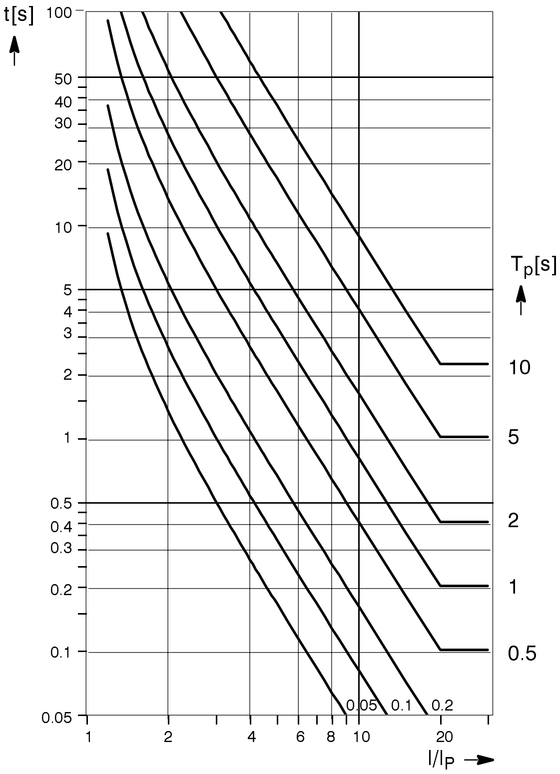
– Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	≤ 1 %
– Temperature in range $0\ °C \leq \vartheta_{amb} \leq 40\ °C$	≤ 0.5 %/10 K
– Frequency in range $0.95 \leq f/f_N \leq 1.05$	≤ 8 %



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



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

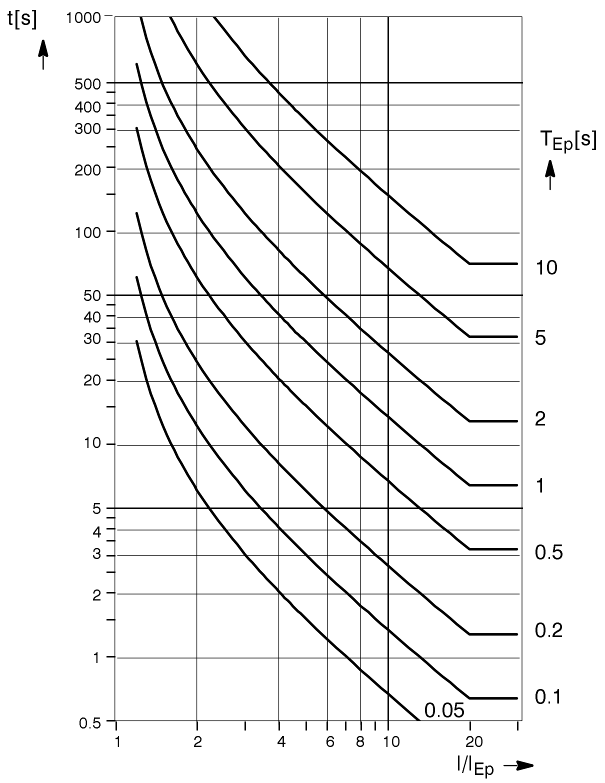


Extremely inverse: $t = \dfrac{80}{(I/I_p)^2 - 1} \cdot T_p$ [s]

t trip time
T_p set time multiplier
I Fault current
I_p Set pick-up current

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

Figure 3.1 Trip time characteristics of inverse time overcurrent protection (phase and earth currents)



Note concerning the characteristics Figure 3.2:

The time scale of the *long time* characteristic differs from that of the characteristics in Figure 3.1 by the factor 10.

Long time: $t = \frac{120}{(I/I_{Ep}) - 1} \cdot T_{Ep}$ [s]

t tripping time
T_{Ep} set time multiplier
I earth fault current
I_{Ep} set earth fault pick-up value

Figure 3.2 Tripping time characteristics of inverse time overcurrent protection (only earth current)

3.4 Directional determination (optional)

Direction determination for phase faults

Measurement method	phase current polarized with quadrature voltages; with memorized voltage (memory depth 2 a.c. periods) if polarizing voltages too small
“Forwards” area	−45° to +135° (if quadrature voltage is rectangular with respect to the fault voltage)
Directional sensitivity	unlimited for single-phase and two-phase faults for three-phase faults dynamically unlimited, steady-state approx. 7 V phase-to-phase no dead zone
Directional delay time	possibilities of characteristics and setting ranges are the same as for non-directional time overcurrent protection, refer to Section 3.2 or 3.3

Direction determination for earth faults

Measurement method	earth current polarized with displacement voltage
“Forwards” area	−45° to +135°
Directional sensitivity	approx. 1 V displacement voltage
Directional delay time	possibilities of characteristics and setting ranges are the same as for non-directional time overcurrent protection, refer to Section 3.2 or 3.3

Tolerances and influencing variables

Angle error under reference conditions	
– for phase faults	± 5° electrical
– for earth faults	± 5° electrical (if U_{en} voltage connected)
Frequency dependent influence	
– with non-memorized voltage	approx. 1° in the range $0.95 \leq f/f_N \leq 1.05$
– with memorized voltage	approx. 7.5° per % $\Delta f/f_N$

3.5 Thermal overload protection

Setting ranges/steps

Factor k according to IEC 60255−8		1.00 to 4.00	(steps 0.01)
Time constant	τ	1.0 to 999.9 min	(steps 0.1 min)
Thermal warning stage	$\Theta_{warn} / \Theta_{trip}$	50 to 100 % referred to trip temperature rise	(steps 1 %)
Current warning stage	I_{warn}/I_N	0.10 to 4.00	(steps 0.01)

Trip time characteristic

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

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

Reset ratios

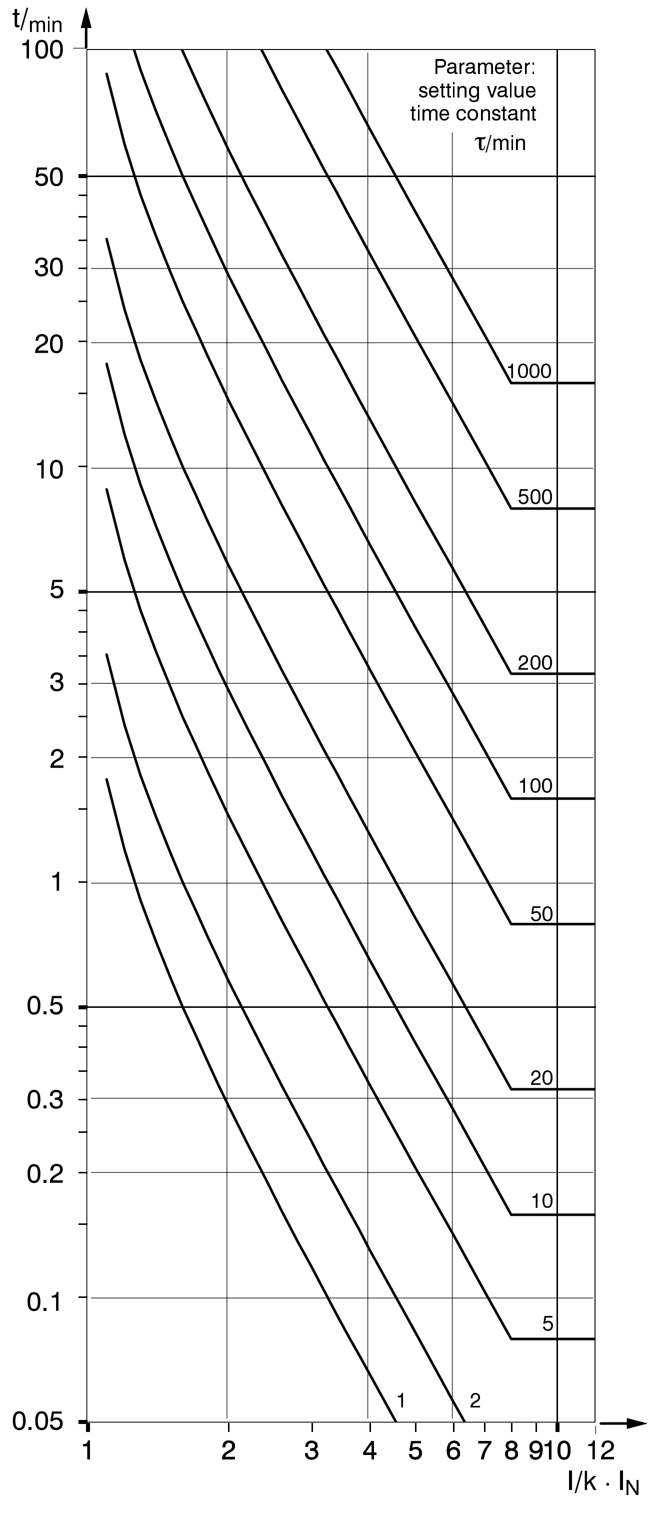
Θ / Θ_{trip}	approx. 0.99
Θ / Θ_{warn}	approx. 0.99
I/I_{warn}	approx. 0.99

Tolerances

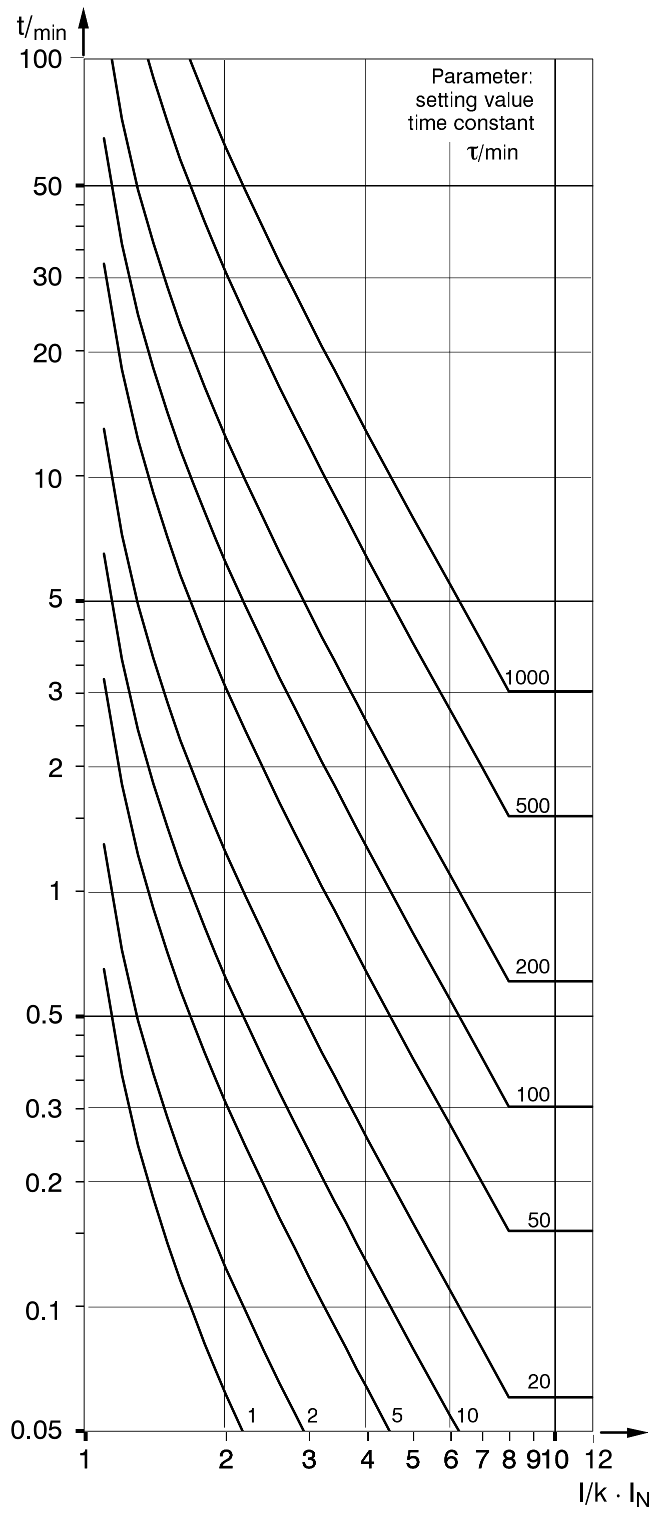
– referring to $k \cdot I_N$	± 10 %
– referring to trip time	± 10 % ± 2 s

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 $-5\ ^\circ C \leq \vartheta_{amb} \leq +40\ ^\circ C$	$\leq$ 0.5 %/10 K
– Frequency in range $0.95 \leq f/f_N \leq 1.05$	$\leq$ 1 %



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



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

for 90 % preload

Figure 3.3 Trip time characteristic of overload protection – without preload –

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

3.6 Highly sensitive earth fault protection

Displacement voltage detection for all earth faults

Displacement voltage	U_E>	2 V to 130 V	(steps 1 V)
Measurement time		approx. 60 ms	
Pick-up delay	$T_{E/F}$	0.04 s to 320.00 s	(steps 0.01 s)
Additional trip delay	$T_{Ue\ TRIP}$	0.10 s to 320.00 s	(steps 0.01 s)
Drop-off ratio		approx. 0.95	
Measuring tolerance according VDE 0435 part 303		5 % of set value	
Time tolerances		1 % of set value or 10 ms	

The set times are pure delay times.

Faulted phase determination for earth fault in non-earthed systems (only for models with directional discrimination supplement)

Measuring principle	voltage measurement phase to earth	
U< (faulted phase) U> (unfaulted phases)	10 V to 100 V 10 V to 100 V	(steps 1 V) (steps 1 V)
Measuring tolerance according VDE 0435 part 303	5 % of set value	

Earth current detection for all earth faults

High-level earth current pick-up I_{EE}>>	0.003 A to 1.000 A	(steps 0.001 A)
Delay time $T_{IEE>>}$	0.00 s to 320 s or ∞ (ineffective)	(steps 0.01 s)
Low-level earth current pick-up I_{EE}> (definite time)	0.003 A to 1.000 A	(steps 0.001 A)
Delay time (definite) $T_{IEE>}$	0.00 s to 320.00 s or ∞ (ineffective)	(steps 0.01 s)
Measurement time (definite time)	approx. 60 ms approx. 100 ms	(non-directional) (directional)
Low-level earth current pick-up I_{EEp} (inverse time)	0.003 A to 1.000 A	(steps 0.001 A)
Time multiplier (inverse time) T_{IEEP}	0.00 to 4.00 or ∞ (ineffective)	(steps 0.01)

Characteristics (inverse time)	normal inverse very inverse extremely inverse long time inverse user specified refer to Section 3.3, Figure 3.1 and 3.2
Measuring tolerance according VDE 0435 part 303 – definite time – inverse time	 5 % of set value pick-up at $1.05 \leq I/I_p \leq 1.15$
Time tolerances – definite time – inverse time within linear range	 1 % of set value or 10 ms 7 % of theoretical value for $2 \leq I/I_{EEP} \leq 20$ + 2 % current tolerance; at least 70 ms
Drop-off ratio	approx. 0.95

Note: Due to the high sensitivity of this protection function, the measured current input has restricted linearity range of 0.003 to 1.2 A. No time reduction according to the characteristics (Figures 3.1 and 3.2) are to be expected for currents above 1.2 A at this current input.

The set times are pure delay times in definite time mode.

Directional determination

Measurement	with I_E (= $3 \cdot I_0$) and U_E (= $\sqrt{3} \cdot U_0$)
Measuring principle	measurement of active and reactive power
Measurement release $I_{EE\ DIREC}$	0.003 A to 1.000 A (steps 0.001 A)
Directional characteristic	$I_E \cdot \cos \varphi$ or $I_E \cdot \sin \varphi$, additional phase shifting ± 45° possible
CT angle error correction of summation c.t. for compensated systems	0.0° to 5.0° (steps 0.1°) for 2 operating points of the c.t. characteristic
Measuring tolerance according VDE 0435 part 303	10 % of set value for $I_E < 0.45$ A
Angle tolerance (if U_{en} voltage connected)	2° for I_E = 0.2 A to 1.2 A 7° for $I_E < 0.2$ A
Angle tolerance (if U_{en} voltage not connected)	10°

Note: Due to the high sensitivity of this protection function, the measured current input has restricted linearity range of 0.003 to 1.2 A. No correct directional decision is ensured for currents above 1.2 A at this current input.

3.7 Intermittent earth fault protection (optional)

Setting ranges/steps

Pick-up value for earth current	$0.05 \cdot I_N$ to $25.00 \cdot I_N$	(steps $0.01 \cdot I_N$)
Pick-up prolongation time	0.00 s to 10.00 s	(steps 0.01 s)
Earth fault accumulation time	0.00 s to 100.00 s	(steps 0.01 s)
Reset time for accumulation	1 s to 600 s	(steps 1 s)
Number of pick-ups for intermittent earth fault	1 to 10	(steps 1)

Pick-up times

– at 1.25 times setting value	approx. 30 ms
– at $\geq$2 times setting value	approx. 22 ms

Drop-off time

without prolongation time	approx. 22 ms

Tolerances

– Pick-up value I_{IE}>	3 % of setting value
– Times	1 % of setting value or 10 ms

Influence variables

– Auxiliary voltage in range $0.8 \leq U_H/U_{HN} \leq 1.15$	$\leq$ 1 %
– Temperature in range $0\ °C \leq \vartheta_{amb} \leq 40\ °C$	$\leq$ 0.5 %/10 K
– Frequency in range $0.95 \leq f/f_N \leq 1.05$	$\leq$ 3 %

3.8 Auto-reclosure

Max. number of possible shots	1 RAR (first shot) up to 9 DAR (further shots)
Auto-reclose modes	three-pole

Action times (separate for RAR and DAR)	0.01 s	to	320.00 s	(steps 0.01 s)
1st dead time RAR	0.01 s	to	320.00 s	(steps 0.01 s)
Further dead times DAR	0.01 s	to	1800.00 s	(steps 0.01 s)
Reclaim times	0.50 s	to	320.00 s	(steps 0.01 s)
Reclaim time after manual close	0.50 s	to	320.00 s	(steps 0.01 s)
Duration of RECLOSE command	0.01 s	to	32.00 s	(steps 0.01 s)

3.9 Circuit breaker failure protection

Setting ranges/steps

Pick-up value of current stage	I/I_N	0.10 to 4.00 (steps 0.01)
Time stage	T_{BF}	0.06 s to 60.00 s (steps 0.01 s) or ∞ (ineffective)

Times

pick-up time	
– with internal start	included in O/C time
– with external start	approx 40 ms
Reset time	approx 40 ms

Tolerances

– Pick-up value	3 % of setting value
– Delay time T	1 % of setting value or 20 ms

3.10 Ancillary functions

Output of measured values

Operational values of currents	I_{L1}, I_{L2}, I_{L3}, I_E in A primary and in % I_N
– range	0 % to 240 % I_N
– tolerance	2 % of I_N for $I \leq I_N$ 2 % of meas. value for $I > I_N$
Operational values of voltages (models with directional determination)	U_{L1-E}, U_{L2-E}, U_{L3-E} in kV primary and in % $U_N/\sqrt{3}$
– range	0 % to 120 % $U_N/\sqrt{3}$
– tolerance	2 % of $U_N/\sqrt{3}$
Operational values of powers (models with directional determination)	P_a, P_r, S (active, reactive and apparent power) in MW or MVAr or MVA primary and in % S_N $(= \sqrt{3} \cdot U_N \cdot I_N)$
– range	0 % to 120 % S_N
– tolerance	5 % of S_N
Operational values of power factor (models with directional determination)	cos φ
– range	−1 to +1
– tolerance	0.02
Operational value of frequency (models with directional determination)	f in % f_N
– range	95 % to 105 % f_N
– tolerance	0.5 % of f_N
Thermal overload values	Θ/Θ_{trip}
– range	0 % to 200 %
– tolerance	3 % referred to Θ_{trip}

Measured values plausibility checks

– Sum of currents	phases and earth
– Sum of voltages	phases and earth (if available)

Steady-state measured value supervision

Current unbalance	I_{max}/I_{min} > symmetry factor as long as $I > I_{limit}$
Voltage unbalance	U_{max}/U_{min} > symmetry factor as long as $U > U_{limit}$ (if available)
Phase sequence	clockwise phase rotation (if voltages available)

Fault event data storage

Storage of annunciations of the last four faults, three of which can be read out locally

Circuit breaker operation log

Number of stored trip and reclose events	0 to 65535
Last interrupted current	0 to 50 · I_N
Total of tripped currents	0 to 6553.5 I_N

Real time clock

Resolution for operational annunciations	1 min
Resolution for fault event annunciations	1 ms
Clock module	DALLAS Type DS 138 – 32k RAMfield TIMEKEEPER Self-discharge time >10 years
Max time deviation	0.01 %

Data storage for fault recording max 8 fault events

Storage period (fault detection or trip command = 0 ms) max.	total of 5 s, selectable pre-trigger and post-fault time
Sampling rate	1 instantaneous value per ms at 50 Hz 1 instantaneous value per 0.83 ms at 60 Hz

User definable annunciations

four annunciations can be defined by the user	for annunciation processing can be delayed

4 Method of operation

4.1 Operation of complete unit

The numerical time overcurrent protection relay 7SJ512 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 basic structure of the unit.

The transducers of the measured value input section ME transform the currents and voltages from the measurement transformers of the switch-gear and match them to the internal processing level of the unit (phase voltage inputs only in models with directional determination supplement). Apart from galvanic and low-capacitance isolation provided by the input transformers, filters are provided for the sup-

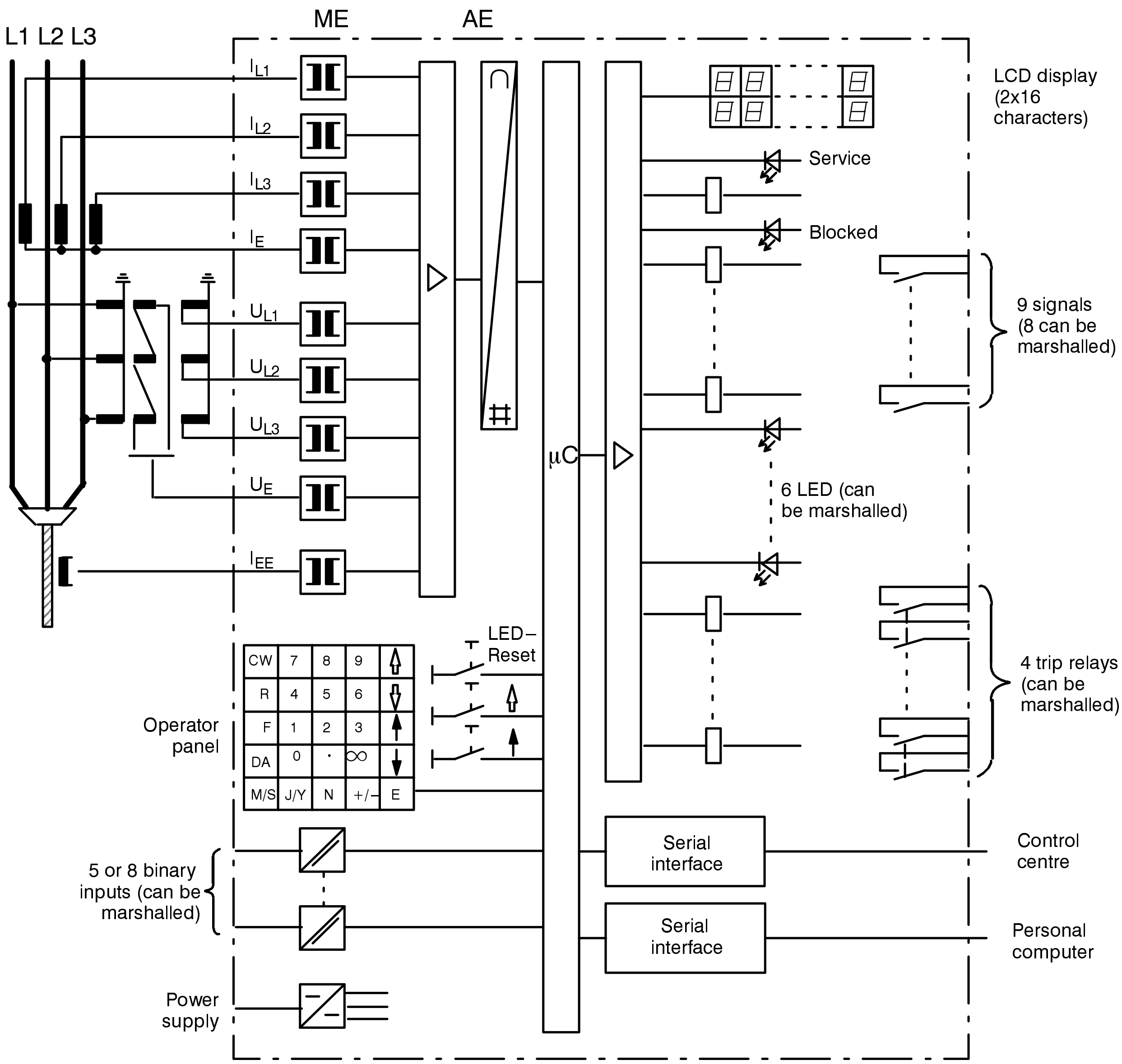


Figure 4.1 Hardware-structure of the time overcurrent protection relay 7SJ512 − example

pression 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.

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,
- continuous calculation of the values which are relevant for fault detection,
- determination of the fault direction (for models with directional measuring supplement),
- calculation of r.m.s. values for overload detection,
- calculation of the earth fault data,
- scanning of limit values and time sequences,
- decision about trip and close commands,
- storage of measured quantities during a fault for analysis.

Binary inputs and outputs to and from the processor are channelled via the input/output elements. From these the processor receives information from the switch-gear (e.g. remote resetting) or from other equipment (e.g. blocking signals). Outputs include, in particular, trip and close 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 on the front plate by means of an operator panel or a personal computer.

Via a second serial interface (optional), 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 second interface is 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.

Communication via this interface is alternatively possible by means of fibre optic links, provided this interface is accordingly ordered (refer to Section 2.3 Ordering data).

A power supply unit provides the auxiliary supply on the various voltage levels to the described functional units. +18 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 dc supply system of the plant are bridged by a dc voltage storage element (rated auxiliary voltage ≥ 110 Vdc).

4.2 Time overcurrent protection

The time overcurrent 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. In addition, a user specified characteristic can be defined. One more characteristic is available for earth faults. The trip time characteristics and the applied formulae are given in the Technical data, refer to Figures 3.1 and 3.2, Section 3.3.

The selected overcurrent time characteristics 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. All stages are independent from each other and can be set individually.

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

The time overcurrent protection can also be used in conjunction with auto-reclosure. In these cases a number of special stages is available (refer to Section 4.7.2).

4.2.1 Formation of the measured quantities

The measured currents are fed to the relay via the input transducers for each phase. The inputs are galvanically isolated against the electronic circuits as well as against each other. Thus, the star point of the three phase currents can be formed outside of the relay, or further protection or supervision devices can be included in the current transformer circuits. For the earth current input, either the residual current of the phase current transformers can be used, or a separate summation current transformer can be connected.

The secondary sides of the relay input transformers are terminated by shunt resistors which transform the currents to proportional voltages; these voltages are converted to numerical values by analog-to-digital converters.

4.2.2 Definite time overcurrent protection

Each phase current is compared with the limit value which is set in common for the three phases. Pick-up is indicated for each phase. The phase dedicated timer is started. After the time has elapsed trip signal is given. The protection contains two stages: The I> stage is delayed with T−I>, the high-set stage I>> is delayed with T−I>>.

The residual (earth) current is processed separately and compared with separate overcurrent stages I_E> and I_E>>. Pick-up is indicated. After the associated time T−I> or T−I>> has elapsed, trip command is given.

The pick-up values of each stage I> (phases), I_E> (earth), I>> (phases) and I_E>> (earth) as well as the associated time delays can be set individually.

The logic diagram of the definite time overcurrent protection is shown in Figure 4.2.

4.2.3 Inverse time overcurrent protection

Each phase current is compared with the limit value which is set in common for the three phases. Pick-up is indicated for each phase. Following pick-up of the inverse time stage I_p, the trip time delay is calculated from the set inverse time characteristic and the magnitude of the fault current. After the time has elapsed trip signal is given. For the residual (earth) current a different characteristic can be selected.

When the high-set overcurrent stage I>> (phases) or I_E>> (earth) has picked up, the associated timer is started which is independent of the set inverse time characteristic for I_p or I_{Ep}. After the associated time T−I>> or T−Ie>> has elapsed, trip command is given.

The pick-up values of each stage I_p (phases), I_{Ep}> (earth), I>> (phases) and I_E>> (earth) as well as the associated time factors can be set individually.

The logic diagram of the inverse time overcurrent protection is shown in Figure 4.3.

For inverse time overcurrent protection stages, one can select whether the fundamental wave of the currents or the true r.m.s. values are processed. If the fundamental wave is selected, d.c. components and the harmonic content in the currents are suppressed as they are for the definite time overcurrent protection stages.

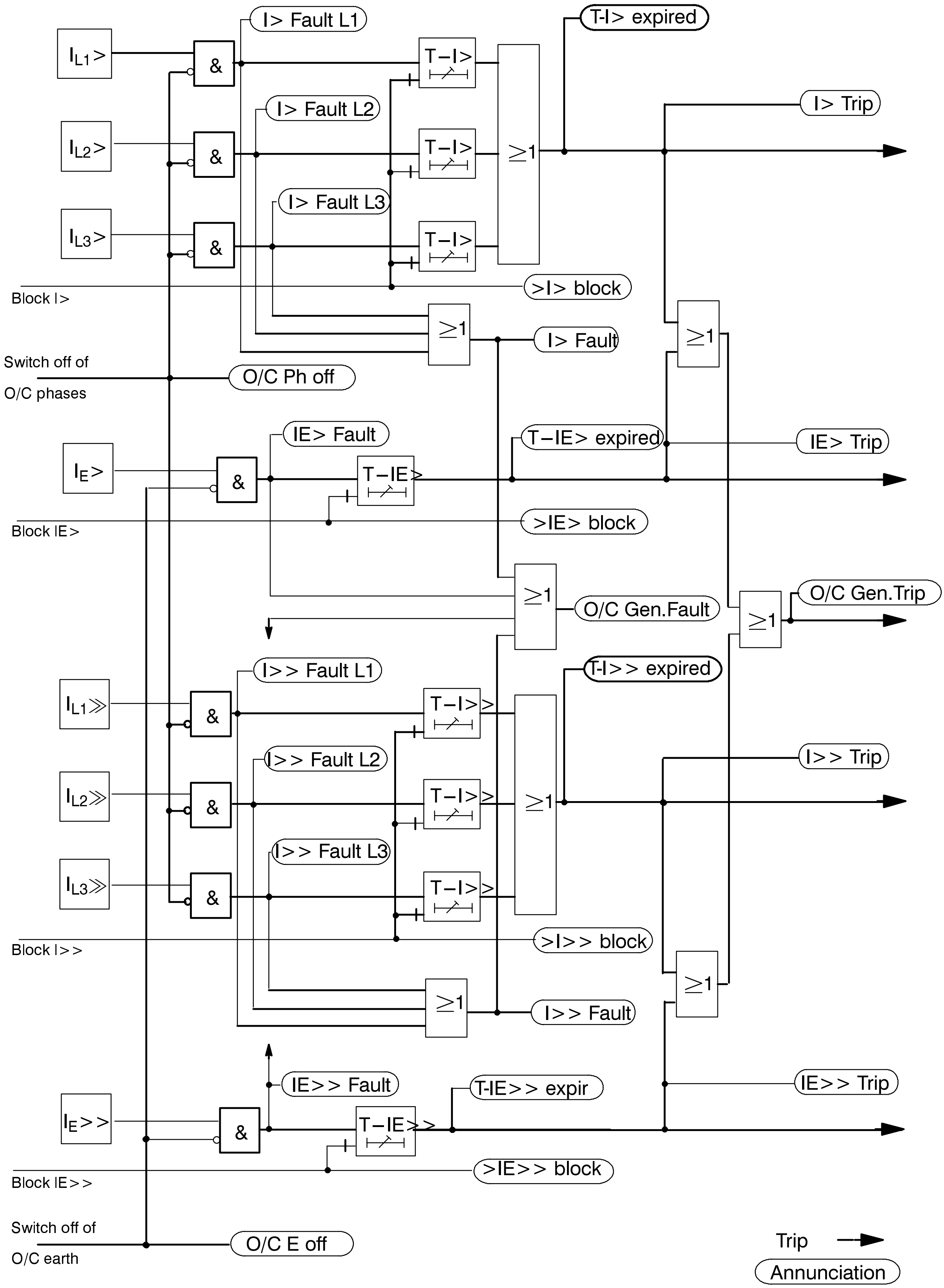


Figure 4.2 Logic diagram of the definite time overcurrent protection

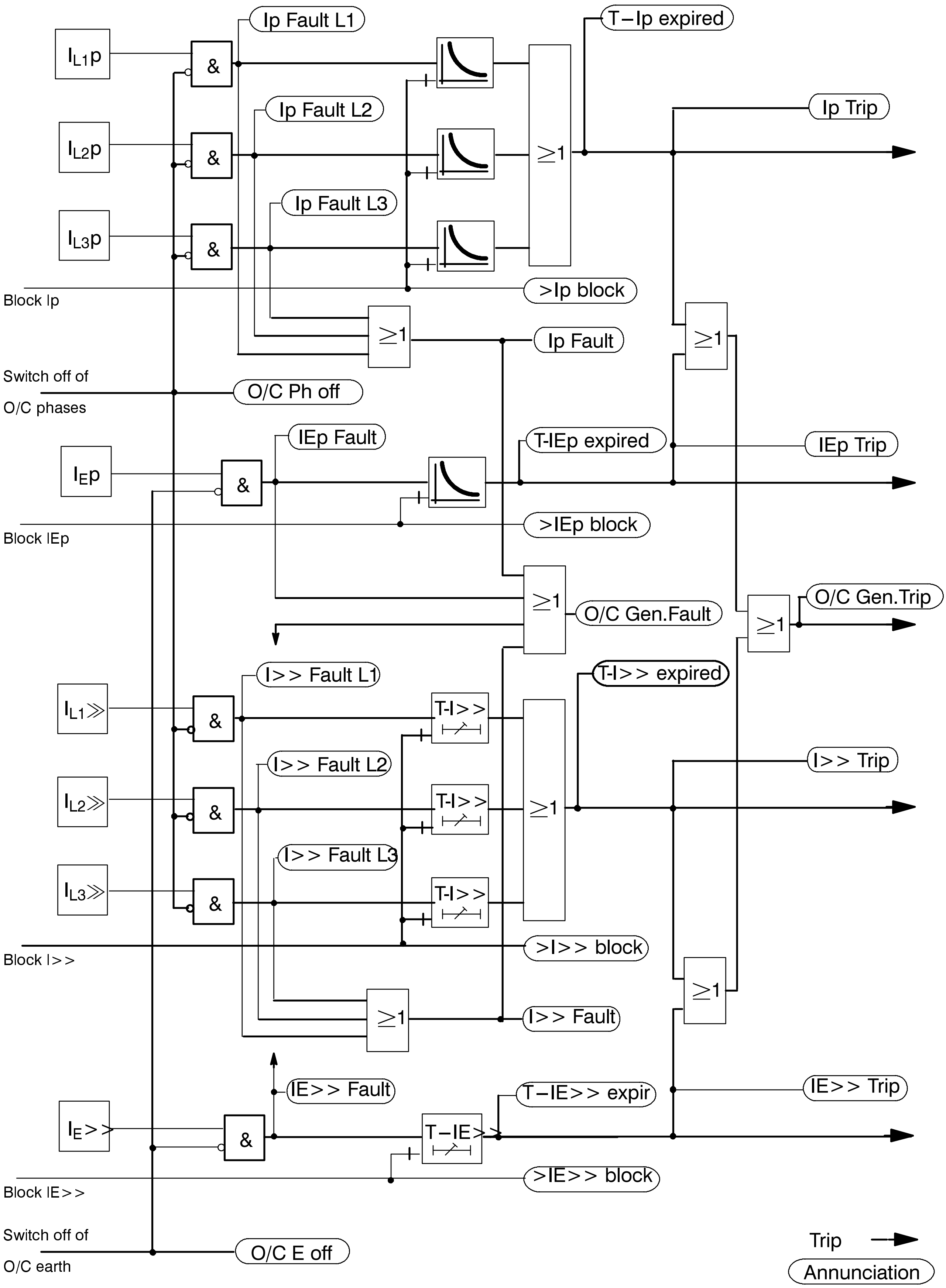


Figure 4.3 Logic diagram of the inverse time overcurrent protection

4.2.4 Fast bus-bar protection using reverse interlocking scheme

Each of the overcurrent stages can be blocked via binary inputs of the relay. A setting parameter determines whether the binary input operates in the “normally open” (i.e. energize input to block) or the “normally closed” (i.e. energize input to release) mode. Thus, the time overcurrent protection can be used as fast busbar protection in star connected networks or in open ring networks (ring open at one location), using the “reverse interlock” principle. This is used in high voltage systems, in power station auxiliary supply networks, etc., in which cases a transformer feeds from the higher voltage system onto a busbar with several outgoing feeders (refer Figure 4.4).

“Reverse interlocking” means, that the time overcurrent protection can trip within a short time T–I>>, which is independent of the grading time, if it is not blocked by pick-up of one of the next downstream time overcurrent relays (Figure 4.4). Therefore, the protection which is closest to the fault will always trip within a short time, as it cannot be blocked by a relay behind the fault location. The time stages I> or I_p operate as delayed back-up stages.

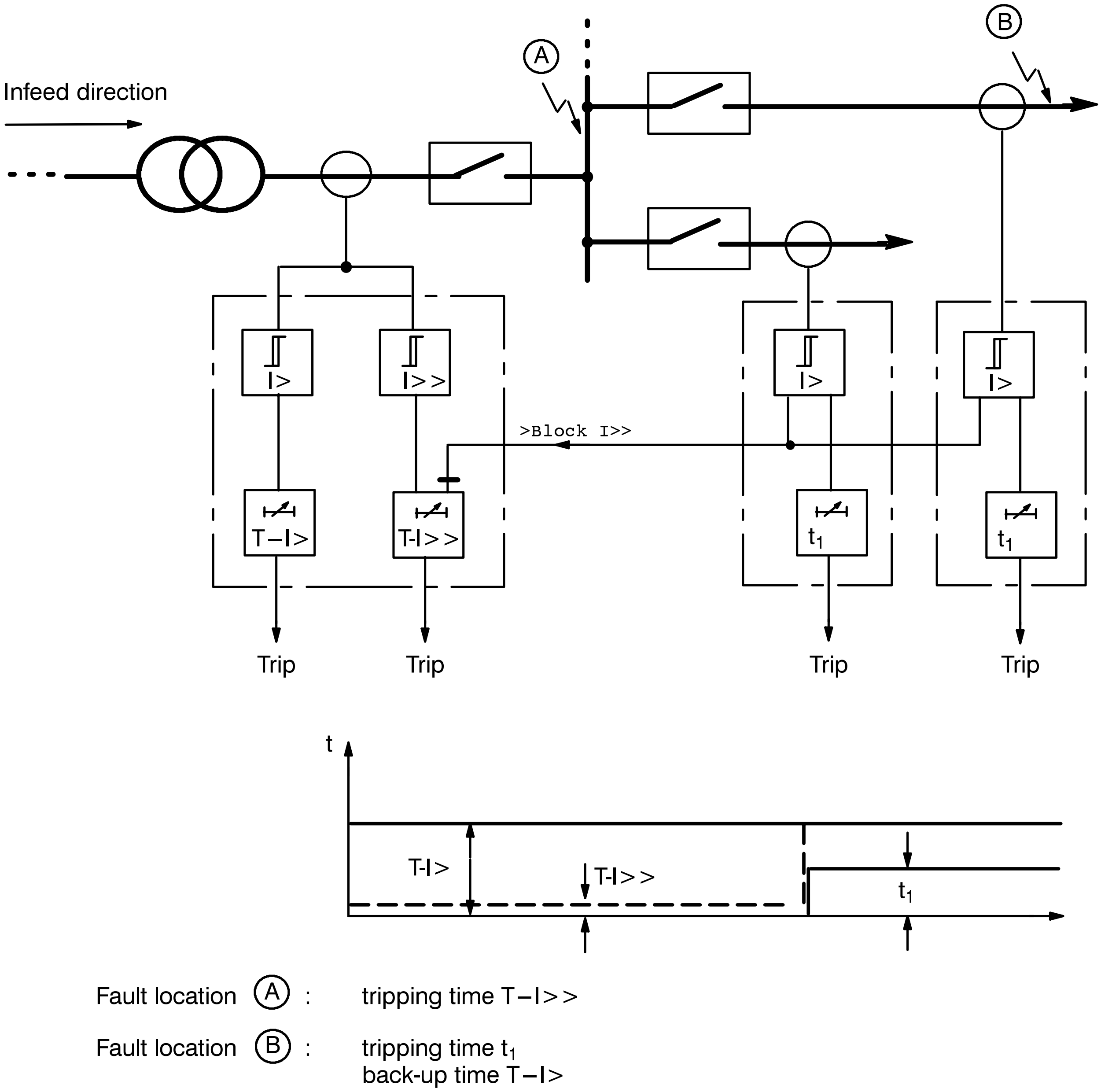


Figure 4.4 Busbar protection using reverse interlocking principle

4.3 Directional time overcurrent protection (optional)

4.3.1 General

7SJ512 provides, dependent of the ordered model, a directional time overcurrent protection. Thus, it can be used in systems where the direction of energy flow to the fault location is required as a further criterion, besides the overcurrent criterion, in order to achieve selectivity.

For parallel lines or transformers, which are fed from one side (refer to Figure 4.5), a fault on one branch (I) can result in the other branch (II) being disconnected unless the tripping of the circuit breaker in the parallel (healthy) branch is prevented by a directional measuring element (at B). Therefore, a **directional** overcurrent scheme must be installed at the points indicated by the directional arrow in Figure 4.5. It must be noted that the “forwards” direction of the directional relay is the direction to the protected object. This is not normally identical with the direction of the normal load flow as can be seen in the figure.

Also in networks with infeed from both sides or in ring networks, the time overcurrent protection must have a directional criterion. Figure 4.6 shows a ring network as a development; in the actual ring network the two infeeds shown in the figure merge into a single infeed.

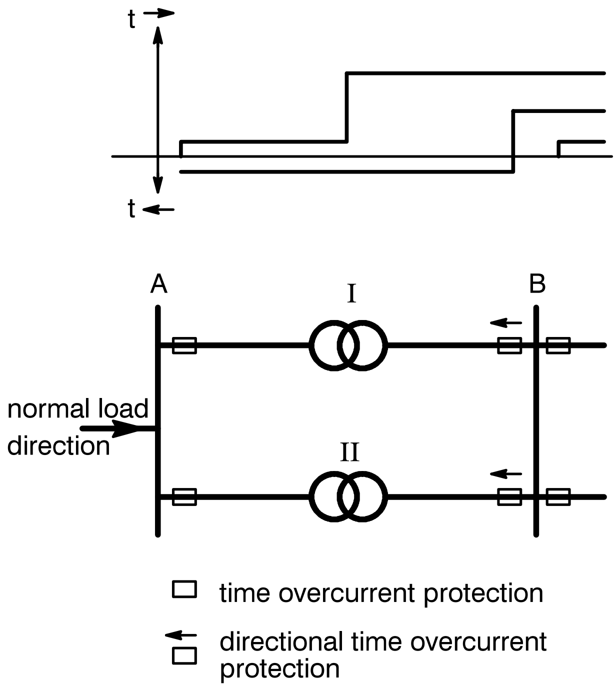


Figure 4.5 Time overcurrent protection for parallel transformers

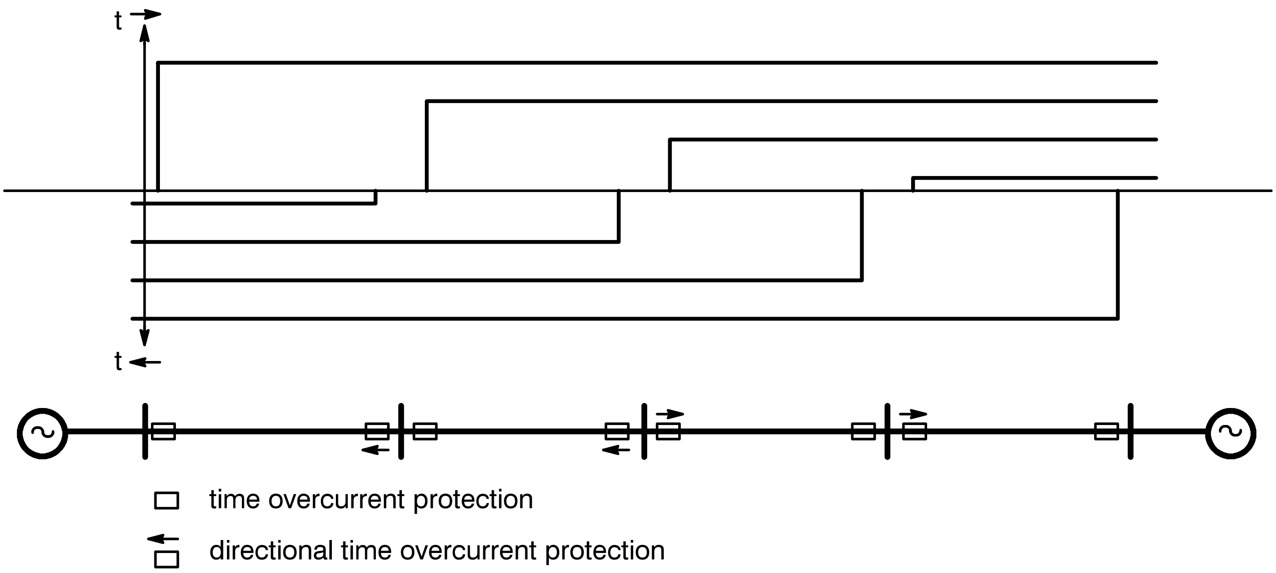


Figure 4.6 Double end fed line or ring feeder

7SJ512 provides an additional directional time overcurrent stage for each of the phase currents and for the earth current. The (non-directional) time overcurrent stages as described in Section 4.2 can either be used as superimposed back-up stages, or made ineffective, or individual non-directional stages can be used in connection with the directional time overcurrent stages (e.g. the I>> phase current stage and/or the I_E>> stage).

The directional time overcurrent protection can be used – as the non-directional – as definite time or inverse time overcurrent protection. For inverse time mode, selection can be made from the same characteristics, whereby different characteristics can be chosen for phase currents as well as for the earth current. The only restriction is, that the pick-up value I> or I_p is the same for non-directional and directional overcurrent protection. The same is valid for I_E> or I_{Ep}.

For use with auto-reclosure, a number of special stages is available (refer to Section 4.7.2).

4.3.2 Directional determination

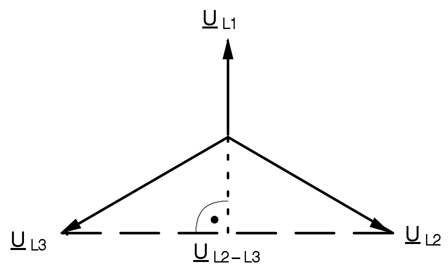
The direction of the current flow is determined in four logically independent measuring elements, one for each of the phases and one for earth faults.
The phase related measuring elements use the assigned current and a sound voltage. This ensures correct and reliable directional decision to be made even when the fault voltage has completely collapsed (close-up fault). Stored voltages are used in case of a close-up three-phase fault as long as the measured voltages are not sufficient for reliable directional discrimination. After the storage time has elapsed (two a.c. periods), the determined direction is maintained but only as far and as long as no sufficient measured voltage is available.

The earth related measuring element operates with the zero sequences quantities: $I_E = -3 \cdot I_0$ and $U_E = \sqrt{3} \cdot U_0$. This ensures high sensitivity in case of earth fault even when the assigned phase measuring element does not pick up.

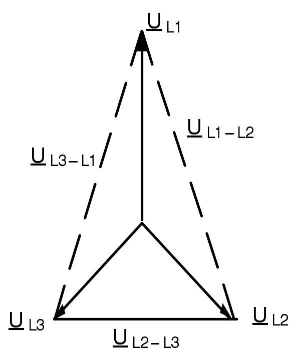
A short-circuit between two phases is processed by two phase measuring elements, namely those which are related to the two affected phases. An earth fault is processed by the earth fault measuring element and by the concerned phase element provided the fault current is sufficient for pick-up of the phase element.

For single-phase faults, the quadrature voltages for the phase measuring elements are at right angles to the short-circuit voltages (Figure 4.7). This is considered in the calculation of the directional vector. For phase–phase faults, the shape of the directional characteristic may be displaced, dependent of the magnitude of the fault voltage.

Table 4.1 shows the allocation of measured values for the direction to the different types of fault.



a) Loop phase–earth (L1–E)



b) Loop phase–phase (L2–L3)

Figure 4.7 Reference voltages for directional determination

Pick-up \ Measuring element	L1 current	L1 voltage	L2 current	L2 voltage	L3 current	L3 voltage	E current	E voltage
L1	I_{L1}	$U_{L2}-U_{L3}$	–	–	–	–	–	–
L2	–	–	I_{L2}	$U_{L3}-U_{L1}$	–	–	–	–
L3	–	–	–	–	I_{L3}	$U_{L1}-U_{L2}$	–	–
E	–	–	–	–	–	–	I_E	U_E
L1, E	I_{L1}	$U_{L2}-U_{L3}$	–	–	–	–	I_E	U_E
L2, E	–	–	I_{L2}	$U_{L3}-U_{L1}$	–	–	I_E	U_E
L3, E	–	–	–	–	I_{L3}	$U_{L1}-U_{L2}$	I_E	U_E
L1, L2	I_{L1}	$U_{L2}-U_{L3}$	I_{L2}	$U_{L3}-U_{L1}$	–	–	–	–
L2, L3	–	–	I_{L2}	$U_{L3}-U_{L1}$	I_{L3}	$U_{L1}-U_{L2}$	–	–
L3, L1	I_{L1}	$U_{L2}-U_{L3}$	–	–	I_{L3}	$U_{L1}-U_{L2}$	–	–
L1, L2, E	I_{L1}	$U_{L2}-U_{L3}$	I_{L2}	$U_{L3}-U_{L1}$	–	–	I_E	U_E
L2, L3, E	–	–	I_{L2}	$U_{L3}-U_{L1}$	I_{L3}	$U_{L1}-U_{L2}$	I_E	U_E
L3, L1, E	I_{L1}	$U_{L2}-U_{L3}$	–	–	I_{L3}	$U_{L1}-U_{L2}$	I_E	U_E
L1, L2, L3	I_{L1}	$U_{L2}-U_{L3}$	I_{L2}	$U_{L3}-U_{L1}$	I_{L3}	$U_{L1}-U_{L2}$	–	–
L1, L2, L3, E	I_{L1}	$U_{L2}-U_{L3}$	I_{L2}	$U_{L3}-U_{L1}$	I_{L3}	$U_{L1}-U_{L2}$	I_E	U_E

Table 4.1 Measured values for directional determination

The theoretical directional line is shown in Figure 4.8, in the complex R–X–diagram (solid line a). In practice, the position of the directional characteristic is dependent upon the source impedance as well as the load current carried by the line immediately before fault inception.

Since the unfaulted voltage is influenced by the magnitude of the fault voltage, for two-phase faults (refer also to Figure 4.7.b), the actual directional characteristic may differ from the theoretical characteristic. When, for example, a two-phase fault L2–L3 has occurred, the directional characteristic of the measuring element L2 appears to be displaced in mathematically positive sense (broken line b in Figure 4.8), whereas the the directional characteristic of the measuring element L3 appears to be displaced in mathematically negative sense (broken line c in Figure 4.8). In practice, this is irrelevant because the fault impedance vector can be located only in the first or third quadrant of the complex plane.

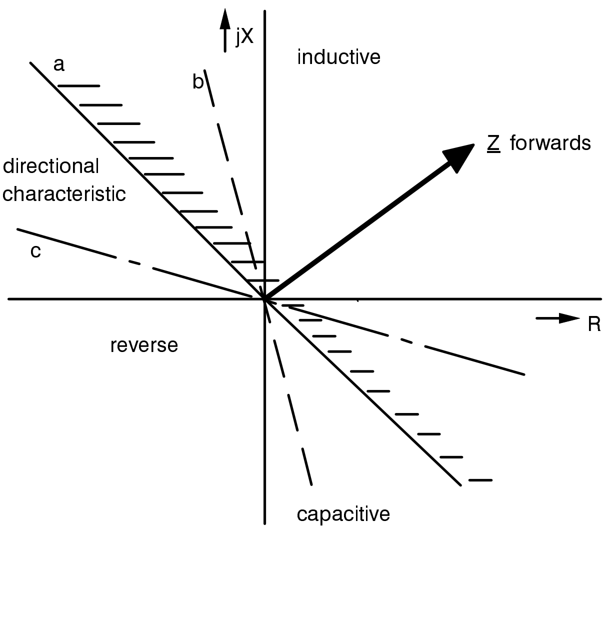


Figure 4.8 Directional characteristics

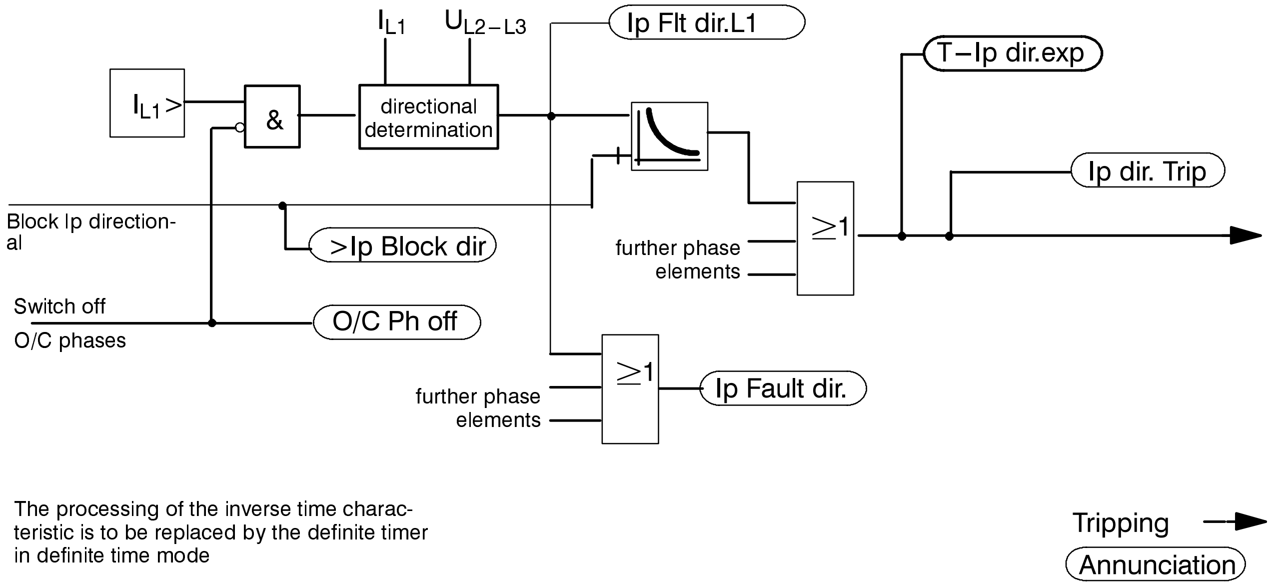


Figure 4.9 Logic diagram of the directional time overcurrent protection, example of one phase with inverse time mode

4.4 Inrush stabilization

If the time overcurrent protection 7SJ512 is used on a transformer feeder, particular attention is to be drawn to the in-rush currents which flow after the transformer is energized. The inrush current can amount to a multiple of the rated current and last some ten milliseconds up to minutes.

Although the numerical filters of the time overcurrent protection ensure that only the fundamental wave of the measured currents are compared with the set thresholds, malfunction might be caused by inrush currents when transformer feeders are switched in, since – dependent of the size and construction of the transformer – a high magnitude of fundamental wave may be found in the inrush current.

7SJ512 provides an integrated inrush blocking function. This can be switched effective and blocks the I> or I_p stages (not I>> stages) as long as inrush current is detected, for a settable time period. Since no pick-up occurs, no fault report is initiated.

The inrush current is characterized by a considerable 2nd harmonic content (double rated frequency) which is practically absent in the case of a short-circuit. Numerical filters are used to perform a Fourier analysis of each current. As soon as the harmonic content exceeds the set value, blocking of the respective phase evaluation is introduced.

Since the harmonic stabilization operates individually per phase, the protection is fully operative even when the transformer is switched onto a single-phase fault, whereby inrush currents may possibly be present in one of the healthy phases. However, it is also possible to set the protection such that not only the measuring element with inrush current exhibiting harmonic content in excess of the permissible value is stabilized but also the other measuring elements, including the highly sensitive earth current stage, are blocked (so called “cross-block function”).

4.5 Highly sensitive earth fault protection

The highly sensitive earth fault protection can be used in isolated or arc compensated networks to detect an earth fault, to determine the earth faulted phase and to discriminate the earth fault direction. In effectively grounded or low-impedance earthed networks, detection of high-resistance earth faults with very small fault currents is possible. It can be delayed and result in annunciation or also in a trip.

Because of its high sensitivity it is not suited for detection of higher earth fault currents (from 1 A and above at the relay terminals for high-sensitivity earth fault protection). For those applications use the time overcurrent protection for earth currents as described in Section 4.2.

4.5.1 Voltage stages

The voltage stages comprise residual voltage detection and determination of the earth-faulted phase. Determination of the faulted phase is only possible for models with directional determination, where the relay is fitted with measured phase voltage inputs and connected to three star connected and earthed voltage transformers.

The residual voltage U_E initiates earth fault detection and is one condition for release of directional determination according to Section 4.5.3. U_E means the voltage at the input of the device, with open delta VT; if this input is not used, the three phase voltages must be available (possible only for models with directional determination); the relay then calculates

$$U_E = \sqrt{3} \cdot U_0 = (U_{L1} + U_{L2} + U_{L3}) / \sqrt{3}.$$

In order to ensure measurement of stable values, the earth fault detection is delayed until 1 second (adjustable) after inception of voltage displacement.

After recognition of displaced voltage conditions the first objective of the device is selective detection of the earth-faulted phase (if possible). For this purpose the individual phase-to-earth voltages are measured. The affected phase is the one in which the voltage is below the settable threshold $U_{ph}<$ when simultaneously the other two voltages exceed an equally settable maximum threshold $U_{ph}>$.

Pick-up by the displacement voltage can be used for time delayed trip command. Note, that the total command time is composed of the inherent measuring time (approximately 60 ms) plus pick-up delay plus trip delay time.

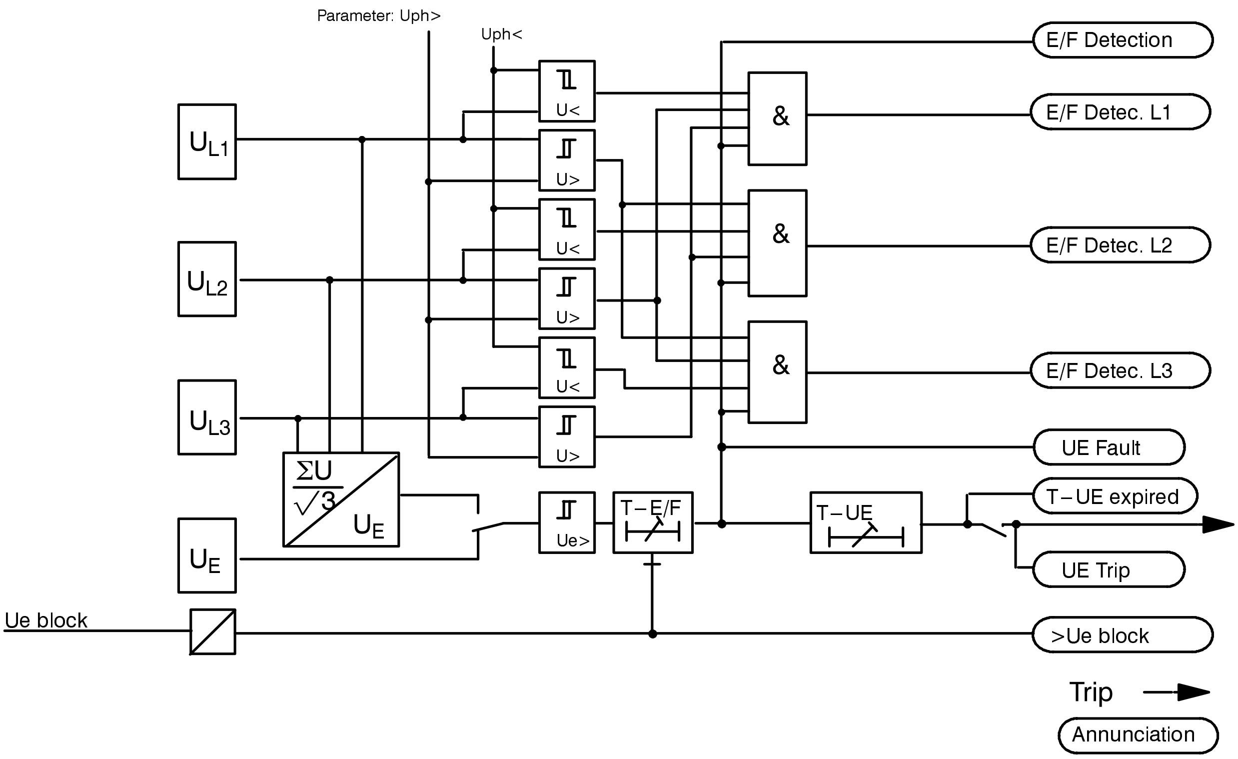


Figure 4.10 Logic diagram of the voltage stages of earth fault protection

4.5.2 Highly sensitive earth current stages

The magnitude of the earth current is decisive for pick-up of the highly sensitive earth current stages. They are used in cases where the magnitude of the earth current is the main criterion of the earth fault, therefore, preferably in solidly earthed or low-impedance earthed systems, or for electrical machines in bus-bar connection with isolated systems, where the high capacitive current of the system can be expected in case of machine earth fault but only an insignificant earth current in case of a system earth fault because of the low machine capacitance.

In order to detect earth currents, a two-stage current time characteristic can be set. Each stage can operate directional or non-directional.

The high-value stage is designated with I_{EE}>>.

The low-value stage can operate with a definite time lag or inverse time lag characteristic. For inverse time, a choice can be made between one of the four pre-defined characteristics (refer to Figure 3.1 and 3.2 under Technical data), or the user defined characteristic.

The definite time earth overcurrent stage is often used as the last back-up for high-ohmic earth faults in effectively earthed or low-ohmic earthed systems, where the main short-circuit protection may not pick up on these faults.

The inverse time earth overcurrent stage is used e.g. in strongly meshed, all-round earthed networks, where the highest fault current flows at the ends of the faulty line section: the inverse characteristic has the effect that here the shortest response time occurs and the remaining relays reset.

The direction determination is performed with the zero sequences quantities: $I_E = -3 \cdot I_0$ and $U_E = \sqrt{3} \cdot U_0$, as described in Section 4.5.3.

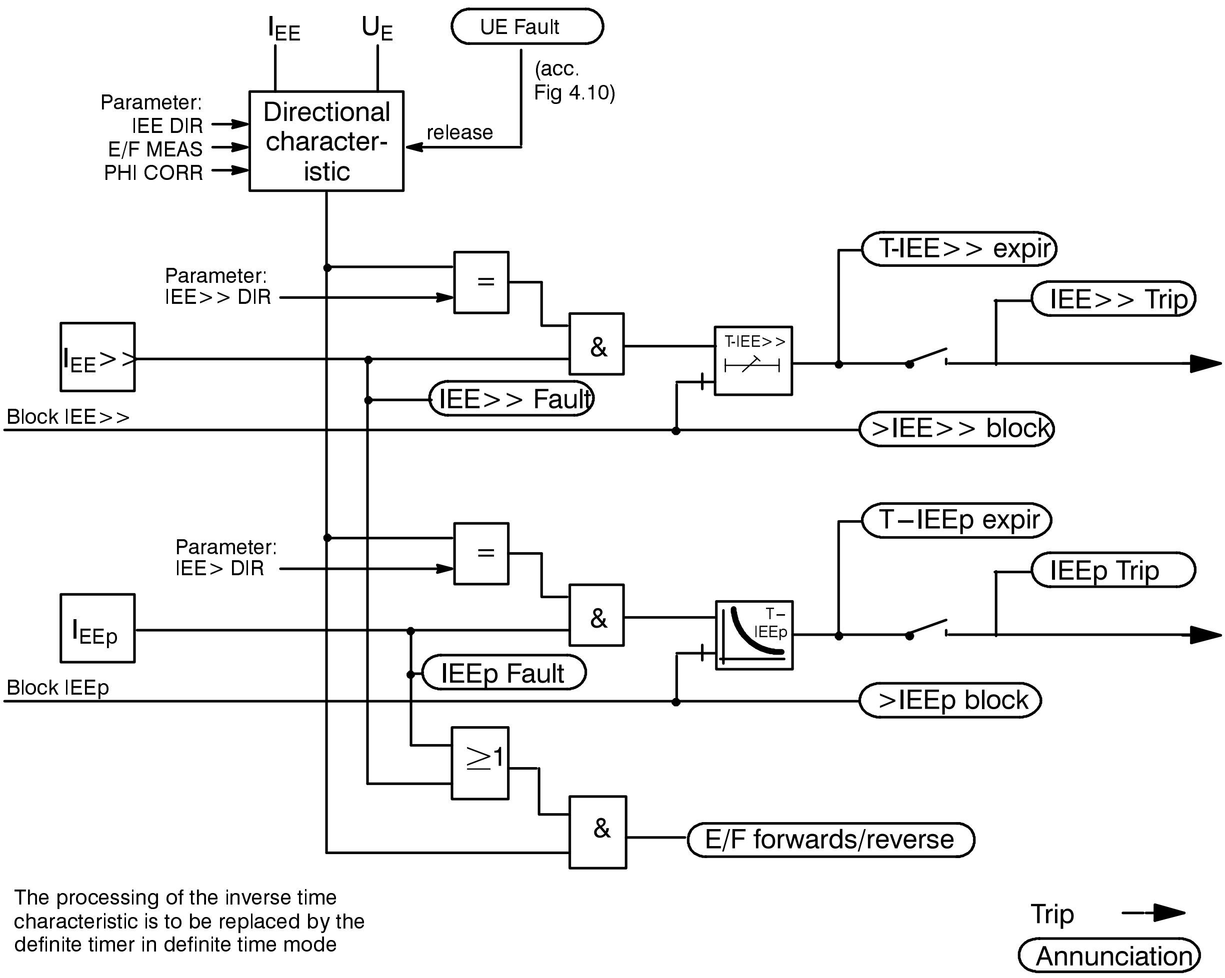


Figure 4.11 Logic diagram of directional earth fault protection

4.5.3 Highly sensitive directional determination

The highly sensitive earth fault directional determination does not process the magnitude of the earth current but the component which is at right angle to a settable directional symmetry axis. A precondition for determination of the fault direction is that one of the current magnitude stages has picked up and that the residual voltage exceeds the set value of the voltage stage.

Figure 4.12 shows an example in the complex phasor diagram, in which U_E forms the real axis. In this example, the active component I_{Ea} of the earth current I_E, related to the displacement voltage U_E, is decisive and is compared with the set threshold value $I_{EE\ DIREC}$. Thus, this example is valid for directional earth fault determination in an arc compensated system, where the quantity $I_E \cdot \cos\varphi$ is the determining factor. The symmetry axis is identical with the I_{Ea} axis. The current magnitude threshold appears as a circle (dotted circle IEE> in the figure).

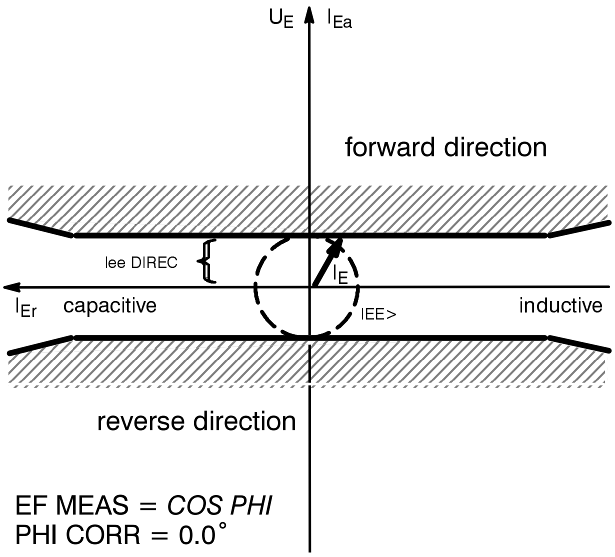


Figure 4.12 Directional characteristic with cos φ measurement

The symmetry axis can be shifted by up to ±45° (settable). Thus, it is possible, for example, to achieve maximum sensitivity for ohmic-inductive currents by −45° (inductive) angle displacement, in earthed systems, or, for example, to achieve maximum sensitivity for ohmic-capacitive currents by +45° (capacitive) angle displacement, for use on electrical machines which are directly connected to an isolated network. In addition, 90° shifting is possible in order to detect earth faults in isolated systems.

The earth fault direction and the magnitude of the current in this direction is determined from a highly accurate calculation of active and reactive power using the definitions:

Active power:

$$P_{Ea} = \frac{1}{T} \int_{t}^{t+T} u_E(t) \cdot i_E(t) \cdot dt$$

Reactive power:

$$P_{Er} = \frac{1}{T} \int_{t}^{t+T} u_E(t - 90°) \cdot i_E(t) \cdot dt$$

where T equals period of integration.

The use of an efficient calculation algorithm and simultaneous numerical filtering allows the directional determination to be achieved with high accuracy and sharply defined threshold limits (see Figure 4.13) and insensitivity to harmonic influences – particularly the frequently strong third and fifth harmonics which occur particularly in ohmic earth fault currents. The directional decision results from the signs of active and reactive power.

Since the active and reactive component of the current – not the power – determine pick-up of the earth fault directional decision, these current components are calculated from the power components. Thus for determination of the direction of the earth fault active and reactive components of the earth fault current as well as the direction of the active and reactive power are evaluated.

With sin φ measurement (for isolated systems):

– earth fault forwards, when $P_{Er} > 0$ and $I_{Er} >$ set value,

– earth fault backwards, when $P_{Er} < 0$ and $I_{Er} >$ set value.

With cos φ measurement (for compensated systems):

– earth fault forwards, when $P_{Ea} > 0$ and $I_{Ea} >$ set value,

– earth fault backwards, when $P_{Ea} < 0$ and $I_{Ea} >$ set value.

In all other cases the symmetry axis is produced by processing the sum of parts of the active and reactive power.

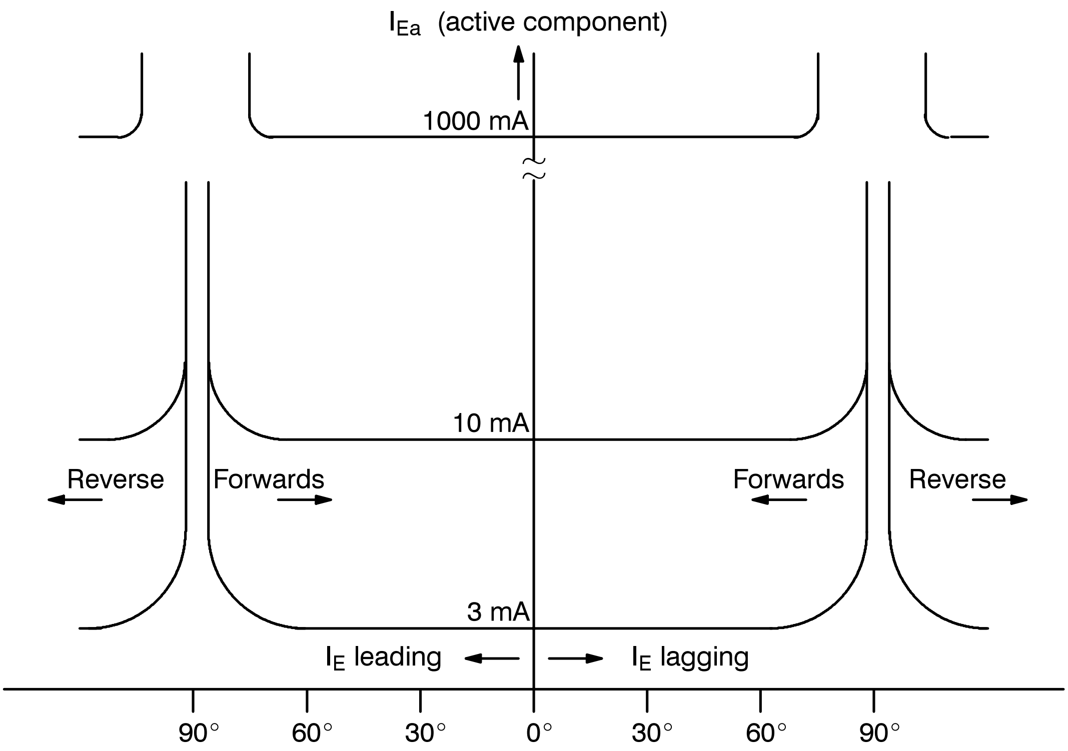


Figure 4.13 Directional earth fault measurement characteristic – example I · cos φ

In networks with isolated starpoint, the earth fault current flows as a capacitive current from the healthy lines via the measuring point to the point of fault. This capacitive current determines the direction.

In networks with arc suppression coils, the Petersen coil superimposes a corresponding inductive current on the capacitive earth fault current when an earth fault occurs, so that the capacitive current at the point of fault is compensated. Dependent upon the point of measurement in the network the resultant measured current can however be inductive or capacitive and the reactive current is therefore not suitable for the determination of direction. In this case, only the ohmic residual current which results from the losses of the Petersen coil can be used for directional determination. This earth fault ohmic current is only a few percent of the capacitive earth fault current.

In the latter case it must be noted that, dependent upon the location of the protective relay, a considerable reactive component may be superimposed which, in the most unfavourable cases, can attain 50 times the active component. Even the extremely high accuracy of the calculation algorithm is then inadequate if the current transformers do not exactly convert the primary values.

The measurement input circuit of the relay for highly sensitive earth fault detection is particularly designed for this purpose and permits an extremely high sensitivity for the directional determination of the wattmetric residual current. In order to utilize this sensitivity it is recommended that window-type current transformers be used for earth fault detection in compensated networks. As even the core balance transformers have an error of angle, the protection system allows the setting of factors which, dependent upon the reactive current, will correct the error angle.

Further explanation concerning the characteristic and symmetry axis are given in the setting hints in Section 6.3.11.

4.5.4 Earth fault location

By means of the directional indication of the network, the earth-faulted line can often be located. In radial networks, location of the faulted line is relatively simple. Since all circuits on a busbar (Figure 4.14) carry a capacitive partial current, the measuring point on the faulted line in an isolated network sees almost the entire prospective earth fault current of the network; in compensated networks the wattmetric residual current from the Petersen coil flows through the measuring point. For the faulted line or cable, a definite "forwards" decision will result, whilst in the remaining circuits a "reverse" indication will be given unless the earth current is so small that no measurement can be taken. In any case the faulted cable can be clearly determined.

In meshed or ring networks the measuring points at the ends of the faulted cable equally see a maximum of earth fault (capacitive or ohmic) current. Only in this cable will the direction "forwards" be indicated on both line ends (Figure 4.15). Even the remaining directional indications in the network can aid location of the earth fault. But under certain circumstances one or more indications may not be given due to insufficient earth current. Further advice can be found in the leaflet "Earth-fault detection in isolated neutral or arc-suppression coil earthed high voltage systems".

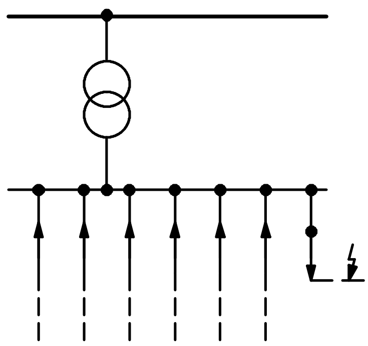


Figure 4.14 Faulted line location in radial network

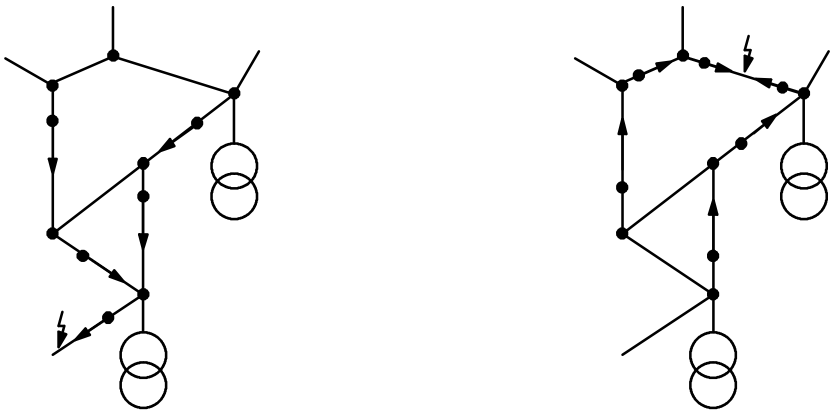


Figure 4.15 Location of earth fault based on the directional indicators in a meshed network

4.6 Intermittent earth fault protection (optional)

Intermittent earth faults may occur in cables with weak insulation conditions or in cable junction boxes where water has got in. These faults often are naturally quenched but re-ignite after an indefinite time. The duration may be some milliseconds up to a few seconds.

The short duration of the faults is often insufficient to make it cleared by the time overcurrent protection. Only after the fault has burned itself to such an extent that it remains standing, it can be cleared selectively by the short-circuit protection.

Since these intermittent earth faults endanger the power equipment thermally, 7SJ512 provides a protection function which can detect such intermittent earth faults and accumulate the duration of the faults.

When an adjusted pick-up value "I_{IE}>" (r.m.s. value) is exceeded, pick-up occurs (refer to Figure 4.16). The pick-ups are annunciated ("`IIE Fault det`") and counted. When more than two pick-ups occur (pre-setting), annunciation "`Intemit.EF`" is output. When pick-up is reset, the fault detection signal can be maintained for an adjustable time "T_E" (parameter T−det.ext; annunciation "`IIE stab.Flt`").

The duration of the prolonged fault detection signals is accumulated in the integrator "Tsum". If this accumulated times exceed a set threshold, alarm "`IIE Tsum exp`" is given. Trip signal is issued provided a pick-up signal is present (annunciation "`IEF Trip`"). The trip command is maintained for at least the minimum trip duration, which is set for the relay, even when the pick-up signal is very short. At the end of the trip signal all memories of this protection function are reset so that the protection reverts to its quiescent state.

Besides the fault time accumulator "Tsum", another timer "Treset" is started with each pick-up which is set to a longer time. But this timer is reset and re-triggered each time a renewed pick-up occurs within its set time interval. Only when the set time for "Treset" has expired without occurrence of a new earth fault (annunciation "`IIE Tres run`"), then all memories of the intermittent earth fault protection function are reset so that the protection reverts to its quiescent state. That means, "Treset" is the time period within which the next earth fault must occur so that it is treated as an intermittent earth fault, together with the previous earth fault. An earth fault which occurs later is regarded as a new fault.

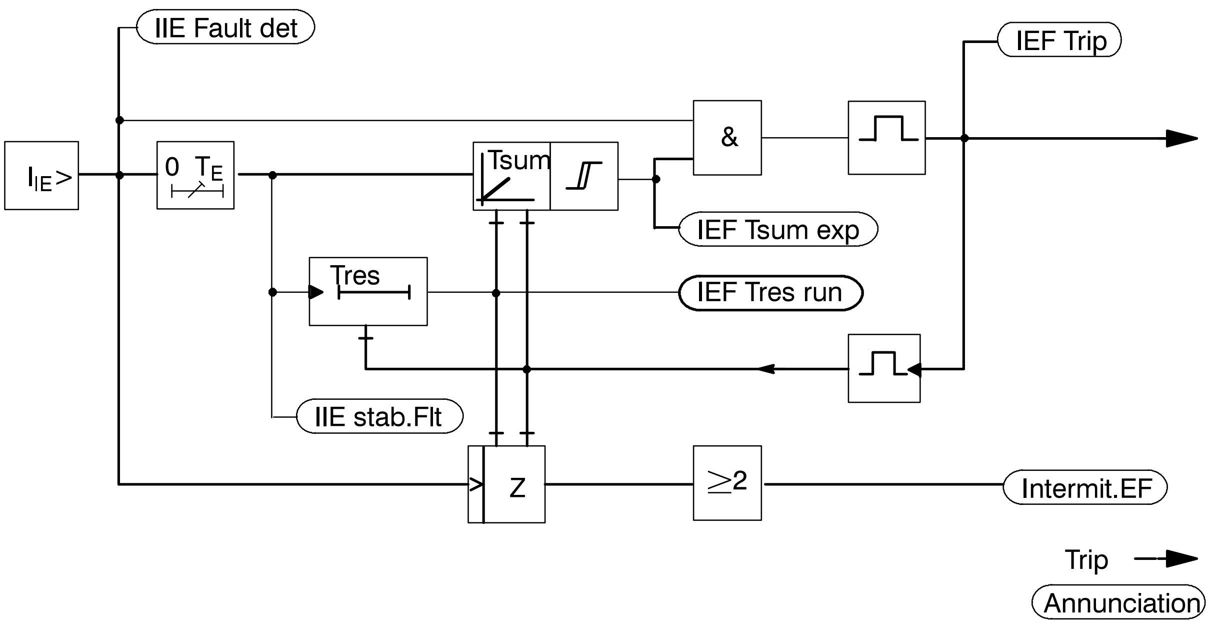


Figure 4.16 Logic scheme of the intermittent earth fault protection

4.7 Automatic reclosure

4.7.1 General

Experience has shown that approximately 85 % of short circuits are caused by an arc, on overhead lines, and self-extinguish after interruption by the protective device. The line can therefore be re-energized. This is carried out by the automatic reclosure (AR) function.

If the short circuit is still present after the auto-reclosure (arc not quenched or metallic short circuit), then the protective relay finally disconnects the power. Multiple auto-reclosure attempts, often with a first rapid auto-reclosure (RAR) and subsequent delayed auto-reclose cycles (DAR) are possible in some networks.

7SJ512 allows automatic three-pole as well as single- and multi-shot reclosure. If more than one reclose attempt will be carried out, the second and any further auto-reclose cycle are designated in the following with DAR (delayed auto-reclosure) independent on the real setting of the dead times of the cycles.

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

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

4.7.2 Protection stages and selectivity during automatic reclosure

For the auto-reclosure sequence to be successful, faults on any part of the line must be cleared from the feeding line ends within the same – shortest possible – time. Usually, therefore, an instantaneous stage of the short-circuit protection is set to operate before a reclosure by the AR–unit. Therefore, each short-circuit protection stage of 7SJ512 which can initiate the auto-reclose function provides special AR stages (see below). Furthermore, one can decide for each short-circuit protection whether or not it shall generally initiate the auto-reclose function.

For each of the protection functions:

– I>> stages for phase currents,

– I> stages (definite time) or I_p stages (inverse time) for phase currents,

– directional I> stages (definite time) or directional I_p stages (inverse time) for phase currents, if available,

– I_E>> stage for earth currents,

– I_E> stage (definite time) or I_{Ep} stage (inverse time) for earth currents,

– directional I_E> stage (definite time) or directional I_{Ep} stage (inverse time) for earth currents, if available,

– I_{EE}>> stage for highly sensitive earth fault detection,

– I_{EE}> stage (definite time) or I_{EEp} stage (inverse time) for highly sensitive earth fault detection,

the following can be individually chosen:

– whether the stage shall initiate the RAR function or not,

– which delay time should be valid before an RAR cycle,

– whether the stage shall initiate the DAR function or not,

– which delay time should be valid before a DAR cycle,

– which delay time should be valid before a final trip.

In addition, a choice can be made for RAR and DAR separately, whether each of the high-current stages (i.e. I>> or I_E>> or I_{EE}>> stage) should block auto-reclosure.

The remaining protection functions – thermal overload protection, circuit breaker failure protection, user defined trip functions – always operate without auto-reclosure, therefore they have no AR stages. Auto-reclose is always blocked when the circuit breaker failure protection has tripped.

The auto-reclose function provides an action time for each of RAR and DAR function which can separately set. The action times are started with any fault detection of a protection function which shall trigger the AR function. If the action time has elapsed before any trip signal is given, it is assumed that the fault is not on the protected line but on another line; auto-reclosure is not initiated.

All protection functions which can operate directional can block reclosure in case the fault lies in reverse direction. This applies also if a trip command is given for a reverse fault before the action time has elapsed. Note that the **non**-directional stages do not block auto-reclosure even when they trip on a fault in reverse direction. In order to avoid reclosure in such cases, the action time (refer to Section 4.7.3) must be set below the non-directional trip time.

4.7.3 Action times and reclaim times

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

The AR–functions of 7SJ512 are provided with settable action times, separate for RAR and DAR, which are started by the fault detection signal. If, after expiry of the action time, no tripping signal has been given, reclosure is blocked.

The AR–functions of 7SJ512 are provided with three settable reclaim times, which do not discriminate between RAR and DAR. Generally, the reclaim time is the time period during which no further reclosure attempt is permitted.

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

The lock-out time T–LOCK is the time period during which any further close command by the 7SJ512 relay is blocked after final disconnection. This applies for all closing attempts which are performed by the relay. If this time is set to ∞, closing is locked out until the AR function is reset by energization of the binary input "`>AR Reset`". After the reset signal all functions reset to the quiescent condition.

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

4.7.4 Three-pole rapid auto-reclosure

When the AR function is ready for operation, the short-circuit protection trips three-pole for all faults within the stage valid for RAR (refer to Section 4.7.2). The AR−function is initiated provided tripping occurs within the action time (refer Section 4.7.3). With fault clearance due to a trip command from a phase current element, the (settable) dead time RAR T−PHAse commences; with fault clearance due to a trip command from an earth current element, the (settable) dead time RAR T−EARth commences. After the corresponding dead time, the circuit breaker receives a closing command, the duration of which is settable. Simultaneously, the (settable) reclaim time T−RECLAIM (Section 4.7.3) is started.

If the fault is cleared (successful RAR), the reclaim time T−RECLAIM (Section 4.7.3) expires and all functions reset to the quiescent condition. The network fault is cleared.

If the fault has not been cleared (unsuccessful AR) then the short-circuit protection carries out a final disconnection in the stage that is valid for final trip (refer to Section 4.7.2). Also, every fault during the reclaim time will result in final disconnection.

After unsuccessful AR (final disconnection) the lock-out time T−LOCK (Section 4.7.3) is started. For this time any close command from 7SJ512 is locked.

The above sequence comes into effect with single-shot RAR. With 7SJ512, multiple AR−attempts (up to 9 DAR−shots, refer Section 4.7.5) are also possible.

4.7.5 Multi-shot delayed auto-reclosure

The internal auto-reclose feature in 7SJ512 will also permit multi-shot reclosure, up to 9 consecutive DAR−cycles. A separate DAR time is available for each of the protection stages (refer also to Section 4.7.2). Also the action time can be independently set for these DAR cycles.

Different numbers of DAR cycles can be set for phase faults and earth faults. The set number of DAR cycles does not include the first RAR cycle.

The dead times can be individually set for phase faults and earth faults.

Each new pick-up restarts the action time DAR T−ACT, within which a tripping command must occur. After fault clearance, the dead time begins. At the end of this, the circuit breaker is given a new closing command. Simultaneously, the reclaim time T−RECLAIM (Section 4.7.3) is started.

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

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

If none of the AR−cycles has been successful then the short-circuit protection carries out a final disconnection after the last permissible cycle in the stage that is valid for final trip (refer to Section 4.7.2). The lock-out time T−LOCK (Section 4.7.3) is started. For this time any close command from 7SJ512 is locked.

The subsequent cycles (DAR) can be blocked by a binary input.

4.8 Thermal overload protection

The thermal overload protection prevents the protected object, particularly in case of cables, transformers, and motors, 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 referred to 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 current (r.m.s. value) referred to the maximum permissible 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 protected object can be disconnected from the network.

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

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

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

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

Apart from the thermal warning stage, the overload protection also includes a current-dependent warning stage. This latter 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.

4.9 Circuit breaker failure protection

In order to supervise correct functioning of the circuit breaker, a check is made that the current disappears after a trip signal has been given. When the protection issues a trip command to the breaker, a timer T–B/F is started. The timer continues to run for as long as the trip command is maintained and the current continues to flow. If the circuit breaker does not respond to the trip command the timer runs to its set limit. The breaker failure protection then outputs a signal to trip the upstream circuit breaker(s) to clear the fault. This breaker failure trip signal can be assigned to a trip relay output of the device or to any signal relay as, normally, a further external multi-contact trip relay is used to produce the required number of trip contacts (observe switching capability!).

Start of the circuit breaker failure protection can also be initiated by an external feeder protection relay. The trip signal of the external protection device is coupled into the 7SJ512 relay via a binary input.

Figure 4.17 shows the logic diagram of the circuit breaker failure protection.

4.10 Dynamic switch-over of pick-up values

The pick-up values of the phase time overcurrent protection, the earth time overcurrent protection, and the high-sensitivity earth fault protection can be switched over dynamically to an alternative set of values during operation, by energizing an associated binary input. After energization of the binary input the relay operates immediately with the switched set of pick-up values.

4.11 Processing of user defined annunciations

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 delayed, allocated to signal relays, LEDs or trip relays, or transmitted to the front display, a PC or LSA. Examples are Buchholz protection or temperature monitor, or similar.

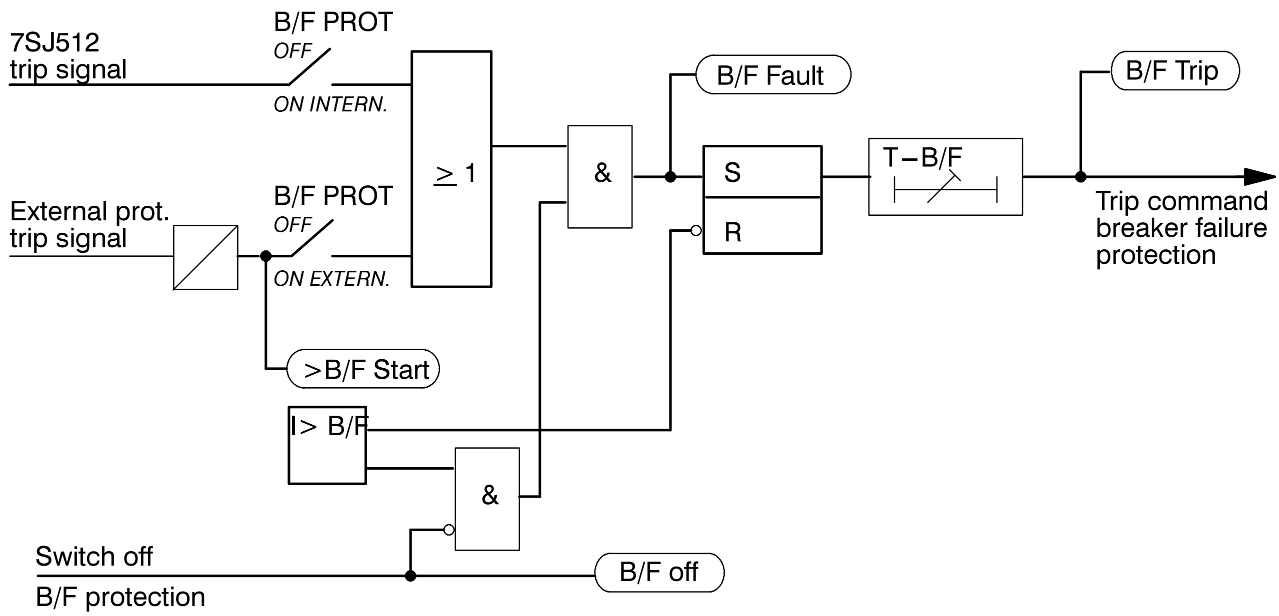


Figure 4.17 Logic diagram of the circuit breaker failure protection

4.12 Circuit breaker trip test

Numerical time overcurrent protection relay 7SJ512 allows checking of the tripping circuits and the circuit breaker by a simple method. By means of the incorporated auto-reclose feature, a TRIP−CLOSE test sequence is possible.

A precondition for any test sequence is that no protection 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 should not be defeated.

Additionally, for a TRIP−CLOSE cycle, the conditions for an auto-reclose sequence must be fulfilled (circuit breaker ready, auto-reclose not blocked).

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 monitored by the position of the breaker, as given by its auxiliary contact provided the auxiliary contact is connected to a binary input. If the breaker does not respond to a command, the test sequence will be interrupted and an appropriate indication is given. The sequence can be followed on the indicator panel or a personal computer screen.

The test sequence can also be started by a binary input.

4.13 Ancillary functions

The ancillary functions of the numerical time overcurrent protection relay 7SJ512 include:

– Processing of annunciations,

– Storage of short circuit data for fault recording,

– Operational measurements and testing routines,

– Monitoring functions.

4.13.1 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.

4.13.1.1 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. They can be reset:

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

– remotely by energization of the remote reset input,

– via the operating and system interface,

– 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.

4.13.1.2 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 operating 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 4.13.1.1.

The device also has several event buffers, e.g. for operating messages, circuit breaker operation statistics etc. (refer to Section 6.4) which can be saved against supply voltage failure by a buffer battery. 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. The sequence of the events is tagged with the relative time referred to the moment at which the fault detector has picked up. Thus, the elapsed time until tripping is initiated and until the trip signal is reset can be read out. The resolution is 1 ms at 50 Hz.

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

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

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

4.13.1.3 Information to a central unit (optional)

In addition, all stored information can be transmitted via an optical fibre connector or the isolated second interface 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 or, selectable, according to DIN 19244.

4.13.2 Data storage and transmission for fault recording

The instantaneous values of the measured values

i_{L1}, i_{L2}, i_{L3}, i_E
and, if available, u_{L1}, u_{L2}, u_{L3}, u_E

are sampled at intervals of $^1/_{20}$ a.c. cycle 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 operation interface at the front and evaluated by the protection data evaluation program DIGSI®. The currents and voltages 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”.

Alternatively, the fault record data can be transmitted to a control centre via the serial interface (if fitted). Evaluation of the data is made in the control centre, using appropriate software programs. The currents and voltages 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, readout 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.

4.13.3 Operating measurements and conversion

As long as the relay is not busy with a fault, the true r.m.s. values of the phase currents and the earth current are available as are – if available – the voltages, the active, reactive, and apparent power, for local recall or transmission of data. When the thermal overload protection is operative, the calculated temperature rises can also be read out.

The following is valid:

- I_{L1}, I_{L2}, I_{L3}, I_E phase and earth currents in amps primary and in % of rated current,
- U_{L1}, U_{L2}, U_{L3} voltages (phase–earth) in kilovolts primary and in % $U_N/\sqrt{3}$ (model with directional determination),
- I_{EEa} active component of the earth fault current in A primary and mA secondary,
- I_{EEr} reactive component of the earth fault current in A primary and mA secondary,
- U_E displacement voltage in kilovolts primary and in % U_N,
- P, Q, S active, reactive, and apparent power in megawatts or MVA or MVAr primary and in % of $\sqrt{3} \cdot I_N \cdot U_N$ (model with directional determination),
- cos φ power factor,
- f frequency in % of rated frequency,
- Θ/Θ_{trip} calculated temperature rise referred to trip temperature rise.

4.13.4 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 and voltage transformer circuits are also included in the monitoring system.

4.13.4.1 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

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

  An adjustable factor k_I (parameter Ie/Iph) can be set to correct the different ratios of phase and earth current transformers (e.g. summation transformer). If the residual earth current is derived from the current transformer starpoint, $k_I = 1$. SUM.Ithres and SUM.Fact.I are setting parameters (refer to Section 6.3.10). The component

SUM.Fact.I x I_{max} takes into account permissible current proportional transformation errors in the input converters which may particularly occur under conditions of high short circuit currents (Figure 4.18).

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.

A further current sum monitoring function operates with the phase currents and the earth current of the input for high-sensitivity earth fault detection, in the same way.

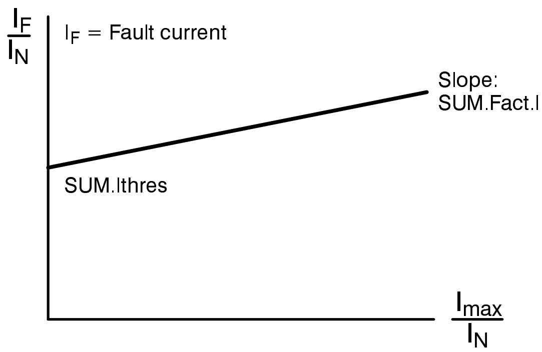


Figure 4.18 Current sum monitoring (current plausibility check)

– Command output channels:

The command relays for tripping and closing are controlled by two command and one additional release channels. As long as no pick-up condition exists, the processor makes a cyclic check of these command output channels for availability, by exciting each channel 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.

In the **voltage path**, there are four input converters: three connected to each phase – earth voltage and one further connected to the displacement voltage U_{EN}. A fault in the voltage circuits will be recognized when

$$|u_{L1} + u_{L2} + u_{L3} + k_U \cdot u_{EN}| > 25\ V.$$

Factor k_U (parameter Uph/Udelta) can be set to correct different ratios of phase and open delta voltage transformer windings.

Note: Voltage sum (phase – earth) monitoring can operate properly only when the device is equipped with phase voltage inputs (models with directional determination) and an externally formed open delta voltage U_{EN} is connected to the residual voltage input of the relay.

4.13.4.2 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.

4.13.4.3 Monitoring of external measuring transformer circuits

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

– Current symmetry

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

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

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

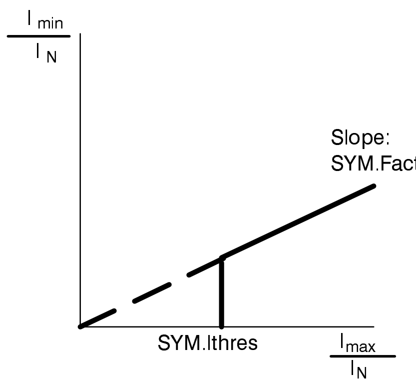


Figure 4.19 Current symmetry monitoring

– Voltage symmetry (models with directional determination)

In healthy operation it can be expected that the voltages will be approximately symmetrical. Therefore, the device checks the three connected phase voltages for symmetry.

The following applies:

$$|U_{min}| / |U_{max}| < \text{SYM.Fact.U}$$
if
$$|U_{max}| > \text{SYM.Uthres}$$

whereby U_{max} is the largest of the three voltages and U_{min} the smallest. The symmetry factor SYM.Fact.U represents the magnitude of the asymmetry of the voltages. The threshold SYM.Uthres is the lower limit of the processing area of this monitoring function (see Figure 4.20). Both parameters can be set (see Section 6.3.10).

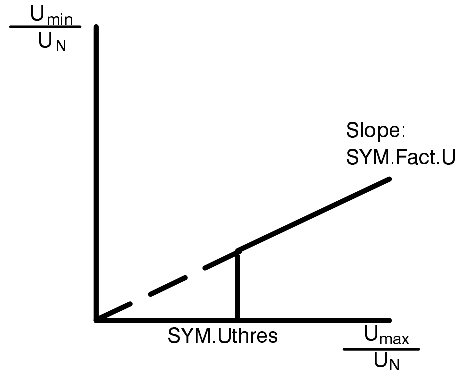


Figure 4.20 Voltage symmetry monitoring

– Phase rotation

Since correct functioning of directional determination relies upon a clockwise sequence of the measured quantities, the direction of rotation is monitored:

U_{L1} before U_{L2} before U_{L3} and

I_{L1} before I_{L2} before I_{L3}

These checks are carried out when the measured values have a minimum value of

$$|U_{L1}|, |U_{L2}|, |U_{L3}| > 40V \text{ and/or}$$

$$|I_{L1}|, |I_{L2}|, |I_{L3}| > 0.5 \cdot I_N$$

Counter-clockwise rotation will cause an alarm.

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

Monitoring	Failure covered, reaction
1. Plausibility check of currents $\|i_{L1} + i_{L2} + i_{L3} +$ **Ie/Iph** x $i_E\| >$ **SUM.Ithres** x I_N + **SUM.Fact.I** x I_{max}	Relay failures in the signal acquisition circuits i_{L1}, i_{L2}, i_{L3}, i_E delayed alarm "`Failure ΣI`"
2. Plausibility check of currents with I_{EE} $\|i_{L1} + i_{L2} + i_{L3} +$ **IEE/IPH** x $i_{EE}\| >$ **SUM.Ithres** x I_N + **SUM.Fact.I** x I_{max}	Relay failures in the signal acquisition circuits i_{L1}, i_{L2}, i_{L3}, i_{EE} delayed alarm "`Fail.ΣI (IEE)`"
3. Plausibility check of voltages phase−earth $\|u_{L1} + u_{L2} + u_{L3} +$ **Uph/Udelta** x $u_{EN}\| > 25$ V	Relay failures in the signal acquisition circuits u_{L1}, u_{L2}, u_{L3}, u_E delayed alarm "`Failure ΣUp-e`"
4. Current unbalance $\frac{\|I_{min}\|}{\|I_{max}\|} <$ **SYM.Fact.I** and $\|I_{max}\| >$ **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 delayed alarm "`Failure Isymm`"
5. Voltage unbalance (phase−phase) $\frac{\|U_{min}\|}{\|U_{max}\|} <$ **SYM.Fact.U** and $\|U_{max}\| >$ **SYM.Uthres**	Short-circuit or interruption (1-phase, 2-phase) in v.t. secondary circuits or unbalanced voltage on the system delayed alarm "`Failure Usymm`"
6. Phase rotation Phase sequence u_{L1} before u_{L2} before u_{L3}, as long as $\|U_{L1}\|, \|U_{L2}\|, \|U_{L3}\| > 40$ V and i_{L1} before i_{L2} before i_{L3}, as long as $\|I_{L1}\|, \|I_{L2}\|, \|I_{L3}\| > 0.5 \cdot I_N$	Swopped voltage connections or swopped current connections or reverse rotation sequence delayed alarm "`Fail.PhaseSeq`"

Bolted figures are setting values.

Table 4.2 Summary of measuring circuit monitoring

5 Installation instructions

Warning

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

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

5.1 Unpacking and repacking

When dispatched from the factory, the equipment is packed in accordance with the guidelines laid down in IEC 60255–21, which specifies the impact resistance of packaging.

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

The transport packing can be re-used for further transport when applied in the same way. The storage packing of the individual relays is not suited to transport. If alternative packing is used, this must also provide the same degree of protection against mechanical shock, as laid down in IEC 60255–21–1 class 2 and IEC 60255–21–2 class 1.

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

5.2 Preparations

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

Caution!

The modules of digital relays contain CMOS circuits. These shall not be withdrawn or inserted under live conditions! The modules must be so handled that any possibility of damage due to static electrical charges is excluded. During any necessary handling of individual modules the recommendations relating to the handling of **e**lectrostatically **e**ndangered **c**omponents (EEC) must be observed.

In installed conditions, the modules are in no danger.

5.2.1 Mounting and connections

5.2.1.1 Model 7SJ512⋆–⋆B⋆⋆⋆ for panel surface mounting

– Secure the unit with four screws to the panel. Refer to Figure 2.2 for dimensions.

– 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 7SJ512⋆–⋆C⋆⋆⋆ for panel flush mounting or –⋆E⋆⋆⋆ for cubicle installation

– Lift up both labelling strips on the lid of the unit and remove cover to gain access to four holes for the fixing screws.

– Insert the unit into the panel cut-out and secure it with the fixing screws. For dimensions refer to Figure 2.3.

– Connect earthing screw on the rear of the unit to the protective earth of the panel or cubicle.

– Make a solid low-ohmic and low-inductive operational earth connection between the earthing surface at the rear of the unit using at least one standard screw M4, and the earthing continuity system of the panel or cubicle; recommended grounding strap DIN 72333 form A, e.g. Order-No. 15284 of Messrs Druseidt, Remscheid, Germany.

– Make connections via the screwed or snap-in terminals of the sockets of the housing. Observe labelling of the individual connector modules to ensure correct location; observe the max. permissible conductor cross-sections. The use of the screwed terminals is recommended; snap-in connection requires special tools and must not be used for field wiring unless proper strain relief and the permissible bending radius are observed.

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.

5.2.2.1 Control d.c. voltage of binary inputs

When delivered from factory, the binary inputs are designed to operate in the total control voltage range from 19 V to 288 V d.c. 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 in order to increase stability against stray voltages in the d.c. circuits.

To fit a higher pick-up threshold to a binary input, solder bridges must be removed. Figure 5.1 shows the assignment of these solder bridges and their location on the basic p.c.b. EPS. Figure 5.2 shows the assignment of these solder bridges and their location on the additional input/output p.c.b. EAZ.

– Open housing cover.

– Loosen the 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.

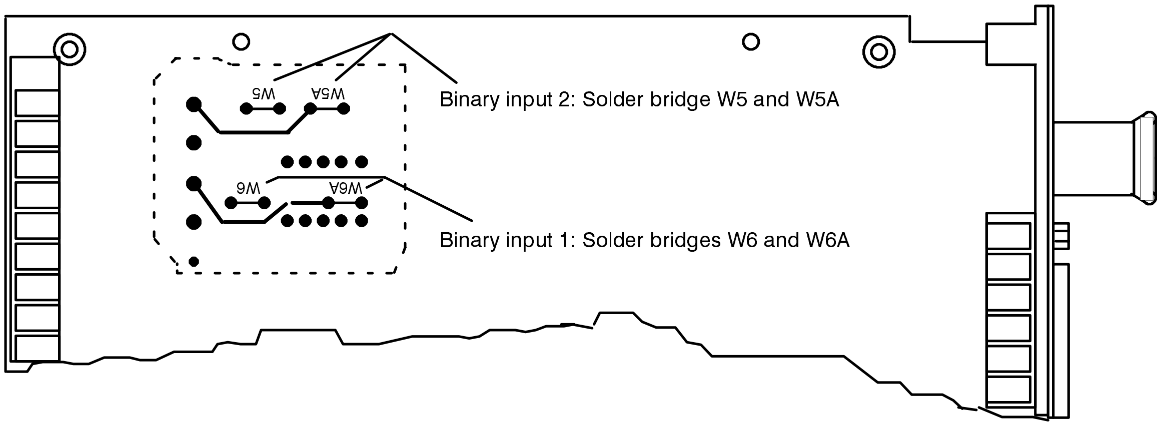
– Pull out module and place onto a conductive surface.

– Check the solder bridges according to Figures 5.1 and 5.2, remove bridges where necessary.

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

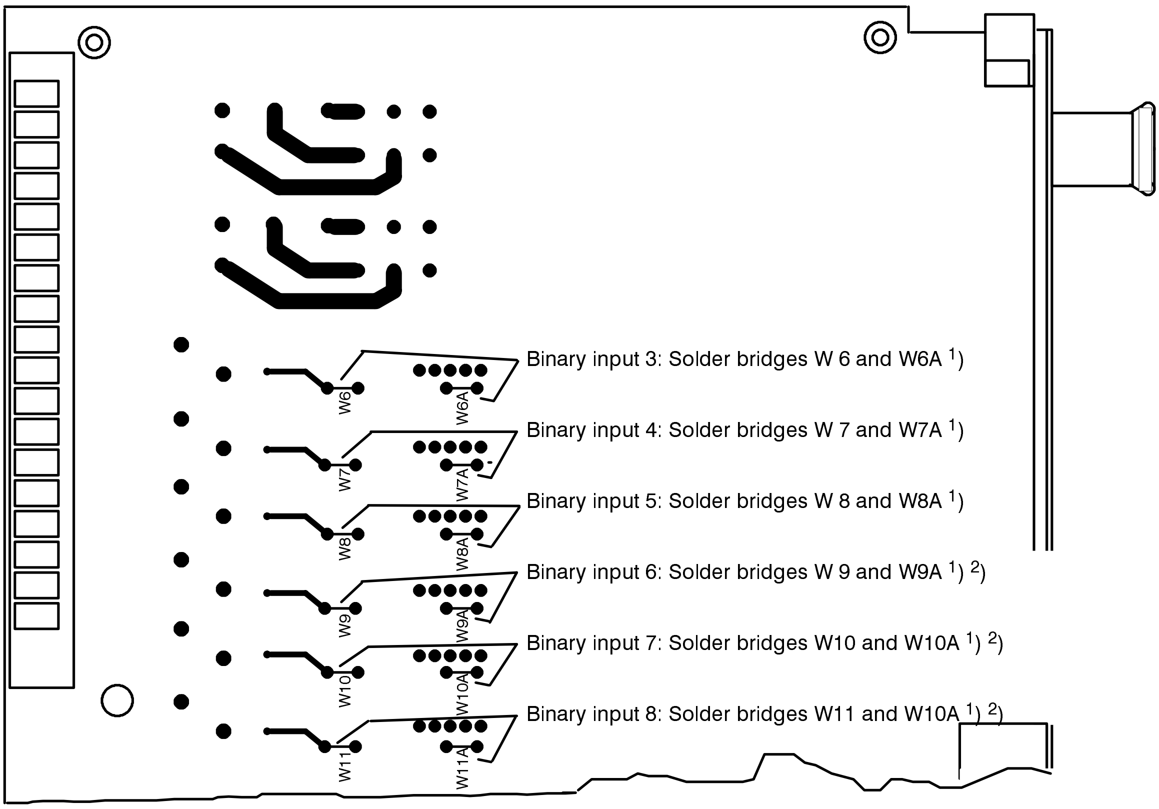
– Firmly push in the module using the releasing lever.

– Close housing cover.



For rated voltages 24/48/60 Vdc: Solder bridges W* and W*A must be fitted (pick-up approx. 16 V)
For rated voltages 110/125 Vdc: Solder bridges W* may be removed (pick-up approx. 80 V)
For rated voltages 220/250 Vdc: Solder bridges W* and W*A may be removed (pick-up approx. 160 V)
Cut and bend aside
[1]) Bridges W*A in models with production series /FF or later

Figure 5.1 Checking for control voltages for binary inputs 1 and 2 on basic p.c.b. EPS



For rated voltages 24/48/60 Vdc: Solder bridges W* and W*A must be fitted (pick-up approx. 16 V)
For rated voltages 110/125 Vdc: Solder bridges W* may be removed (pick-up approx. 80 V)
For rated voltages 220/250 Vdc: Solder bridges W* and W*A may be removed (pick-up approx. 160 V)
Cut and bend aside.
[1]) Bridges W*A in models with production series /FF or later
[2]) only for version 7SJ512★−★★★★−0★

Figure 5.2 Checking for control voltages for binary inputs 3 to 8 on additional p.c.b. EAZ

5.2.3 Checking the LSA data transmission link

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.

If data cables are used, 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

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.

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

The normal signal position for the data transmission is factory preset as “light off”. This can be changed by means of a plug jumper X91 which is accessible when the plug-in module is removed from the case. The jumper is situated in the rear area of the CPU board between the connector modules (Figure 5.3).

Jumper	Position	Normal signal position
X91	90 – 91	“Light off”
X91	91 – 92	“Light on”

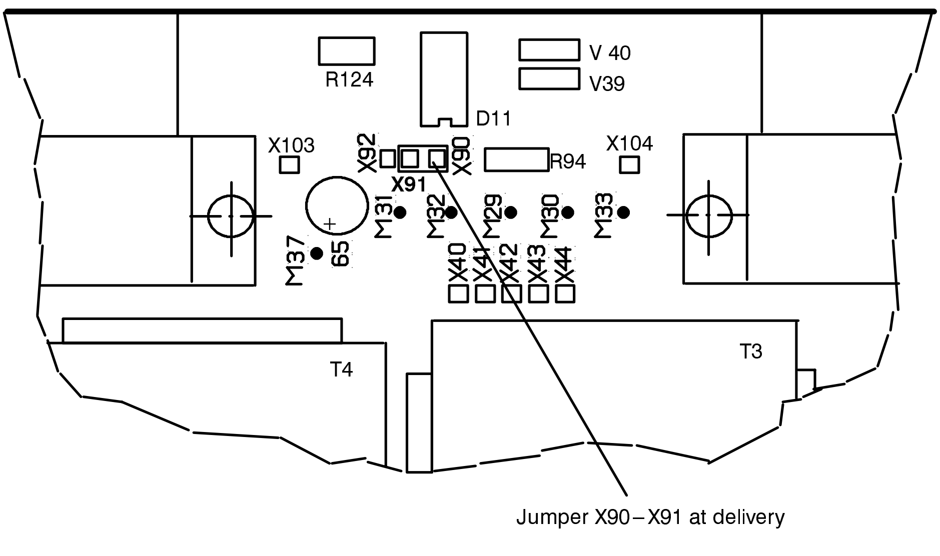


Figure 5.3 Position of the jumper X91 on the CPU board

5.2.4 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.

5.2.5 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 and the voltage transformer circuits!

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

  - Are the current transformers correctly earthed?
  - Are the polarities of the current transformer connections consistent?
  - Is the phase relationship of the current transformers correct?
  - Are the voltage transformers correctly earthed (if used)?
  - Are the polarities of the voltage transformer circuits correct (if used)?
  - Is the phase relationship of the voltage transformers correct (if used)?
  - Is the polarity of the summation current transformer correct (if used)?
  - Is the polarity of the open delta winding on the voltage transformers and the connection 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.

– 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 correspond to approximately 8 W. Transient movement of the ammeter pointer only indicates the charging current of the storage capacitors.

– 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 5 sec.

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

– Remove d.c. ammeter; reconnect the auxiliary voltage leads.

– Close the voltage transformer m.c.b. (secondary circuit, for models with directional supplement).

– Check the direction of phase rotation at the relay terminals (clockwise!).

– Open the m.c.b.’s for voltage transformer secondary circuits and d.c. power supply.

– 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, interface configuration and device configuration,

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

– setting of functional parameters (thresholds, functions),

– starting of test procedures.

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

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

```
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 **7 0 0 0** 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 present text can be rejected by the "No"–key **N**. The next text choice then appears, as shown in the boxes below. The chosen alternative **must be confirmed with enter key E!**

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

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

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

5.3.2 Settings for the integrated operation – address block 71

Operating parameters can be set in address block 71. This block allows the operator language to be changed. 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; this can be changed in address 7102.

⇑⇓ `7100▮ INTEGRATED`
`OPERATION`

Beginning of the block “Integrated operation”

↕ `7101▮ LANGUAGE`
`DEUTSCH`

`ENGLISH`

`US-ENGLISH`

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

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

↕ `7102▮ DATE FORMAT`
`DD.MM.YYYY`

`MM/DD/YYYY`

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)

```
7105  OPER.   1st   L
IL1   [%]=
```

```
IL2   [%]=
```

```
IL3   [%]=
```

etc.

Message to be displayed in the **1st** display line during operation. Any of the operational measured values according to Section 6.4.6 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.

```
7106  OPER.   2nd   L
IL2   [%]=
```

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.

```
7107  FAULT   1st   L
Fault   Type
```

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

type of fault (faulty phases),

```
Prot.Pick-up
```

protection function which has picked up,

```
Prot.Trip
```

protection function, which has tripped,

```
T-Drop
```

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

```
T-Trip
```

the elapsed time from pick-up to trip command,

```
Iie/In
```

the maximum earth fault current during intermittent earth fault,

```
Nos.IIE
```

the number of pick-ups during intermittent earth fault (if available).

```
7108  FAULT   2nd   L
T-Trip
```

etc.

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

the possibilities are the same as under address 7107.

```
7110  FAULT   INDIC
WITH  FAULT   DETEC
```

```
WITH  TRIP  COMM.
```

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

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

```
7200█ PC/SYSTEM
INTERFACES
```

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

```
7201█ DEVICE ADD.
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**

```
7202█ FEEDER ADD.
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**

```
7203█ SUBST. ADD.
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**

```
7208█ FUNCT. TYPE
160
```

Function type in accordance with VDEW/ZVEI and IEC 60870−5−103; for overcurrent time protection no. 160

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

```
7209█ DEVICE TYPE
24
```

Device type for identification of the device in Siemens LSA 678 and program *DIGSI*® . For 7SJ512 V3 no. 24

This address is mainly for information, it should not 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*.

7211 PC INTERF.	Data format for the PC (operating) interface:
DIGSI V3	format for Siemens protection data processing program *DIGSI*® Version *V3*
ASCII	*ASCII* format

7215 PC BAUDRATE	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**.
9600 BAUD	
19200 BAUD	
1200 BAUD	
2400 BAUD	
4800 BAUD	

7216 PC PARITY	Parity and stop-bits for the PC (operating) interface:
DIGSI V3	format for Siemens protection data processing program *DIGSI*® Version *V3* with even parity and 1 stop-bit
NO 2 STOP	transmission with *NO* parity and *2 STOP*-bits
NO 1 STOP	transmission with *NO* parity and *1 STOP*-bit, e.g. modem

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

7221 SYS INTERF.	Format of annunciations and fault records for the system (LSA) interface:
VDEW COMPATIBLE	only data in accordance with *VDEW*/ZVEI and IEC 60870–5–103
VDEW EXTENDED	data in accordance with *VDEW*/ZVEI and IEC 60870–5–103, extended by Siemens specified data
DIGSI V3	format for Siemens protection data processing program *DIGSI*® Version *V3*
LSA	format of the former Siemens *LSA* version

```
7222▮ SYS MEASUR.
VDEW COMPATIBLE
```

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

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

```
VDEW EXTENDED
```

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

```
7225▮ SYS BAUDR.
9600 BAUD
```

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**.

```
19200 BAUD
```

```
1200 BAUD
```

```
2400 BAUD
```

```
4800 BAUD
```

```
7226▮ SYS PARITY
VDEW/DIGSIV3/LSA
```

Parity and stop-bits for the system (LSA) interface:

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

```
NO 2 STOP
```

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

```
NO 1 STOP
```

transmission with *NO* parity and *1 STOP*-bit, e.g. 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 is shall be permitted to change parameters via this interface.

```
7235▮ SYS PARAMET
NO
```

Remote parameterizing via the system interface

NO – is not permitted

```
YES
```

YES – is permitted

5.3.4 Settings for fault recording – address block 74

The overcurrent time protection relay is equipped with a fault data store (see Section 4.13.2). Distinction must be made between the reference instant and the storage criterion (address 7402). Normally, the general fault detection signal of the protection is the reference instant. The storage criterion can be the general fault detection, too (*STORAGE BY FD*), or the trip command (*STORAGE BY TRIP*). Alternatively, the trip command can be selected as reference instant (*START WITH TRIP*), in this case, the trip command is the storage criterion, too.

A fault event begins with the fault detection of any protection functions and ends with drop-off of the latest fault detection. The scope of a fault record is normally this fault event (address 7403). If auto-reclosure is carried out, the complete network fault sequence – with one or more reclosure attempts – can be recorded until final fault clearance. This shows the total time sequence of the fault but utilizes more memory space even during the dead time(s).

The actual recording time starts with the pre-trigger time T–PRE (address 7411) before the reference instant and ends with the post-fault time T–POST (address 7412) after the recording criterion has disappeared. The permissible recording time for each record is set as T–MAX 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 set times are related on a system frequency of 50 Hz. They are to be matched, accordingly, for different frequencies.

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

```
7400
FAULT RECORDINGS
```

Beginning of block “Fault recordings”

```
7402 INITIATION
STORAGE BY FD.
```
```
STORAGE BY TRIP
```
```
START WITH TRIP
```

Data storage is initiated:

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

```
7403 SCOPE
FAULT EVENT
```
```
FAULT IN POW.SYS
```

Scope of a fault record:

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

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

```
7410 T-MAX
1.00 s
```

Maximum time period of a fault record
Smallest setting value: **0.30** s
Largest setting value: **5.00** s

```
7411█ T-PRE
0.10 s
```

Pre-trigger time before the reference instant
Smallest setting value: **0.05** s
Largest setting value: **0.50** s

```
7412█ T-POST
0.10 s
```

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

```
7431█ T-BINARY IN
0.50 s
```

Storage time when fault recording is initiated via a binary input (but not longer than T−MAX), 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)

```
7432█ T-KEYBOARD
0.50 s
```

Storage time when fault recording is initiated via the membrane keyboard (but not longer than T−MAX), pre-trigger and post-fault times are additive
Smallest setting value: **0.10** s
Largest setting value: **5.00** s

Address 7490 is not relevant in case that the relay is connected to a control and storage processing system which operates with the protocol according to VDEW/ZVEI (IEC 60870−5−103). But, if the relay is connected to a former LSA system, the relay must be informed how long a transmitted fault record must be, so that the former LSA system receives the correct number of fault record values.

Only for communication with a former LSA system:

```
7490█ SYS LENGTH
660 VALUES FIX
```

Length of a fault record which is transmitted via the serial system interface:

660 values fix or

```
<=3000 VAL. VAR
```

variable length with a maximum of 3000 values

5.4 Configuration of the protective functions

5.4.1 Introduction

The **device** 7SJ512 is capable of providing a series of **protection** and additional functions. The scope of the hard- and firmware is matched to these functions. Furthermore, individual functions can be set (configured) to be effective or non-effective or the interaction of the functions can be modified by configuration parameters. Additionally, the relay can be adapted to the system frequency.

1st example for configuration of the scope of the device:
Assume a network comprising overhead lines and cable sections. Since auto-reclose is only applicable for the overhead line sections, this function will be "de-configured" for the devices protecting the cable sections.

2nd example for the interaction of the functions:
The high current stages I>> shall operate with autoreclosure, not so the remaining stages. The device will be "informed" of this condition during configuration.

The configuration parameters are input through the integrated operation keyboard at the front of the device or by means of a personal computer, connected to this front-interface. The use of the integrated operating keyboard is described in detail in Section 6.2. Alteration of the programmed parameters requires the input of the codeword (see Section 5.3.1). Without codeword, the setting can be read out but not altered.

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

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

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

Within the bock 78 one can page forward with ↑ or back with ↓. Each paging action leads to a further address for the input of a configuration parameter.

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

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

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

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

When one exits the setting program, the altered parameters, which until then have been stored in volatile memories, are then permanently secured in EEPROMs and protected against power outage. The processor system will reset and re-start. During restart 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 7SJ512: There will be no annunciations and the associated setting parameters (functions, limit values) will not be requested during setting (Section 6.3). In contrast, **switch-off** of a function means that the function will be processed, that indication will appear (e.g. "... switched off") but that the function will have no effect on the result of the protective process (e.g. no tripping command).

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

```
7800 SCOPE OF
FUNCTIONS
```

Beginning of the block "scope of functions"

Characteristic for phase overcurrent protection

```
7812 CHARAC. PH
DEFINITE TIME
```

```
INVERSE TIME
```

Characteristic for earth overcurrent protection

```
7815 CHARAC. E
DEFINITE TIME
```

```
INVERSE TIME
```

Dynamic threshold switch-over via binary input:

```
7826 PARAM. BI
NON-EXIST
```

```
EXIST
```

Thermal overload protection:

```
7827 THERMAL OL
NON-EXIST
```

```
EXIST
```

Highly sensitive earth fault protection:

```
7830 EARTH FAULT
NON EXIST
```

```
EXIST
```

Intermittent earth fault protection:

```
7833 INTERMIT.EF
NON EXIST
```

```
EXIST
```

Internal auto-reclosure function:

```
7834 INTERNAL AR
NON-EXIST
```

```
EXIST
```

Directional supplement for overcurrent time protection:

```
7842 DIRECTION
EXIST
```

```
NON-EXIST
```

Parameter change-over:

```
7885 PARAM. C/O
NON-EXIST

EXIST
```

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.

```
7899 FREQUENCY
fN 50 Hz

fN 60 Hz
```

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

5.4.3 Setting the device configuration – address block 79

The configuration affects the interaction of the protective and additional functions, above all, for 7SJ512, the interaction of the auto-reclosing system with the protection functions.

```
7900 DEVICE
CONFIGURATION
```

Beginning of the block “Device configuration”

```
7901 I>>
WITH AR

WITHOUT AR
```

I>> stage of phase overcurrent time protection initiates auto-reclosure or not

```
7902 I>/Ip
WITH AR

WITHOUT AR
```

I> stage (definite time) or I_p stage (inverse time) of phase overcurrent time protection initiates auto-reclosure or not

```
7903 I>/Ip DIREC
WITH AR

WITHOUT AR
```

I> stage (definite time) or I_p stage (inverse time) of directional phase overcurrent time protection initiates auto-reclosure or not

```
7904 IE>>
WITH AR

WITHOUT AR
```

I_E>> stage of earth overcurrent time protection initiates auto-reclosure or not

```
7905 IE>/IEp
WITH AR

WITHOUT AR
```

I_E> stage (definite time) or I_{Ep} stage (inverse time) of earth overcurrent time protection initiates auto-reclosure or not

```
7906 IE>/IEp DIR
WITH AR

WITHOUT AR
```

I_E> stage (definite time) or I_{Ep} stage (inverse time) of directional earth overcurrent time protection initiates auto-reclosure or not

```
7907 IEE>>
WITH AR

WITHOUT AR
```

I_{EE}>> stage of high-sensitivity earth fault protection initiates auto-reclosure or not

```
7908 IEE>/IEEp
WITH AR

WITHOUT AR
```

I_{EE}> stage (definite time) or I_{EEp} stage (inverse time) of high-sensitivity earth fault protection initiates auto-reclosure or not

```
7909 AR CYCLES
IDENTICAL CYCLES

RAR/DAR/END DIFF
```

If AR CYCLES is set to *IDENTICAL CYCLES*, then the AR stages of the protection functions need only be parameterized one single time; these stages are then common for RAR, DAR, and final trip. Only if different stages are desired for RAR, DAR, and final trip then AR CYCLES is set to *RAR*/*DAR*/*END DIFF*erent; in this case the RAR, DAR and final trip stages of the protection functions must be set individually.

```
7910 CB TEST BI
THREE-POLE TRIP

TRIP-CLOSE 3POLE
```

Circuit breaker test via binary input is carried out

THREE–POLE TRIP will be initiated (without reclose)

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

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: An earth fault is registered from the overcurrent time protection. 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 3, the processor must be advised that the logical signal "`IE>> Fault`" should be transmitted to the signal relay 3. 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. blocking of the I>> stages) is connected to the unit via a (physical) input module and should initiate a (logical) function, namely blocking. The corresponding question to the operator is then: **Which** signal from a (physical) input relay should initiate **which** reaction in the device? One physical input signal can initiate up to 10 logical functions.

The trip relays can also be assigned different functions. Each trip relay can be controlled by a 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:

```
⇑  6 0 0 0 █
⇓  M A R S H A L L I N G
```

Beginning of marshalling blocks

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

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

On this selection level the allocated function can be changed by pressing the "No"–key **N**. By repeated use of the key **N** all marshallable functions can be paged through the display. Back-paging is possible with the backspace key **R**. When the required function appears press the execute key **E**. After this, further functions can be allocated to the same physical input or output module (with further index numbers) by using the key ↑. **Each selection must be confirmed by pressing the key E!** If a selection place shall not be assigned to a function, selection is made with the function "`not allocated`".

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

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

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

The function numbers and designations are listed completely in Appendix C.

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

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

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

5.5.2 Marshalling of the binary inputs – address block 61

The unit contains 5 or 8 binary inputs (dependent on model) which are designated INPUT 1 to INPUT 5 or INPUT 8. 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 the 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 ↑:

F↑ ↓
```
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
> L E D   r e s e t        N O
```
Reset of stored LED indications, FNo `6`; "normally open" operation: LEDs are reset 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 ↑

```
6 1 0 1▮ B I N A R Y
I N P U T   1
```

Marshalling binary input 1

FNo	Abbreviation	Description
1	not allocated	Binary input is not allocated to any input function
3	>Time Synchro	Synchronize internal real time clock
4	>Start FltRec	Start fault recording from external command via binary input
5	>LED reset	Reset LED indicators
7	>ParamSelec.1	Parameter set selection 1 (in conjunction with 8)
8	>ParamSelec.2	Parameter set selection 2 (in conjunction with 7)
11	>Annunc. 1	User definable annunciation 1
12	>Annunc. 2	User definable annunciation 2
13	>Annunc. 3	User definable annunciation 3
14	>Annunc. 4	User definable annunciation 4
354	>CB Aux.3p cl	Circuit breaker is 3-pole closed (from CB auxiliary contact)
356	>Manual Close	Circuit breaker is manually closed (from discrepancy switch)
1156	>CB Test	Trigger circuit breaker test
1201	>UE block	Block displacement voltage stage of high-sensitivity E/F protection
1202	>IEE>> block	Block I_{EE}>> stage of high-sensitivity E/F protection
1203	>IEE> block	Block I_{EE}> stage (definite time) of high-sensitivity E/F protection
1204	>IEEp block	Block I_{EEp} stage (inverse time) of high-sensitivity E/F protection
1205	>E/F Det. on	Switch on high-sensitivity earth fault detection
1206	>E/F Det. off	Switch off high-sensitivity earth fault detection
1401	>B/F on	Switch on circuit breaker failure protection
1402	>B/F off	Switch off circuit breaker failure protection
1431	>B/F Start	Initiate circuit breaker failure protection (start)
1501	>O/L on	Switch on thermal overload protection
1502	>O/L off	Switch off thermal overload protection
1503	>O/L block	Block thermal overload protection
1701	>O/C Ph on	Switch on overcurrent time protection for phase currents
1702	>O/C Ph off	Switch off overcurrent time protection for phase currents
1711	>O/C E on	Switch on overcurrent time protection for earth currents
1712	>O/C E off	Switch off overcurrent time protection for earth currents
1721	>I>> block	Block I>> stage of phase overcurrent time protection
1722	>I> block	Block I> stage (definite time) of phase overcurrent protection
1723	>Ip block	Block I_p stage (inverse time) of phase overcurrent protection
1724	>IE>> block	Block I_E>> stage of earth overcurrent time protection
1725	>IE> block	Block I_E> stage (definite time) of earth overcurrent protection
1726	>IEp block	Block I_{Ep} stage (inverse time) of earth overcurrent protection
1844	>Param BI	Dynamic change over of pick-up values by binary input
2621	>I> Block dir	Block directional I> stage (definite time) of phase O/C protection
2622	>Ip Block dir	Block directional I_p stage (inverse time) of phase O/C protection
2623	>IE>Block dir	Block directional I_E>stage (definite time) of earth O/C protection
2624	>IEpBlock dir	Block directional I_{Ep} stage (inverse time) of earth O/C protection

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

FNo	Abbreviation	Description
2701	>AR on	Switch on internal auto-reclose function
2702	>AR off	Switch off internal auto-reclose function
2703	>AR block	Block internal auto-reclose function statically
2704	>AR reset	Reset internal auto-reclose function
2709	>DAR block	Block complete DAR
2730	>CB ready	Circuit breaker ready for AR cycle
6901	>IEF on	Switch on intermittent earth fault protection
6902	>IEF off	Switch off intermittent earth fault protection
6903	>IEF block	Block intermittent earth fault protection

Table 5.1 Marshalling possibilities for binary inputs

The complete presettings are listed in Table 5.2.

Addr	1st display line	2nd display line	FNo	Remarks
6100	MARSHALLING	BINARY INPUTS		Heading of the address block
6101	BINARY INPUT 1	INPUT 1 >LED reset NO	5	Acknowledge and reset of stored LED and display indications, LED–test
6102	BINARY INPUT 2 INPUT 2	INPUT 2 >I>> block NO >IE>> block NO	1721 1724	Block I>> stages of overcurrent time protection
6103	BINARY INPUT 3	INPUT 3 >Manual Close NO	356	Manual close command from discrepancy switch
6104	BINARY INPUT 4	INPUT 4 >CB Aux.3p cl NO	354	Circuit breaker auxiliary contact: indicates position 3-pole closed
6105	BINARY INPUT 5	INPUT 5 >Start FltRec NO	4	Start fault recording from external source
6106	BINARY INPUT 6	INPUT 6 not allocated	1	Binary inputs 6 to 8 are only available in models 7SJ512★–★★★★★–**0**★ (without direction supplement). No functions are preset by the factory
6107	BINARY INPUT 7	INPUT 7 not allocated	1	
6108	BINARY INPUT 8	INPUT 8 not allocated	1	

Table 5.2 Preset binary inputs

5.5.3 Marshalling of the signal output relays − address block 62

The unit contains 5 or 9 signal outputs (alarm relays), dependent on the ordered model. One relay signals the availability of the relay (SIGNAL RELAY 5), its allocation cannot be changed. The relays are designated SIGNAL RELAY 1 to SIGNAL RELAY 5 or SIGNAL RELAY 1 to SIGNAL RELAY 9 and can be marshalled in address block 62. The block is reached by paging in blocks with ⇑ ⇓ or by directly addressing **DA 6 2 0 0 E**. The selection procedure is carried out as described in Section 5.5.1. Multiple annunciations are possible, i.e. one logical annunciation function can be routed 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 is not fitted in the relay or 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 which are indicated by a leading ">" sign, represent the direct confirmation of the binary inputs and are available as long as the corresponding binary input is energized.

Further information about annunciations see Section 6.4.

```
⇑ 6200 MARSHALLING
⇓ SIGNAL RELAYS
```

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

The first signal relay is reached with the key ↑:

```
F↑ 6201 SIGNAL
 ↓ RELAY 1
```

Allocations for signal relay 1

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

```
↑ 001 RELAY 1
↓ O/C Gen.Fault
```

Signal relay 1 has been preset for:
General fault detection of overcurrent time protection, FNo 1761

```
↑ 002 RELAY 1
↓ not allocated
```

no further functions are preset for signal relay 1

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

```
↑ 6201 SIGNAL
↓ RELAY 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 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
51	Dev.operative	Protection relay operative
60	LED reset	Stored annunciations 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
98	Param. Set C	Parameter Set C is activated
99	Param. Set D	Parameter Set D is activated
143	Failure 15V	Failure 15 V internal dc supply
144	Failure 5V	Failure 5 V internal dc supply
145	Failure 0V	Failure 0 V A/D converter
150	Failure I/O	Failure in input/output module
161	I supervision	General failure detected by current supervision
162	Failure ΣI	Failure supervision ΣI (measured currents)
163	Failure Isymm	Failure supervision symmetry I (measured currents)
164	U supervision	General failure detected by voltage supervision
165	Failure ΣUp-e	Failure supervision ΣU phase−earth
167	Failure Usymm	Failure supervision symmetry U
171	Fail.PhaseSeq	Failure supervision phase sequence
173	Fail.ΣI (IEE)	Failure superv. ΣI (phase currents with sensitive earth current input)
354	>CB Aux.3p cl	Circuit breaker is 3-pole closed (from CB auxiliary contact)
356	>Manual Close	Circuit breaker is manually closed (from discrepancy switch)
501	Device FltDet	General fault detection of the device
511	Device Trip	General trip of the device
516	Dev.Trip forw	Trip by the device on detected fault in forward (line) direction
517	Dev.Trip rev.	Trip by the device on detected fault in reverse (bus-bar) direction
561	Manual Close	Manual close indication of circuit breaker
563	CB Alarm Supp	Circuit breaker operation alarm suppressed
1156	>CB Test	Trigger circuit breaker test
1174	CB in Test	Circuit breaker test is in progress
1181	CB Test Trip	Trip by internal circuit breaker test function, general
1201	>UE block	Block displacement voltage stage of high-sensitivity E/F protection
1202	>IEE>> block	Block I_{EE}>> stage of high-sensitivity E/F protection
1203	>IEE> block	Block I_{EE}> stage (definite time) of high-sensitivity E/F protection
1204	>IEEp block	Block I_{EEp} stage (inverse time) of high-sensitivity E/F protection
1205	>E/F Det. on	Switch on high-sensitivity earth fault detection
1206	>E/F Det. off	Switch off high-sensitivity earth fault detection
1211	E/F Det. off	High-sensitivity earth fault protection is switched off
1212	E/F Det.activ	High-sensitivity earth fault protection is active
1213	E/F Fault	Earth fault detected by high-sensitivity earth fault protection
1214	E/F Trip	General trip of high-sensitivity earth fault protection
1215	UE Fault	Earth fault detected by displacement voltage stage U_E>
1216	T-UE expired	Delay time for trip by displacement voltage stage expired
1217	UE Trip	Trip by displacement voltage time stage

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

FNo	Abbreviation	Description
1221	IEE>> Fault	Earth fault detected by highly sensitive protection stage I_{EE}>>
1222	T-IEE>> expir	Delay time of highly sensitive earth stage I_{EE}>> expired
1223	IEE>> Trip	Trip by highly sensitive earth stage I_E>>
1224	IEE> Fault	Earth fault detected by highly sensitive definite time stage I_{EE}>
1225	T-IEE> expir	Delay time of highly sensitive earth stage I_{EE}> (definite) expired
1226	IEE> Trip	Trip by highly sensitive earth stage I_{EE}> (definite time)
1227	IEEp Fault	Earth fault detected by highly sensitive inverse time stage I_{EEp}
1228	T-IEEp expir	Delay time of highly sensitive earth stage I_{EEp} (inverse) expired
1229	IEEp Trip	Trip by highly sensitive earth stage I_{EEp} (inverse time)
1271	E/F Detection	Earth fault detected by highly sensitive earth fault protection
1272	E/F Detec. L1	Earth fault in phase L1 detected
1273	E/F Detec. L2	Earth fault in phase L2 detected
1274	E/F Detec. L3	Earth fault in phase L3 detected
1276	E/F forwards	Earth fault in forward direction detected
1277	E/F reverse	Earth fault in reverse direction detected
1401	>B/F on	Switch on breaker failure function
1402	>B/F off	Switch off breaker failure function
1431	>B/F Start	Start breaker failure protection
1451	B/F off	Breaker failure protection is switched off
1453	B/F active	Breaker failure protection is active
1455	B/F Fault	Breaker failure protection initiated (started)
1471	B/F Trip	Trip by breaker failure protection
1501	>O/L on	Switch on thermal overload protection
1502	>O/L off	Switch off thermal overload protection
1503	>O/L block	Block thermal overload protection
1511	O/L Prot. off	Thermal overload protection is switched off
1512	O/L blocked	Thermal overload protection is blocked
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 by trip stage
1701	>O/C Ph on	Switch on overcurrent time protection for phase currents
1702	>O/C Ph off	Switch off overcurrent time protection for phase currents
1711	>O/C E on	Switch on overcurrent time protection for earth currents
1712	>O/C E off	Switch off overcurrent time protection for earth currents
1721	>I>> block	Block I>> stage of phase overcurrent time protection
1722	>I> block	Block I> stage (definite time) of phase overcurrent protection
1723	>Ip block	Block I_p stage (inverse time) of phase overcurrent protection
1724	>IE>> block	Block I_E>> stage of earth overcurrent time protection
1725	>IE> block	Block I_E> stage (definite time) of earth overcurrent protection
1726	>IEp block	Block I_{Ep} stage (inverse time) of earth overcurrent protection
1751	O/C Ph off	Phase overcurrent time protection is switched off
1753	O/C Ph active	Phase overcurrent time protection is active
1756	O/C E off	Earth overcurrent time protection is switched off
1758	O/C E active	Earth overcurrent time protection is active
1761	O/C Gen.Fault	General fault detection of overcurrent time protection
1762	O/C Fault L1	Fault detection phase L1 of overcurrent time protection
1763	O/C Fault L2	Fault detection phase L2 of overcurrent time protection
1764	O/C Fault L3	Fault detection phase L3 of overcurrent time protection
1765	O/C Fault E	Earth fault detection of overcurrent time protection
1791	O/C Gen.Trip	General trip by overcurrent time protection
1800	I>> Fault	Fault detection overcurrent time stages I>> (phases)

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

FNo	Abbreviation	Description
1801	I>> Fault L1	Fault detection overcurrent time stage I>> phase L1
1802	I>> Fault L2	Fault detection overcurrent time stage I>> phase L2
1803	I>> Fault L3	Fault detection overcurrent time stage I>> phase L3
1804	T-I>> expired	Delay time of phase overcurrent stage I>> expired
1805	I>> Trip	Trip by overcurrent time stage I>> (phases)
1810	I> Fault	Fault detection overcurrent time stages I> (definite time phases)
1811	I> Fault L1	Fault detection overcurrent time stage I> phase L1
1812	I> Fault L2	Fault detection overcurrent time stage I> phase L2
1813	I> Fault L3	Fault detection overcurrent time stage I> phase L3
1814	T-I> expired	Delay time of phase overcurrent stage I> expired
1815	I> Trip	Trip by overcurrent time stage I> (phases)
1820	Ip Fault	Fault detection overcurrent time stages I_p (inverse time phases)
1821	Ip Fault L1	Fault detection overcurrent time stage I_p phase L1
1822	Ip Fault L2	Fault detection overcurrent time stage I_p phase L2
1823	Ip Fault L3	Fault detection overcurrent time stage I_p phase L3
1824	T-Ip expired	Delay time of phase overcurrent stage I_p expired
1825	Ip Trip	Trip by overcurrent time stage I_p (phases)
1831	IE>> Fault	Fault detection overcurrent time stage I_E>> earth
1832	T-IE>> expir	Delay time of earth overcurrent stage I_E>> expired
1833	IE>> Trip	Trip by overcurrent time stage I_E>> (earth)
1834	IE> Fault	Fault detection overcurrent time stage I_E> earth
1835	T-IE> expired	Delay time of earth overcurrent stage I_E> expired
1836	IE> Trip	Trip by overcurrent time stage I_E> (earth)
1837	IEp Fault	Fault detection overcurrent time stage I_{Ep} earth
1838	T-IEp expired	Delay time of earth overcurrent stage I_{Ep} expired
1839	IEp Trip	Trip by overcurrent time stage I_{Ep} (earth)
1840	Rush Block L1	Phase L1 blocked by inrush stabilization
1841	Rush Block L2	Phase L2 blocked by inrush stabilization
1842	Rush Block L3	Phase L3 blocked by inrush stabilization
1843	Rush Crossbl.	Crossblock of inrush stabilization has operated
1844	>Param BI	Dynamic change-over of pick-up values by binary input
2621	>I> Block dir	Block directional I> stage (definite time) of phase O/C protection
2622	>Ip Block dir	Block directional I_p stage (inverse time) of phase O/C protection
2623	>IE>Block dir	Block directional I_E>stage (definite time) of earth O/C protection
2624	>IEpBlock dir	Block directional I_{Ep} stage (inverse time) of earth O/C protection
2640	Forward dir.	Fault in forward direction (e.g. line direction)
2641	Reverse dir.	Fault in reverse direction (e.g. bus-bar direction)
2660	I> Fault dir.	Fault detection directional overcurrent time stages I>
2661	I> Flt dir.L1	Fault detection directional overcurrent time stage I> phase L1
2662	I> Flt dir.L2	Fault detection directional overcurrent time stage I> phase L2
2663	I> Flt dir.L3	Fault detection directional overcurrent time stage I> phase L3
2664	T-I> dir.exp.	Delay time of directional phase overcurrent stage I> expired
2665	I> dir. Trip	Trip by directional overcurrent time stage I> (phases)
2670	Ip Fault dir	Fault detection directional O/C time stages I_p (phases)
2671	Ip Flt dir.L1	Fault detection directional overcurrent time stage I_p phase L1
2672	Ip Flt dir.L2	Fault detection directional overcurrent time stage I_p phase L2
2673	Ip Flt dir.L3	Fault detection directional overcurrent time stage I_p phase L3
2674	T-Ip dir.exp.	Delay time of directional phase overcurrent stage I_p expired
2675	Ip dir. Trip	Trip by directional overcurrent time stage I_p (phases)
2681	IE>Fault dir.	Fault detection directional overcurrent time stage I_E> earth
2682	T-IE> dir.exp	Delay time of directional earth overcurrent stage I_E> expired
2883	IE> dir. Trip	Trip by directional overcurrent time stage I_E> (earth)

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

FNo	Abbreviation	Description
2684	IEpFault dir.	Fault detec. directional overcurrent time stage I_{Ep} earth
2685	T-IEp dir.exp	Delay time of directional earth overcurrent stage I_{Ep} expired
2886	IEp dir. Trip	Trip by directional overcurrent time stage I_{Ep} (earth)
2701	>AR on	Switch on internal auto-reclose function
2702	>AR off	Switch off internal auto-reclose function
2703	>AR block	Block internal auto-reclose function statically
2704	>AR reset	Reset internal auto-reclose function
2709	>DAR block	Block DAR
2730	>CB ready	Circuit breaker ready for AR cycle
2781	AR off	Internal auto-reclose function is switched off
2783	AR inoperativ	Internal auto-reclose function not operative (ineffective)
2784	AR not ready	Internal auto-reclose function (momentarily) not ready for reclose
2785	AR block.dyn.	Auto-reclose function blocked internally
2787	CB not ready	Circuit breaker not ready for a trip/reclose cycle
2801	AR in prog.	Auto-reclose cycle is in progress
2812	RAR T-act.run	Auto-reclose function action time for RAR is running
2813	RAR T-E run.	AR function dead time for RAR (initiated by earth fault) is running
2814	RAR T-Ph run.	AR function dead time for RAR (initiated by phase fault) is running
2817	RAR Zone Rel.	Internal AR function permits trip in RAR stage
2832	DAR T-act.run	Auto-reclose function action time for DAR is running
2833	DAR T-E run.	AR function dead time for DAR (initiated by earth fault) is running
2834	DAR T-Ph run.	AR function dead time for DAR (initiated by phase fault) is running
2837	DAR Zone Rel.	Internal AR function permits trip in DAR stage
2851	AR Close Cmd	Reclose command from internal auto-reclose function
2853	RAR Close	Reclose command after 3-pole 1st RAR (rapid AR)
2854	DAR Close	Reclose command after 3-pole further DAR (delayed AR)
2861	AR T-Recl.run	Auto-reclose function reclaim time is running
2862	AR successful	Auto-reclosure was successful
2863	Definit.Trip	Definitive trip signal
6901	>IEF on	Switch on intermittent earth fault protection
6902	>IEF off	Switch off intermittent earth fault protection
6903	>IEF block	Block intermittent earth fault protection
6921	IEF off	Intermittent earth fault protection is switched off
6922	IEF blocked	Intermittent earth fault protection is blocked
6923	IEF enabled	Intermittent earth fault protection is active
6924	IIE Fault det	Intermittent earth fault protection pick-up
6925	IIE stab.Flt.	Intermittent earth fault protection prolonged pick-up
6927	Intermitt.EF	Intermittent earth fault detected (more than 2 pickups within Treset)
6928	IEF Tsum exp.	Accumulated earth fault time expired
6929	IEF Tres run.	Reset time is running
6930	IEF Trip	Trip by intermittent earth fault protection

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 O/C Gen.Fault	1761	General fault detection of overcurrent time protection
6202	SIGNAL RELAY 2 RELAY 2 RELAY 2	RELAY 2 I>> Fault L1 I>> Fault L2 I>> Fault L3	1801 1802 1803	Fault detection annunciations
6203	SIGNAL RELAY 3	RELAY 3 IE>> Fault	1831	
6204	SIGNAL RELAY 4	RELAY 4 Device Trip	511	Trip signal given from either protection function or CB test of the device
6205	SIGNAL RELAY 5	RELAY 5 Dev.operative	51	**Cannot be altered**: device operative; the NC contact indicates “device fault”
6206	SIGNAL RELAY 6	RELAY 6 Dev.Trip forw	516	Trip of the device on a fault in forward direction
6207	SIGNAL RELAY 7	RELAY 7 not allocated	1	No presettings are arranged for signal relays 7 to 9
6208	SIGNAL RELAY 8	RELAY 8 not allocated	1	
6209	SIGNAL RELAY 9	RELAY 9 not allocated	1	

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 ⇑ ⇓ or by directly addressing with **DA 6 2 0 0 E**. The selection procedure is carried out as described in Section 5.5.1. Multiple annunciations are possible, i.e. one logical annunciation function can be given to several LEDs (see also Section 5.5.1).

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

The marshallable annunciation functions are the same as those listed in Table 5.3. Annunciation functions are, of course, not effective when the corresponding protection function is not fitted in the relay or has been programmed out (de-configured).

With direct input of the function number it is not necessary to input the leading zeros. To indicate whether the stored or unstored mode shall be effective the function number can be extended by a decimal point followed by 0 or 1, whereby

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

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

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

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

```
⇑ 6300█ MARSHALLING
⇓ LED INDICATORS
```

Beginning of the block "Marshalling of the LED indicators"

Select a LED with the key ↑, e.g. LED 1 in address 6301:

```
6301█ LED 1
```

Allocations for LED 1

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

```
001█ LED 1
Failure ΣI         nm
```

LED 1 has been preset for
1st: Failure detected by current sum monitor ΣI, not memorized, FNo 162

```
002█ LED 1
Failure Isymm      nm
```

LED 1 has been preset for
2nd: Failure detected by current symmetry monitor, not memorized, FNo 163

```
003█ LED 1
Failure ΣUp-e      nm
```

LED 1 has been preset for
3rd: Failure detected by voltage sum monitor ΣU, not memorized, FNo 165
(only models with phase voltage inputs)

```
004▌ LED 1
Failure Usymm nm
```

LED 1 has been preset for
4th: Failure detected by voltage symmetry monitor, not memorized, FNo 167
(only models with phase voltage inputs)

```
005▌ LED 1
Fail.PhaseSeq nm
```

LED 1 has been preset for
5th: Failure detected by phase sequence monitor, not memorized, FNo 171

```
006▌ LED 1
not allocated
```

no further functions are preset for LED 1

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

```
6301▌ LED 1
```

Allocations for LED 1; meaning: detected failures in the measured quantities

Addr	1st display line	2nd display line	FNo	Remarks
6300	MARSHALLING	LEDs		Heading of the address block
6301	LED 1 LED 1 LED 1 LED 1 LED 1 LED 1	 Failure ΣI nm Failure Isymm nm Failure ΣUp-e nm Failure Usymm nm Fail.PhaseSeq nm	 162 163 165 167 171	Group annunciation of all disturbances in measured quantities
6302	LED 2 LED 2	 O/C Fault L1 m	 1762	Fault detection annunciations of the overcurrent time protection
6303	LED 3 LED 3	 O/C Fault L2 m	 1763	
6304	LED 4 LED 4	 O/C Fault L3 m	 1764	
6305	LED 5 LED 5	 O/C Fault E m	 1765	
6306	LED 6 LED 6 LED 6 LED 6 LED 6	 Failure 15V nm Failure 5V nm Failure 0V nm Failure I/O nm	 143 144 145 150	Group annunciation of all disturbances in internal auxiliary voltages and trip relay circuits

Table 5.5 Preset LED indicators

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

The unit contains 4 trip relays which are designated TRIP RELAY 1 to TRIP RELAY 4. They can be marshalled in the address block 64. The block is reached by paging in blocks with ⇑ ⇓ or by directly addressing with **DA**, input of the address number **6 4 0 0** and pressing the enter key **E**. The selection procedure is carried out as described in Section 5.5.1. Multiple commands are possible, i.e. one logical command function can be given to several trip relays (see also Section 5.5.1).

Most of the annunciation functions in accordance with Table 5.3, can be marshalled to output command relays. But those listed in Table 5.6 are particularly suitable for trip relay output. Regard the table as a recommended pre-selection. Command functions are naturally not effective when the corresponding protection function is not fitted in the relay or has been programmed out (de-configured).

The assignment of the trip relays as delivered from factory is shown in the general diagrams in Appendix A. The following boxes show examples for marshalling of trip relays 1. Table 5.7 shows all trip relays as preset from the factory.

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

```
⇑ 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 ↑:

```
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** ↑:

```
↑ 0 0 1█ T R I P   R E L .   1
↓ O / C   G e n . T r i p
```

Trip relay 1 has been preset for:
General trip command of the overcurrent time protection, FNo 1791;

```
↑ 0 0 2█ T R I P   R E L A Y   1
↓ n o t   a l l o c a t e d
```

no further functions are preset for trip relay 1

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

```
↑ 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
501	Device FltDet	General fault detection of the device
511	Device Trip	General trip of the device
516	Dev.Trip forw	Trip by the device on fault in forward (line) direction
517	Dev.Trip rev.	Trip by the device on fault in reverse (bus-bar) direction
1181	CB Test Trip	Trip by internal circuit breaker test function, general
1213	E/F fault	Earth fault detected by high-sensitivity earth fault protection
1214	E/F Trip	General trip of high-sensitivity earth fault protection
1217	UE Trip	Trip by displacement voltage time stage
1223	IEE>> Trip	Trip by highly sensitive earth stage I_{EE}>>
1226	IEE> Trip	Trip by highly sensitive earth stage I_{EE}> (definite time)
1229	IEEp Trip	Trip by highly sensitive earth stage I_{EEp} (inverse time)
1455	B/F Fault	Breaker failure protection initiated (started)
1471	B/F Trip	Trip by breaker failure protection
1521	O/L Trip	Thermal overload protection trip by trip stage
1761	O/C Gen.Fault	General fault detection of overcurrent time protection
1791	O/C Gen.Trip	General trip by overcurrent time protection
1805	I>> Trip	Trip by overcurrent time stage I>> (phases)
1815	I> Trip	Trip by overcurrent time stage I> (phases)
1825	Ip Trip	Trip by overcurrent time stage I_p (phases)
1833	IE>> Trip	Trip by overcurrent time stage I_E>> (earth)
1836	IE> Trip	Trip by overcurrent time stage I_E> (earth)
1839	IEp Trip	Trip by overcurrent time stage I_{Ep} (earth)
2665	I> dir. Trip	Trip by directional overcurrent time stage I> (phases)
2675	Ip dir. Trip	Trip by directional overcurrent time stage I_p (phases)
2683	IE> dir. Trip	Trip by directional overcurrent time stage I_E> (earth)
2686	IEp dir. Trip	Trip by directional overcurrent time stage I_{Ep} (earth)
2851	AR Close Cmd.	Reclose command from internal auto-reclose function
2853	RAR Close	Reclose command after 3-pole 1st RAR (rapid AR)
2854	DAR Close	Reclose command after 3-pole further DAR (delayed AR)
6927	Intermitt.EF	Intermittent earth fault detected (more than 2 pickups within Treset)
6930	IEF Trip	Trip by intermittent earth fault protection

Table 5.6 Command functions

Addr	1st display line	2nd display line	FNo	Remarks
6400	MARSHALLING	TRIP RELAYS		Heading of the address block
6401	TRIP TRIP REL. 1	RELAY 1 O/C Gen.Trip	 1791	General trip command of the overcurrent time protection
6402	TRIP TRIP REL. 2 TRIP REL. 2	RELAY 2 I>> Trip IE>> Trip	 1805 1833	Trip command of any of the I>> stages of the overcurrent time protection
6403	TRIP TRIP REL. 3	RELAY 3 not allocated	 1	no functions are preset for trip relays 3 and 4
6404	TRIP TRIP REL. 4	RELAY 4 not allocated	 1	

Table 5.7 Preset command functions for trip relays

6 Operating instructions

6.1 Safety precautions

⚠ Warning

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

⚠ Caution!

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

6.2 Dialog with the relay

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

6.2.1 Membrane keyboard and display panel

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

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

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

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

Numerical keys for the input of numerals:

[0] to [9]	Digits 0 to 9 for numerical input
[•]	Decimal point
[∞]	Infinity symbol
[+/−]	Change of sign (input of negative numbers)

Yes/No keys for text parameters:

[J/Y]	Yes key: operator affirms the displayed question
[N]	No key: operator denies the displayed question or rejects a suggestion and requests for alternative

Keys for paging through the display:

[↑]	Paging forwards: the next address is displayed
[↓]	Paging backwards: the previous address is displayed
[⇧]	Block paging forwards: the beginning of the next address block is displayed
[⇩]	Block paging backwards: the beginning of previous address block is displayed

Confirmation key:

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

Control and special keys:

CW	Codeword: prevents unauthorized access to setting programs (not necessary for call-up of annunciations or messages)
R	Backspace erasure of incorrect entries
F	Function key; explained when used
DA	Direct addressing: if the address number is known, this key allows direct call-up of the address
M/S	Messages/Signals: interrogation of annunciations of fault and operating data (refer Section 6.4)

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

6.2.2 Operation with a personal computer

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

All data can be read in from, or copied onto, magnetic data carrier (floppy disc) (e.g. for settings and configuration). Additionally, all the data can be documented on a connected printer. It is also possible, by connecting a plotter, to print out the fault history traces.

For operation of the personal computer, the instruction manuals of this device are to be observed. The PC program DIGSI® is available for setting and processing of all digital protection data. Note that the operating interface in the front of the relay is not galvanically isolated and that only adequate connection cables are applied (e.g. 7XV5100−2). Further information about facilities on request.

6.2.3 Operational preconditions

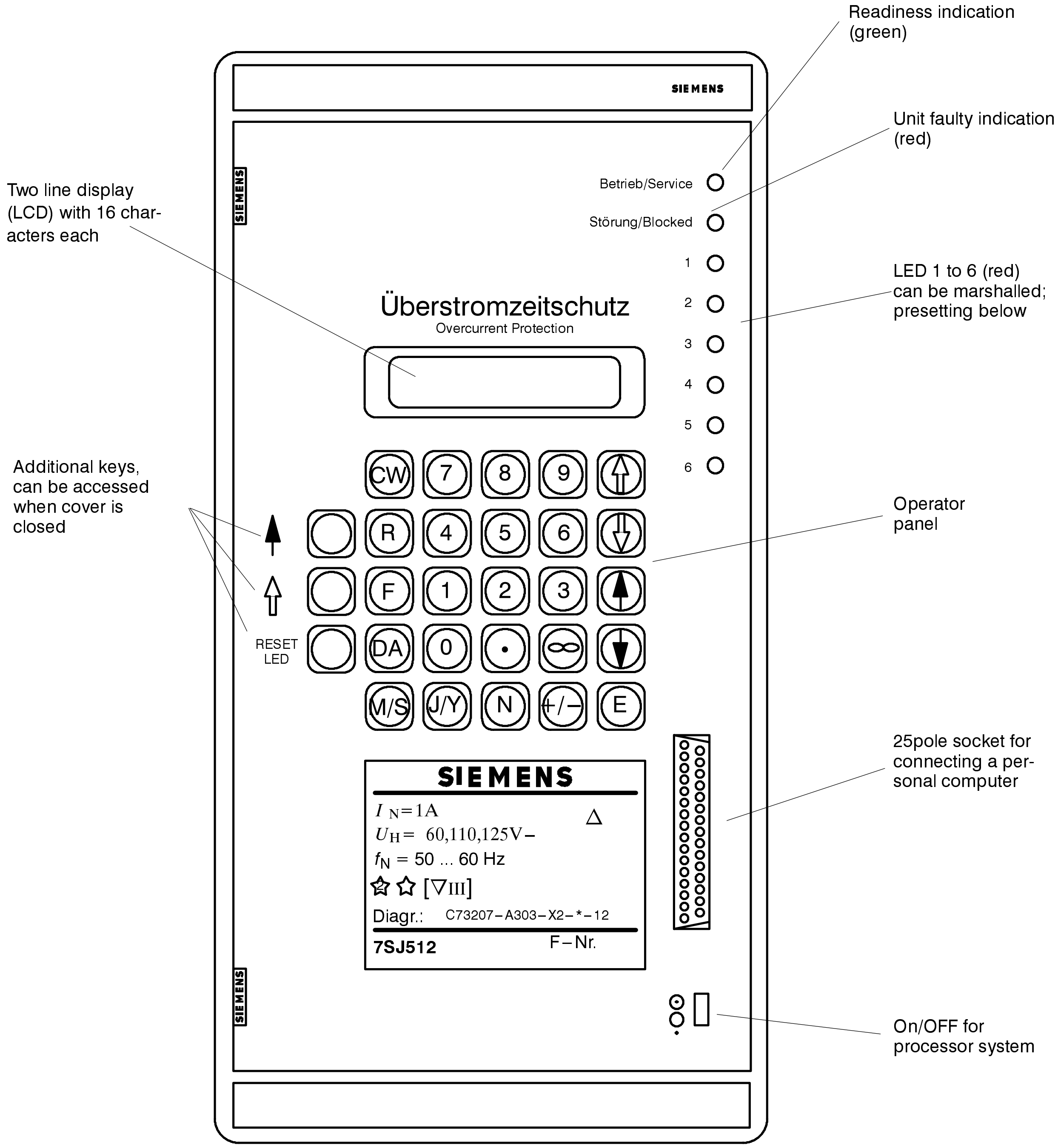
For most operational functions, the input of a codeword is necessary. This applies for all entries via the membrane keyboard or front interface which concern the operation on the relay, for example

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

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

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

6.2.4 Representation of the relay (front view)



Factory presetting LEDs:

1 Measured values faulty
2 Fault detected phase L1
3 Fault detected phase L2
4 Fault detected phase L3
5 Fault detected earth
6 Internal supply voltage faulty

Figure 6.1 Front view with operating key board and display panel

6.3 Setting the functional parameters

6.3.1. Introduction

6.3.1.1 Parameterizing procedure

For setting the functional parameters it is necessary to enter the codeword (see 5.3.1). Without codeword entry, parameters can be read out but not be changed.

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

– Addresses without request for operator input

  The address is identified by the block number followed by 00 as sequence number (e.g. **11**00 for block **11**). Displayed text forms the heading of this block. No input is expected. By using keys ⇑ or ⇓ the next or the previous block can be selected. By using the keys ↑ or ↓ the first or last address within the block can be selected and paged.

– Addresses which require numerical input

  The display shows the four-digit address, i.e. block and sequence number (e.g. **1103** for block **11**, sequence number **3**). Behind the bar appears the meaning of the required parameter, in the second display line, the value of the parameter. When the relay is delivered a value has been preset. In the following sections, this value is shown. If this value is to be retained, no other input is necessary. One can page forwards or backwards within the block or to the next (or previous) block. If the value needs to be altered, it can be overwritten using the numerical keys and, if required, the decimal point and/or change sign (**+**/**--**) or, where appropriate, infinity sign ∞. The permissible setting range is given in the following text, next to the associated box. Entered values beyond this range will be rejected. The setting steps correspond to the last decimal place as shown in the setting box. Inputs with more decimal places than permitted will be truncated down to the permissible number. **The value must be confirmed with the entry key E!** The display then confirms the accepted value. The changed parameters are only saved after termination of parameterizing (refer below).

– Addresses which require text input

  The display shows the four-digit address, i.e. block and sequence number (e.g. **1101** for block **11**, sequence number **1**). Behind the bar appears the meaning of the required parameter, in the second display line, the applicable text. When the relay is delivered, a text has been preset. In the following sections, this text is shown. If it is to be retained, no other input is necessary. One can page forwards or backwards within the block or to the next (or previous) block. If the text needs to be altered, press the “No” key **N**. The next alternative text, also printed in the display boxes illustrated in the following sections, then appears. If the alternative text is not desired, the **N** key is pressed again, etc. The alternative which is chosen, **is confirmed with the entry key E.** The changed parameters are only saved after termination of parameterizing (refer below).

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

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

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

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

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

6.3.1.2 Selectable parameter sets

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

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

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

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

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

All parameter sets can be accessed in a similar manner:

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

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

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

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

It is finally still possible to define the active parameter set, i.e. the parameter set which is valid for the functions and threshold values of the unit. See Section 6.5.5 for more details.

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

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

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

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

⇑⇓

```
8 5 0 0█ P A R A M E T E R
C H A N G E - O V E R
```

Beginning of the block "Parameter change-over"; processing of parameter sets

Addr.	Copy	
	from	to
8510	ORIG.SET	SET A
8511	ORIG.SET	SET B
8512	ORIG.SET	SET C
8513	ORIG.SET	SET D
8514	SET A	SET B
8515	SET A	SET C
8516	SET A	SET D
8517	SET B	SET A
8518	SET B	SET C
8519	SET B	SET D
8520	SET C	SET A
8521	SET C	SET B
8522	SET C	SET D
8523	SET D	SET A
8524	SET D	SET B
8525	SET D	SET C

Table 6.1 Copying parameter sets

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

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

6.3.1.3 Setting of date and time

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

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

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

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

⇑⇓
```
8100█ SETTING
REAL TIME CLOCK
```

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

↑↓
```
04.08.1993
10:25:21
```

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

↑↓
```
8102█ DATE
```

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**

↑↓
```
8103█ TIME
```

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

↑↓
```
8104█ DIFF. TIME
```

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 type number). When the device is operative and displays a quiescent message, any desired address can be reached e.g. by pressing the direct address key **DA** followed by the address number.

```
0█ 7SJ512   V3.**B
7SJ512**********
```

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”.

```
 1000█
PARAMETERS
```

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.

```
 1100█
POWERSYSTEM DATA
```

Beginning of the block “Power system data”

```
 1101█ CT STARPNT
TOWARDS LINE

TOWARDS BUSBAR
```

Current transformer polarity:
LINE – c.t. starpoint towards line
BUSBAR – c.t. starpoint towards bus-bar
This setting determines the measurement direction of the relay (forwards = line direction)

```
 1103█ Un PRIMARY
110 kV
```

Voltage transformer primary voltage (line-to-line)
Smallest setting value: **1** kV
Largest setting value: **400** kV

```
 1104█ Un SECOND.
100 V
```

Voltage transformer secondary voltage (line-to-line)
Smallest setting value: **100** V
Largest setting value: **125** V

```
  1 1 0 5█ I n   P R I M A R Y
4 0 0   A
```

Current transformer primary rated current (phases)
Smallest setting value: **10** A
Largest setting value: **50000** A

With addresses 1109 to 1114, the device is instructed as to how the earth paths of current and voltage transformers are connected. This information is important for the treatment of earth faults (in earthed networks), earth leakage (in unearthed networks) and the monitoring of measured values.

If the voltage transformer set has e–n (delta) windings, and if these are connected to the device, then this has to be recorded in address 1109. Since the ratio of the voltage transformers is normally:

$$\frac{U_{Nprim}}{\sqrt{3}} : \frac{U_{Nsec}}{\sqrt{3}} : \frac{U_{Nsec}}{3}$$

the factor Uph/Udelta (secondary values, address 1110) shall be set as $3/\sqrt{3} = \sqrt{3} \approx 1.73$ when the delta windings are connected. If the ratio is different, e.g. when the displacement voltage is formed by intermediate transformers, the factor has to be selected accordingly.

Two possibilities exist for the earth current path:

– Connection of the earth current from the star point of the current transformers (standard circuit arrangement, see also Appendix B, e.g. Figure B.1):

  Address 1112 is set as Ie/Iph = 1.000

– Connection of the earth current from a separate earth current transformer (e.g. summation current transformer, see also Appendix B, e.g. Figure B.3).

  Address 1112 is set as

$$Ie/Iph = \frac{\text{ratio of the earth current CT}}{\text{ratio of the phase current CT}}$$

Example:

Phase current transformers	500A/5A
Summation current transformer	300A/5A

$$Ie/Iph = \frac{300/5}{500/5} = 0.600$$

Additionally, an earth current input is available for high-sensitivity earth fault detection; connection from a separate earth current transformer (e.g. window type current transformer, see also Appendix B, e.g. Figure B.5).

Address 1114 is set as

$$Ie/Iph = \frac{\text{ratio of the earth current CT}}{\text{ratio of the phase current CT}}$$

Example:

Phase current transformers	400A/5A
Window type summation transformer	60A/1A

Relay type for high-sensitive earth fault detection

$$Ie/Iph = \frac{60/1}{400/5} = 0.750$$

```
  1 1 0 9█ V T   D E L T A
C O N N E C T E D

N O T   C O N N E C T E D
```

Have the voltage transformers open delta windings (for detection of earth faults) and are they connected?

```
  1 1 1 0█ U p h / U d e l t a
1 . 7 3
```

Matching factor for residual voltage:

$$\frac{\text{rated secondary voltage of v.t. phase winding}}{\text{rated secondary voltage of open delta winding}}$$

normally 1.73

Smallest setting value: **0.10**
largest setting value: **9.99**

```
  1 1 1 2█ I e / I p h
1 . 0 0 0
```

Matching factor for earth current:

1 for connection in c.t. starpoint;

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

for connection to separate earth current transformer

Smallest setting value: **0.001**
Largest setting value: **20.000**

```
  1 1 1 4█ I E E / I P H
1 . 0 0 0
```

Matching factor for high-sensitivity earth current input:

1 for connection in c.t. starpoint;

$$\frac{\text{(window-type) earth c.t. ratio}}{\text{(phase) c.t. ratio}}$$

for connection to separate earth current transformer

Smallest setting value: **0.001**
Largest setting value: **20.000**

Under addresses 1135 and 1141, some additional general device data are entered to the protection relay.

Under address 1141, the minimum trip command duration can be set. this time is then valid for all protection functions of the device which can lead to trip.

Under address 1135, the minimum close command duration can be set. This time is then valid for all functions of the device which can close the circuit breaker. It must be long enough to ensure reliable closure of the circuit breaker. An excessively long time does not present any danger, since the closing command will be interrupted at once on renewed trip command of any of the protection functions.

Finally, address 1150 allows for matching of the phase rotation of the system. Normally, it is clockwise. In case the phase rotation is counter-clockwise, this parameter is switched to *COUNTER–CLOCK*. The relay considers this in its calculations, so that no external phase exchanges are necessary and all phase indications etc. remain correct. The phase rotation is relevant only for models with directional determination.

```
  1 1 3 5█ T - C L O S E
1 . 0 0   s
```

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

```
  1 1 4 1█ 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 0█ P H A S E   R O T .
C L O C K W I S E
```

Phase rotation of the system, can be

clockwise or

```
A N T I - C L O C K W I S E
```

counter-clockwise

6.3.4 Settings for phase fault time overcurrent protection − address block 12

6.3.4.1 General settings and non-directional stages

```
  1200█ O/C  PROT.
PHASES
```

Beginning of the block “Time overcurrent protection for phase faults”

```
  1201█ O/C  PHASES
ON
```

Switching *ON* of the phase fault time overcurrent protection

```
OFF
```

Switching *OFF* of the phase fault time overcurrent protection

---

If the relay is intended to operate with an auto-reclose device, a short tripping time is often desired when automatic reclosure will be carried out. In this case unselectivity can be tolerated: Auto-reclosure is the attempt to retain operation of the network, thus, rapid fault clearance has higher priority than selectivity. 7SJ512 contains an auto-reclosure function which can be used also for multiple reclose attempts. For this, separates stages can be set for tripping before auto-reclosure. Details are given in Section 6.3.14. The values which are parameterized here are those which are valid without auto-reclosure, e.g. auto-reclosure not configured or switched off or blocked or not activated by phase time overcurrent protection.

At first, the high-set overcurrent stage I>> is set under addresses 1202 to 1206. This stage is often used for current grading before high impedances, e.g. transformers, motors or generators. This stage is always a definite time stage, independent on which characteristic is set for the overcurrent stage (I> or I_P). It is set such that it picks up on short-circuits into this impedance, e.g. for transformers to 1.5 times of the value

$$\frac{1}{u_{K\ transf}} \cdot \frac{I_{N\ transf}}{I_{N\ c.t.}}$$

The effect of inrush currents is reduced in 7SJ512 by numerical filters. If the fundamental wave exceeds the setting value, T−I>> must be delayed accordingly.

A further application of the I>> stage is in conjunction with the reverse interlocking principle (as described in Section 4.2.4). The different tripping time is of interest in this case, too. The I>> stage is used for rapid tripping in case of a busbar fault, with only a short safety time. The overcurrent stage is the back-up for faults on an outgoing feeder. The pick-up values I>> and I> or Ip are set at the same value, in this case.

The set times are pure delay times which do not include the operating time of the protection.

If the high-set overcurrent stage I>> is not used then set the time T−I>> to ∞. This does not avoid pick-up annunciation.

```
  1202█ I>>
2.00  I/In
```

Pick-up value of the high-set stage I>> for phase faults
Setting range: **0.05** to **25.00** · I_N

```
  1203█ T-I>>
0.10  s
```

Trip time delay of the high-set stage for phase faults
Setting range: **0.00** s to **60.00** s
or ∞ (no trip with I>> for phase faults)

```
1206 MEAS.REPET
NO

YES
```

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

7SJ512 can be used as definite time overcurrent protection or inverse time overcurrent protection. This function mode has been selected during configuration in Section 5.4.2 (address 7812). In this block 12, only those parameters are available which are associated with the function mode of the selected time overcurrent protection.

For **inverse time**, a choice can be made between three tripping time characteristics defined in IEC 60255−3. The characteristic for phase faults is selected in address 1211. Furthermore, one user defined characteristic is possible. The values of this characteristic must be defined in address block 25 (refer to Section 6.3.7).

```
1211 CHARACTER.
NORMAL INVERSE

VERY INVERSE

EXTREMELY INVERS

USER CHARACTER.
```

For inverse time overcurrent protection only:
Characteristic of the overcurrent stage I> for phase faults, can be

NORMAL INVERSE	time lag acc. IEC 60255−3, type A
VERY INVERSE	time lag acc. IEC 60255−3, type B
*EXTREMELY INVERS*e	time lag acc. IEC 60255−3, type C
USER CHARACTER.	user defined characteristic; for this, the table in address 2501 must be filled out

---

Addresses 1212 and 1213 are relevant only in case the **definite time** characteristic has been chosen under address 7812 (CHARAC. PH = *DEFINITE TIME*). The maximum load current determines the setting of the overcurrent stage I>. Pick-up on overload must be excluded since the unit operates in this mode as short-circuit protection with adequate short tripping time and not as overload protection. Therefore, the overcurrent stage is set to 120 % for feeder lines, and 150 % for transformers or motors referred to maximum (over)load current.

The effect of inrush currents on the overcurrent stage is reduced in 7SJ512 by numerical filters. The characteristics of the inrush blocking function are set in address block 20 (see Section 6.3.6).

The time delay T−I> depends on the grading plan for the network. The set times are pure delay times which do not include the operating time of the protection.

If the overcurrent stage I> is not used then set the time T−I> to ∞. This does not avoid pick-up annunciation.

```
1212 I>
1.00 I/In
```

For definite time overcurrent protection only:

Pick-up value of the overcurrent stage I> for phase faults
Setting range: **0.05** to **25.00** · I_N

```
1213 T-I>
0.50 s
```

Trip time delay for the overcurrent stage I>
Setting range: **0.00** s to **60.00** s
and ∞ (no trip with I> for phase faults)

Addresses 1214 and 1215 are relevant only in case an **inverse time** characteristic has been chosen under address 7812 (CHARAC. PH = *INVERSE TIME*, refer to Section 5.4.2). It must be considered that, according to IEC 60255−3, the protection picks up only when approximately 1.1 times the set value is exceeded (>1.05 times according to IEC 60255−3).

The effect of inrush currents on the overcurrent stage is reduced in 7SJ512 by numerical filters. The characteristics of the inrush blocking function are set in address block 20 (see Section 6.3.6).

If the overcurrent stage I_p is not used then set the time T−Ip to ∞. This does not avoid pick-up annunciation. If it is set to 0, the protection will trip with its inherent operating time.

For inverse time overcurrent protection only:

```
1214█ Ip
1.00  I/In
```

Pick-up value of the inverse time overcurrent stage Ip for phase faults
Setting range: **0.10** to **4.00** · I_N

```
1215█ T-Ip
0.50  s
```

Time multiplier for the inverse time overcurrent stage I_p
Setting range: **0.05** s to **10.00** s
and 0 (trip after the inherent operating time)
and ∞ (no trip with I_p for phase faults)

When the definite time characteristic is chosen, 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 of the measured currents are formed for evaluation, or if the *TRUE RMS* values 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 *TRUE RMS* can be advantageous (address 1216).

For inverse time overcurrent protection only:

```
1216█ RMS FORMAT
FUNDAMENTAL
```

The fundamental waves of the measured currents are evaluated by a Fourier filter

```
TRUE RMS
```

The true r.m.s. values of the measured currents are evaluated (only for inverse time characteristics)

Finally, address 1221 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 1201 to 1215.

```
1221█ MAN. CLOSE
I>> UNDELAYED
```

```
I>/Ip UNDELAYED
```

```
INEFFECTIVE
```

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

I>> i.e. I>> stage (address 1202) but without delay (address 1203)

I>/Ip i.e. I> stage (definite time, address 1212) or Ip stage (inverse time, address 1214) but without delay (address 1213 or 1215)

INEFFECTIVE, i.e. stages operate as parameterized

6.3.4.2 Directional stage (if fitted)

Depending on the model ordered (refer to Section 2.3 Ordering data), the time overcurrent protection contains directional stages. This sub-section is valid only for models 7SJ512★–★★★★★–**1/3**★. For other models it can be passed over.

The operation mode – definite time or inverse time overcurrent protection – as set under address 7812 during configuration (refer to Section 5.4.2) is also valid for the directional stage for phase currents. Nevertheless, for inverse time mode, a different characteristic can be selected under address 1223.

Switching on or off of the phase time overcurrent protection under address 1201 is also effective for the directional phase current stage. Equally, the current pick-up settings under address 1212 (for definite time overcurrent protection) or 1214 (for inverse time overcurrent protection) are valid for the directional phase current stage. The I>> stage (addresses 1202 and 1203) is always non-directional.

The operating direction of the directional stage can be changed in address 1222. Normally, this stage operates in the direction of the protected object (line, transformer). If the current transformer polarity has been correctly set under address 1101(refer to Section 6.3.3), *FORWARDS* direction is that of the protected object.

The delay time T–I> DIREC (address 1224 for definite time) or the time multiplier T–Ip DIREC (address 1225 for inverse time) is set shorter than that of the non-directional stage (address 1213 or 1215). Thus, the non-directional stage is superimposed on the directional stage and acts as back-up stage.

If parallel transformers are fed from one side only, delay is set to 0 or a very short time value at the non-feeding ends.

If the directional stage for phase currents is not needed the delay is set to ∞ or to the same value as for the non-directional stage,.

```
1222 DIREC.   I>
FORWARDS
```
```
REVERSE
```

Operating direction for the directional phase current stage

FORWARDS	forward direction, normally line or transformer
REVERSE	reverse direction, normally bus-bar

```
1223 CHAR.DIREC
NORMAL INVERSE
```
```
VERY INVERSE
```
```
EXTREMELY INVERS
```
```
USER CHARACTER.
```

For directional inverse time O/C protection only:
Characteristic of the phase overcurrent stage, can be

NORMAL INVERSE	time lag acc. IEC 60255–3, type A
VERY INVERSE	time lag acc. IEC 60255–3, type B
EXTREMELY INVERSe	time lag acc. IEC 60255–3, type C
USER CHARACTER.	user defined characteristic; for this, the table in address 2501 must be filled out

```
1224 T-I>  DIREC
0.40 s
```

For directional definite time O/C protection only:
Trip time delay for the directional overcurrent stage I>
Setting range: **0.00** s to **60.00** s
and ∞ (no directional trip with I> for phase faults)

```
1225 T-Ip  DIREC
0.40 s
```

For directional inverse time O/C protection only:
Time multiplier for the directional inverse time overcurrent stage I_p
Setting range: **0.05** s to **10.00** s
and 0 (trip after the inherent operating time)
and ∞ (no directional trip with I_p for phase faults)

6.3.5 Settings for earth fault time overcurrent protection − address block 15

6.3.5.1 General settings and non-directional stages

```
1500 O/C PROT.
EARTH
```

Beginning of the block “Time overcurrent protection for earth faults”

```
1501 O/C EARTH
ON
```

Switching *ON* of the earth fault time overcurrent protection

```
OFF
```

Switching *OFF* of the earth fault time overcurrent protection

---

If the relay is intended to operate with an auto-reclose device, a short tripping time is often desired when automatic reclosure will be carried out. Separates stages can be set for tripping before auto-reclosure in case of earth faults, too. Details are given in Section 6.3.14. The values which are parameterized here are those which are valid without auto-reclosure, e.g. auto-reclosure not configured or switched off or blocked or not activated by earth time overcurrent protection.

At first, the high-set overcurrent stage I_E>> is set under addresses 1502 to 1506, if used; if not used, set T−IE>> (address1503) to ∞. This does not avoid pick-up annunciation. For determination of the setting values similar considerations are valid as for the phase fault stage I>> (refer to Section 6.3.4.1).

The set times are pure delay times which do not include the operating time of the protection.

```
1502 IE>>
0.50 I/In
```

Pick-up value of the high-set stage I_E>> for earth faults
Setting range: **0.05** to **25.00** · I_N

```
1503 T-IE>>
0.10 s
```

Trip time delay of the high-set earth fault stage I_E>>
Setting range: **0.00** s to **60.00** s
or ∞ (no trip with I_E>> for earth faults)

```
1506 MEAS.REPET
NO
```

```
YES
```

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

7SJ512 can be used as definite time overcurrent protection or inverse time overcurrent protection. Selection for earth faults is independent of that for phase faults. The function mode has been selected during configuration in Section 5.4.2 (address 7815). In this block 15, only those parameters are available which are associated with the selected function mode of the time overcurrent protection for earth faults.

For **inverse time**, a choice can be made between three tripping time characteristics defined in IEC 60255−3. The characteristic for earth faults is selected in address 1511. Furthermore, a long time earth fault characteristic can be selected. Additionally, one user definable characteristic is possible. The values of this characteristic must be defined in address block 25 (see Section 6.3.7).

```
 1511█ CHARACTER.
NORMAL INVERSE
```

```
VERY INVERSE
```

```
EXTREMELY INVERS
```

```
USER CHARACTER.
```

```
LONG EARTH FAULT
```

For inverse time overcurrent protection only:
Characteristic of the overcurrent stage I_E> for earth faults, can be

NORMAL INVERSE	time lag acc. IEC 60255−3, type A
VERY INVERSE	time lag acc. IEC 60255−3, type B
EXTREMELY INVERSe	time lag acc. IEC 60255−3, type C
USER CHARACTER.	user defined characteristic; for this, the table in address 2501 must be filled out

LONG time *EARTH FAULT* characteristic

A separate characteristic can be selected for earth faults. Addresses 1512 and 1513 are relevant only in case the **definite time** characteristic has been chosen under address 7815 (CHARAC. E = *DEFINITE TIME*). The minimum earth fault current determines the setting of the overcurrent stage IE>.

The time delay T−IE> depends on the grading plan for the network which can be separate for earth faults. The set times are pure delay times which do not include the operating time of the protection.

The effect of inrush currents on the overcurrent stage is reduced in 7SJ512 by numerical filters. The characteristics of the inrush blocking function are set in address block 20 (see Section 6.3.6).

If the overcurrent stage I_E> is not used then set the time T−IE> to ∞. This does not avoid pick-up annunciation.

For definite time overcurrent protection only:

```
 1512█ IE>
0.20 I/In
```

Pick-up value of the overcurrent stage I_E> for earth faults
Setting range: **0.05** to **25.00** · I_N

```
 1513█ T-IE>
0.50 s
```

Trip time delay for the overcurrent stage Ie>
Setting range: **0.00** s to **60.00** s
and ∞ (no trip with I_E> for earth faults)

Addresses 1514 and 1515 are relevant only in case an **inverse** time characteristic has been chosen under address 7815 (CHARAC. E = *INVERSE TIME*, Section 5.4.2). With these parameters, a separate time grading can be selected for earth fault with often shorter trip time delays. It must be considered that, according to IEC 60255−3, the protection picks up only when 1.1 times the set value is exceeded. If the overcurrent stage I_{Ep} is not used then set the time T−IEp to ∞. This does not avoid pick-up annunciation. If it is set to 0, the protection will trip with its inherent operating time.

The effect of inrush currents on the overcurrent stage is reduced in 7SJ512 by numerical filters. The characteristics of the inrush blocking function are set in address block 20 (see Section 6.3.6).

For inverse time overcurrent protection only:

```
  1514█ IEp
0.20  I/In
```

Pick-up value of the inverse time overcurrent stage I_{Ep} for earth faults
Setting range: **0.10** to **4.00** · I_N

```
  1515█ T-IEp
0.50  s
```

Time multiplier for the inverse time overcurrent stage I_{Ep}
Setting range: **0.05** s to **10.00** s
and 0 (trip after the inherent operating time)
and ∞ (no trip with I_{Ep} for earth faults)

When the definite time characteristic is chosen, 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 of the measured currents are formed for evaluation, or if the *TRUE RMS* values 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 *TRUE RMS* can be advantageous (address 1516).

For inverse time overcurrent protection only:

```
  1516█ RMS FORMAT
FUNDAMENTAL
```

The fundamental wave of the measured current is evaluated by a Fourier filter

```
TRUE R.M.S.
```

The true r.m.s. value of the measured current is evaluated (only for inverse time characteristics)

Finally, address 1521 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 1501 to 1515.

```
  1521█ MAN. CLOSE
IE>> UNDELAYED
```

```
IE>/Iep UNDELAY.
```

```
INEFFECTIVE
```

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

IE>> i.e. I_E>> stage (address 1502) but without delay (address 1503)

IE>/IEp i.e. I_E> stage (definite time, address 1512) or I_{Ep} stage (inverse time, address 1514) but without delay (address 1513 or 1515)

INEFFECTIVE, i.e. stages operate as parameterized

6.3.5.2 Directional stage (if fitted)

Depending on the model ordered (refer to Section 2.3 Ordering data), the time overcurrent protection contains directional stages. This sub-section is valid only for models 7SJ512★−★★★★★−**1**/**3**★. For other models it can be passed over.

The operation mode − definite time or inverse time overcurrent protection − as set under address 7815 during configuration (refer to Section 5.4.2) is also valid for the directional stage for earth currents. Nevertheless, a different characteristic can be selected under address 1523 for inverse time mode.

Switching on or off the phase time overcurrent protection under address 1501 is also valid for the directional earth current stage. Equally, the current pick-up settings under address 1512 (for definite time) or 1514 (for inverse time) are valid for the directional phase current stage. The I>> stages (addresses 1502 and 1503) are always non-directional.

The operating direction of the directional stage can be changed for earth time overcurrent protection in address 1522. Direction definition is the same as for phase faults.

The delay time T−IE> DIRE (address 1524 for definite time) or the time multiplier T−IEp DIRE (address 1525 for inverse time) is set shorter than that of the non-directional stage (address 1513 or 1515). Thus, the non-directional stage is superimposed on the directional stage and acts as back-up stage.

If the directional stage for earth current is not needed the delay is set to ∞ or to the same value as for the non-directional stage.

```
1522 DIREC.  IE>
FORWARDS

REVERSE
```

Operating direction for the directional earth current stage

FORWARDS forward direction, normally line or transformer

REVERSE reverse direction, normally bus-bar

```
1523 CHAR.DIREC
NORMAL INVERSE

VERY INVERSE

EXTREMELY INVERS

USER CHARACTER.

LONG EARTH FAULT
```

For directional inverse time O/C protection only:
Characteristic of the earth fault overcurrent stage Ie>, can be

NORMAL INVERSE time lag acc. IEC 60255−3, type A

VERY INVERSE time lag acc. IEC 60255−3, type B

*EXTREMELY INVERS*e time lag acc. IEC 60255−3, type C

USER CHARACTER. user defined characteristic; for this, the table in address 2501 must be filled out

LONG time *EARTH FAULT* characteristic

```
1524 T-IE>  DIR.
0.40 s
```

For directional definite time O/C protection only:
Trip time delay for the directional earth overcurrent stage I_E>
Setting range: **0.00** s to **60.00** s
and ∞ (no directional trip with I_E> for earth faults)

```
1225 T-IEp  DIR.
0.40 s
```

For directional inverse time O/C protection only:
Time multiplier for the directional inverse time earth overcurrent stage I_{Ep}
Setting range: **0.05** s to **10.00** s
and 0 (trip after the inherent operating time)
and ∞ (no directional trip with I_{Ep} for earth faults)

6.3.6 Settings for inrush stabilization – address block 20

Although the numerical filters of the time overcurrent protection ensure that only the fundamental wave of the measured currents are compared with the set thresholds, malfunction might be caused by inrush currents when transformer feeders, protected by 7SJ512, are switched in, since – dependent of the size and construction of the transformer – a high magnitude of fundamental wave may be found in the inrush current.

7SJ512 provides an integrated inrush blocking function. This can be switched effective under address 2001. It blocks the overcurrent stages $I_{(E)}>$ or $I_{(E)p}$ (not $I_{(E)}>>$ stages) as long as inrush current is detected.

Inrush current detection is based on the evaluation of the second harmonic content of the inrush current. A ratio of I_{2fN}/I_{fN} = 20 % has been preset by the factory and can – as a rule – be retained without change. The magnitude which is needed for stabilizing, however, can be parameterized in order to provide for a more sensitive setting (= lower value) in exceptional cases under especially unfavourable switch-in conditions (address 2002).

Inrush blocking operates individually for each phase current. Thus, the protection is fully operative even when the transformer is switched onto a single-phase fault, whereby inrush currents may possibly be present in one of the healthy phases. However, it is also possible to activate a “cross-block” function (address 2003). CROSSBLOCK = *YES* means that not only the phase with inrush current exhibiting harmonic content in excess of the permissible value is blocked but also the other phases and the earth path are blocked (so called “cross-block function”). When the high-sensitivity earth fault protection is used, the $I_{EE}>$ stage of this function is blocked by the crossblock function, too.

Blocking by the inrush stabilization function can be limited to a specific time T–RUSH (address 2004). After this time tripping is released even when the second harmonic content exceeds the setting value.

```
2000 INRUSH
STABILIZATION
```

Beginning of the block “Inrush stabilization”

```
2001 RUSH
OFF
```

Switching *OFF* of the inrush stabilization

```
ON
```

Switching *ON* of the inrush stabilization

```
2002 2nd HARMON
20 %
```

2nd harmonic content in a phase current which just initiates blocking, in % of fundamental wave of the current
Setting range: **10** % to **45** %

```
2003 CROSSBLOCK
NO
```

```
YES
```

Crossblock function:

NO harmonic stabilization operates for each individual phase

YES harmonic stabilization of one phase blocks also the other phases

```
2004 T-RUSH
1.50 s
```

Limitation time of blocking after pick-up when 2nd harmonic content has exceeded limit value
Setting range: **0.10** s to **60.00** s

6.3.7 Setting a user specified current time characteristic – address block 25

Besides the standard characteristics for inverse time overcurrent protection which are integrated in the relay (refer to Sections 6.3.4 and 6.3.5), one user specified current time characteristic can be defined. Up to 60 pairs of values of current and time can be entered to the relay under address 2501. The relay calculates intermediate values by linear interpolation.

When one has reached the address block 25 (address 2500), scrolling on with key ↑ leads to address 2501 CHARACTERISTIC 1 (the first and only).

In order to enter the value pairs, one must switch over to the table definition level with key combination **F** ↑, i.e. depressing the function key **F** followed by the arrow key ↑. During this change-over (i.e. from pressing the **F** key until pressing the ↑ key) the bar behind the address number is replaced by an "F". The display shows, in the upper line, the heading of the value table, this time with a three digit index number 001 followed by the solid bar. In the second display line a pair of values can be input for each index number.

An ★ at the beginning of the second display line indicates that the relay expects the first current value. After input of this value it **must be confirmed by pressing the key E**! Then, the ★ appears in the middle of the second display line where the first time value is expected. Enter this value and **confirm with the enter key E**. Corrections can be made using the backspace key **R**, as usual.

Page on with the arrow key ↑ to the next value pair. In the first line the index number has changed to 002 for the second value pair. Proceed as for the first value pair. You can always page on with ↑ to the next value pair. With ↓, backwards paging is possible to the foregoing value pair, e.g. in order to look it up or to correct it.

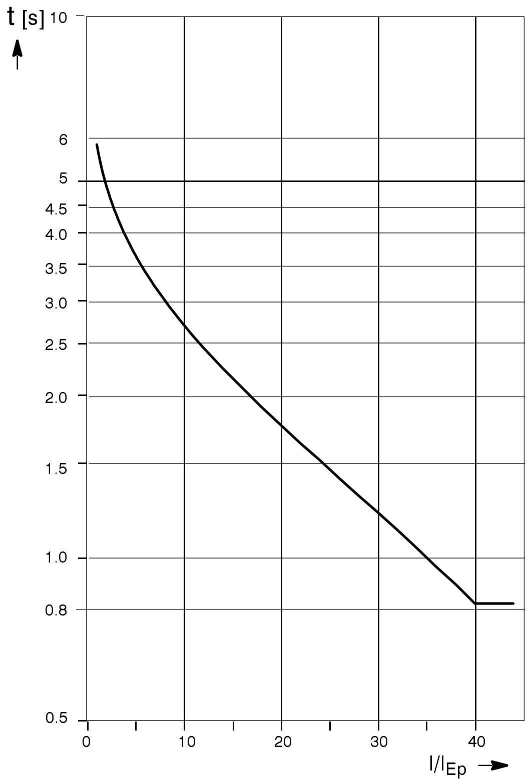
The pairs of values can be entered in any desired order. The relay itself will sort them. A value pair can be marked as invalid by entering a 0 as the left (current) value. Nevertheless, ensure that the values define an unequivocal and continuous curve.

Up to 60 pairs of values can be defined. It is permitted to enter less pairs: In most cases, approximately 10 pairs of values are enough to define a sufficiently exact current time curve.

The current values are entered in multiple of setting value (I_p, I_{Ep}, I_{EEp}). The entered time values can be influenced by the time multipliers (T_{Ip}, T_{IEp}, T_{IEEp}) of the respective protection functions.

You can leave the table definition level by pressing the key combination **F** ↑ (i.e. depressing the function key **F** followed by the arrow key ↑). The display shows again the four digit address number.

Note: The preset values produce a residual dependent characteristic as shown in the following figure:



Residual dependent time:

$$t = T_{IEp} \cdot \left(5{,}8 - 1{,}35 \cdot ln\left(\frac{I}{I_{Ep}}\right)\right) \text{ [s]}$$

t tripping time
I earth fault current
I_{Ep} set earth current value
T_{IEp} set time multiplier

```
⇧  2500█ SPECIFIC
⇩ CHARACTERISTICS
```

Beginning of the block “User specified current time characteristics”

Page on with key ↑ to address 2501.

```
F↑  2501█
   CHARACTERISTIC 1
```

Definition of characteristic 1

Switch over to the table definition level with key combination **F** ↑, in order to get access to the first pair of values with index number 001.

```
↑ 001█ I/Ip  -  T
↓ ★      ★
```

Space for I/Ip   Space for T in s

Pair of values No 001; for current I/Ip and time T
permissible ranges
for current value I/Ip: **1.00** to **40.00**
for time value T: **0.01** s to **999.00** s

Example before entry of the current value:

```
↑ 001█ I/Ip  -  T
↓ ★
```

Pair of values No 001; for current I/Ip and time T
e.g. first current value: I/Ip = 1.00
(zeroes after decimal point can be omitted)

Example after entry of the current value and confirmation with **E**:

```
↑ 001█ I/Ip  -  T
↓ 1.00     ★
```

Pair of values No 001; for current I/Ip and time T
e.g. first current value: I/Ip = 1.00
(zeroes after decimal point can be omitted)

Example after entry of the time value:

```
↑ 001█ I/Ip  -  T
↓ ★1.00        5.80
```

Pair of values No 001; for current I/Ip and time T
e.g. first current value: I/Ip = 1.00
first time value: T = 5.80 s
(zeroes after decimal point can be omitted)

Continue with ↑

```
↑ 002█ I/Ip  -  T
↓ ★1.10        5.67
```

Pair of values No 002; for current I/Ip and time T
e.g. second current value: I/Ip = 1.10
second time value: T = 5.67 s
(zeroes after decimal point can be omitted)

After entry of all desired pairs of values return to the address level with **F**↑

```
↑  2501█
↓ CHARACTERISTIC 1
```

Definition of characteristic 1

6.3.8 Settings for thermal overload protection − address block 27

The relay includes a thermal overload protection function (refer to Section 4.8). This can operate only when it is configured to THERMAL OL = *EXIST* under address 7827 during configuration of the device functions (refer to Section 5.4.2).

Cables, transformers, and electrical machines are particularly endangered by overloads of longer duration. These overloads cannot and should not be detected by the short-circuit protection. The time overcurrent 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 object nor to utilize its (limited) overload capacity.

The time overcurrent protection relay 7SJ512 includes an overload function with a thermal trip characteristic which can be matched to the overload capacity of the protected object. 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) (address 2701).

The rated current of the device 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 of the relay:

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

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

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

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

```
 2700█ THERMAL
OVERLOAD PROT.
```

Beginning of block “Thermal overload protection”

```
 2701█ THERMAL OL
OFF
```

Thermal overload protection can be set to

be switched *OFF* or

```
ON
```

be switched *ON* i.e. trip and alarms

```
 2702█ K-FACTOR
1.10
```

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

```
 2703█ T-CONSTANT
100.0 min
```

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

By setting a warning temperature rise (address 2704), 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 (address 2705). This can be set as a factor of the rated current of the relay and should be equal or less than the continuously admissible current. It can be used besides the temperature warning stage or instead of that.

When setting $\Theta_{warn}/\Theta_{trip}$ to 100 %, the temperature warning is practically ineffective.

A choice can be made whether the temperature rise which is decisive for the threshold stages, is the maximum calculated temperature rise of the three conductors, the mean value of the calculated temperature rises of the three conductors, or the temperature rise calculated from the maximum current of the three conductors (address 2706).

```
 2704█ Θ WARN
90 %
```

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

```
 2705█ I WARN
1.00 I/In
```

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

```
 2706█ O/L CALCUL
Θ MAX
Θ MEAN
Θ FROM IMAX
```

Calculation method decisive for thermal stages

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

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

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

6.3.9 Settings for user definable annunciations – address block 28

Four annunciations are available, which can be defined by the user himself. These are assigned to the annunciation function numbers (FNo) `11` to `14`. 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 (refer to Section 5.5), or transmitted to the front display, a PC or LSA. Examples are Buchholz protection or temperature monitor, or similar.

These annunciations can be delayed in address block 28.

The delay can be used to stabilize the binary inputs and to increase the dynamic noise immunity; 0.03 s to 0.1 s are conventional in this case. If the annunciation should, additionally, lead to trip, higher delay times could be appropriate – depending on the application.

```
2800 DELAYTIMES
ANNUNCIATIONS
```

Beginning of block “Delay times for user definable annunciations”

```
2801 T-ANNUNC.1
0.00 s
```

Delay for the first user definable annunciation (via binary input FNo `11`)
Setting range: **0.00** s to **10.00** s

```
2802 T-ANNUNC.2
0.00 s
```

Delay for the second user definable annunciation (via binary input FNo `12`)
Setting range: **0.00** s to **10.00** s

```
2803 T-ANNUNC.3
0.01 s
```

Delay for the third user definable annunciation (via binary input FNo `13`)
Setting range: **0.00** s to **10.00** s

```
2804 T-ANNUNC.4
0.00 s
```

Delay for the fourth user definable annunciation (via binary input FNo `14`)
Setting range: **0.00** s to **10.00** s

6.3.10 Settings for measured value monitoring – address block 29

The different monitoring functions of the protective relay are described in Section 4.13.4. They partly monitor the relay itself, partly the steady-state measured values of the transformer circuits.

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

NOTE: Voltage monitoring (addresses 2901 and 2902) are only available in models with directional determination facility. 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 parameters concerning earth current, voltage connections and the matching factors.

```
2900█ MEAS.VALUE
SUPERVISION
```

Beginning of block
“Measured value supervision”

```
2901█ SYM.Uthres
50  V
```

Voltage threshold (phase–phase) above which the symmetry monitoring is effective (see Figure 4.20)
Smallest setting value: **10** V
Largest setting value: **100** V

```
2902█ SYM.Fact.U
0.75
```

Symmetry factor for the voltage symmetry = slope of the symmetry characteristic (see Figure 4.20)
Smallest setting value: **0.58**
Largest setting value: **0.95**

```
2903█ SYM.Ithres
0.50  I/In
```

Current threshold above which the symmetry monitoring is effective (refer to Figure 4.19)
Smallest setting value: **0.10** · I_N
Largest setting value: **1.00** · I_N

```
2904█ SYM.Fact.I
0.50
```

Symmetry factor for the current symmetry = slope of the symmetry characteristic (see Figure 4.19)
Smallest setting value: **0.10**
Largest setting value: **0.95**

```
2905█ SUM.Ithres
0.10  I/In
```

Current threshold above which the summation monitoring (refer to Figure 4.18) reacts (absolute content, referred to I_N only)
Smallest setting value: **0.05** · I_N
Largest setting value: **2.00** · I_N

```
2906█ SUM.Fact.I
0.10
```

Relative content (related to the maximum conductor current) for operation of the current summation monitoring (refer to Figure 4.18)
Smallest setting value: **0.00**
Largest setting value: **0.95**

6.3.11 Settings for highly sensitive earth fault protection – address block 30

Highly sensitive earth fault protection is only possible if the respective configuration parameter (Section 5.4.2, address 7830) is set to *EXIST.*

This function can be used in isolated or arc compensated networks to detect an earth fault, to determine the earth faulted phase (models with directional supplement) and to discriminate the earth fault direction. In effectively grounded or low-impedance earthed networks, detection of high-resistance earth faults with very small fault currents is possible. Because of its high sensitivity it is not suited for detection of higher earth fault currents (from 1 A and above at the relay terminals for high-sensitivity earth fault protection). For those applications use the time overcurrent protection for earth currents as described in Section 6.3.5.

```
3000 EARTHFAULT
DETECTION
```

Beginning of block "Highly sensitive earth fault protection"

```
3001 EARTHFAULT
ALARM ONLY
```

High-sensitivity earth fault protection is

operative but issues *ALARM ONLY* (no trip, no fault annunciations, but earth fault report)

```
ON
```

switched *ON* (trip with fault annunciations)

```
OFF
```

switched *OFF*

The high reactive current component in **compensated** networks and the unavoidable air gap of the window-type current transformers often make compensation of the angle error of the current transformer necessary. This is possible through addresses 3002 to 3005. The maximum angle error F1 of the c.t. with its associated current I1 as well as another c.t. operating point I2/F2 above which the angle error remains practically constant, are entered, for the actually connected burden. The relay then approximates, with adequate accuracy, to the characteristic of the transformer. In **isolated** or **earthed** networks this angle error compensation is not necessary.

```
3002 CT ERR. I1
0.050 A
```

Secondary current for max. error angle of current transformer

Smallest setting value **0.003** A
Largest setting value **1.600** A

```
3003 CT ERR. F1
0.0 °
```

Error angle of current transformer at I1

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

```
3004 CT ERR. I2
1.000 A
```

Secondary current above which the angle error is practically constant

Smallest setting value: **0.003** A
Largest setting value: **1.600** A

```
3005 CT ERR. F2
0.0 °
```

Error angle of current transformer at I2

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

The function “high-sensitivity earth fault protection” in **isolated** or **compensated** systems comprises residual voltage detection, determination of the earth-faulted phase and the determination of the earth fault direction. Determination of the faulted phase is only possible for models with directional discrimination, where the relay is fitted with measured phase voltage inputs and connected to three star connected and earthed voltage transformers. Directional discrimination is only possible when the earth current is available at the measured current input for high-sensitivity earth fault protection.

The residual voltage Ue> initiates earth fault detection and is one condition for release of directional determination. It is set in address 3010. Ue means the voltage at the input to the device, with open delta VT; if this input is not used, the three phase voltages must be available (possible only for models with directional discrimination); the relay then calculates

$$Ue = (U_{L1} + U_{L2} + U_{L3}) / \sqrt{3}.$$

Since, for earth faults in **isolated** or **compensated** networks, the full displacement voltage appears, the setting value is not critical; it should lie between 30 V an 60 V. Earth fault is detected and annunciated only when the displacement voltage has been stayed for the duration T–E/F (address 3011). In **earthed** networks, the set value of the earth voltage Ue> can be more sensitive (smaller); but it shall not be exceeded by operational asymmetry of the voltages of the power system.

If the three phase voltages are available at the relay terminals, the earth faulted phase can be determined in **isolated** or **compensated** systems. For phase determination Uph< (address 3006) is the criterion for the earth faulted phase, when simultaneously the other two phase voltages have exceeded Uph> (address 3007). Accordingly, Uph< must be set lower than the minimum operational phase–earth voltage. This setting is, however, also not critical, 40 V should be adequate. Uph> must lie above the maximum operational phase–earth voltage, but below the minimum operational phase–phase voltage, therefore, for example, 75 V at U_N = 100 V. These parameters are **irrelevant in earthed** systems.

Pick-up by the displacement voltage can be used for time delayed trip command. Pre-condition is that the trip facility has been switched on (address 3001 EARTH FAULT = *ON*). Trip delay is then set under address 3012 T–UE. Note, that the total command time is composed of the inherent measuring time (approximately 60 ms) plus pick-up delay T–E/F (address 3011) plus trip delay T–UE (address 3012).

```
  3006█ Uph<
40  V
```

Phase–earth voltage of a faulted phase which will be safely undershot under earth fault conditions
Smallest setting value: **10** V
Largest setting value: **100** V

```
  3007█ Uph>
75  V
```

Phase–earth voltage of healthy phases which will safely be exceeded under earth fault conditions
Smallest setting value: **10** V
Largest setting value: **100** V

```
  3010█ Ue>
40  V
```

Threshold value for displacement voltage Ue> (= $\sqrt{3} \cdot U_0$). *Note:* Address 1110 has no influence on this pick-up value
Smallest setting value: **2** V
Largest setting value: **130** V

```
  3011█ T-E/F
1.00  s
```

Duration of displacement voltage after which earth fault is detected and annunciated
Smallest setting value: **0.04** s
Largest setting value: **320.00** s
and ∞ (no earth fault annunciation)

```
  3 0 1 2█ T - U E
1 0 . 0 0   s
```

Time delay for tripping with Ue> (only if trip: EARTH FAULT = *ON* in address 3001)

Smallest setting value:	**0.01** s
Largest setting value:	**320.00** s

and ∞ (no trip)

In order to detect earth currents, a two-stage current time characteristic can be set under addresses 3013 to 3021. Each stage can operate directional or non-directional. The magnitude of the earth current is decisive for pick-up of these stages. They are used in cases where the magnitude of the earth current is the mean criterion of the earth fault, therefore, preferably in **solidly earthed** or **low-impedance earthed** systems, or for **electrical machines** in busbar connection with isolated systems, where the high capacitive current of the system can be expected in case of machine earth fault but only an insignificant earth current in case of a system earth fault because of the low machine capacitance.

The position of the directional characteristics can be set under addresses 3023 and 3024 to suit the application. Explanations are given below, before the illustration of these parameter addresses.

The high-value stage is designated with IEE>> (pick-up value in address 3013). It can be delayed by T−IEE>> (address 3014) and lead to annunciation or even to trip. The latter is only possible if trip has been set, i.e. under address 3001 EARTH FAULT = *ON*. The direction of this stage can be set to *FORWARDS*, *REVERSE*, or *NON−DIRECTIONAL* under address 3015.

```
  3 0 1 3█ I E E > >
0 . 3 0 0   A
```

Threshold value for I_{EE}>> stage

Smallest setting value:	**0.003** A
Largest setting value:	**1.000** A

```
  3 0 1 4█ T - I E E > >
1 . 0 0   s
```

Time delay for tripping with the I_{EE}>> stage (only if trip: EARTH FAULT = *ON* in address 3001)

Smallest setting value:	**0.00** s
Largest setting value:	**320.00** s

and ∞ (no trip)

```
  3 0 1 5█ I E E > >   D I R .
F O R W A R D S

R E V E R S E

N O N - D I R E C T I O N A L
```

Operating direction for the I_{EE}>> stage

FORWARDS	forward direction, normally line or transformer
REVERSE	reverse direction, normally busbar
NON−DIRECTIONAL	in either direction; in this case, no displacement voltage is necessary

The low-value stage can operate with a definite time lag or inverse time lag characteristic. This depends on selection for earth faults during configuration in Section 5.4.2 (address 7815). In addresses 3016 to 3020, only those parameters are available which are associated with the selected function mode of the earth fault protection. The direction of this stage can be set to *FORWARDS*, *REVERSE*, or *NON−DIRECTIONAL* under address 3022.

For **inverse time**, a choice can be made between three tripping time characteristics defined in IEC 60255−3 in address 3016. Furthermore, a long time earth fault characteristic can be selected. Additionally, the user defined characteristic is even possible. The values of this characteristic must be defined in address block 25 (refer to Section 6.3.7).

```
 3016▌CHARACTER.
NORMAL INVERSE
```
```
VERY INVERSE
```
```
EXTREMELY INVERS
```
```
USER CHARACTER.
```
```
LONG EARTH FAULT
```

Only for inverse time mode:
Characteristic of the earth fault overcurrent stage I_{EEp}, can be

NORMAL INVERSE	time lag acc. IEC 60255−3 (type A)
VERY INVERSE	time lag acc. IEC 60255−3 (type B)
EXTREMELY INVERSe	time lag acc. IEC 60255−3 (type C)
USER CHARACTER.	user defined characteristic; for this, the table in address 2501 must be filled out

LONG time *EARTH FAULT* characteristic

Addresses 3017 and 3018 are relevant only in case the **definite time** characteristic has been chosen under address 7815 (CHARAC. E = *DEFINITE TIME*).

If the stage IEE> is not used then set the time T−IEE> to ∞.

Addresses 3019 and 3020 are relevant only in case an **inverse** time characteristic has been chosen under address 7815 (CHARAC. E = *INVERSE TIME*, Section 5.4.2). It must be considered that, according to IEC 60255−3, the protection picks up only when 1.1 times the set value is exceeded. If the stage I_{EEp} is not used then set the time T−IEEp to ∞.

```
 3017▌IEE>
0.100 A
```

Only for definite time mode:
Threshold value for I_{EE}> stage
Smallest setting value: **0.003** A
Largest setting value: **1.000** A

```
 3018▌T-IEE>
2.00 s
```

Time delay for tripping with the I_{EE}> stage (only if trip function has been parameterized, address 3001 EARTHFAULT = *ON*)
Smallest setting value: **0.00** s
Largest setting value: **320.00** s
and ∞ (no trip)

```
 3019▌IEEp
0.100 A
```

Only for inverse time mode:
Threshold value for I_{EEp} stage
Smallest setting value: **0.003** A
Largest setting value: **1.000** A

```
 3020▌T-IEEp
2.00 s
```

Time multiplier for tripping with the I_{EEp} stage (only if trip: EARTHFAULT = *ON* in address 3001)
Smallest setting value: **0.00** s
Largest setting value: **10.00** s
and ∞ (no trip)

```
 3022▌IEE> DIR.
FORWARDS
```
```
REVERSE
```
```
NON-DIRECTIONAL
```

Operating direction for the I_{EE}> (definite time) or I_{EEp} (inverse time) stage

FORWARDS	forward direction, normally line or transformer
REVERSE	reverse direction, normally bus-bar
NON−DIRECTIONAL	in either direction

Addresses 3023 to 3025 are decisive for directional determination.

The current value IEE>/pDIR (address 3023) represents the release threshold for directional determination. In this case, it is the current component which is rectangular to the directional characteristic. The position of the directional characteristic itself is determined in addresses 3024 and 3025.

If address 3024 is set to PHI CORR = 0.0° then

– address 3025 E/F MEAS = *COS PHI*
  means that only the active component of the earth current is decisive for the threshold IEE>/p DIR (Figure 6.2),

– address 3025 E/F MEAS = *SIN PHI*
  means that only the capacitive component of the earth current is decisive for the threshold IEE>/p DIR (Figure 6.3).

Based on this definition, the directional characteristic can be shifted by ±45°. An example is illustrated in Figure 6.4.

In **isolated** systems earth fault measurement with *SIN PHI* is used because the capacitive current is decisive for the earth fault direction.

In **compensated** systems earth fault measurement with *COS PHI* is used because the ohmic current is decisive for the earth fault direction.

In **earthed** systems earth fault measurement with *COS PHI* is used with a correction angle of −45° because the earth current is ohmic-inductive.

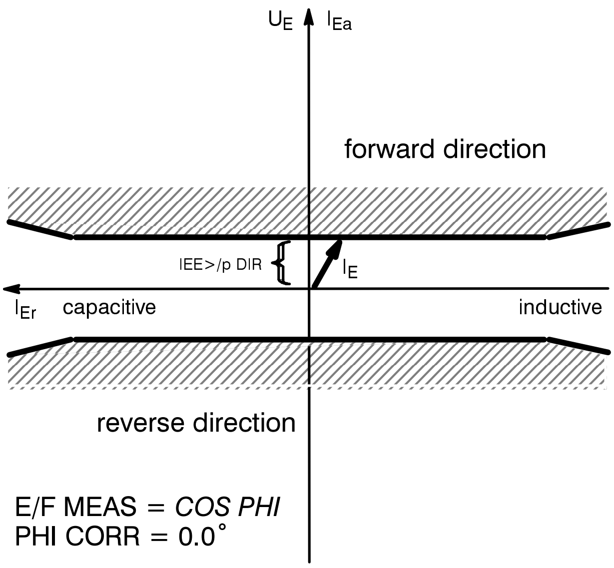


Figure 6.2 Directional characteristic with cos φ measurement

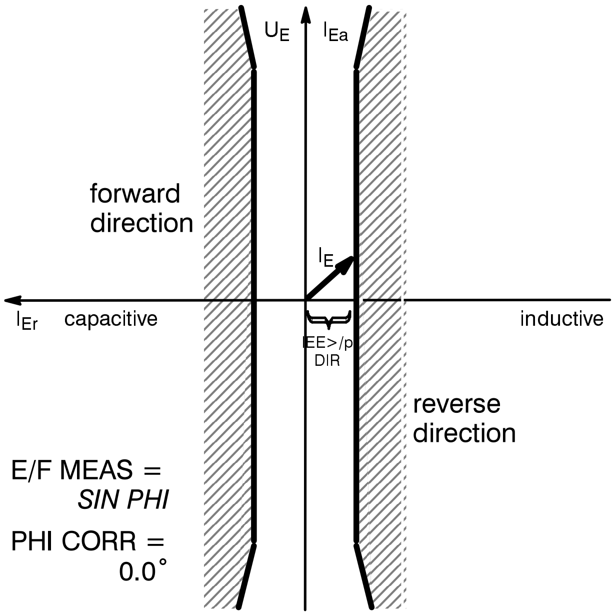


Figure 6.3 Directional characteristic with sin φ measurement

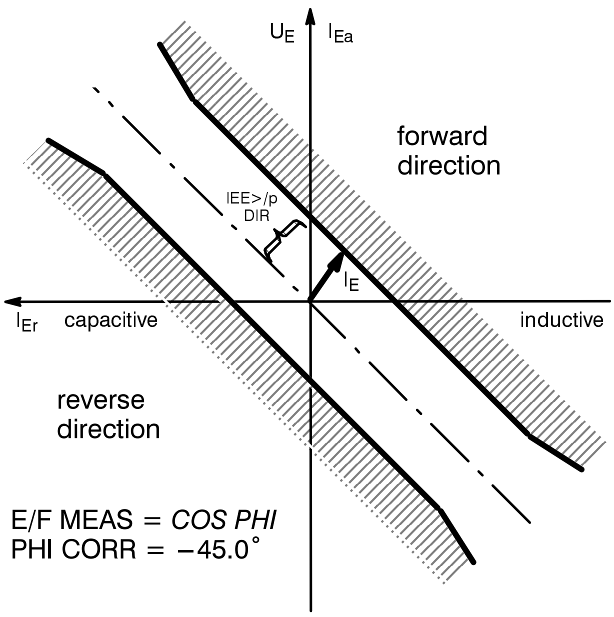


Figure 6.4 Directional characteristic with cos φ measurement and correction angle of −45°

In **electrical machines** in bus-bar connection with an isolated system, *COS PHI* measurement can be selected with a correction angle of approximately +45° because the earth current is often composed of a capacitive component from the system and an active component from a earth fault load resistor.

For determination of the direction of the earth fault, in general, the threshold current (address 3023) should be set as high as possible to prevent faulty operation due to asymmetrical currents in the network and through the current transformers (particularly in Holmgreen connection).

In **isolated** networks an earth fault in a cable will allow the total capacitive earth fault currents of the entire electrically connected network, with the exception of the faulted cable itself, to flow through the measuring point. It is normal to use half the value of this earth fault current as the threshold value.

In **compensated** networks directional determination is made more difficult since a much larger reactive current of capacitive or inductive character is superimposed on the critical wattmetric current. The total earth current available to the relay can therefore, dependent upon the network configuration and location of the compensation coil, assume very different values in magnitude and phase angle. The relay, however, must evaluate only the real component of the earth fault current, that is, I_E x cos φ. This demands extremely high accuracy, particularly with regard to phase angle accuracy of all the instrument transformers. Also, the relay should not be set unnecessarily sensitive. When used in compensated networks therefore, reliable directional determination is only expected when core balance window-type transformers are used. Here also, use the thumb rule: setting at half the expected measured current, whereby only the residual wattmetric current is applicable. This residual wattmetric current is provided principally by the losses in the Petersen coil.

In **earthed** networks the threshold IEE>/p DIR is set slightly below the minimum expected earth fault current. Note that only the current component rectangular to the directional characteristic is decisive for pick-up of the IEE>/p DIR stage.

Generally the following applies: If directional determination is used in conjunction with one of the sensitive earth current stages as described above (address 3013 etc. for IEE>> or address 3017 etc. for IEE> or IEEp), then only a value smaller than the pick-up value of one of the above stages is meaningful for IEE>/p DIR.

```
 3023█ IEE>/pDIR.
0.010 A
```

Threshold value for directional determination
- capacitive component of earth fault current for isolated systems
- ohmic earth fault current component for arc compensated systems
- ohmic-inductive component of earth current according to the setting 3024 and 3025

Smallest setting value: **0.003** A
Largest setting value: **1.000** A

```
 3024█ PHI CORR
0.0 °
```

Correction angle for directional determination, based on the measurement direction as defined under address 3025

Smallest setting value: **–45.0** deg
Largest setting value: **45.0** deg

```
 3025█ E/F MEAS.
COS PHI
```

```
SIN PHI
```

Measurement mode for directional determination

COS PHI the ohmic current component is decisive for directional determination; for use in arc compensated and earthed systems

SIN PHI the capacitive current component is decisive for directional determination; for use in systems with isolated neutral

6.3.12 Settings for the intermittent earth fault protection – address block 33

Depending on the model ordered (refer to Section 2.3 Ordering data), the time overcurrent relay 7SJ512 contains a protection function for intermittent earth faults. This sub-section is valid only for models 7SJ512★–★★★★★–**2**/**3**★. For other models it can be passed over.

The intermittent earth fault protection can operate only when it is configured to *EXIST* under address 7833 during configuration of the device functions (refer to Section 5.4.2).

This protection can be switched *OFF* or *ON* under address 3301.

The pick-up value (r.m.s.) is set under address 3302 Iie>. It may be set rather sensitive when it shall respond to very short earth fault occurrences, since pick-up is very fast with high excess of earth current.

The earth fault detection can be prolonged by the pick-up prolongation time T–det.ext. in address 3303. Please refer to Section 4.6 for more details.

The accumulated sum of the (prolonged) pick-up times which leads to trip, is set in address 3304 T–sum det. The reset time is set under address 3305; after this time the protection function is reset to its quiescent state when no renewed pick-up has occurred.

Finally, address 3306 determines, how many times the intermittent earth fault protection must have picked up so that an intermittent earth fault should be assumed.

```
3300 INTERMITT.
EARTHFAULT PROT.
```

Beginning of the block “Intermittent earth fault protection”

```
3301 INTERM.EF
OFF
```

```
ON
```

Intermittent earth fault protection is

OFF switched off

ON switched on

```
3302 Iie>
1.00 I/In
```

Pick-up value for earth fault current
Smallest setting value: **0.05** · I_N
Largest setting value: **25.00** · I_N

```
3303 T-det.ext.
0.10 s
```

Prolongation time for pick-up
Smallest setting value: **0.00** s
Largest setting value: **10.00** s

```
3304 T-sum det.
20.00 s
```

Accumulated time sum for trip
Smallest setting value: **0.00** s
Largest setting value: **100.00** s

```
3305 Treset
300 s
```

Reset time when no renewed earth fault is detected
Smallest setting value: **1** s
Largest setting value: **600** s

```
3306 Nos.det.
3
```

Number of pickups for detection of an intermittent earth fault
Smallest setting value: **2**
Largest setting value: **10**

6.3.13 Settings for auto-reclosure – address block 34

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

When no auto-reclosure is to be carried out on the feeder which is protected by the time overcurrent protection relay (e.g. cables, transformers, motors, etc.), then the internal AR function must be configured as *NON–EXIST* in address 7834 (refer to Section 5.4.2). The AR function is then not effective at all, i.e. 7SJ512 does not process the AR function. No corresponding annunciations are given, binary inputs for auto-reclosure are ignored. All parameters in block 34 are irrelevant and unavailable.

The parameters of the protection functions which are valid when reclosure is expected can be set in address blocks 35 to 37. Refer to Section 6.3.14 for details.

With the internal AR function, generally distinction is made between the first AR–cycle, identified in the following with RAR (rapid auto-reclosure), and further AR–cycles with multi-shot auto-reclosure, identified in the following with DAR (delayed auto-reclosure). The above identifications are regardless whether the dead times are really “rapid” or “delayed”. Setting address 3401 to 3407 are common for all types of auto-reclosure.

If the relay is equipped with the directional supplement reclosure is normally blocked if a fault is detected in reverse direction (address 3402 AR BLO REV = *YES*). Without directional supplement this parameter is only relevant in conjunction with high-sensitivity directional earth fault protection. The non-directional stages do not block reclosure; the active time must be set low enough to avoid reclosure, if desired.

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

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

The dynamic reclaim time T–LOCK (address 3406) is the time period during which after an unsuccessful auto-reclosure further reclosures by 7SJ512 are blocked. If the manual close command is led via the 7SJ512 then this will be blocked also. This time must be longer than the renewed readiness for operation of the circuit breaker. If this time is set to ∞, breaker close command is locked. In this case switching can be unlocked only when the binary input “`>AR Reset`” (FNo `2704`) is energized. Ensure in this case, that this binary input function is allocated to a physical input of the device (refer to Section 5.5.2).

The set time for T–BLOCK MC (address 3407) must cover the time for safe closing and opening of the circuit breaker (0.5 s to 1 s). If any of the protection functions of 7SJ512 detects a fault within this time, definitive trip command is issued and reclosure is blocked provided MC BLOCK (address 3403, see above) is switched to *YES*.

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

```
⇧  3400 AUTO-
⇩ RECLOSE FUNCTION
```

Beginning of block “Auto-reclose functions”

```
3401█ AR FUNCT
ON
```
```
OFF
```

Auto-reclose function is

ON switched on

OFF switched off

```
3402█ AR BLO REV
NO
```
```
YES
```

AR will be blocked when a fault in reverse direction is tripped (if directional discrimination possible); no blocking is carried out by non-directional stages

normal setting: *YES*

```
3403█ MC BLOCK
YES
```
```
NO
```

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

```
3405█ T-RECLAIM
3.00 s
```

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

```
3406█ T-LOCK
3.00 s
```

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

```
3407█ T-BLOCK MC
1.00 s
```

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

For RAR (first auto-reclose cycle), addresses 3424 to 3426 are to be set.

When setting the action time RAR T−ACT (address 3424), it must be ensured that this time is at least as long as the command time of the protective relay. It can also be used to avoid auto-reclosure when a protection function has tripped a fault in a back-up time.

The dead times can be individually set after trip after multi-phase fault (address 3425) and after trip after single-phase fault (incl. high-sensitivity earth fault protection) (address 3426). The duration of the dead times is determined by the application philosophy. For long lines it should be long enough to ensure that the fault arc is extinguished and the air surrounding the arc is de-ionized, so that auto-reclosure can be successful. (0.9 s to 1.5 s). With multiple-end fed lines the stability of the network is the important consideration. Since the disconnected line can no longer produce any synchronizing power, only a short dead time is permitted in most cases. Conventional values lie between 0.3 s and 0.6 s. In radial networks a longer time can be tolerated.

```
 3424█ RAR T-ACT.
100.00 s
```

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

```
 3425█ RAR T-PHA.
0.50 s
```

Dead time for trip after multi-phase faults
Smallest setting value: **0.01** s
Largest setting value: **320.00** s

```
 3426█ RAR T-EAR.
0.50 s
```

Dead time for trip after single-phase faults or by the high-sensitivity earth fault stage
Smallest setting value: **0.01** s
Largest setting value: **320.00** s

For DAR (further auto-reclose cycles), parameters are set under addresses 3443 to 3447.

The number of DARs can be set differently for single-phase faults (address 3443) and for multi-phase faults (address 3444).

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

Different dead times can be set for trip after single-phase faults (address 3446) and trip after multi-phase faults (address 3447).

```
 3443█ DAR SHOT E
1
```

Number of permissible DAR shots after earth faults; the RAR is not included in this number
Smallest setting value: **0**
Largest setting value: **9**

```
 3444█ DAR SHOT P
1
```

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

```
 3445█ DAR T-ACT.
100.00 s
```

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

```
 3446█ DAR T-EAR.
0.80 s
```

Dead time for trip after single-phase faults
Smallest setting value: **0.01** s
Largest setting value: **1800.00** s

```
 3447█ DAR T-PHA.
0.80 s
```

Dead time for trip after multi-phase faults
Smallest setting value: **0.01** s
Largest setting value: **1800.00** s

6.3.14 Protection stages with auto-reclosure – address blocks 35 to 37

If the relay is intended to operate with auto-reclosure, shorter tripping times of the short-circuit protection functions are often desired when automatic reclosure will be carried out. The values which are parameterized in address block 12 (for phase fault time overcurrent protection, refer to Section 6.3.4), in address block 15 (for earth fault time overcurrent protection, refer to Section 6.3.5), and in address block 30 (for high-sensitivity earth fault protection, refer to Section 6.3.11), are those which are valid without auto-reclosure, e.g. auto-reclosure not configured or switched off or blocked. If auto-reclosure is not used at all, this section is of no importance.

In conjunction with auto-reclosure, separate stages can be set for auto-reclosure, individually for tripping before RAR, for tripping before DAR, and after unsuccessful AR (final trip).

Additionally, one can select for each of the protection functions, which stage shall operate with AR (i.e. initiate AR) and which not. Furthermore, auto-reclosure can be blocked when a high-set I>> stage trips during the dead time of an AR cycle.

One address block is available for each of the protection functions:

– address block 35 for parameters of phase time overcurrent stages,

– address block 36 for parameters of earth time overcurrent stages,

– address block 37 for parameters of high-sensitivity earth fault stages.

For the high-sensitive earth fault stages, setting is only relevant if tripping is performed with these stages.

6.3.14.1 Phase fault overcurrent stages – address block 35

```
3500 O/C PROT.
PHASES AR
```

Beginning of the block “Stages for phase fault time overcurrent protection with AR”

RAR stages

```
3503 RAR T-I>>
0.10 s
```

Trip time delay of the high-set stages I>> for phase faults before RAR
Setting range: **0.00** s to **60.00** s
or ∞ (no trip)

```
3513 RAR T-I>
0.50 s
```

For definite time overcurrent protection only:
Trip time delay for the phase overcurrent stages I> before RAR
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
3515 RAR T-Ip
0.50 s
```

For inverse time overcurrent protection only:
Time multiplier for the inverse time phase overcurrent stage I_p before RAR
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
3524 RAR T-I> D
0.40 s
```

For directional definite time O/C protection only:
Trip time delay for the directional phase overcurrent stage I> before RAR
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
 3525█ RAR  T-Ip  D
0.40  s
```

For directional inverse time O/C protection only:
Time multiplier for the directional inverse time phase overcurrent stage I_p before RAR
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
 3526█ RAR  I>>
WITH  AR
```

```
WITHOUT  AR
```

High-set I>> stage for phase faults shall initiate RAR cycle or not

```
 3527█ RAR  I>Ip
WITH  AR
```

```
WITHOUT  AR
```

Overcurrent stage I> (definite time) or I_p (inverse time) for phase faults shall initiate RAR cycle or not

```
 3528█ RAR  I>Ip  D
WITH  AR
```

```
WITHOUT  AR
```

Directional overcurrent stage (if available) I> (definite time) or I_p (inverse time) for phase faults shall initiate RAR cycle or not

```
 3529█ RAR  I>>  BL
NO
```

```
YES
```

Reclosure (RAR) is blocked or not if the high-set I>> stage for phase faults picks up

---

DAR stages

```
 3533█ DAR  T-I>>
0.10  s
```

Trip time delay of the high-set stage I>> for phase faults before DAR
Setting range: **0.00** s to **60.00** s
or ∞ (no trip)

```
 3543█ DAR  T-I>
0.50  s
```

For definite time overcurrent protection only:
Trip time delay for the phase overcurrent stage I> before DAR
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
 3545█ DAR  T-Ip
0.50  s
```

For inverse time overcurrent protection only:
Time multiplier for the inverse time phase overcurrent stage I_p before DAR
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
 3554█ DAR  T-I>  D
0.40  s
```

For directional definite time O/C protection only:
Trip time delay for the directional phase overcurrent stage I> before DAR
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
 3555█ DAR  T-Ip  D
0.40  s
```

For directional inverse time O/C protection only:
Time multiplier for the directional inverse time phase overcurrent stage I_p before DAR
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
  3556█ DAR  I>>
WITH  AR
```
```
WITHOUT  AR
```
High-set I>> stage for phase faults shall initiate DAR cycle or not

```
  3557█ DAR  I>Ip
WITH  AR
```
```
WITHOUT  AR
```
Overcurrent stage I> (definite time) or I_p (inverse time) for phase faults shall initiate DAR cycle or not

```
  3558█ DAR  I>Ip  D
WITH  AR
```
```
WITHOUT  AR
```
Directional overcurrent stage (if available) I> (definite time) or I_p (inverse time) for phase faults shall initiate DAR cycle or not

```
  3559█ DAR  I>>  BL
NO
```
```
YES
```
Reclosure (DAR) is blocked or not if the high-set I>> stage for phase faults picks up

---

Final trip stages after unsuccessful reclose attempts

```
  3563█ END  T-I>>
0.10  s
```
Trip time delay of the high-set stage I>> for phase faults before final trip
Setting range: **0.00** s to **60.00** s
or ∞ (no trip)

```
  3573█ END  T-I>
0.50  s
```
For definite time overcurrent protection only:
Trip time delay for the phase overcurrent stage I> before final trip
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
  3575█ END  T-Ip
0.50  s
```
For inverse time overcurrent protection only:
Time multiplier for the inverse time phase overcurrent stage I_p before final trip
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
  3584█ END  T-I>  D
0.40  s
```
For directional definite time O/C protection only:
Trip time delay for the directional phase overcurrent stage I> before final trip
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
  3585█ END  T-Ip  D
0.40  s
```
For directional inverse time O/C protection only:
Time multiplier for the directional inverse time phase overcurrent stage I_p before final trip
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

6.3.14.2 Earth fault overcurrent stages -- address block 36

```
 3600 O/C  PROT.
EARTH  AR
```

Beginning of the block “Stages for earth fault time overcurrent protection with AR”

RAR stages

```
 3603 RAR  T-IE>>
0.10  s
```

Trip time delay of the high-set stage for earth faults before RAR
Setting range: **0.00** s to **60.00** s
or ∞ (no trip)

```
 3613 RAR  T-IE>
0.50  s
```

For definite time overcurrent protection only:
Trip time delay for the earth overcurrent stage I_E> before RAR
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
 3615 RAR  T-IEp
0.50  s
```

For inverse time overcurrent protection only:
Time multiplier for the inverse time earth overcurrent stage I_{Ep} before RAR
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
 3624 RAR  T-IE>D
0.40  s
```

For directional definite time O/C protection only:
Trip time delay for the directional earth overcurrent stage I_E> before RAR
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
 3625 RAR  T-IEpD
0.40  s
```

For directional inverse time O/C protection only:
Time multiplier for the directional inverse time earth overcurrent stage I_{Ep} before RAR
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
 3626 RAR  IE>>
WITH  AR

WITHOUT  AR
```

High-set I_E>> stage for earth faults shall initiate RAR cycle or not

```
 3627 RAR  IE>IEp
WITH  AR

WITHOUT  AR
```

Overcurrent stage I_E> (definite time) or I_{Ep} (inverse time) for earth faults shall initiate RAR cycle or not

```
 3628█ RAR  IE>/pD
WITH AR
WITHOUT AR
```

Directional overcurrent stage (if available) $I_E>$ (definite time) or I_{Ep} (inverse time) for earth faults shall initiate RAR cycle or not

```
 3629█ RAR  IE>>BL
NO
YES
```

Reclosure (RAR) is blocked or not if the high-set $I_E>>$ stage for earth faults picks up

---

DAR stages

```
 3633█ DAR  T-IE>>
0.10 s
```

Trip time delay of the high-set stage $I_E>>$ for earth faults before DAR
Setting range: **0.00** s to **60.00** s
or ∞ (no trip)

```
 3643█ DAR  T-IE>
0.50 s
```

For definite time overcurrent protection only:
Trip time delay for the earth overcurrent stage $I_E>$ before DAR
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
 3645█ DAR  T-IEp
0.50 s
```

For inverse time overcurrent protection only:
Time multiplier for the inverse time earth overcurrent stage I_{Ep} before DAR
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
 3654█ DAR  T-IE>D
0.40 s
```

For directional definite time O/C protection only:
Trip time delay for the directional earth overcurrent stage $I_E>$ before DAR
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
 3655█ DAR  T-IEpD
0.40 s
```

For directional inverse time O/C protection only:
Time multiplier for the directional inverse time earth overcurrent stage I_{Ep} before DAR
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
 3656█ DAR  IE>>
WITH AR
WITHOUT AR
```

High-set $I_E>>$ stage for earth faults shall initiate DAR cycle or not

```
  3657█ DAR  IE>IEp
WITH AR
```
```
WITHOUT AR
```

Overcurrent stage I_E> (definite time) or I_{Ep} (inverse time) for earth faults shall initiate DAR cycle or not

```
  3658█ DAR  IE>/pD
WITH AR
```
```
WITHOUT AR
```

Directional overcurrent stage (if available) I_E> (definite time) or I_{Ep} (inverse time) for earth faults shall initiate DAR cycle or not

```
  3659█ DAR  IE>>BL
NO
```
```
YES
```

Reclosure (DAR) is blocked or not if the high-set I_E>> stage for earth faults picks up

Final trip stages after unsuccessful reclose attempts

```
  3663█ END  T-IE>>
0.10 s
```

Trip time delay of the high-set stage I_E>> for earth faults before final trip
Setting range: **0.00** s to **60.00** s
or ∞ (no trip)

```
  3673█ END  T-IE>
0.50 s
```

For definite time overcurrent protection only:
Trip time delay for the earth overcurrent stage I_E> before final trip
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
  3675█ END  T-IEp
0.50 s
```

For inverse time overcurrent protection only:
Time multiplier for the inverse time earth overcurrent stage I_{Ep} before final trip
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
  3684█ END  T-IE>D
0.40 s
```

For directional definite time O/C protection only:
Trip time delay for the directional earth overcurrent stage I_E> before final trip
Setting range: **0.00** s to **60.00** s
and ∞ (no trip)

```
  3685█ END  T-IEpD
0.40 s
```

For directional inverse time O/C protection only:
Time multiplier for the directional inverse time earth overcurrent stage I_{Ep} before final trip
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

6.3.14.3 High-sensitivity earth fault stages -- address block 37

```
3700█ EARTH
FAULT AR
```

Beginning of the block "Stages for high-sensitive earth fault protection with AR"

RAR stages

```
3703█ R T-IEE>>
1.00 s
```

Trip time delay of the high-level stage I_{EE}> for high-sensitivity earth fault protection before RAR
Setting range: **0.00** s to **320.00** s
or ∞ (no trip)

```
3713█ R T-IEE>
2.00 s
```

For definite time earth fault mode only:
Trip time delay for the low-level stage I_{EE}> for high-sensitivity earth fault protection before RAR
Setting range: **0.00** s to **320.00** s
and ∞ (no trip)

```
3715█ R T-IEEp
2.00 s
```

For inverse time earth fault mode only:
Time multiplier for the low-level stage I_{EEp} for high-sensitivity earth fault protection before RAR
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
3726█ R IEE>>
WITH AR

WITHOUT AR
```

High-level stage I_{EE}>> for high-sensitivity earth fault protection shall initiate RAR cycle or not

```
3727█ R IEE>/p
WITH AR

WITHOUT AR
```

Low-level stage I_{EE}> (definite time) or I_{EEp} (inverse time) for high-sensitivity earth fault protection shall initiate RAR cycle or not

```
3729█ R IEE>> BL
NO

YES
```

Reclosure (RAR) is blocked or not if the high-level stage for high-sensitivity earth fault protection picks up

---

DAR stages

```
3733█ D T-IEE>>
1.00 s
```

Trip time delay of the high-level stage I_{EE}>> for high-sensitivity earth fault protection before DAR
Setting range: **0.00** s to **320.00** s
or ∞ (no trip)

```
3743█ D  T-IEE>
2.00  s
```

For definite time earth fault mode only:
Trip time delay for the low-level stage I_{EE}> for high-sensitivity earth fault protection before DAR
Setting range: **0.00** s to **320.00** s
and ∞ (no trip)

```
3745█ D  T-IEEp
2.00  s
```

For inverse time earth fault mode only:
Time multiplier for the low-level stage I_{EEp} for high-sensitivity earth fault protection DAR
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

```
3756█ D  IEE>>
WITH AR
```

```
WITHOUT AR
```

High-level stage of high-sensitivity earth fault protection shall initiate DAR cycle or not

```
3757█ D  IEE>/p
WITH AR
```

```
WITHOUT AR
```

Low-level stage I_{EE}> (definite time) or I_{EEp} (inverse time) for high-sensitivity earth fault protection shall initiate DAR cycle or not

```
3759█ D  IEE>>  BL
NO
```

```
YES
```

Reclosure (DAR) is blocked or not if the high-level stage for high-sensitivity earth fault protection picks up

Final trip stages

```
3763█ E  T-IEE>>
1.00  s
```

Trip time delay of the high-level stage I_{EE}>> for high-sensitivity earth fault protection before final trip
Setting range: **0.00** s to **320.00** s
or ∞ (no trip)

```
3773█ E  T-IEE>
2.00  s
```

For definite time earth fault mode only:
Trip time delay for the low-level stage I_{EE}> for high-sensitivity earth fault protection before final trip
Setting range: **0.00** s to **320.00** s
and ∞ (no trip)

```
3775█ E  T-IEEp
2.00  s
```

For inverse time earth fault mode only:
Time multiplier for the low-level stage I_{EEp} for high-sensitivity earth fault protection before final trip
Setting range: **0.00** s to **10.00** s
and ∞ (no trip)

6.3.15 Dynamic switch-over of pick-up values – address block 26

The pick-up values of the phase time overcurrent protection, the earth time overcurrent protection, and the high-sensitivity earth fault protection can be switched over dynamically to an alternative set of values during operation, by energizing an associated binary input (BE). In contrast to the parameter switch-over (refer to Section 6.5.5) these values (and only these values) can be switched over even during a fault event. After energization of the binary input the relay operates immediately with the switched set of pick-up values.

```
2600█ BIN-INPUT
PARAMETERS
```

Beginning of the block "Dynamic switch-over of pick-up values by binary input"

```
2601█ BE:  I>>
2.00  I/In
```

Alternative pick-up value of the high-set stage I>> for phase faults (normally acc. address 1202)
Setting range: **0.05** to **25.00**

```
2602█ BE:  I>
1.00  I/In
```

Alternative pick-up value of the **definite** time overcurrent stage I> for phase faults (normally acc. address 1212)
Setting range: **0.05** to **25.00**

```
2603█ BE:  Ip
1.00  I/In
```

Alternative pick-up value of the **inverse** time overcurrent stage I_p for phase faults (normally acc. address 1214)
Setting range: **0.10** to **4.00**

```
2604█ BE:  IE>>
0.50  I/In
```

Alternative pick-up value of the high-set stage I_E>> for earth faults (normally acc. address 1502)
Setting range: **0.05** to **25.00**

```
2605█ BE:  IE>
0.20  I/In
```

Alternative pick-up value of the **definite** time overcurrent stage I_E> for earth faults (normally acc. address 1512)
Setting range: **0.05** to **25.00**

```
2606█ BE:  IEp
0.20  I/In
```

Alternative pick-up value of the **inverse** time overcurrent stage I_{Ep}> for earth faults (normally acc. address 1514)
Setting range: **0.10** to **4.00**

```
2607█ BE:  IEE>>
0.300  A
```

Pick-up value of the high-level stage I_{EE}>> of the high-sensitivity earth fault protection (normally acc. address 3013
Setting range: **0.003** A to **1.000** A

```
2608█ BE:  IEE>
0.100  A
```

Pick-up value of the **definite** time stage I_{EE}> of the high-sensitivity earth fault protection (normally acc. address 3017
Setting range: **0.003** A to **1.000** A

```
2609█ BE:  IEEp
0.100  A
```

Pick-up value of the **inverse** time stage I_{EEp} of the high-sensitivity earth fault protection (normally acc. address 3019
Setting range: **0.003** A to **1.000** A

6.3.16 Settings for circuit breaker failure protection – address block 39

7SJ512 includes a breaker failure protection with integrated current monitor. Setting is common for all three poles. The current threshold is set at least 10 % below the smallest expected fault current (including earth faults).

On the other hand, the current threshold should not be set more sensitive than necessary to avoid extended resetting times on transient phenomena of the current transformers after interruption of high short-circuit currents.

The time delay is determined from the maximum tripping time of the circuit breaker, the reset time of the current detectors plus a safety margin.

The sequence is shown in Figure 6.5.

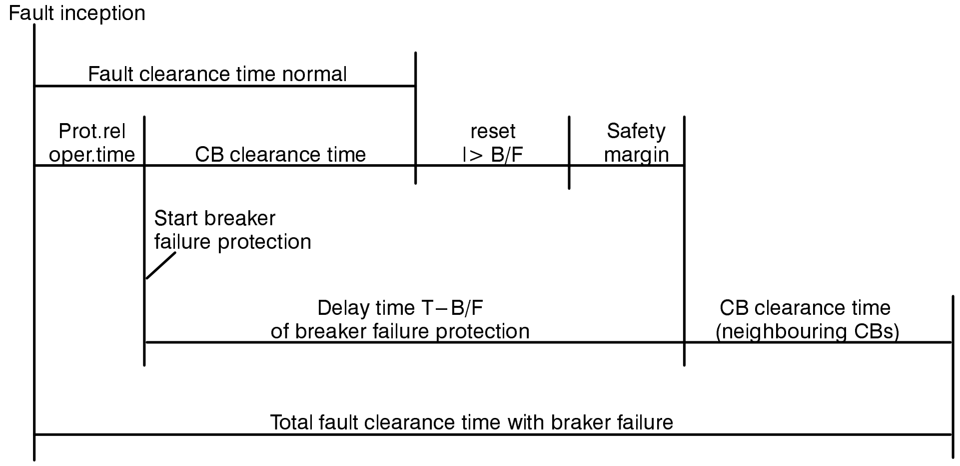


Figure 6.5 Time sequence for normal clearance of a fault, and with circuit breaker failure

---

```
3900 BREAKER
FAILURE PROT.
```

Beginning fo the block "Circuit breaker failure protection"

```
3901 B/F PROT.
OFF
```

Switching *OFF* of the circuit breaker failure protection

```
ON, INTERN.START
```

Switching *ON* of the circuit breaker failure protection, start by *INTERN*al overcurrent protection

```
ON, EXTERN.START
```

Switching *ON* of the circuit breaker failure protection, start by *EXTERN*al protection, via binary input

```
ON, INT. OR EXT.
```

Switching *ON* of the circuit breaker failure protection, start by *INT*ernal overcurrent protection or by *EXT*ernal protection, via binary input

```
3902 I> B/F
0.20 I/In
```

Pick-up value of the current threshold of the circuit breaker failure protection
Setting range: **0.10** to **4.00**

```
3903 T-B/F
0.25 s
```

Trip delay time of the circuit breaker failure protection
Setting range: **0.06** s to **60.00** s
or ∞ (no trip)

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 (optional).

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).

Block 51 Operational annunciations; these are messages which can appear during the operation of the relay: information about condition of relay functions, measurement data etc.

Block 52 Event annunciations for the last fault; pick-up, trip, AR, expired times, or similar. As defined, a network fault begins with pick-up of any fault detector. If auto-reclosure is carried out, the network fault ends after expiry of the last reclaim time; thus an AR–shot (or all shots) occupy only one fault data store. Within a network fault, several fault events can occur, from pick-up of any fault detection until drop-off.

Block 53 Event annunciations for the previous network fault, as block 52.

Block 54 Event annunciations for the last but two network fault, as block 52.

Block 55 Annunciations of an earth fault report.

Block 56 Annunciations for CB operation statistics, that is counters for first AR (RAR), second or further AR (DAR) and tripping commands, together with accumulated short circuit currents of each breaker pole.

Block 57 Indication of operational measured values (currents, voltages, powers, frequency).

Block 58 Indication of earth fault values.

Block 59 Indication of measured values of the thermal overload protection.

```
⇑  5 0 0 0
⇓  A N N U N C I A T I O N S
```

Commencement of “Annunciation blocks”

A comprehensive list of the possible annunciations and output functions with the associated function number FNo is given in Appendix C. It is also indicated to which device each annunciation can be routed.

6.4.2 Operational annunciations – address block 51

Operational and status annunciations contain information which the unit provides during operation and about the operation. They begin at address 5100. Important events and status changes are chronologically listed, starting with the most recent message. Time information is shown in hours and minutes. Up to 50 operational indications can be stored. If more occur, the oldest are erased in sequence.

Faults in the network are only indicated as "`System Flt`" together with the sequence number of the fault. Detailed information about the history of the fault is contained in blocks "Fault annunciations"; refer to Section 6.4.3.

Earth faults detected by the high-sensitivity earth fault protection in non-earthed systems are indicated with "`E/F Detec`"; detailed information can be found in the earth fault report (refer to Section 6.4.4).

The input of the codeword is not required.

After selection of the address 5100 (by direct selection with **DA 5 1 0 0 E** and/or paging with ⇑ or ⇓ and further scrolling ↑ or ↓) the operational annunciations appear. The boxes below show all available operational annunciations. In each specific case, of course, only the associated annunciations appear in the display.

Next to the boxes below, the abbreviated forms are explained. It is indicated whether an event is announced on occurrence (**C** = "**C**oming") or a status is announced "**C**oming" and "**G**oing" (**C**/**G**).

The first listed message is, as example, assigned with date and time in the first line; the second line shows the beginning of a condition with the character **C** to indicate that this condition occurred at the displayed time.

```
⇑ 5100 █ OPERATIONAL
⇓ ANNUNCIATIONS
```

Beginning of the block "Operational annunciations"

```
↑ 12.05.96    09:49
↓ Manual  Close  :C
```

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

2nd line: Annunciation text, in the example **C**oming

If the real time clock is not available the date is replaced by ⋆⋆.⋆⋆.⋆⋆, the time is given as relative time from the last re-start of the processor system.

Direct response from binary inputs:

`>Start FltRec`	Fault recording started via binary input (C)
`>Annunc. 1`	User defined annunciation No 1 received via binary input (C/G)
`>Annunc. 2`	User defined annunciation No 2 received via binary input (C/G)
`>Annunc. 3`	User defined annunciation No 3 received via binary input (C/G)
`>Annunc. 4`	User defined annunciation No 4 received via binary input (C/G)
`>Sys-Test`	Messages and measured values via the system interface are marked with "test operation" (C/G)

`>Sys-MM-block`	Messages and measured values via the system interface are blocked (C/G)
`>Param BI`	Dynamic change-over of pick-up values by binary input (C/G)
`>UE block`	Trip by displacement voltage U_E is blocked from an external device (C/G)
`>I>> block`	Block I>> stage of phase overcurrent protection from an external device (C/G)
`>I> block`	Block I> stage of definite time phase overcurrent protection from an external device (C/G)
`>Ip block`	Block I_p stage of inverse time phase overcurrent protection from an external device (C/G)
`>IE>> block`	Block I_E>> stage of earth overcurrent protection from an external device (C/G)
`>IE> block`	Block I_E> stage of definite time earth overcurrent protection from an external device (C/G)
`>IEp block`	Block I_{Ep} stage of inverse time earth overcurrent protection from an external device (C/G)
`>I> Block dir`	Directional I> (definite time) stage of phase time overcurrent protection is blocked from external (C/G)
`>Ip Block dir`	Directional I_p (inverse time) stage of phase time overcurrent protection is blocked from external (C/G)
`>IE>Block dir`	Directional I_E> (definite time) stage of earth time overcurrent protection is blocked from external (C/G)
`>IEpBlock dir`	Directional I_{Ep} (inverse time) stage of earth time overcurrent protection is blocked from external (C/G)
`>IEE>> block`	I_{EE}>> stage of high-sensitivity earth fault protection is blocked from an external device (C/G)
`>IEE> block`	I_{EE}> (definite time) stage of high-sensitivity earth fault protection is blocked from external (C/G)
`>IEEp block`	I_{EEp} (inverse time) stage of high-sensitivity earth fault protection is blocked from external (C/G)
`>O/L block`	Block thermal overload protection via binary input (C/G)
`>IEF block`	Block intermittent earth fault protection (C/G)
`>AR reset`	Auto-reclose function reset via binary input (C/G)
`>DAR Block`	DAR blocked via binary input (C/G)

General operational annunciations of the protection device:

`Dev.operative`	Device operative (C)
`Prot. operat.`	At least one protection function operative (C/G)
`Initial start`	Initial start of the processor system (C)

`LED Reset`	Stored LED indications reset (C)
`LogMeasBlock`	Messages and measured values via the system interface are blocked (C/G)
`Test mode`	Messages and measured value via the system interface are marked with “Test operation” (C/G)
`Param.Running`	Parameters are being set (C/G)
`Param. Set A`	Parameter set A is active (C/G)
`Param. Set B`	Parameter set B is active (C/G)
`Param. Set C`	Parameter set C is active (C/G)
`Param. Set D`	Parameter set D is active (C/G)
`Syst.Flt`	Network system fault (C/G), detailed information in the fault annunciations
`E/F Det.`	Earth fault (C/G), detailed information in the earth fault report
`Manual Close`	Manual close command registered (impulse) (C)
`CB in Test`	Circuit breaker test is in progress (C/G)
`Flt.RecDatDel`	Fault recording data deleted (C)
`Flt.Rec.viaBI`	Fault recording triggered via binary input (C)
`Flt.Rec.viaKB`	Fault recording triggered via the front keyboard (C)
`Flt.Rec.viaPC`	Fault recording triggered via operating (PC) interface (C)

Operational annunciations of monitoring functions:

`Wrong SW-vers`	Software version of the device is wrong (C)
`Wrong dev. ID`	Device identification number is wrong (C)
`Annunc. lost`	Annunciations lost (buffer overflow) (C)
`Annu. PC lost`	Annunciations for operating (PC) interface lost (C)
`Oper.Ann.Inva`	Operational annunciations invalid (C/G)
`Flt.Ann.Inval`	Fault annunciations invalid (C/G)

E/F Prot Inva	Earth fault protocol invalid (C/G)
Stat.Buff.Inv	Buffer for operation statistics invalid (C/G)
LED Buff.Inva	Buffer for stored LEDs invalid (C/G)
VDEW StateInv	VDEW state (IEC 60870–5–103) invalid (C/G)
Chs.Error	Check-sum error detected (C/G)
Chs.A Error	Check-sum error detected for parameter set A: no operation possible with this set (C/G)
Chs.B Error	Check-sum error detected for parameter Set B: no operation possible with this set (C/G)
Chs.C Error	Check-sum error detected for parameter set C: no operation possible with this set (C/G)
Chs.D Error	Check-sum error detected for parameter set D: no operation possible with this set (C/G)
Failure 15V	Failure in internal supply voltage 15 V (C/G)
Failure 5V	Failure in internal supply voltage 5 V (C/G)
Failure 0V	Failure in offset voltage 0 V (C/G)
Failure I/O	Failure detected in input/output p.c.b. (C/G)
Fail. TripRel	Failure in internal trip relay control circuit (C/G)
LSA disrupted	LSA–link disrupted (system interface) (C/G)
Failure Σ I	Failure detected by current plausibility monitor ΣI (C/G)
Fail.Σ I (IEE)	Failure detected by current plausibility monitor ΣI with highly sensitive input I_{EE} (if used) (C/G)
Failure Isymm	Failure detected by current symmetry monitor (C/G)
Failure Σ Up-e	Failure detected by voltage plausibility monitor ΣU_{ph-e} (if available) (C/G)
Failure Usymm	Failure detected by voltage symmetry monitor (if available) (C/G)
Fail.PhaseSeq	Failure detected by phase sequence monitor (C/G)

Operational annunciations of time overcurrent protection functions:

O/C Ph off	Phase fault time overcurrent protection is switched off (C/G)
>I>> block	Block I>> stage of phase overcurrent protection from an external device (C/G)

>I> block	Block I> stage of definite time phase overcurrent protection from an external device (C/G)
>Ip block	Block I_p stage of inverse time phase overcurrent protection from an external device (C/G)
>I> Block dir	Directional I> (definite time) stage of phase time overcurrent protection is blocked from external (C/G)
>Ip Block dir	Directional I_p (inverse time) stage of phase time overcurrent protection is blocked from external (C/G)
O/C E off	Earth fault time overcurrent protection is switched off (C/G)
>IE>> block	Block I_E>> stage of earth overcurrent protection from an external device (C/G)
>IE> block	Block I_E> stage of definite time earth overcurrent protection from an external device (C/G)
>IEp block	Block I_{Ep} stage of inverse time earth overcurrent protection from an external device (C/G)
>IE>Block dir	Directional I_E> (definite time) stage of earth time overcurrent protection is blocked from external (C/G)
>IEpBlock dir	Directional I_{Ep} (inverse time) stage of earth time overcurrent protection is blocked from external (C/G)

Operational annunciations of thermal overload protection:

O/L off	Thermal overload protection is switched off (C/G)
>O/L block	Block thermal overload protection via binary input (C/G)
O/L Warn I	Thermal overload protection: current warning stage (C/G)
O/L Warn Θ	Thermal overload protection: thermal warning stage (C/G)

Operational annunciations of high-sensitivity earth fault protection:

E/F det. off	Earth fault protection is switched off (C/G)
>UE block	Trip by displacement voltage U_E is blocked from an external device (C/G)
>IEE>> block	I_{EE}>> stage of high-sensitivity earth fault protection is blocked from an external device (C/G)
>IEE> block	I_{EE}> (definite time) stage of high-sensitivity earth fault protection is blocked from external (C/G)
>IEEp block	I_{EEp} (inverse time) stage of high-sensitivity earth fault protection is blocked from external (C/G)

Operational annunciations of intermittent earth fault protection:

`IEF off`	Intermittent earth fault protection is switched off (C/G)
`IEF blocked`	Intermittent earth fault protection is blocked (C/G)
`>IEF block`	Block intermittent earth fault protection (C/G)

Operational annunciations of the internal auto-reclose function:

`AR off`	Auto-reclose function is switched off (C/G)
`AR inoperativ`	Auto-reclose function inoperative, i.e, cannot be initiated (C/G)
`CB not ready`	Circuit breaker not ready for auto-reclose sequence (C/G)
`>AR reset`	Auto-reclose function reset via binary input (C/G)
`>DAR Block`	DAR blocked via binary input (C/G)

Operational annunciation of the circuit breaker failure protection:

`B/F off`	Circuit breaker failure protection is switched off (C/G)

Operational annunciations of the circuit breaker test function:

`CB Test`	Circuit breaker test in progress (C/G)
`CB Test Trip`	Trip by circuit breaker test function (C)

Further messages:

`Table overflow`	If more messages have been received the last valid message is *Table overflow*.
`End of table`	If not all memory places are used the last message is *End of table*.

6.4.3 Fault annunciations – address blocks 52 to 54

The annunciations which occurred during the last three network faults can be read off on the front panel or via the operating interface. The indications are recorded in the sequence from the youngest to the oldest under addresses 5200, 5300 and 5400. When a further fault occurs, the data relating to the oldest are erased. Each fault data buffer can contain up to 120 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 5 2 0 0 E** or by paging with the keys ⇑ or ⇓ . With the keys ↑ or ↓ one can page the individual annunciations forwards or backwards. Each annunciation is assigned with a sequence item number.

For these purposes, the term "system fault" means the period from short circuit inception up to final clearance. If auto-reclosure occurs, then the "system fault" is finished on expiry of the last reclaim time, that is, after successful or unsuccessful AR. Thus the total fault clearance procedure inclusive AR–cycles occupies only one fault annunciation store. Within one system fault, several fault events can have occurred, i.e. from pick-up of any protection function until drop-off of the last pick-up of a protection function.

In the following clarification, all the available fault annunciations are indicated. In the case of a specific fault, of course, only the associated annunciations appear in the display. At first, an example is given for a system fault, and explained.

⇑⇓
```
5200█ LAST
FAULT
```
Beginning of the block "Fault annunciations of the last system fault"

↑↓
```
001█ 16.08.96
Syst.Flt 10
```
under item 1, the date of the system fault is indicated, in the second line the consecutive number of the system fault

↑↓
```
002█ 09:04:39.767
Fault 17       :C
```
under item 2, the time of the beginning of the fault is given; time resolution is 1 ms

↑↓
```
003█ 0 ms
I>> Fault      :C
```
The following items indicate all fault annunciations from fault detection until drop-off, in chronological sequence. These annunciations are tagged with the relative time, starting with fault detection.

↑↓
```
004█ 0 ms
Fault L12      :C
```

↑↓
```
005█ 101 ms
T-I>> expired:C
```

↑↓
```
007█ 101 ms
O/C Gen.Trip   :C
```

↑↓
```
006█ 196 ms
Dev. Drop-off:C
```
etc.

General fault annunciations of the device:

`Syst.Flt`	System fault with consecutive number
`Fault`	Beginning of fault
`Flt.Buff.Over`	Buffer for fault annunciations overflow
`Dev.Trip forw`	Trip on fault in forward direction (directional)
`Dev.Trip rev.`	Trip on fault in reverse direction (directional)
`IL1/In=`	Interrupted fault current of phase L1
`IL2/In=`	Interrupted fault current of phase L2
`IL3/In=`	Interrupted fault current of phase L3
`Dev. Drop-off`	Drop-off of the device, general

Fault annunciations of time overcurrent protection:

`Fault L1`	Fault detection phase L1
`Fault L1E`	Fault detection phase L1 – E
`Fault L2`	Fault detection phase L2
`Fault L2E`	Fault detection phase L2 – E
`Fault L12`	Fault detection phases L1 – L2
`Fault L12E`	Fault detection phases L1 – L2 – E
`Fault L3`	Fault detection phase L3
`Fault L3E`	Fault detection phase L3 – E
`Fault L13`	Fault detection phases L1 – L3
`Fault L13E`	Fault detection phases L1 – L3 – E
`Fault L23`	Fault detection phases L2 – L3
`Fault L23E`	Fault detection phase L2 – L3 – E
`Fault L123`	Fault detection phases L1 – L2 – L3

`Fault L123E`	Fault detection phases L1 – L2 – L3 – E
`Fault E`	Fault detection earth fault
`I>> Fault`	Fault detection in an I>> phase current stage
`I> Fault`	Fault detection in an I> phase current stage (definite time)
`Ip Fault`	Fault detection in an I_p phase current stage (inverse time)
`IE>> Fault`	Fault detection in I_E>> earth current stage
`IE> Fault`	Fault detection in I_E> earth current stage (definite time)
`IEp Fault`	Fault detection in I_{Ep} earth current stage (inverse time)
`T-I>> expired`	Delay time of I>> phase current stage expired
`T-I> expired`	Delay time of I> phase current stage (definite time) expired
`T-Ip expired`	Delay time of I_p phase current stage (inverse time) expired
`T-IE>> expir.`	Delay time of I_E>> earth current stage expired
`T-IE> expired`	Delay time of I_E> earth current stage (definite time) expired
`T-IEp expired`	Delay time of I_{Ep} earth current stage (inverse time) expired
`Rush Block L1`	Block of phase L1 by inrush stabilization
`Rush Block L2`	Block of phase L2 by inrush stabilization
`Rush Block L3`	Block of phase L3 by inrush stabilization
`Rush Crossbl.`	Crossblock function has operated
`I> Fault dir.`	Fault detection in an I> directional phase current stage (definite time)
`Ip Fault dir.`	Fault detection in an I_p directional phase current stage (inverse time)
`IE>Fault dir.`	Fault detection in I_E> directional earth current stage (definite time)
`IEpFault dir.`	Fault detection in I_{Ep} directional earth current stage (inverse time)
`T-I> dir.exp.`	Time delay for directional definite time phase current stage I> expired
`T-Ip dir.exp.`	Time delay for directional inverse time phase current stage I_p expired

`T-IE> dir.exp`	Time delay for directional definite time earth current stage I_E> expired
`T-IEp dir.exp`	Time delay for directional inverse time earth current stage I_{Ep} expired
`O/C Gen.Trip`	General trip command of time overcurrent protection

Fault annunciation of thermal overload protection:

`O/L Trip`	Trip by thermal overload protection

Fault annunciations of high-sensitivity earth fault protection:

Note: The following annunciation can only be displayed in the fault annunciations when the high-sensitivity earth fault protection is configured to trip on earth faults detected by this function (address 3001 EARTH FAULT = *ON*, refer also to Section 6.3.11). Otherwise, earth fault annunciations of the high-sensitivity earth fault protection are stored only in the earth fault report (refer to Section 6.4.4).

`E/F Detec. L1`	Earth fault detection in phase L1 (models with directional determination supplement)
`E/F Detec. L2`	Earth fault detection in phase L2 (models with directional determination supplement)
`E/F Detec. L3`	Earth fault detection in phase L3 (models with directional determination supplement)
`E/F forwards`	Earth fault detection in forward direction (if set directional)
`E/F reverse`	Earth fault detection in reverse direction (if set directional)
`UE Fault`	Earth fault detection by displacement voltage
`T-UE expired`	Delay time for trip by displacement voltage expired
`IEE>> Fault`	Fault detected by high-level stage I_{EE}>> of high-sensitivity earth fault protection
`IEE> Fault`	Fault detected by definite time stage I_{EE}> of high-sensitivity earth fault protection
`IEEp Fault`	Fault detected by inverse time stage I_{EEp} of high-sensitivity earth fault protection
`T-IEE>> expir`	Time delay for earth current stage I_{EE}>> of high-sensitivity earth fault protection expired

T-IEE> expir	Time delay for definite time earth current stage $I_{EE}>$ of high-sensitivity earth fault protection expired
T-IEEp expir	Time delay for inverse time earth current stage I_{EEp} of high-sensitivity earth fault protection expired
E/F Trip	Trip (general) by high-sensitivity earth fault protection
IEE=	Magnitude of the earth fault current (only if set non-directional)
IEEa=	Active component of the earth fault current (only if set directional)
IEEr=	Reactive component of the earth fault current (only if set directional)

Fault annunciations of intermittent earth fault protection:

IIE Fault det.	Pick-up on earth fault
Intermitt.EF	Intermittent earth fault detected (more than the set number of pick-ups); this annunciations locks further pick-up annunciations for earth faults
IEF Tsum exp.	Accumulated earth fault time expired
IEF Tres run.	Reset time is running
Nos.IIE=	Number of earth faults (with value)
Iie/In=	Maximum earth fault current (r.m.s.) (with value)
IEF Trip	Trip by intermittent earth fault protection

Fault annunciation of internal auto-reclose function:

AR Close Cmd.	Reclose command from auto-reclose function issued

Fault annunciations of circuit breaker failure protection:

B/F fault	Initiation of breaker failure protection
B/F Trip	Trip by breaker failure protection

Further messages:

`Table empty`	means that no fault event has been recorded
`Table overflow`	means that other fault data have occurred, however, memory is full
`Table superceded`	a new fault event has occurred during read-out: page on with ↑ or ↓; the display shows the first annunciation in the actualized order
`End of table`	If not all memory places are used the last message is `End of table`.

The data of the **second to last** system fault can be found under address 5300. The available annunciations are the same as for the last fault.

⇧⇩ `5300█ 2nd TO LAST FAULT`	Beginning of the block “Fault annunciations of the second to last system fault”
etc.	

The data of the **third to last** system fault can be found under address 5400. The available annunciations are the same as for the last fault.

⇧⇩ `5400█ 3rd TO LAST FAULT`	Beginning of the block “Fault annunciations of the third to last system fault”
etc.	

6.4.4 Earth fault report − address block 55

For earth faults detected by the high-sensitivity earth fault protection a special earth fault data store is available under Address 5500. This is available only when this function is not parameterized to give trip command (address 3001 EARTHFAULT = *ALARM ONLY*, refer also to Section 6.3.11), i.e. normally for use in isolated or compensated systems. Up to 40 messages can be stored for each of the three last earth faults. Input of the codeword is not required.

The earth fault reports can be called up by direct addressing, using **DA 5 5 0 0 E** or by paging with the keys ⇑ or ⇓ to the Address 5500. With the keys ↑ or ↓ one can page forwards or backwards within the indications.

In the following list, the available earth fault annunciations are attached to the box with main heading. In a specific case, of course, only the associated indications appear in the display.

```
⇑ 5500█ ISOLATED
⇓ EARTH FLT DATA
```

Beginning of block "Earth fault event data for non-earthed system"

```
↑ 001█ 16.05.96
↓ E/F Det. 16
```

under item No. 1, the date and the sequence number of the earth fault are displayed

```
↑ 002█ 16:55:02
↓ Ieea=
```

Item No. 2 shows the time of commencement of the earth fault, together with the measured value: active component of earth fault current

The following items show earth fault annunciations:

IEEr=	reactive component of earth fault current
E/F Detec. L1	earth fault detected in phase L1 (models with directional determination supplement)
E/F Detec. L2	earth fault detected in phase L2 (models with directional determination supplement)
E/F Detec. L3	earth fault detected in phase L3 (models with directional determination supplement)
E/F forwards	earth fault in forward direction (when directional)
E/F reverse	earth fault in reverse direction (when directional)
E/F Buff.Over	buffer of earth fault annunciations overflow (C)

Reports of further earth faults begin with item number 101 and 201, e.g.:

```
↑ 101█ 19.05.96
↓ E/F Det. 15
```

under Item No. 101, the date of another earth fault can be displayed, followed by the respective data

6.4.5 Circuit breaker operation statistics – address block 56

The number of trip commands initiated by 7SJ512 is counted. Also, the number of auto-reclose attempts is counted, separately for RAR and DAR. Additionally, the interrupted currents are stated for each individual pole and given under the fault annunciations (refer to Section 6.4.3) following each trip command. These currents are accumulated and stored. Counter status and stores are secured against auxiliary voltage failure and can be read off under address 5600. The address can be reached by direct addressing **DA 5 6 0 0 E** or by paging with the keys ⇑ or ⇓ until address 5600 is reached. The counters can be called up using the key ↑ for forwards paging or ↓ for backwards paging.

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

⇑⇓ `5600█ CB OPERAT. STATISTICS`	Beginning of the block “Circuit breaker operation statistics”
↑↓ `5602█ AR 3pole= 4`	Number of auto-reclose attempts after three-pole trip RAR cycles, e.g. 4

Page on with key ↑ to get further counter states

↑ `5603█ DAR 3pol=`	Number of auto-reclose attempts after three-pole trip, DAR cycles
↑ `5604█ Trip No=`	Number of trip commands
↑ `5607█ ΣIL1/In=`	Accumulated interrupted currents for CB pole L1
↑ `5608█ ΣIL2/In=`	Accumulated interrupted currents for CB pole L2
↑ `5609█ ΣIL3/In=`	Accumulated interrupted currents for CB pole L3
↑ `5610█ IL1/In`	Last interrupted current for CB pole L1
↑ `5611█ IL2/In`	Last interrupted current for CB pole L2
↑ `5612█ IL3/In`	Last interrupted current for CB pole L3

The maximum values of the counters are:

– *AR 3pole, DAR 3pole*	9 digits
– *Trip No*	9 digits
– *ΣIL1/In*, *ΣIL2/In*, *ΣIL3/In*	7 digits plus 1 decimal digit
– *LAST IL1/In*, *LAST IL2/In*, *LAST IL3/In*	7 digits plus 1 decimal digit

The counters can be reset to 0 in address block 82 (see Section 6.5.2).

6.4.6 Read-out of operational measured values – address blocks 57 and 59

The steady state r.m.s. operating values can be read out at any time under the address 5700. The address can be called up directly using **DA 5 7 0 0 E** or by paging with ⇑ or ⇓. The individual measured values can be found by further paging with ↑ or ↓. Entry of the codeword is not necessary. The values will be updated in approximately 5 seconds intervals.

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 typical values have been inserted. In practice the actual values appear.

```
5700 OPERATIONAL
MEASURED VALUES
```

Beginning of the block “Operational measured values”

Use ↑ key to move to the next address with the next measured value:

```
5701 MEAS.VALUE
IL1[%]  = 76.6
```

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

One address is available for each measured value. The values can be reached also by direct addressing using key **DA** followed by the address number and execute with **E**.

```
5702 MEAS.VALUE
IL2[%]  =  80.8
```

The percentage is referred to rated relay current

```
5703 MEAS.VALUE
IL3[%]  =  78.8
```

```
5704 MEAS.VALUE
IE[%]  =  1.3
```

```
5705 MEAS.VALUE
UL1E[%]=  103.9
```

Phase voltages, powers, power factor available only with models with directional determination supplement.
The percentage of phase-to-earth voltage is related on rated voltage/$\sqrt{3}$.

```
5706 MEAS.VALUE
UL2E[%]=  102.7
```

```
5707 MEAS.VALUE
UL3E[%]=  103.3
```

```
5708█ MEAS.VALUE
UE[%]=  1.3
```

if displacement voltage available

```
5709█ MEAS.VALUE
P[%]=  96.8
```

The percentage is related on rated apparent power $\sqrt{3} \cdot U_N \cdot I_N$

```
5710█ MEAS.VALUE
Q[%]=  28.6
```

```
5711█ MEAS.VALUE
S[%]=  98.6
```

```
5712█ MEAS.VALUE
f[%]=  99.8
```

The percentage is related on rated frequency 50 Hz or 60 Hz as parameterized under address 7899 (refer to Section 5.4.2)

```
5713█ MEAS.VALUE
IL1  =  306 A
```

The primary values (addresses 5713 to 5723) are related to the primary rated values as parameterized under addresses 1103 (for U_N) and 1105 (for I_N) (refer to Section 6.3.3).

```
5714█ MEAS.VALUE
IL2  =  323  A
```

```
5715█ MEAS.VALUE
IL3  =  315 A
```

```
5716█ MEAS.VALUE
IE  =  5  A
```

The correct matching factor according to address 1112 (Section 6.3.3) is a precondition for correct calculation of the primary earth current

```
5717█ MEAS.VALUE
UL1E=  66.0  kV
```

Phase voltages and powers available only with models with directional determination supplement

```
5718█ MEAS.VALUE
UL2E=  65.2  kV
```

```
5719█ MEAS.VALUE
UL3E=  65.6  kV
```

```
5720█ MEAS.VALUE
UE=  0.8  kV
```

if displacement voltage available

```
5721█ MEAS.VALUE
P=  103.7  MW
```

```
5722█ MEAS.VALUE
Q=  32.7  MVAr
```

```
5723█ MEAS.VALUE
S=  112.7  MVA
```

```
5724█ MEAS.VALUE
cos  phi=  0.92
```

The calculated temperature rise for the overload protection can be read out in address block 59. The address can be called up directly using **DA 5900 E** or by paging with ⇑ or ⇓. The individual measured values can be found by further paging with ↑ or ↓. Entry of the codeword is not necessary.

The values are available as long as the thermal overload protection is configured as THERMAL OL = *EXIST* (address 7827) and switched on (address 2701). Page on with the ↑ key to read off the next address with the next measured value, or page back with ↓.

```
5901█ MEAS.VALUE
Θ/Θtrip  L1=  49  %
```

The calculated temperature rises of the individual phases are not presented if the measuring method Θ *FROM IMAX* has been selected (address 2706)

```
5902█ MEAS.VALUE
Θ/Θtrip  L2=  54  %
```

```
5903█ MEAS.VALUE
Θ/Θtrip  L3=  51  %
```

```
5904█ MEAS.VALUE
Θ/Θtrip  =  54  %
```

The percentage is referred to the trip temperature rise according to the measurement method as selected in address 2706

6.4.7 Read-out of earth fault measured values in non-earthed systems – address block 58

The measured values which occur during an earth fault can be read out in address block 58. They are available when the high-sensitivity earth fault detection is not configured to give trip command (address 3001 EARTHFAULT = *ALARM ONLY*, refer also to Section 6.3.11), i.e. normally for use in isolated or compensated systems. The address can be directly called up using **DA 5 8 0 0 E** or by paging with keys ⇑ or ⇓. The individual values can be found then by further paging with ↑ or ↓. Entry of the codeword is not necessary. The values are recorded only during earth fault if the relay is equipped with the earth fault detection function and when this is configured to *EXIST*.

The displayed values are: the active component IEEa and the reactive component IEEr of the earth current, as primary values and as secondary values at the relay terminals. Pre-requisite for correct output of the current values is that the rated data are correctly parameterized in address block 11 (refer to Section 6.3.3).

In the following example, some typical values have been inserted. In practice the actual values appear. Values outside the operation range of the relay are indicated with ★★★★.

```
⇑  5800█ ISOL.  E/F
⇓  MEASURED VALUES
```

Beginning of the block “Measured values of earth fault detection in non-earhed systems

```
↑  5801█ MEAS.VALUE
↓  IEEa=  1.3   A
```

```
↑  5802█ MEAS.VALUE
↓  IEEr=  9.2   A
```

```
↑  5803█ MEAS.VALUE
↓  IEEa[mA]=  0.2
```

```
↑  5804█ MEAS.VALUE
↓  IEEr[mA]=  1.5
```

Use ↑ key to display the next address with the next measured value, or use ↓ key for the previous address.

Each measured value is assigned to one address; each address, alternatively, can be reached by direct addressing, using key **DA** followed by the address number.

The primary values in amps (addresses 5801 and 5802) are derived from the primary rated values as parameterized under addresses 1114 and 1105 (refer to Section 6.3.3).

The secondary values in milliamps (addresses 5803 and 5804) are derived from the current which flows through the measured current input for highly sensitive earth fault detection.

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. 7SJ512 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 (refer to Section 2.3 Ordering data).

The functions can be controlled from the operating panel on the front of the device, via the operating or system 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 installation of the device and that they have been connected (refer to Section 5.5.2 Marshalling of the binary inputs).

The control facilities begin with address block 8000. This address is reached

– by block paging with the keys ⇑ forwards or ⇓ backwards up to address 8000, or

– by direct selection with address code, using key **DA**, address **8 0 0 0** and execute with key **E.**

```
⇑ 8 0 0 0█ D E V I C E
⇓ C O N T R O L
```

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 operates. Setting is carried out in block 81 which is reached by direct addressing **DA 8 1 0 0 E** or by paging with ⇑ and ⇓. Input of the codeword is required to change the data.

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

```
⇑ 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 5 . 1 9 9 6
↓ 1 2 : 1 8 : 2 5
```

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.

6.5.2 Erasing stored annunciations and counters – address block 82

The statistical indications (Section 6.4.5, address block 56) are stored in EEPROMs in the device. They are not therefore erased if the auxiliary power supply fails. Additionally, annunciations and the status of the LED memories are stored in NV–RAMs and thus saved provided the back-up battery is installed. These stores can be cleared in block 82. Block 82 is called up by paging with the keys ⇑ or ⇓ or directly by keying in the code **DA 8 2 0 0 E**. With the exception of resetting the LED indications (address 8201), codeword entry is necessary to erase the stored items. Reset is separate for the different groups of counters, memories and annunciations. One reaches the individual items by paging ↑ ↓. Erasure requires confirmation with the key **J/Y**. The display then confirms the erasure. If erasure is not required, press key **N** or simply page on.

⇑⇓ 8 2 0 0 █ R E S E T	Beginning of block "Reset"
↑↓ 8 2 0 1 █ R E S E T L E D ?	Request whether the LED memories should be reset
↑↓ 8 2 0 2 █ R E S E T O P E R A T . A N N U N C . ?	Request whether the operational annunciation buffer store should be erased
↑↓ 8 2 0 3 █ R E S E T F A U L T A N N U N C . ?	Request whether the fault annunciation buffer store should be erased
↑↓ 8 2 0 4 █ R E S E T C O U N T E R S ?	Request whether the CB operation counters should be set to zero
↑↓ 8 2 0 5 █ R E S E T T O T A L I s c ?	Request whether the total of switched short-circuit currents should be set to zero
↑↓ 8 2 0 6 █ R E S E T E / F A N N U N C . ?	Request whether the earth fault report buffer store (for earth faults in non-earthed systems) should be erased

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 Off/On control of part functions of the device

During operation of protection relay it may be desired to control the relay manually or from system criteria, temporarily to switch off partial functions of the relay or to switch them on only under specific conditions. An example may be the switching on or off of the auto-reclose system when a transfer bus is being used, dependent upon whether a transformer or line branch is switched to the transfer.

The relay allows partial functions to be switched on or off via binary inputs or manual operation via the integrated operator panel or via the operating interface at the front using a personal computer.

For switching via binary inputs it is, of course, necessary that the binary inputs have been marshalled to the corresponding switching functions. Furthermore, it must be noted that a binary input is required for each function, switching off and switching on. The switching command is stored in the relay and protected against auxiliary voltage failure (the function of a bi-stable store). The command can be annunciated via an annunciation relay or LED display.

For switching via the integrated operator panel or the front interface, a code word is necessary. The control functions are found at the beginning of the parameter block of each protection or supplementary function. The switch condition shown in the display can be changed over using the "No"–key **N**. The opposite switch condition then appears in the display. Each change of condition must be confirmed with the **E**–key. The change-over is first recorded in the relay when codeword operation has been terminated. This is done 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. The switched conditions are then permanently stored in EEPROMs and protected against auxiliary voltage failure; the display confirms "NEW SETTINGS SAVED". 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.

A function is switched *ON* when the on-command has been given by both the binary input AND also from the operator panel or interface.

A function is switched *OFF* when the off-command is given by EITHER the binary input OR from the operator panel or the operating interface. Thus it is ensured that a partial function can only be switched on from that place where it was previously switched off.

Control inputs which are not marshalled to a binary input are regarded, from that location, as switched on, so that change of the condition is possible from the operator panel or the operating interface.

At the operator panel and the operating interface the factory setting is equally that all partial functions are switched on, so that switching via binary inputs is possible.

The completion of a switching command is, independent of its cause, output as an operational annunciation:

– "(function) `off`" **C**omes at the instant of switch-off,

– "(function) `off`" **G**oes at the instant that it is switched on.

These annunciations are listed in block 51 under OPERATIONAL ANNUNCIATIONS and can also be transmitted via the LSA interface to a central computer. Also they can be marshalled as binary outputs; the signal relay then indicates the switched-off condition.

For annunciations of binary inputs one must differentiate:

– Direct confirmation of a binary input is available as long as the corresponding binary input is energized. It can be output via a signal relay or LED. In the summary of all annunciations (Appendix C) and in the marshalling tables (Section 5.5) these annunciations are identified with a '>' symbol.

– The completion indication of the switched-off condition is signalized independently of the source of the command. It appears ("Comes") at the instant of switch-off and disappears ("Goes") at the instant of switching on.

The following survey shows the control functions and also indicates which confirmation indications are generated.

Display	Binary input confirmation	Completion indication ('comes' and 'goes')
1201 O/C PHASES ON OFF	Time overcurrent protection for phase currents 1701 >O/C Ph on 1702 >O/C Ph off	 1751 O/C Ph off
1501 O/C EARTH ON OFF	Time overcurrent protection for earth currents 1711 >O/C E on 1712 >O/C E off	 1756 O/C E off
2001 RUSH ON OFF	Inrush stabilization	
2701 THERMAL OL OFF ON	Thermal overload protection 1502 >O/L off 1501 >O/L on	 1511 O/L off
3001 EARTHFAULT ALARM ONLY ON OFF	High-sensitivity earth fault protection 1205 >E/F Det. on 1206 >E/F Det. off	 1211 E/F Det. off
3301 INTERM.EF OFF ON	Intermittent earth fault protection 6902 >IEF off 6901 >IEF on	 6921 IEF off
3401 AR FUNCT ON OFF	Internal auto-reclose function 2701 >AR on 2702 >AR off	 2781 AR off
3901 B/F PROT. OFF ON, INTERN.START ON, EXTERN.START ON, INT. OR EXT.	Circuit breaker failure protection 1402 >B/F off 1401 >B/F on	 1451 B/F off

6.5.4 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.

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.

This features can be accomplished using the integrated operating keyboard or via the operating (PC) interface.

In order to carry out switch-over by the operator, entry of the codeword is necessary (refer to Section 5.3.1). For this purpose, 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 8 3 0 0 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.

```
⇑  8300█ SYS-VDEW
⇓  ANNUNC.-MEAS.VAL
```

Beginning of block "Annunciations and measured values for the system interface with VDEW/ZVEI compatible protocol (IEC 60870–5–103)"

```
↑  8301█ SYS  TEST
↓  OFF

   ON
```

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 the address back to *OFF* after having finished test operations!

6.5.5 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. A pre-requisite is, that during configuration of the scope of functions address 7885 has been set to PARAM. C/O = *EXIST* (refer to Section 5.4.2). Additionally, the pick-up values of time overcurrent protection stages can be switched over to a set of different values during operation and even during a fault. Refer to Section 6.3.15 for details.

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.

6.5.5.1 Read-out of settings of a parameter set

In order to **look up** the settings of a parameter set **in the display** it is sufficient to go to any address of the function parameters (i.e. addresses above 1000 and below 4000), either by direct addressing using key **DA**, entering the four-figure address code and terminating with enter key **E**, or by paging through the display with ⇑ or ⇓. You can switch over to look up a different parameter set, e.g.

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

The parameter set is indicated in the display by a leading character (A to D) before the address number indicating the parameter set identification.
The corresponding procedure is used for the other parameter sets:

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

The relay operates always with the active parameter set even during read-out of the parameters of any desired parameter set. The change-over procedure described here is, therefore, only valid for **read-out** of parameters **in the display**.

6.5.5.2 Change-over of the active parameter set from the operating panel

For **change over to a different parameter set**, i.e. if a different set shall be activated, the address block 85 is to be used. For this, codeword entry is required.

The block for processing parameter sets is reached by pressing the direct address key **DA** followed by the address **8 5 0 0** and enter key **E** or by paging through the display with ⇑ or ⇓. The heading of the block will appear:

```
⇑  8 5 0 0█ P A R A M E T E R
⇓  C H A N G E - O V E R
```

Beginning of the block “Parameter change-over”: processing of parameter sets

It is possible to scroll through the individual addresses using the ↑ key or backwards with ↓.

Address 8501 shows the actually active parameter set with which the relay is operating.

In order to switch over to a different parameter set scroll on with ↑ to address 8503. Using the “No”–key **N** you can change to any desired parameter set; alternatively, you can decide that the parameter sets are to be switched over from binary inputs or via the system interface. 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.

```
8501 ACTIV PARAM
SET A
```

Address 8501 shows the actually active parameter set

```
8503 ACTIVATING
SET A
```

```
SET B
```

```
SET C
```

```
SET D
```

```
SET BY BIN.INPUT
```

```
SET BY LSA CONTR
```

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 6.5.5.3)
If you select *SET BY LSA CONTR*, then the parameter set can be changed over via the system interface using VDEW/ZVEI protocol (IEC 60870−5−103)

6.5.5.3 Change-over of the active parameter set via binary inputs

If change-over of parameter sets is intended to be carried out via binary inputs, the following is to be heeded:

− Locally (i.e. from the operator panel or from PC via the operating interface), ACTIVATING must be switched to *SET BY BIN.INPUT* (refer to Section 6.5.5.2).

− 2 logical binary inputs are available for control of the 4 parameter sets. These binary inputs are designated "`Param.Selec.1`" and "`Param.Selec.2`" (FNo `7` and `8`).

− The logical binary inputs must be allocated to 2 physical input modules (refer to Section 5.5.2) in order to allow control. An input is treated as not energized when it is not assigned to any physical input.

− The control input signals must be continuously present as long as the selected parameter set shall be active.

The active parameter sets are assigned to the logical binary inputs as shown in Table 6.2.

A simplified connection example is shown in Figure 6.6. Of course, the binary inputs must be declared in normally open ("`NO`") mode.

Binary input ParamSelec.1	Binary input ParamSelec.2	causes active set
no	no	Set A
yes	no	Set B
no	yes	Set C
yes	yes	Set D

no = input not energized
yes = input energized

Table 6.2 Parameter selection via binary input

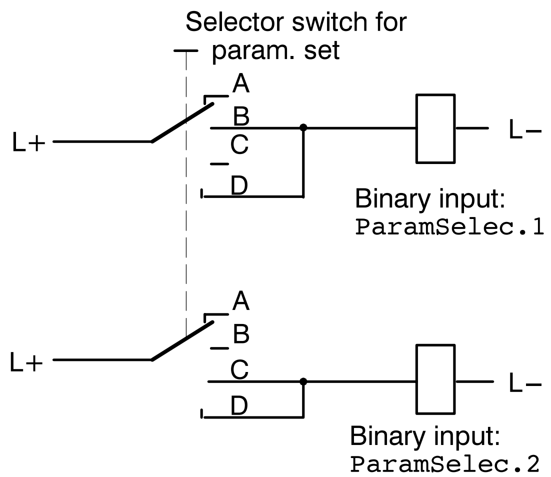


Figure 6.6 Connection scheme for parameter change-over via binary inputs

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 5.2.5).

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 three-phase symmetrical current source with individually adjustable currents, should be available. For checking the pick-up values, a single-phase current source is sufficient, but this is not adequate for a correct functional check of the measured value monitoring systems. For relays with directional determination option, a three-phase voltage source is necessary. The voltages need not be individually adjustable. The phase rotation must be clockwise; otherwise two phases must be interchanged in current as well as in voltage (if applicable).

If unsymmetrical currents and voltages 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 high-set time overcurrent protection stages I>>, I_E>>

In order to test the high-set time overcurrent protection stages, the related functions must be switched on, i.e. address 1201 O/C PHASES = *ON* and/or address 1501 O/C EARTH = *ON* (as delivered).

Testing can be performed with single-phase, two-phase or three-phase test current without difficulties.

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 pick up at 0.9 times setting value. The reset value should lie at 95% of the pick-up value.

When the test current is injected via one phase and the earth path and the set value for IE>> (address 1502, factory setting 0.5 x I_N) is exceeded the pick-up indication for I_E>> appears, with further increase above the pick-up value of the high-set phase current stage (address 1202 I>>, factory setting 2 x I_N) pick-up indication appears for the tested phase (LED 2 for L1 or LED 3 for L2 or LED 4 for L3 or LED 5 for the earth path at factory setting).

After expiry of the time delay (address 1503 T−IE>> for the earth current path, address 1203 T−I>> for the phase path), trip signal is given (LED 6 at delivery). Check that the assigned signal relay and trip relay contacts close.

It must be noted that the set times are pure delay times; operating times of the measurement functions are not included.

6.6.3 Testing the definite time overcurrent protection stages I>, I_E>

For these tests the related functions must be switched on (as before). Furthermore, the *DEFINITE TIME* mode must be configured in addresses 7812 and/or address 7815 (as delivered, refer also to Section 5.4.2).

Testing can be performed with single-phase, two-phase or three-phase test current.

For test current below 4 x I_N, slowly increase the test current over one phase and earth until the protection picks up.

Caution!

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

For test currents above 4 x I_N measurement shall be performed dynamically. It should be stated that the relay picks up at 1.1 times setting value and does not pick up at 0.9 times setting value.

When the test current is injected via one phase and the earth path and the set value for IE> (address 1512, factory setting 0.2 x I_N) is exceeded the pick-up indication for I_E> appears (LED 5 at factory setting), with further increase above the pick-up value of the phase current stage (address 1212 I>, factory setting 1 x I_N) pick-up indication appears for the tested phase (LED 2 for L1 or LED 3 for L2 or LED 4 for L3 at factory setting). Check that the assigned signal relay contacts close.

After expiry of the time delay (address 1513 T−IE> for the earth current path, factory setting 0.5 s; address 1213 T−I> for the phase path, factory setting 0.5 s), trip signal is given (LED 6 at delivery). Check that the assigned signal relay and trip relay contacts close.

Reset occurs at approx. 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.

6.6.4 Testing the inverse time overcurrent protection stages I_p, I_{Ep}

For these tests the related functions must be switched on (as before), furthermore, the *INVERSE TIME* modes must be configured in addresses 7812 and/or address 7815 (contrary to delivered setting).

Testing can be performed with single-phase, two-phase or three-phase test current.

For test current below 4 x I_N, slowly increase the test current over one phase and earth until the protection picks up.

Caution!

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

For test currents above 4 x I_N measurement shall be performed dynamically. It should be stated that the relay picks up at 1.2 times setting value and does not pick up at 1 times setting value.

When the test current is injected via one phase and the earth path and the set value for IEp (address 1514, factory setting 0.2 x I_N) is exceeded the pick-up indication for I_{Ep} appears (LED 5 at factory setting), with further increase above 1.1 times the pick-up value of the phase current stage (address 1214 Ip, factory setting 1 x I_N) pick-up indication appears for the tested phase (LED 2 for L1 or LED 3 for L2 or LED 4 for L3 at factory setting). Check that the assigned signal relay contacts close.

With current less than 1.05 times setting value, no pick-up must occur.

The time delay depends on which characteristic has been set in addresses 1211 and/or 1511 and the set time multiplier in addresses 1215 and/or 1515. The expected time delays can be calculated from the formula given in the technical data (Section 3.3) or read from the characteristic curves in Figures 3.1 or 3.2 (Section 3.3).

It is suggested that one point of the trip time characteristic is checked with 2 x setting value provided the thermal capability of the relay is not exceeded! Check that the assigned signal relay and trip relay contacts close.

6.6.5 Testing the directional stages of time overcurrent protection (if available)

If the relay is fitted with the directional determination supplement (model 7SJ512★−★★★★★−**1**/**3**★), this can be tested with an additional symmetrical three-phase voltage source.

The stages of the phase time overcurrent protection are tested in the same way as described in Section 6.6.3 (for definite time overcurrent protection) or 6.6.4 (for inverse time overcurrent protection), but this time with the applied three-phase voltage (approximately rated voltage). When the polarity of the voltages related to the currents is correct, trip will now occur not corresponding to the non-directional time delays (addresses 1213 or 1215) but corresponding to

- T−I> DIREC (address 1224, 0.4 s at delivery) in definite time overcurrent mode,
- T−Ip DIREC (address 1225, time multiplier 0.4 at delivery) in inverse time overcurrent mode; observe the set characteristic according address 1223, it may be different from that for the non-directional stage.

Testing with earth fault is performed with a single-phase current via one phase and the earth path, and the measured voltage of the same phase is switched off from the relay terminal. The time delay now must be

- T−IE> DIRE (address 1524, 0.4 s at delivery) in definite time overcurrent mode,
- T−IEp DIRE (address 1525, time multiplier 0.4 at delivery) in inverse time overcurrent mode; observe the set characteristic according address 1523, it may be different from that for the non-directional stage.

Should the directional characteristic be verified then note:

- Directional determination can be performed with quadrature voltages (fault-free voltages) and memorized voltages. That is why always all three voltages must be applied before commencement of the test.
- The actual directional characteristic with two-phase tests may deviate against the theoretical directional characteristic by ±30°. This deviation is caused by the use of quadrature voltages.

6.6.6 Testing the thermal overload protection

The overload function can only be tested if it has been configured as THERMAL OL = *EXIST* (address 7827, refer to Section 5.4.2) and parameterized as operative, under address 2701.

The basis current for the detection of overload is always the rated current of the device.

When applying a test current

$$k \cdot I_N$$

tripping must not occur. After an appropriate time (approximately 5 x τ) a steady-state temperature rise according to the following relationship is established:

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

This value can be read out in address block 59 for each phase.

To check the time constant, the current input is simply subjected to 1.6 x 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 x τ.

⚠ **Caution!**

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

If testing with preload is performed, then it must be ensured that a condition of thermal equilibrium has been established before time measurement commences. This is the case, when the preload has been applied constantly for a period of at least 5 x τ.

6.6.7 Testing the highly sensitive earth fault protection

The current stages IEE>>/T–IEE>> (addresses 3013 and 3014), furthermore IEE>/T–IEE> (address 3017 and 3018 if definite time mode is selected under address 7815), IEEp/T–IEEp (addresses 3019 and 3020 if inverse time mode is selected under address 7815), are tested in a similar way as the earth time overcurrent protection (Sections 6.6.2 to 6.6.4). But the following must be observed:

The test current is injected on the measured value input for the high-sensitivity earth fault protection. Otherwise this function cannot operate.

This measured current input is specially designed for highly sensitive measurement. Thus, restricted threshold values are available only, and its input rating is independent of the rated current of the relay.

Caution!

The thermal capability of the measured current input for highly sensitive earth fault protection is 15 A continuous. Test currents larger than 15 A may overload and damage the measured input circuits if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

If one or more stages are set to operate directional, the voltage, which is needed for directional determination is applied to the displacement voltage input (open delta voltage).

For directional determination, the current component in the direction which is determined by the setting under addresses 3023 PHI CORR and 3024 EF MEAS must also be exceeded. Measurement is, for example, not possible when test current and test voltage are in phase and EF MEAS is set *SIN PHI* and PHI CORR is set to 0° as the current vector then lies exactly between the directional characteristics for forward and reverse direction.

Testing of the earth fault protection for non-earthed networks is not completely possible with conventional test sets, since the simulation of an earth fault requires a complete displacement of the voltage triangle. The correct relationship and polarity of the measuring transformer connections, essential for proper earth fault detection, can only be tested when primary load current is available during commissioning (see Section 6.7.3).

6.6.8 Testing the auto-reclose functions

The internal AR function can be tested provided it is configured under address 7834 as INTERNAL AR = *EXIST* (refer to Section 5.4.2) and switched to AR FUNCT = *ON* (Address 3401).

The binary input "circuit breaker ready" must be simulated unless an open circuit contact has "been programmed for this purpose (FNo `2730` "`>CB ready`", refer also to Section 5.5.2).

Depending of the selected AR program short circuit should be simulated for each of the desired auto-reclose shots, each time once with successful and once with unsuccessful AR. Check the proper reaction of the relay according to the set AR programs.

Note that each new test can begin only after the reclaim time for the previous test has expired; otherwise an auto-reclose cannot result: Annunciation "`AR not ready`" (FNo `2784`, not allocated at delivery) must not be present or must be annunciated "**G**oing".

If the circuit breaker is not ready a reclose attempt must not result; clearance of short circuits is delayed by the stage which is set for tripping without auto-reclosure. However, a normal AR cycle must occur when the signal "circuit breaker ready" first disappears after the inception of the fault.

6.6.9 Testing the circuit breaker failure protection

For use and tests of the circuit breaker failure protection it is necessary that at least one of the binary outputs has been assigned to the function "`B/F Trip`" (contrary to the state as delivered).

The trip commands of the time overcurrent protection functions must not interrupt the test current but the test current continues flowing after trip command of the time overcurrent protection.

Switch on test current so that the I> stage (definite time) or I_p (inverse time) will operate. The current must equally be higher than the setting value I> B/F (address 3911).

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!

The trip command starts the breaker failure protection timer. After expiry of T−B/F (address 3912) the breaker failure protection trips the assigned output relay (trip relay and/or signal relay).

If the breaker failure protection shall also be started via a binary input, this function should also be tested. A test current higher than the set value I> B/F (address 3911) but smaller than any setting value of the time overcurrent protection is injected so that the time overcurrent protection functions will not operate but the breaker failure protection function will do.

Now start the breaker failure protection timer by energizing the binary input "`>B/F Start`" (FNo `1431`). After expiry of T−B/F (address 3912) the breaker failure protection trips the assigned output relay (trip relay and/or signal relay).

Switch off test current.

6.7 Commissioning using primary tests

All secondary testing sets and equipment must be removed. Reconnect current and voltage transformers. For testing with primary values the line or protected object must be energized.

Warning

Primary tests shall be performed only by qualified personnel which is trained in commissioning of protection systems and familiar with the operation of the protected object as well as the rules and regulations (switching, earthing, etc.)

6.7.1 Current, voltage and phase sequence checks

Connections to current and voltage transformers are checked with primary values. For this purpose a load current of at least 10 % of the rated current is necessary. If the measuring circuit connections are correct, none of the measured value monitoring systems in the relay will operate. If a fault indication appears, the possible causes can be found in the operational annunciations (Address 5100).

For current sum or voltage sum errors, the matching factors (Section 6.3.3) should be checked.

If the symmetry monitoring appears, it is possible that asymmetry is in fact present on the line. If this is a normal operational condition, the corresponding monitoring function should be set at a less sensitive value (Section 6.3.10).

The phase rotation must be clockwise, otherwise the indication "`Fail.PhaseSeq`" will appear.

Check and correct the phase relationships in the measuring circuits. If the network has counter-clockwise rotation, two phases must be interchanged. This phase exchange must be taken into account in the allocation of the individual phase pick-up indications (Section 5.5.3 and 5.5.4).

Currents and voltages can be read off on the display in the front or via the operating interface in block 57 and compared with the actual measured values.

6.7.2 Direction check with load current (models with directional supplement)

Correct connections of current and voltage transformers are checked using load current over the protected line. The line must be energized and must carry a load current of at least 10 % of the rated current; this shall be ohmic or ohmic–inductive. The direction of the load current must be known. In cases of doubt, interconnected or ring networks must be isolated.

Initiation of the test is made via operator keyboard or personal computer. Tests are listed from address 4000, the directional test in Address 4200. Input of the codeword is necessary.

The address is reached:

– directly with key **DA** followed by address number **4 2 0 0** and finally operation of the enter key **E** or

– by paging through the blocks with ⇑ or ⇓ until address 4200 is reached.

```
⇑ 4 0 0 0
⇓ T E S T S
```

Beginning of block "Tests"

```
⇑ 4 2 0 0  D I R E C T I O N A L
⇓ T E S T S
```

Block "Directional tests"

When the address 4200 appears in the display, the directional test of the individual measurement phases is selected with the key ↑. For confirmation of the directional test, the "Yes"–key **J/Y** is used; this starts the directional test. The selected measurement system carries out a directional check and indicates the result on the display:

4 2 0 1 █ D I R E C . T E S T L 1 E ?	Make directional test L1–E? Confirm with **J/Y**
F o r w a r d D i r	Load flow forwards or
R e v e r s e D i r	load flow backwards or
u n d e f i n e d	directional determination not possible (e.g. current too small)

The load direction must be indicated correctly.

The same applies for the other directional systems: address 4203 for L2–E, address 4205 for L3–E.

All three measurement systems must indicate the correct direction of the load flow. If all directions are wrong, the polarity of the measuring transformers and the programmed polarity (address 1101, Section 6.3.3) do not agree with each other. Check the polarity and program correctly. If the directions given in the display differ from each other, the individual phases in the current or voltage transformer connections are interchanged, or the phase relationship is not correct. Check the connections.

If the load is capacitive, caused for example by underexcited generators or charging currents, borderline cases can occur with respect to the directional characteristics which will lead to undefined or inconsistent directional information. By means of the load power display in address block 57 the position of the load power vector can be determined (see Figure 6.7).

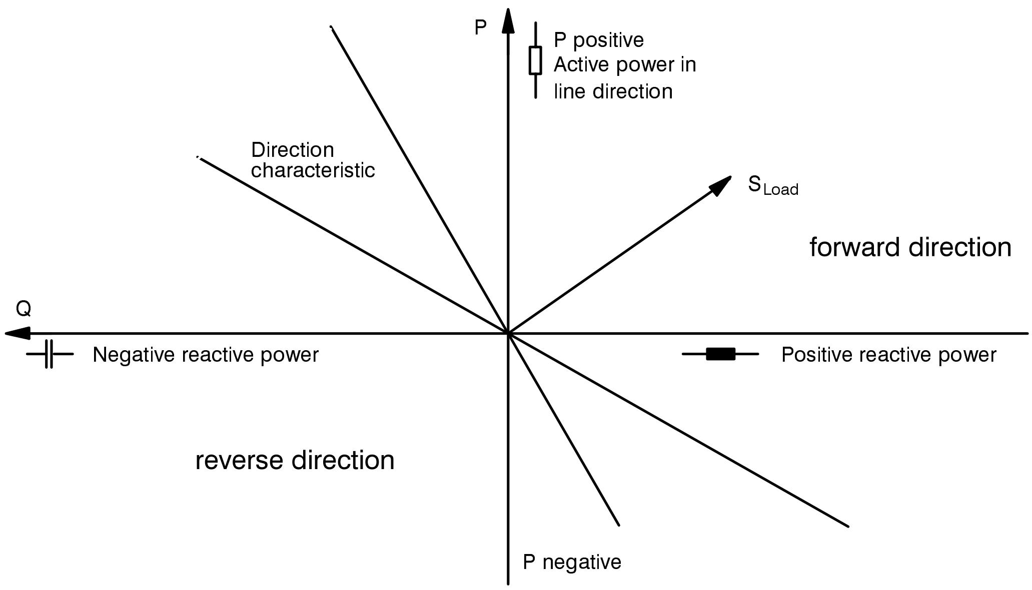


Figure 6.7 Load power vector

6.7.3 Direction check for directional earth fault protection

6.7.3.1 Earth fault checks for non-earthed systems

The primary current test allows determination of the correct polarity of transformer connections for the earth fault direction determination.

DANGER!

Operations in primary area must only be performed with plant sections voltage-free and earthed!

The most reliable test is to apply a primary earth fault. The procedure is as follows:

– Disconnect the line and earth at both ends; the line must remain disconnected at the remote end throughout the whole test.

– Apply a bolted single phase earth bridge to the line. On overhead lines, this can be done at any convenient point, but in any case behind the current transformers (looked at from the direction of the bus-bar of the circuit under test). For cables, the earth should be applied at the remote end (termination).

– Open the line earthing switches.

– Close the circuit breaker at the line end to be tested.

– Check the directional indication given (appropriately allocated LED).

– In the earth fault report on the operator terminal (address 5500, see also Section 6.4.4) the earth faulted phase and the line direction, i.e. "`E/F forwards`" will be indicated. Active and reactive current are equally indicated: for isolated networks the reactive current, for resonant earthed networks the active current is critical. If the display indicates "`E/F reverse`" then there is a crossed connection in the earth circuit of voltage or current transformers. If the display shows "`E/F undefined`" or no earth fault message at all, the earth fault current is probably too small.

– Disconnect the line and earth it; remove the bolted earth connection.

– The test is thus completed.

If a test with a real primary earth fault is not possible, at least a fault should be simulated on the secondary side with the line energized. It must be noted, however, that during all such simulations which do not represent exactly the practical conditions, asymmetry of the measured values cause the measured value monitors to operate. This annunciation should then be ignored.

DANGER!

All precautionary measures must be observed when working on the instrument transformers! Secondary connections of the current transformers must be short-circuited before any current leads to the relay are interrupted!

If the Holmgreen connection is used for the current transformers, the displacement voltage will be derived by bypassing a voltage transformer phase (e.g. L1, see Figure 6.9). If earth detection windings of the voltage transformers are not available, the corresponding phase should be interrupted on the secondary side. In the current circuit, only the current from the current transformer corresponding to the phase in which the voltage is missing, will be used. If the line is carrying real power, practically the same relationships apply for the relay as with an earth fault in the line direction in a resonantly earthed (compensated) network. With an isolated network it must be noted that a load with inductive component flowing in the line direction appears to the relay as an earth fault in the reverse direction. Check the directional indication. In the earth fault report (Address 5500, see also Section 6.4.4) the "earth faulted" phase and the corresponding direction will be indicated. Active and reactive component of the "earth current" are equally indicated: for isolated networks the reactive and for resonantly earthed networks the active current is critical.

If the display indicates the wrong direction then a crossed connection is present in either the current or voltage transformer connections. If the display shows "`E/F undefined`" the measured components of the earth fault current are probably too low or the phase relationship of the test circuit is not correct. If there is no indication whatsoever, it is possible that the threshold value of the displacement voltage (Address 3010) has not been reached, or the relay does not recognize increase in the healthy voltages (address 3007).

If the residual current is derived from a window type summation c.t., the displacement voltage will be derived by bypassing a voltage transformer phase (e.g. L1, see Figure 6.8). If earth detection windings of the voltage transformers are not available, then the corresponding phase should be interrupted on the secondary side. From this interrupted phase a test current is fed into the window type summation c.t. via a series connected impedance Z, which limits the current. Here, direction and connection of the current flow through the window type summation c.t. must be correct as shown. If the current is too small to operate the directional detection, its effect can be increased by making additional turns of the conductor through the window of the summation c.t. In resonantly earthed networks, the value of Z should be an ohmic resistance (60 Ohms/100 W to 600 Ohms/10 W), in isolated networks, a capacitor (5 µF to 100 µF; ≥ 250 V) connected in series with a resistance of approximately 30 to 60 Ohms (≥ 10 W) to limit the closing current. The connection illustrated in Figure 6.8 will simulate an earth fault in the line direction. In the earth fault report (address 5500, see also Section 6.4.4), the display should indicate the "earth faulted" phase and line direction, i.e. "`E/F forwards`" Active and reactive current components are equally indicated; for isolated networks the reactive current component, for compensated systems the active current component is critical.

If the directional indication is wrong, it may be due to a crossed connection of the voltage connections in the earth fault detection winding of the voltage transformers or in the earth current path. If the indication "`E/F undefined`" appears, the earth current is probably too small, it can be increased by winding the conductor repeatedly through the window of the summation c.t. or by reduction of Z (smaller R or larger C). If there is no indication whatsoever, it is probable that the threshold value of the displacement voltage (Address 3007) has not been reached, or the relay does not recognize increase in the healthy voltages (address 3007).

Finally, **properly reconnect all the transformer connections** and correct parameters which may have be changed during the test.

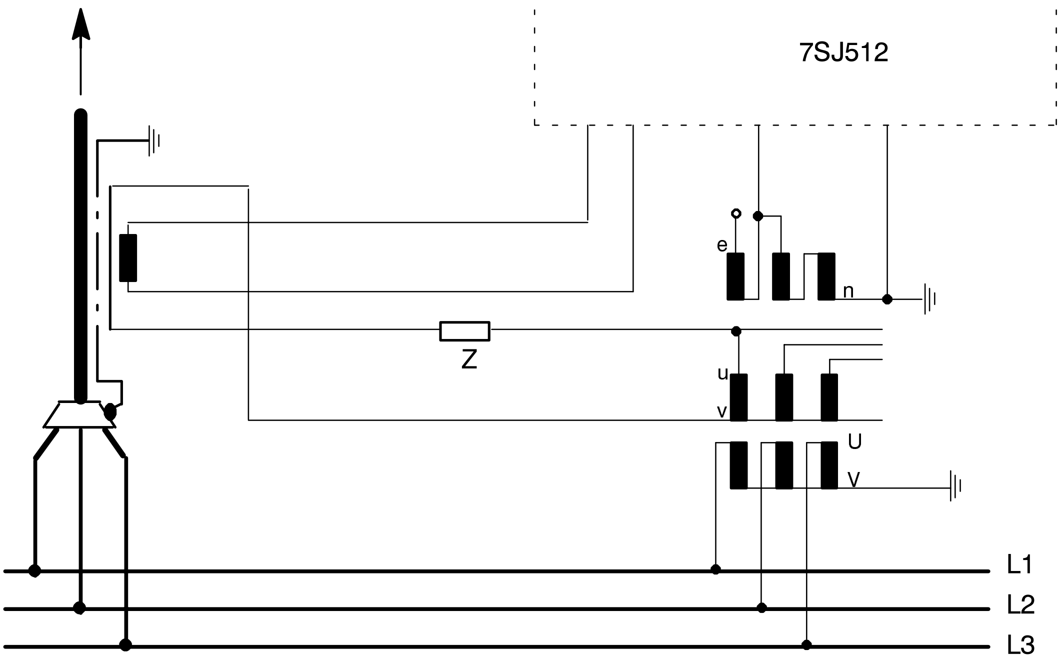


Figure 6.8 Earth fault direction test with window-type summation current transformer

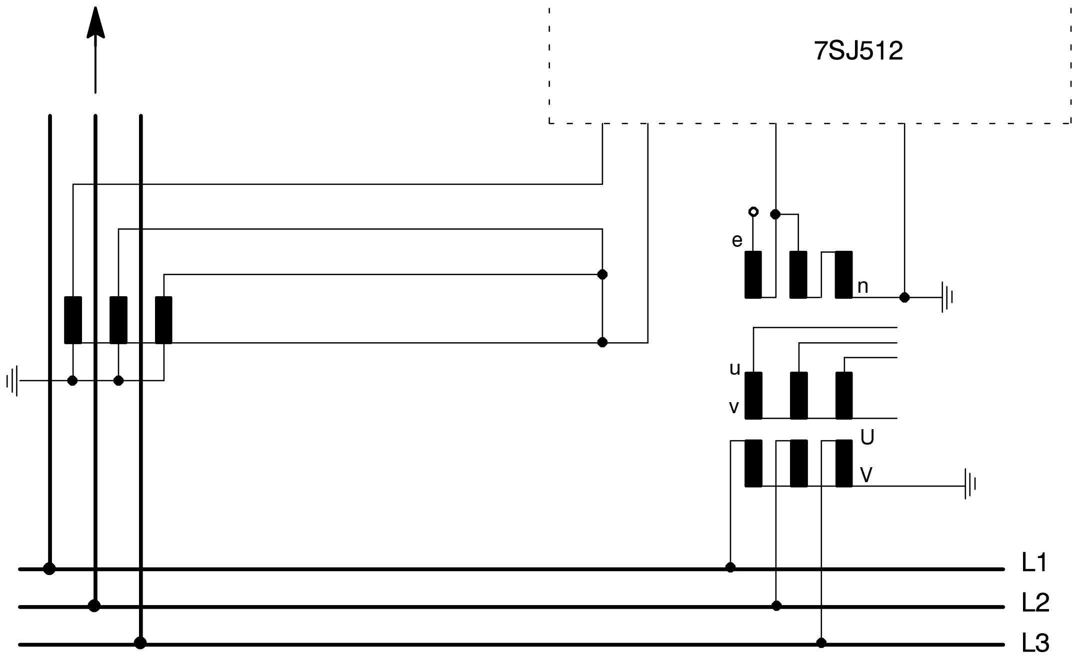


Figure 6.9 Earth fault direction test with Holmgreen connection

6.7.3.2 Direction check for earthed systems

The primary current test allows determination of the correct polarity of transformer connections for the earth fault direction protection.

The trip circuits should be made inoperative as the relay will issue a trip command during this test. Furthermore, it must be noted, that during all such simulations which do not represent exactly the practical conditions, asymmetry of the measured values can cause the measured value monitors to operate. These annunciations should then be ignored.

DANGER!

All precautionary measures must be observed when working on the instrument transformers! Secondary connections of the current transformers must be short-circuited before any current leads to the relay are interrupted!

The displacement voltage will be derived by bypassing a voltage transformer phase (e.g. L1, see Figure 6.9). If earth detection windings of the voltage transformers are not available, the corresponding phase should be interrupted on the secondary side. In the current circuit, only the current from the current transformer corresponding to the phase in which the voltage is missing, will be used. If the line is carrying active and inductive power in line direction, practically the same relationships apply for the relay as with an earth fault in the line direction.

Check the directional indication. In the fault event report on the display panel (address 5200, see also section 6.4.3) at least the following fault annunciations must be indicated: “`E/F forwards`”, and trip annunciation “`E/F Trip`”. If the directional indication is wrong “`E/F reverse`”, it may be due to a crossed connection of the voltage connections in the earth fault detection winding of the voltage transformers or in the earth current path. If the indication “`E/F undefined`” appears, the earth current is probably too small. If no pick-up annunciation occurs the current is probably too low or the phase relationship of the test circuit is not correct. If there is no indication whatsoever, it is possible that the threshold value of the displacement voltage (Address 3010 UE>) has not been reached.

Finally, **properly reconnect all the transformer connections**.

6.7.4 Checking the reverse interlock scheme (if used)

For use and tests of the reverse interlock scheme it is necessary that at least one of the binary inputs has been assigned to the function "`I>> block`" and/or further blocking inputs. When delivered from factory, binary input INPUT 2 has been assigned to this function. Tests can be performed with phase currents or earth current. With earth current the corresponding earth current parameters are valid.

Reverse interlocking can be used in "normally open mode", i.e. the I>> stages are blocked when the binary input "`I>> block`" is energized, or "normally closed" mode, i.e. the I>> stages are blocked when the binary input "`I>> block`" is de-energized. The following procedure is valid for "normally open mode" as preset by the factory.

The protection relay on the incoming feeder and those on all outgoing circuits must be in operation. At first the auxiliary voltage for reverse interlocking should not be switched on.

Apply a test current which makes pick-up the I>> stage as well as the I> or I_p stage. Because of the absence of the blocking signal the relay trips after the (short) delay time T−I>>.

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!

Now switch on the d.c. voltage for the reverse interlocking. The test as described above is repeated, with the same result.

Simulate a pick-up on each protective device on all outgoing feeders. Simultaneously, a short-circuit is simulated on the incoming feeder (as described before). Tripping now occurs after the delayed time T−I> (for definite time protection) or corresponding to T−Ip (for inverse time protection).

These tests have simultaneously proved that the wiring between the protection relays is correct.

6.7.5 Checking the circuit breaker failure protection

The protection function itself has already been tested according to Section 6.6.9.

The most important consideration during checks with the power plant is that the distribution of the trip commands for the adjacent circuit breakers is checked for correctness.

The adjacent circuit breakers are all those which must be tripped in case of failure of the considered feeder breaker, so that the short-circuit current will be interrupted. These are the circuit breakers of all feeders which feed the bus-bar section to which the considered faulty feeder is connected.

A general and detailed description of the checking procedure is not possible since the definition of the adjacent circuit breakers is widely dependent of the configuration of the power plant.

Particularly in case of multi-section bus-bars it is of utmost importance that the distribution logic for the adjacent circuit breakers is checked. For this, it must be checked for each bus-bar section that, in case of failure of the circuit breaker of the considered feeder, all those circuits breakers are tripped, which could feed the same bus-bar section but that no other breaker is tripped.

If the circuit breaker trip signal should also trip the circuit breaker of the opposite line end of the feeder under consideration, then the transmission channel for this remote trip must be checked, too.

6.7.6 Tripping test including circuit breaker

Time overcurrent protection relay 7SJ512 allows simple checking of the tripping circuit and the circuit breaker. If the internal auto-reclose system is activated, a trip – close test cycle is also possible.

6.7.6.1 TRIP – CLOSE test cycle -- address block 43

Prerequisite for the start of a trip – close test cycle is that the integrated auto-reclose function be programmed as *EXIST* (address 7834) and it is switched on (Address 3401).

A TRIP – CLOSE test cycle is also possible with an external auto-reclose system. Since in this case, however, 7SJ512 only gives the tripping command, the procedure shall be followed as described in Section 6.7.6.2.

If the circuit breaker auxiliary contacts advise the relay, through 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.

DANGER!

A successfully started test cycle will lead to closing of the circuit breaker!

Initiation of the test cycle can be given from the operator keyboard or via the front operator interface. A codeword input is necessary. The procedure is started with address 4300 which can be reached by direct addressing **DA 4 3 0 0 E** or by paging with ⇓ or ⇑. Page to address 4304 with the ↑ – key.

Further prerequisites for the start of test are that no protective function fault detector has picked up and that the conditions for reclose (circuit breaker ready, AR not blocked) are fulfilled.

```
⇑  4 3 0 0 █ C B   T E S T
⇓  T R I P - C L O S E   C Y C L E
```

Beginning of the block “Circuit breaker test, TRIP – CLOSE cycle”

```
↑  4 3 0 4 █ C B   T E S T
   L 1 2 3   W I T H   A R   ?
```

Carry out three-pole test cycle of circuit breaker? Confirm with “**J/Y**” – key or abort with page-on key ↑

```
   C B   C L O S E D   ?
```

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, however, the circuit breaker auxiliary contact is programmed to be connected to a binary input, the relay rejects the test as long the auxiliary contact indicates that the circuit breaker is not closed, even if the operator has confirmed that it is. Only when the auxiliary contact is not marshalled to a binary input, will the relay consider the operator confirmation valid.

6.7.6.2 Live tripping of the circuit breaker -- address block 44

To check the tripping circuits, the circuit breaker can be tripped by 7SJ512 independently of whether an auto-reclosure will occur or not. However, this test can also be made with an external auto-reclose relay.

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 configuration of the relay (Section 5.5.2) it has been advised whether the circuit breaker auxiliary contact is connected via a binary input or not. If the auxiliary contact is not marshalled to a binary input, the relay will carry out a test without polling the circuit breaker position.

DANGER!

If an external auto-reclosure device is used, then a successfully started test cycle may lead to closing of the circuit breaker!

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 ⇓. Page to address 4404 with the ↑ – key.

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 “trip circuit breaker”

```
↑ 4 4 0 4 █ C B   T R I P
  C B   T H R E E - P O L E   ?
```

Trip circuit breaker three-pole? Confirm with “**J/Y**” – key or abort with page-on key ↑

```
  C B   C L O S E D   ?
```

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, however, the circuit breaker auxiliary contact is programmed to be connected to a binary input, the relay rejects the test as long the auxiliary contact indicates that the circuit breaker is not closed, even if the operator has confirmed that it is. Only when the auxiliary contact is not marshalled to a binary input, will the relay consider the operator confirmation valid.

6.7.7 Starting a test fault record − address block 49

A fault record can be started 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 pretrigger time was set under address 7411.

Scanning a test fault record is especially interesting for use on cables and long overhead lines where considerable inrush currents can be produced by charging of the line capacitances as well as on power transformers. The fault record is triggered via a binary input 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 ↑:

⇑ ⇓ `4900█ TEST` `FAULT RECORDING`	Beginning of block “Test fault recording” page on with ↑ to address 4901
↑ `4901█ FAULT REC.` `START ?`	Start fault recording? Confirm with “**J/Y**”−key or abort with page-on key ↑
`SUCCESSFUL`	The relay acknowledges successful completion of the test recording

---

6.8 Putting the relay into operation

All setting values should be checked again, in case they were altered during the tests. Particularly check that all desired protection functions have been programmed in the configuration parameters (address blocks 78 and 79, refer to Section 5.4) and all desired protection functions have been switched *ON*.

The counters for circuit breaker operation statistics should be erased (address block 82, refer to Section 6.5.2).

Push the key **M/S** on the front. The display shows the beginning of the annunciation blocks. Thus, it is possible that the measured values for the quiescent state of the relay can be displayed (see below). These values has been chosen during configuration (refer to Section 5.3.2) under the addresses 7105 and 7106.

Stored indications on the front plate should be reset by pressing the push-button “RESET LED” on the front so that from then on only real faults are indicated. From that moment the measured values of the quiescent state are displayed. During pushing the RESET button, the LEDs on the front will light up (except the “Blocked”–LED); thus, a LED test is performed at the same time.

Check that the 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 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 most 10 years of operation (refer to Section 7.2). This recommendation is valid independent on whether the battery has been discharged by occasional supply voltage failures or not.

As the protection is almost completely self-monitored, from the measuring inputs to the command output relays, hardware and software faults are automatically annunciated. This ensures the high availability of the relay and allows a more corrective rather than preventive maintenance strategy. Tests at short intervals become, therefore, superfluous.

With detected hardware faults the relay blocks itself; drop-off of the availability relay signals “equipment fault”. If there is a fault detected in the external measuring circuits, generally an alarm is given only.

Recognized software faults cause the processor to reset and restart. If such a fault is not eliminated by restarting, further restarts are initiated. If the fault is still present after three restart attempts the protective system will switch itself out of service and indicate this condition by the red LED “Blocked” on the front plate. Drop-off of the availability relay signals “equipment fault”.

The reaction to defects and indications given by the relay can be individually and in chronological sequence read off as operational annunciations under the address 5100, for defect diagnosis (refer to Section 6.4.2).

If the relay is connected to a local substation automation system (LSA), defect indications will also be transferred via the serial interface to the central control system.

⚠ Warning

Ensure that the connection modules are not damaged when removing or inserting the device modules! Hazardous voltages may occur when the heavy current plugs are damaged!

7.1 Routine checks

Routine checks of characteristics or pick-up values are not necessary as they form part of the continuously supervised firmware programs. The planned maintenance intervals for checking and maintenance of the plant can be used to perform operational testing of the protection equipment. This maintenance serves mainly for checking the interfaces of the unit, i.e. the coupling with the plant. The following procedure is recommended:

– Read-out of operational values (address block 57) and comparison with the actual values for checking the analog interfaces.

– Simulation of an internal short-circuit with 4 x I_N for checking the analog input at high currents.

⚠ Warning

Hazardous voltages may 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 clock module

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

The clock module should be replaced at the latest after 10 years of operation.

Recommended clock module:
– DALLAS
  DS 1386 – 32 K
  RAMified TIMEKEEPER

The module is located on the CPU cart. The complete draw-out module must be removed from the housing in order to replace the clock module.

The procedure when replacing the battery is described below.

– 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 clock module. They are, therefore, neither lost when the clock module is replaced nor when the device is operated without a clock module.

⚠ Warning

Hazardous voltages may 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 7.3).

⚠ 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.

– Get access to the CPU board.

– Pull out used clock module from the socket according to Figure 7.1; **do not place on the conductive surface!**

– Insert the prepared new clock module into the socket; observe correct mounting position.

– Remount CPU board to the draw-out module.

– Insert draw-out module into the housing; ensure that the releasing lever is pushed fully to the right before the module is pressed in.

– Firmly push in the module using the releasing lever. (Figure 7.3).

⚠ Warning

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

Do not reverse polarities! Do not recharge! Do not throw into fire! Danger of explosion!

– Provided the internal system clock is not automatically synchronized via the LSA interface, it can now be set or synchronized as described in Section 6.5.1

– Close housing cover.

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

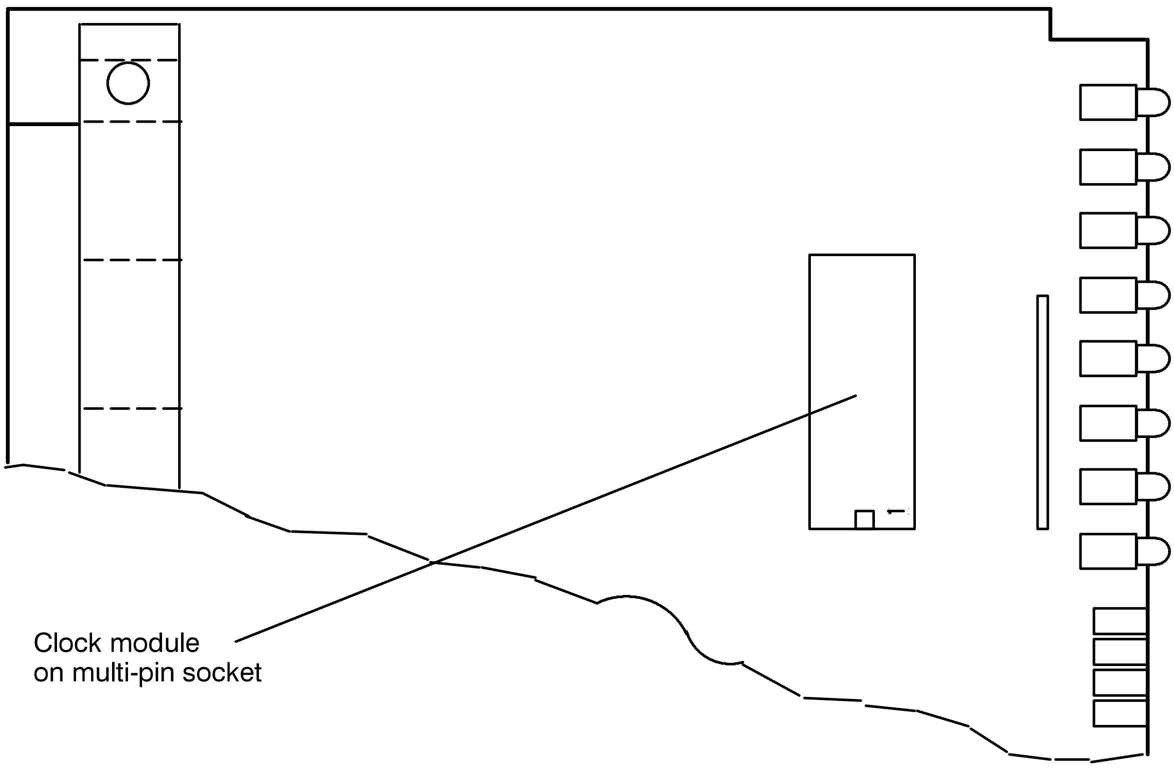


Figure 7.1 Position of the clock module

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:

– Has the module 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 7.2)? 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 ON/OFF switch in the front plate off and on again. This, however, results in loss of fault data and messages if the clock module is not operative, and, if a parameterizing process has not yet been completed, the last parameters are not stored.

7.3.1 Replacing the mini-fuse

– Select a replacement fuse 5 × 20 mm. Ensure that the rated value, time lag (medium slow) and code letters are correct. (Figure 7.2).

– Prepare area of work: provide conductive surface for the basic module.

– Open housing cover.

Warning

Hazardous voltages may 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 7.3).

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.

– Remove blown fuse from the holder (Figure 7.2).

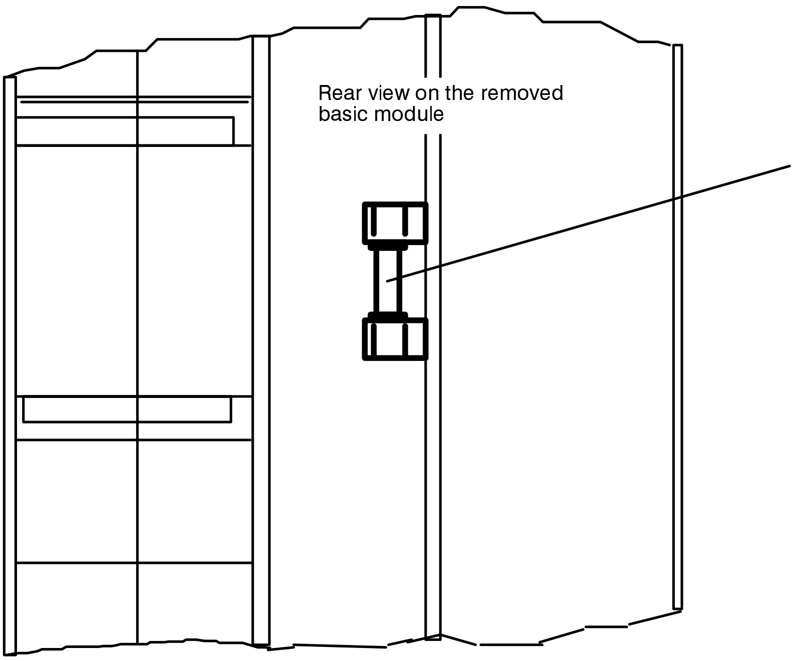
– Fit new fuse into the holder (Figure 7.2).

– Insert basic module into the housing; ensure that the releasing lever is pushed fully to the right before the module is pressed in (Figure 7.3).

– Firmly push in the module using the releasing lever. (Figure 7.3).

– 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).



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

Figure 7.2 Mini-fuse of the power supply

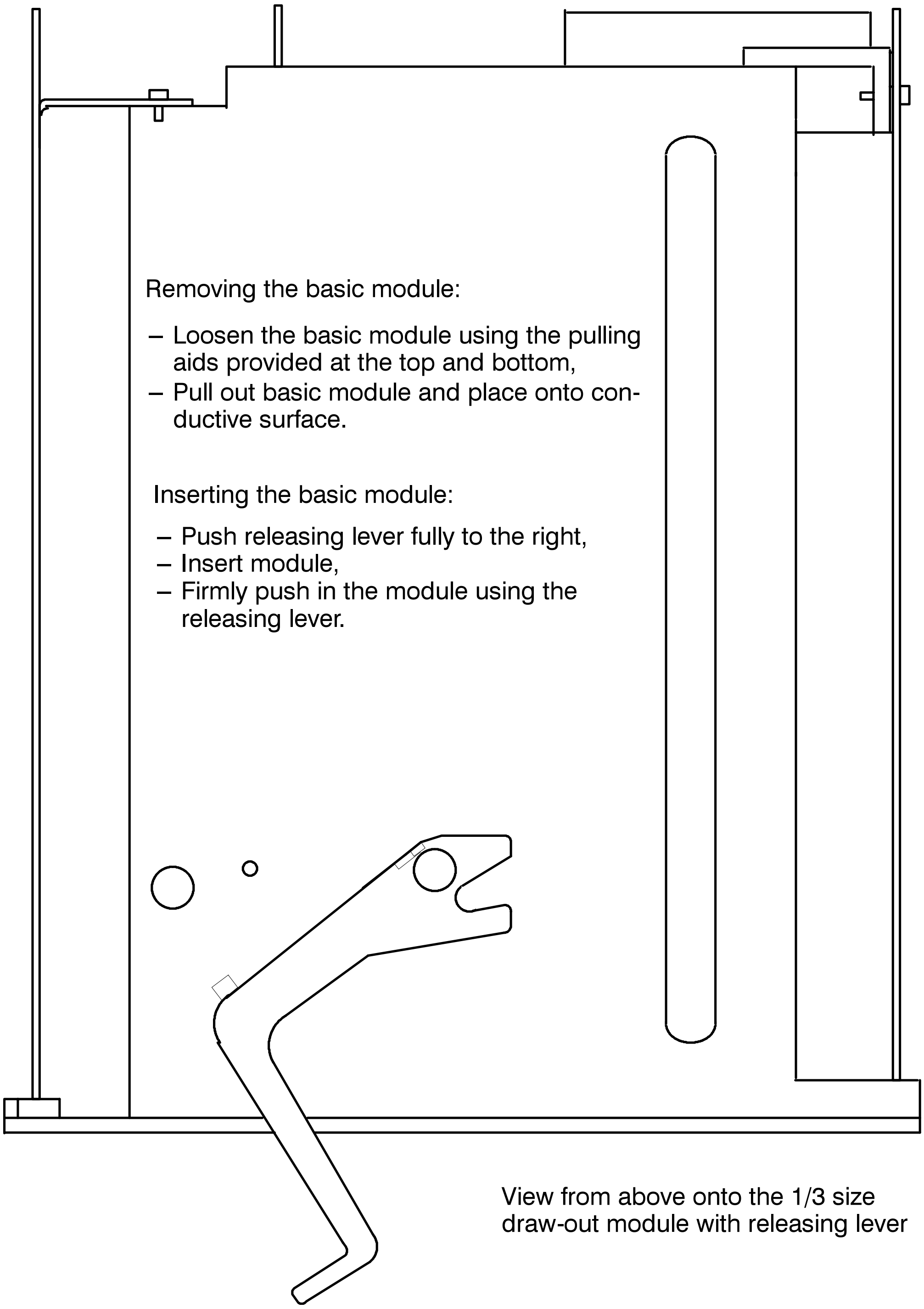


Figure 7.3 Aid for removing and inserting basic module

8 Repairs

Repair of defective modules is not recommended at all because specially selected electronic components are used which must be handled in accordance with the procedures required for **E**lectrostatically **E**ndangered **C**omponents (EEC). Furthermore, special manufacturing techniques are necessary for any work on the printed circuit boards in order to do not damage the bath-soldered multi-layer boards, the sensitive components and the protective finish.

Therefore, if a defect cannot be corrected by operator procedures such as described in Chapter 7, it is recommended that the complete relay should be returned to the manufacturer. Use the original transport packaging for return. If alternative packing is used, this must provide the degree of protection against mechanical shock, as laid down in IEC 60255–21–1 class 2 and IEC 60255–21–2 class 1.

If it is unavoidable to replace individual modules, it is imperative that the standards related to the handling of **E**lectrostatically **E**ndangered **C**omponents are observed.

⚠ Warning

Hazardous voltages may be present in the device even after disconnection of the supply voltage or after removal of the module from the housing (storage capacitors)!

⚠ Caution!

Electrostatic discharges via the component connections, the PCB tracks or the connecting pins of the modules must be avoided under all circumstances by previously touching an earthed metal surface. This applies equally for the replacement of removable components, such as EPROM or EEPROM chips. For transport and returning of individual modules electrostatic protective packing material must be used.

Components and modules are not endangered as long as they are installed within the relay.

Should it become necessary to exchange any device or module, the complete parameter assignment should be repeated. Respective notes are contained in Chapter 5 and 6.

9 Storage

Solid state protective relays shall be stored in dry and clean rooms. The limit temperature range for storage of the relays or associated spare parts is −25 °C to +55 °C (refer Section 3.1.4 under the Technical data), corresponding to −12 °F to 130 °F.

The relative humidity must be within limits such that neither condensation nor ice forms.

It is recommended to reduce the storage temperature to the range +10 °C to +35 °C (50 °F to 95 °F); this prevents from early ageing of the electrolytic capacitors which are contained in the power supply.

For extended 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

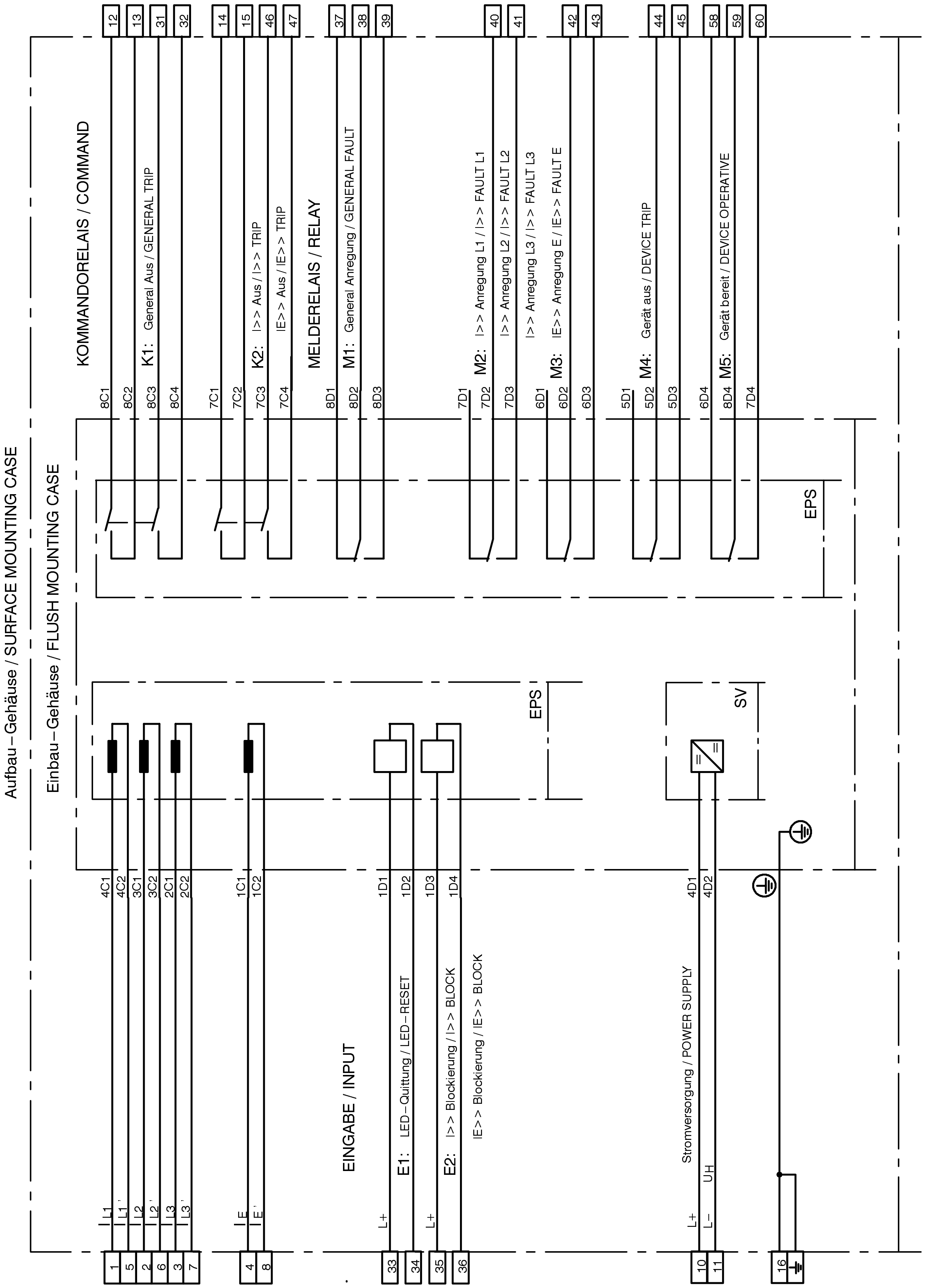


Figure A.1 General diagram 7SJ512★−★★★★★−**0**/**2A**/**C**★★ without directional determination, without or with fibre-optic interface (sheet 1 of 3)

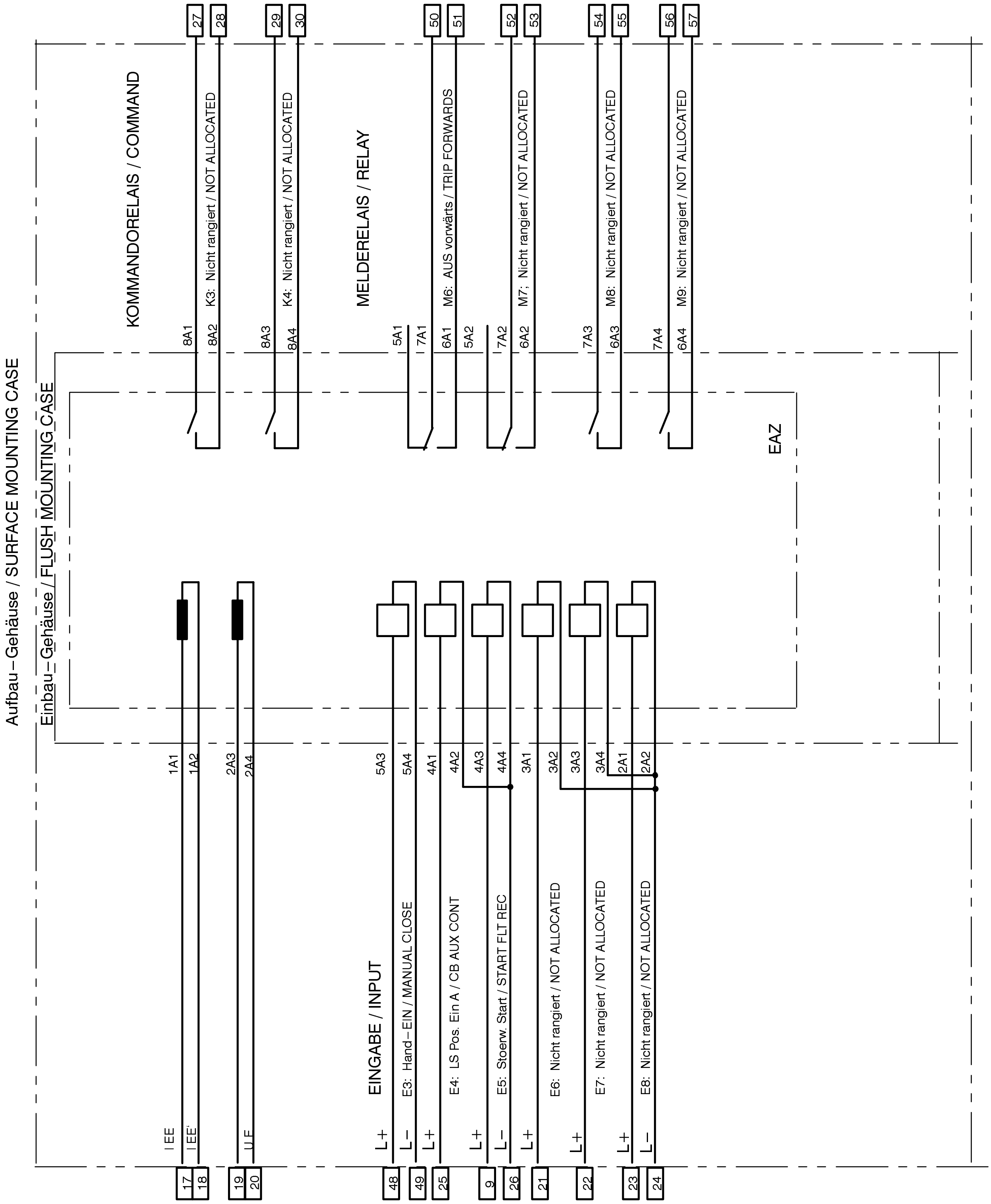


Figure A.2 General diagram 7SJ512★–★★★★★–**0**/**2A**/**C**★★ without directional determination, without or with fibre-optic interface (sheet 2 of 3)

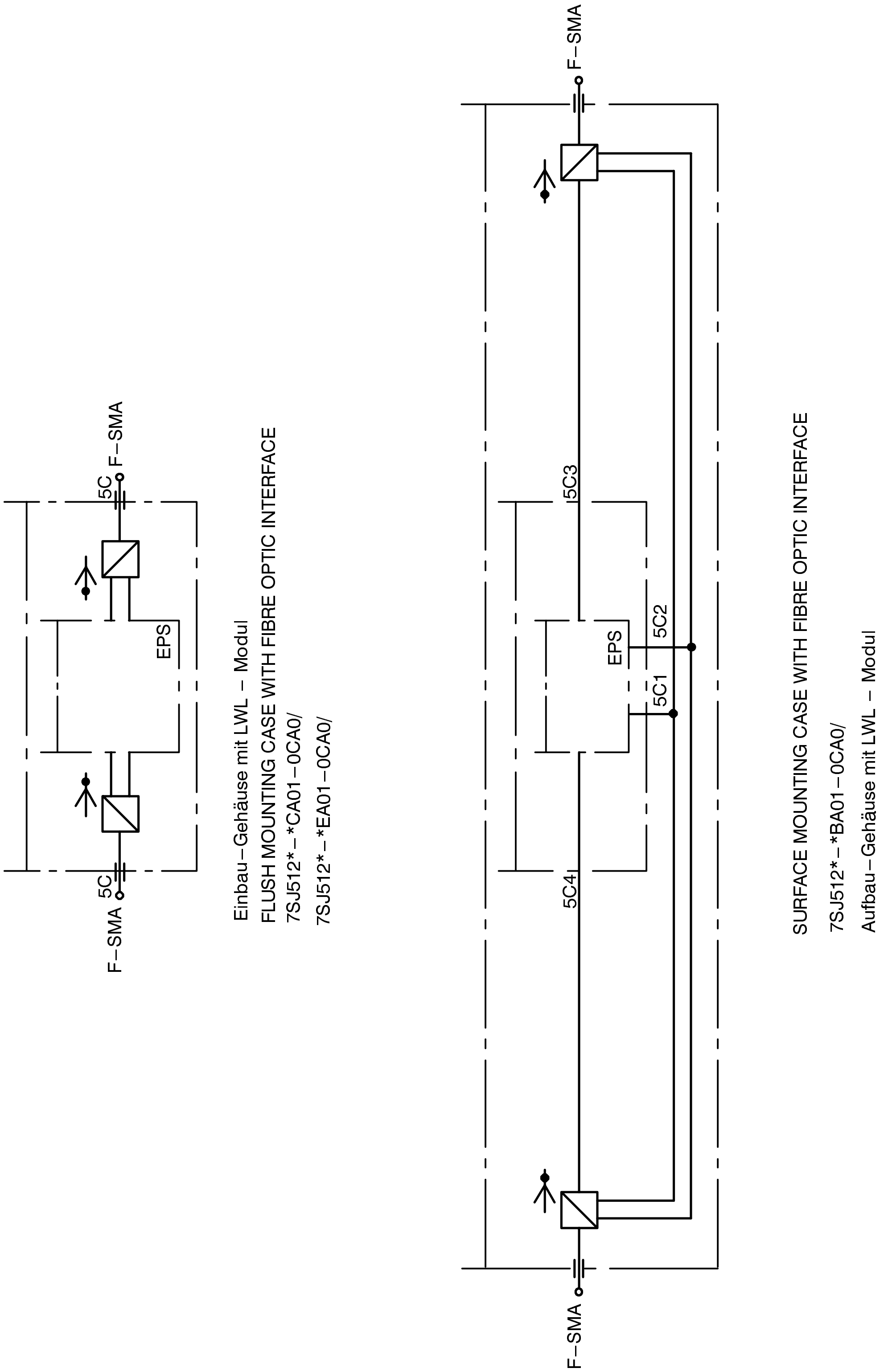


Figure A.3 General diagram 7SJ512★−★★★★★−**0**/**2C**★★ without directional determination, with fibre-optic interface (sheet 3 of 3)

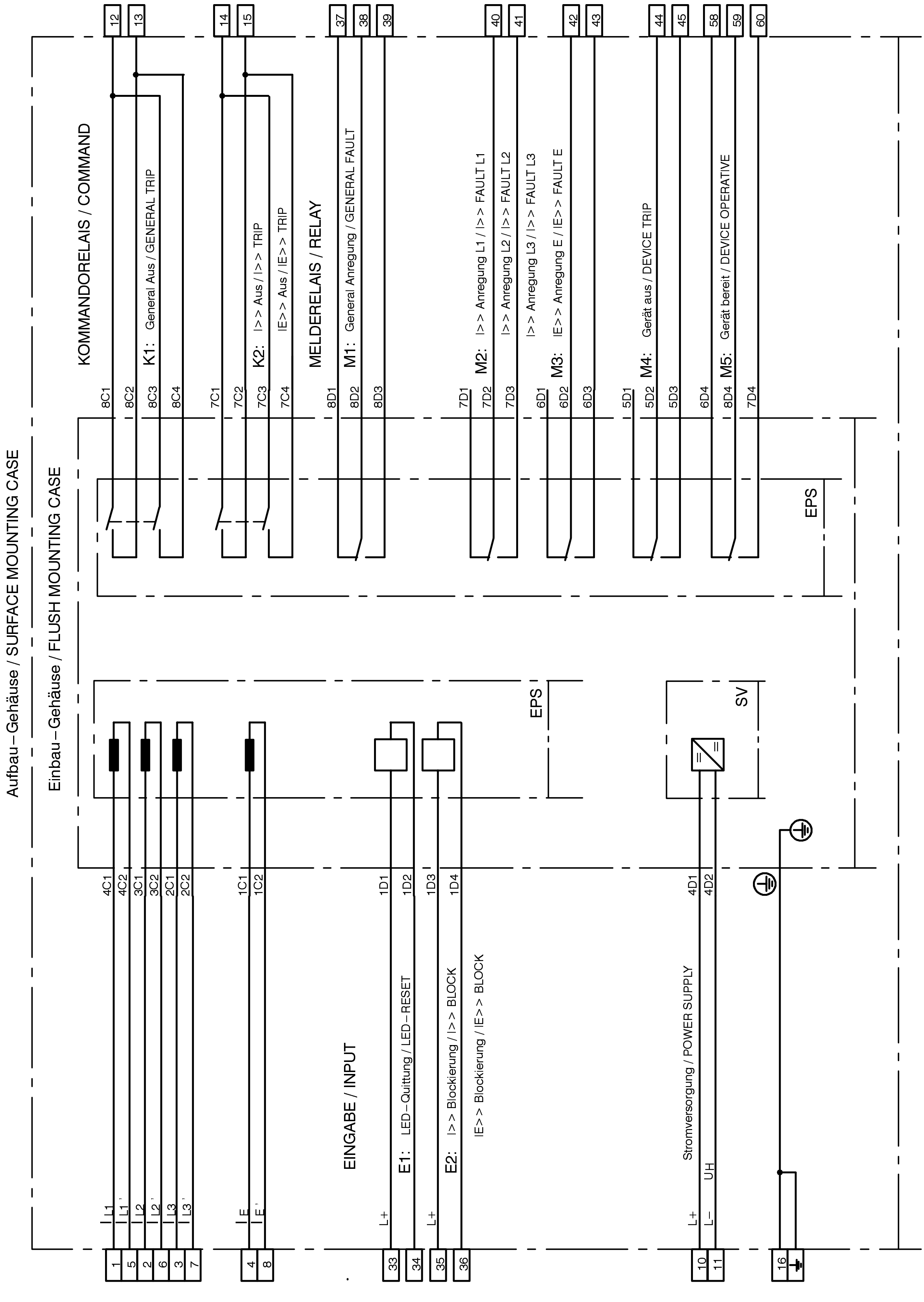


Figure A.4 General diagram 7SJ512⋆–⋆⋆⋆⋆⋆–**0**/**2B**⋆⋆ with directional determination, with V.24 (RS232C) interface (sheet 1 of 3)

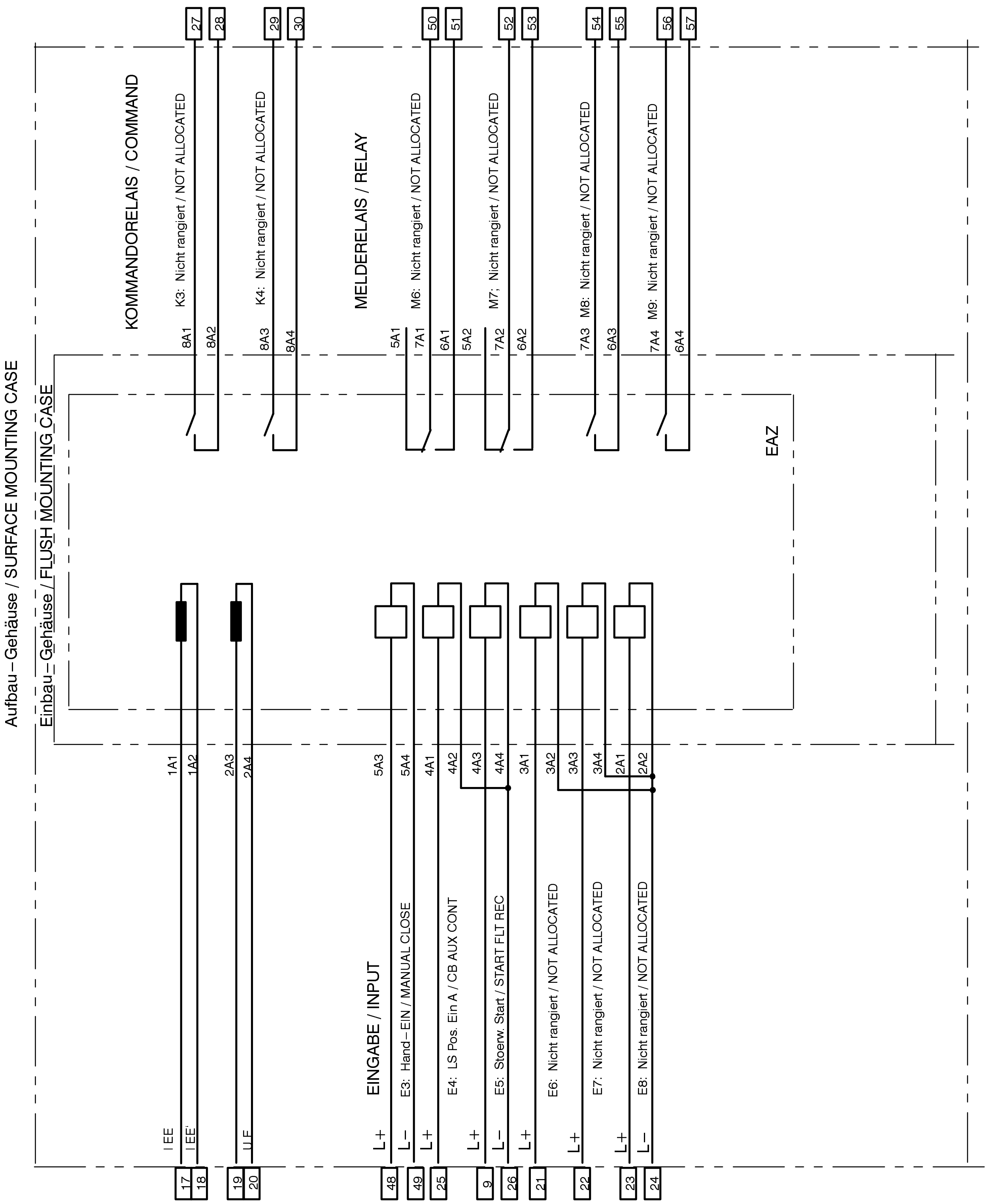


Figure A.5 General diagram 7SJ512★–★★★★★–**0**/**2B**★★ without directional determination, with V.24 (RS232C) interface (sheet 2 of 3)

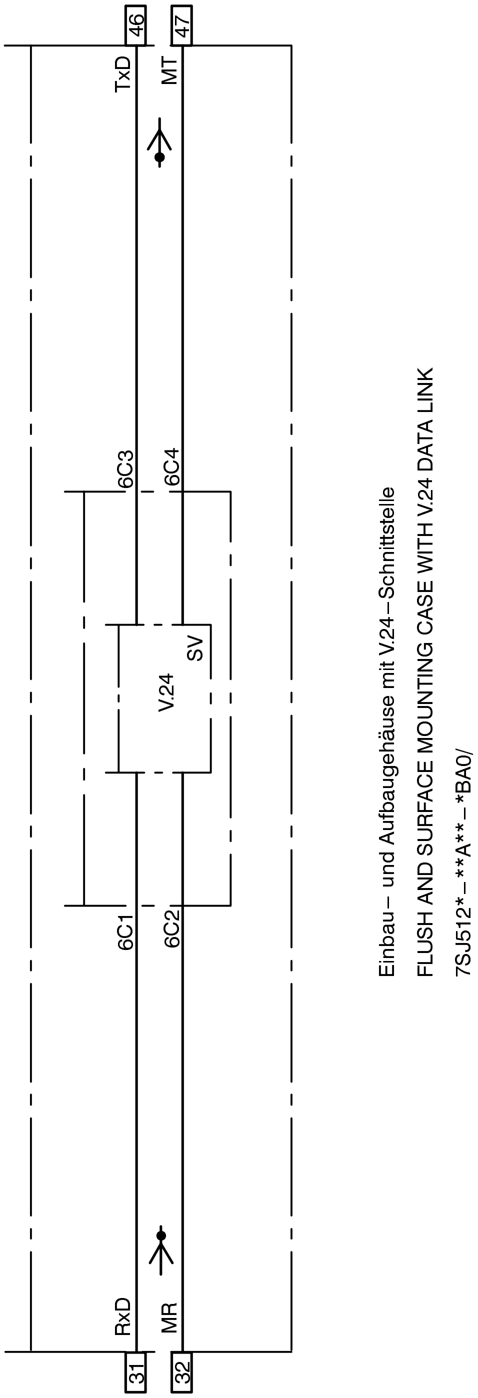


Figure A.6 General diagram 7SJ512⋆–⋆⋆⋆⋆⋆–**0**/**2B**⋆⋆ without directional determination, with V.24 (RS232C) interface (sheet 3 of 3)

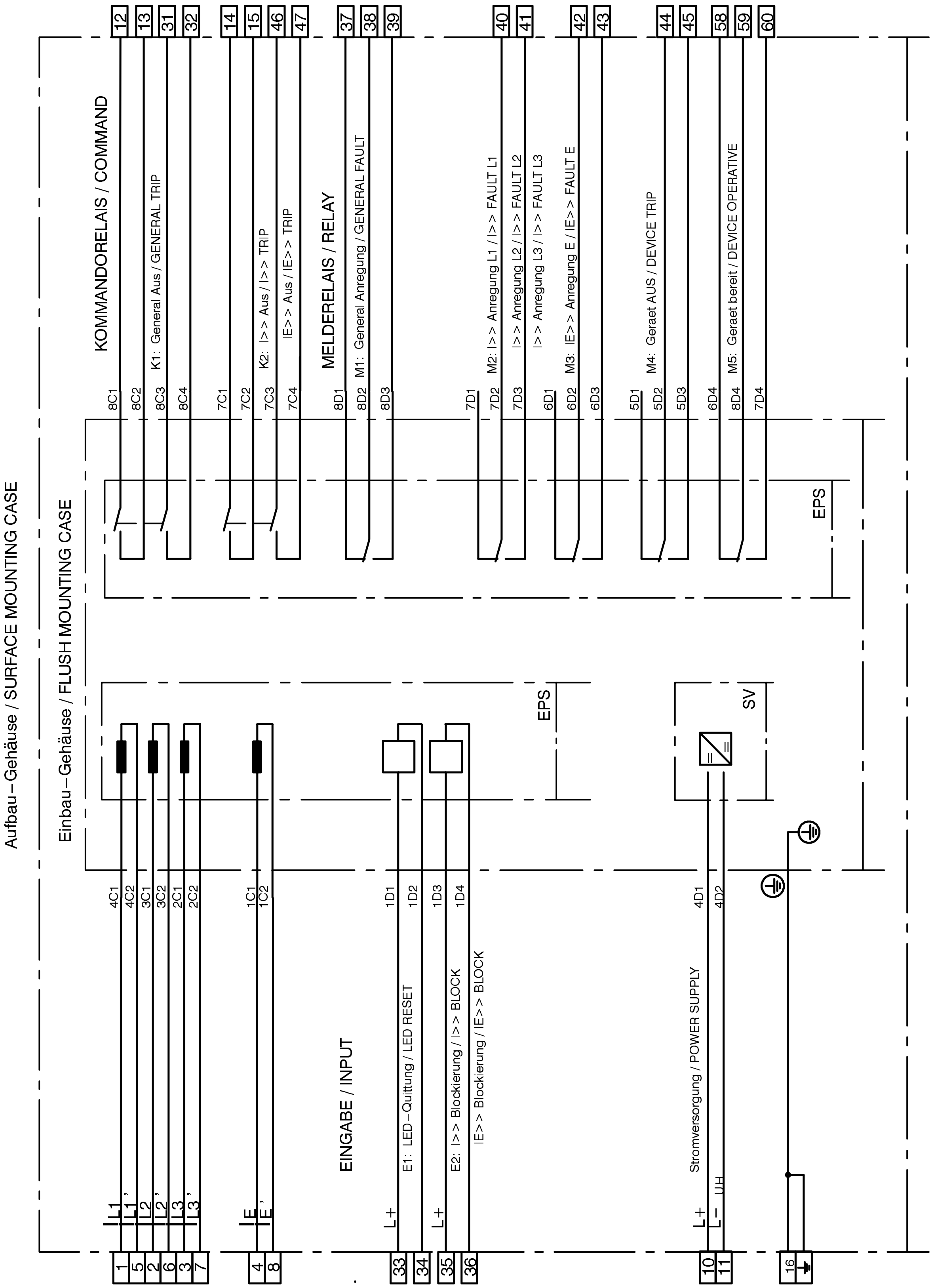


Figure A.7 General diagram 7SJ512★−★★★★★−**1**/**3A**/**C**★★ with directional determination, without or with fibre-optic interface (sheet 1 of 3)

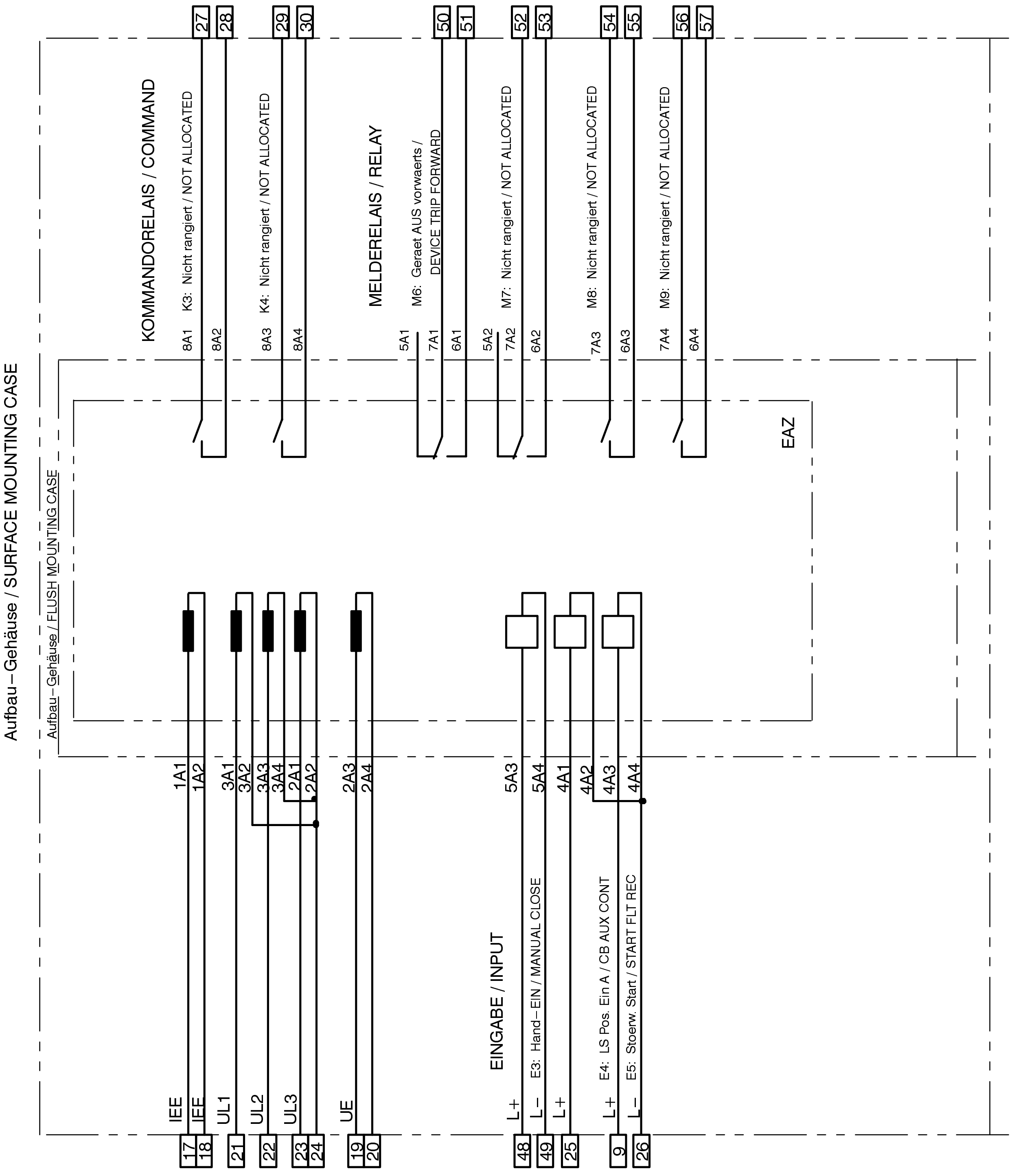


Figure A.8 General diagram 7SJ512★−★★★★★−**1**/**3A**/**C**★★ with directional determination, without or with fibre-optic interface (sheet 2 of 3)

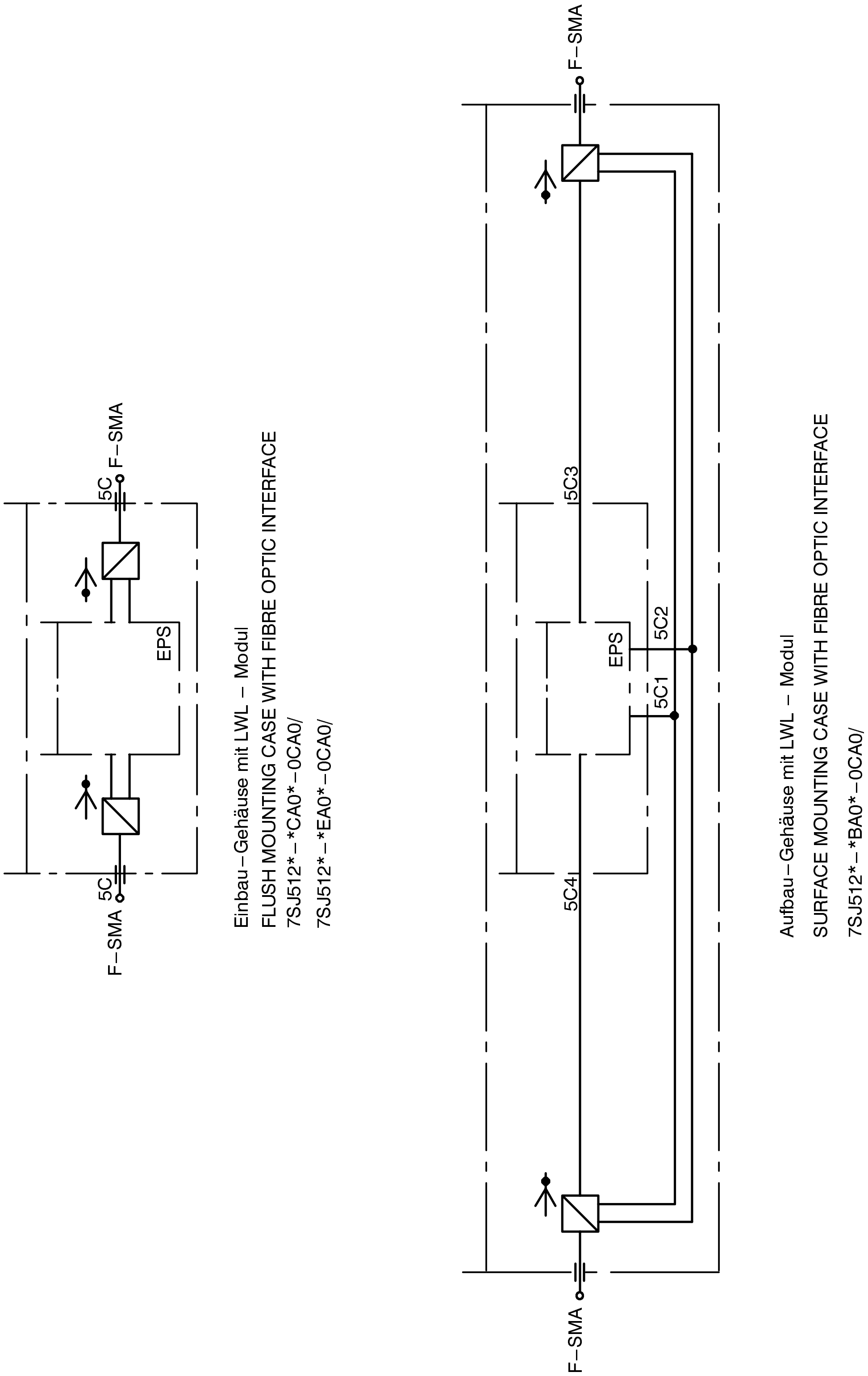


Figure A.9 General diagram 7SJ512★−★★★★★−**1**/**3C**★★ with directional determination, with fibre-optic interface (sheet 3 of 3)

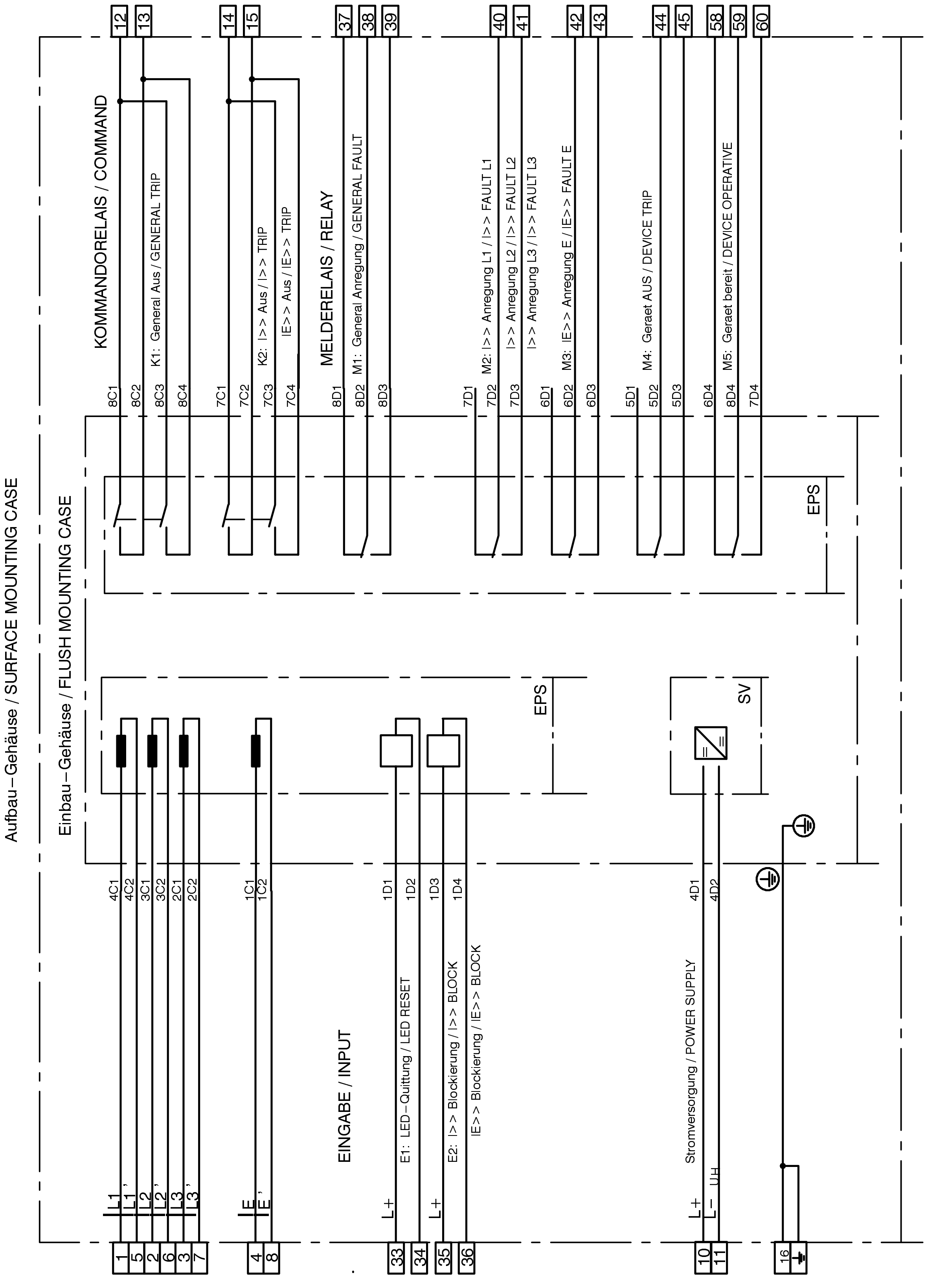


Figure A.10 General diagram 7SJ512★−★★★★★−**1**/**3B**★★ with directional determination, with V.24 (RS232C) interface (sheet 1 of 3)

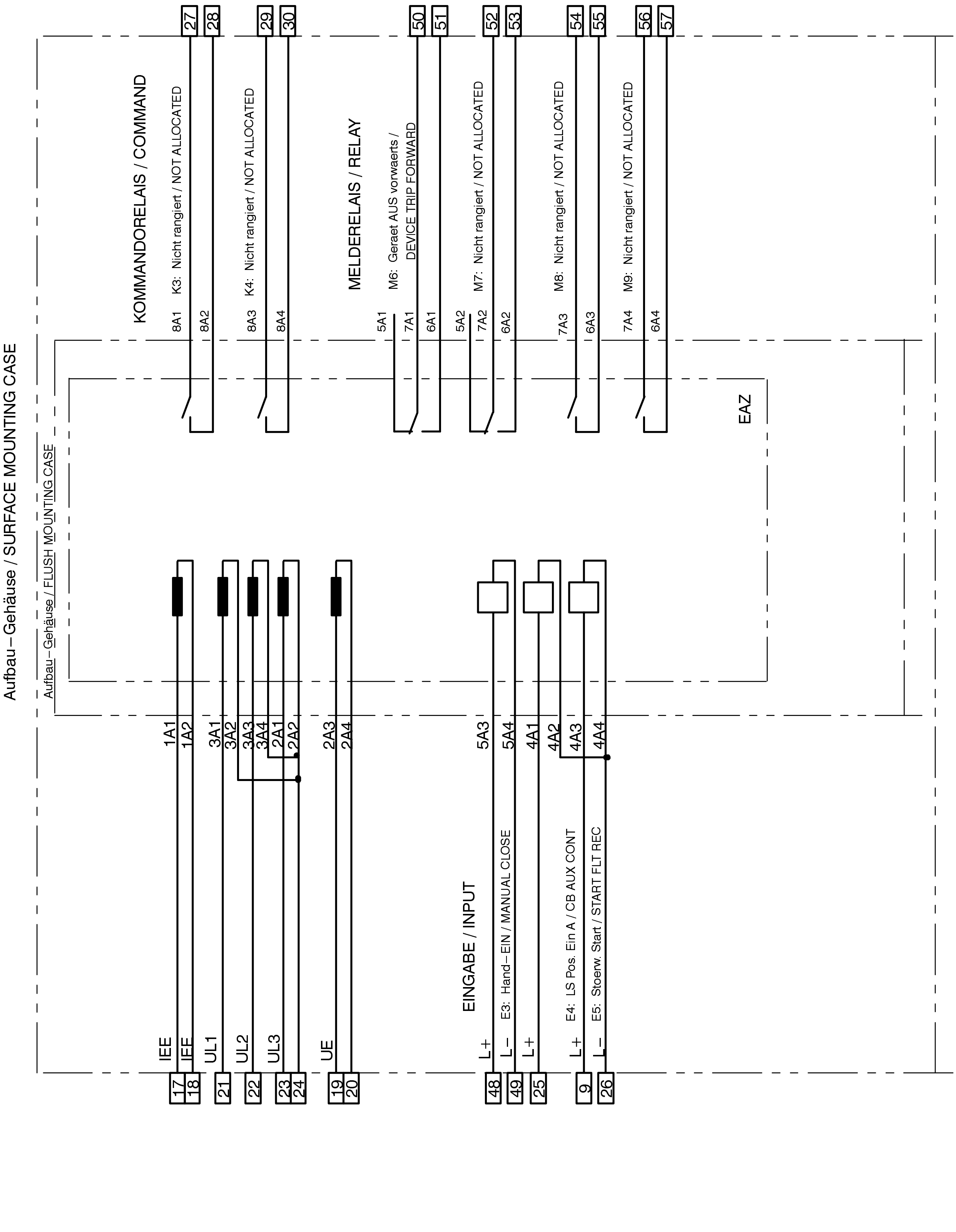


Figure A.11 General diagram 7SJ512★−★★★★★−**1**/**3B**★★ with directional determination, with V.24 (RS232C) interface (sheet 2 of 3)

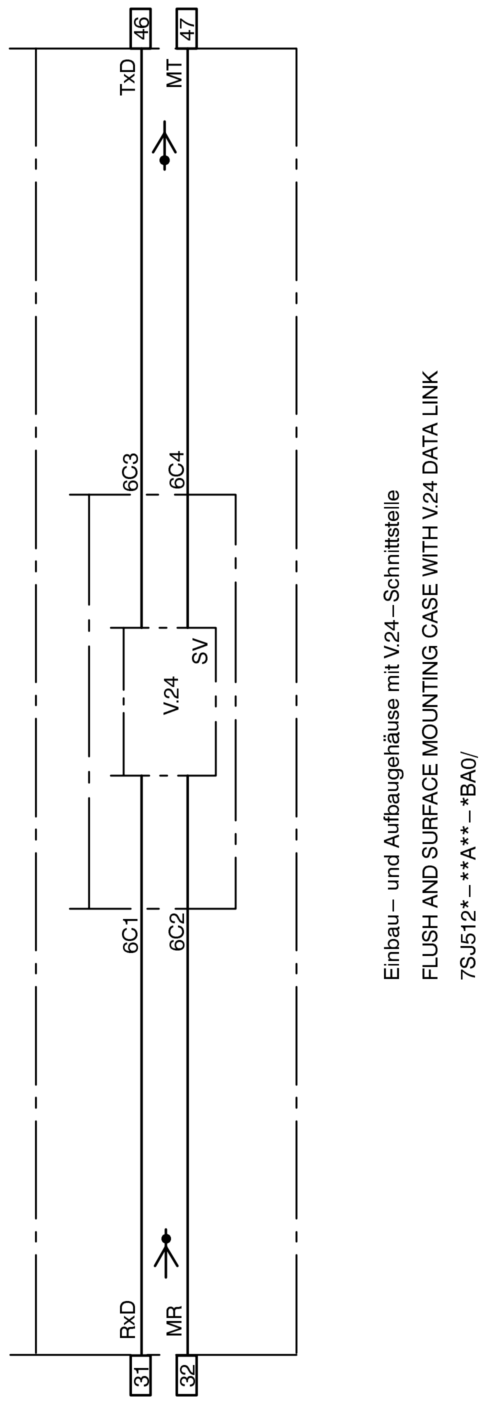


Figure A.12 General diagram 7SJ512★–★★★★★–**1**/**3B**★★ with directional determination, with V.24 (RS232C) interface (sheet 3 of 3)

B C.T. and V.T. circuits – connection examples

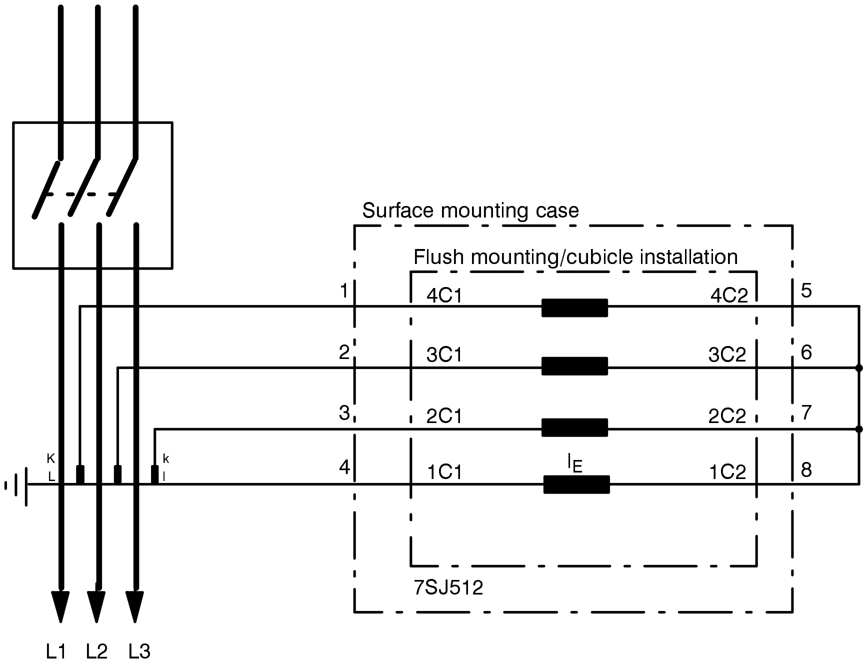


Figure B.1 Connections to three current transformers with star-point (residual current) – standard circuit, suitable for all systems

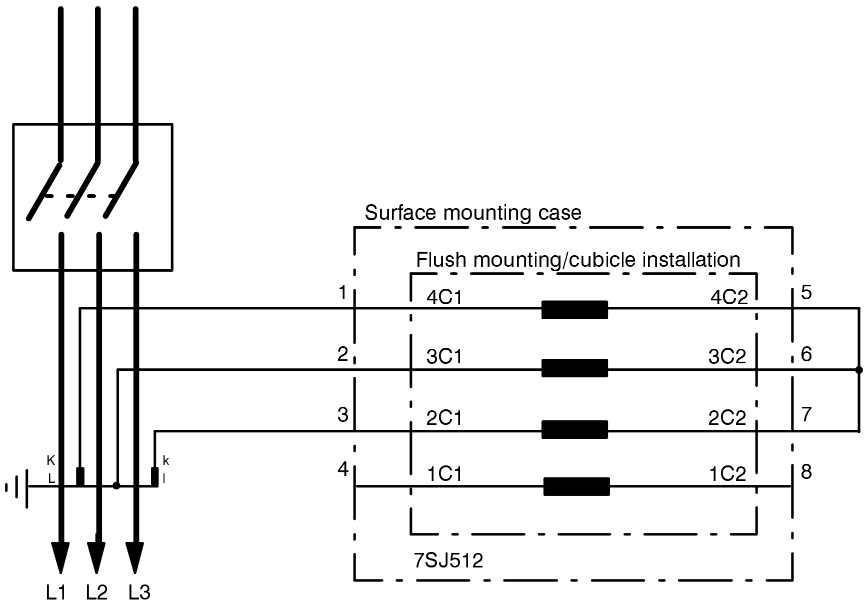


Figure B.2 Connections to two current transformers, only for isolated or compensated systems

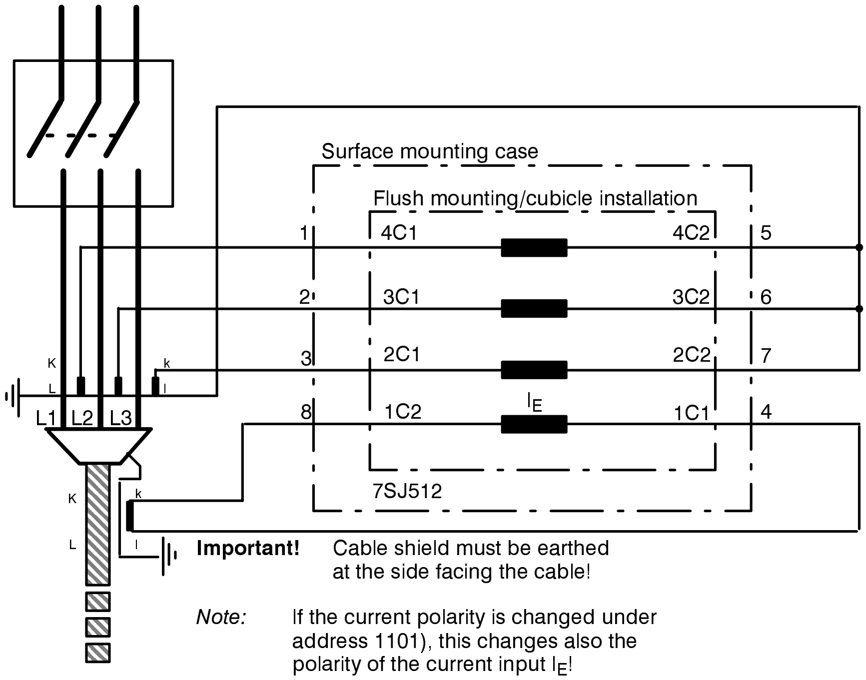


Figure B.3 Connections to three current transformers – residual current fed from particular summation c.t., preferably for effectively earthed or low-resistance earthed systems

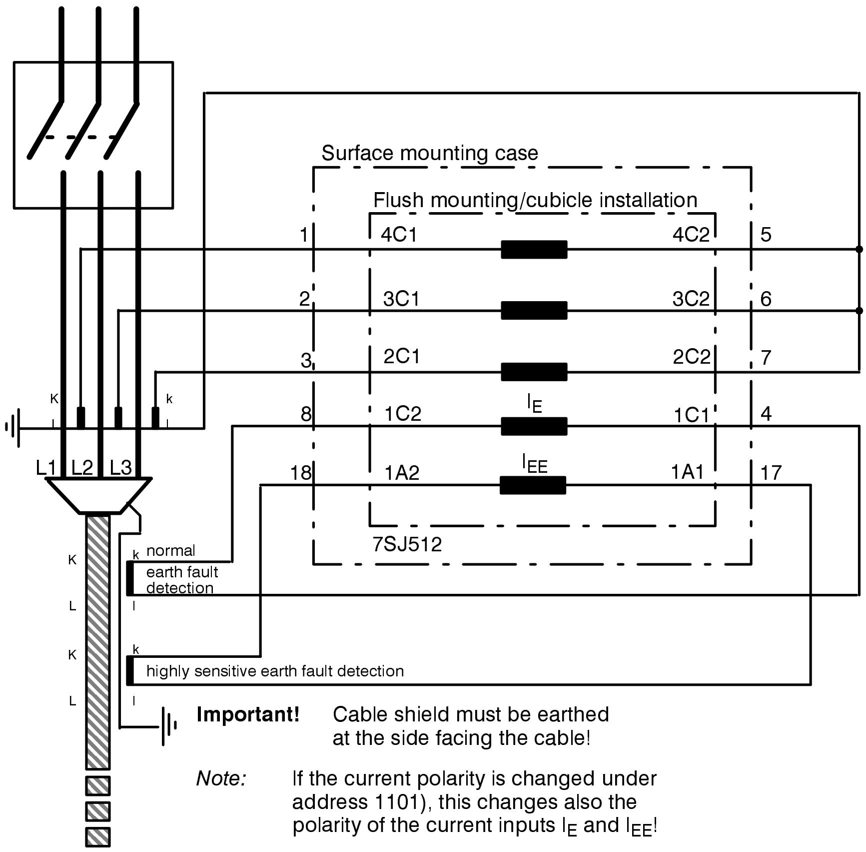


Figure B.4 Example for connections to two different summation c.t.s

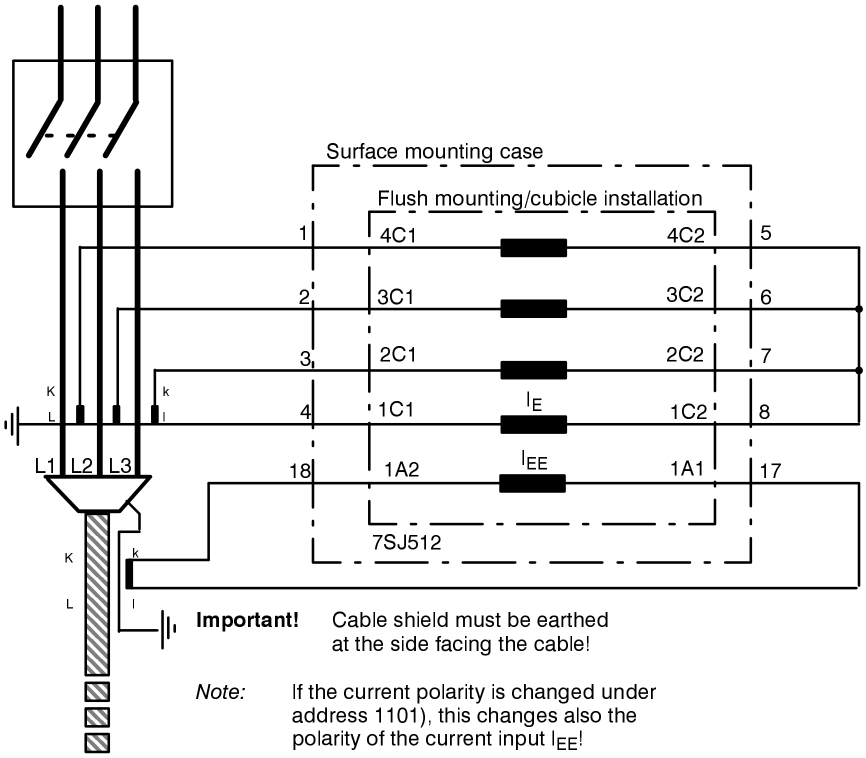


Figure B.5 Connections to three current transformers with star-point (residual current) – additional summation c.t. for highly sensitive earth fault detection, suitable for all systems

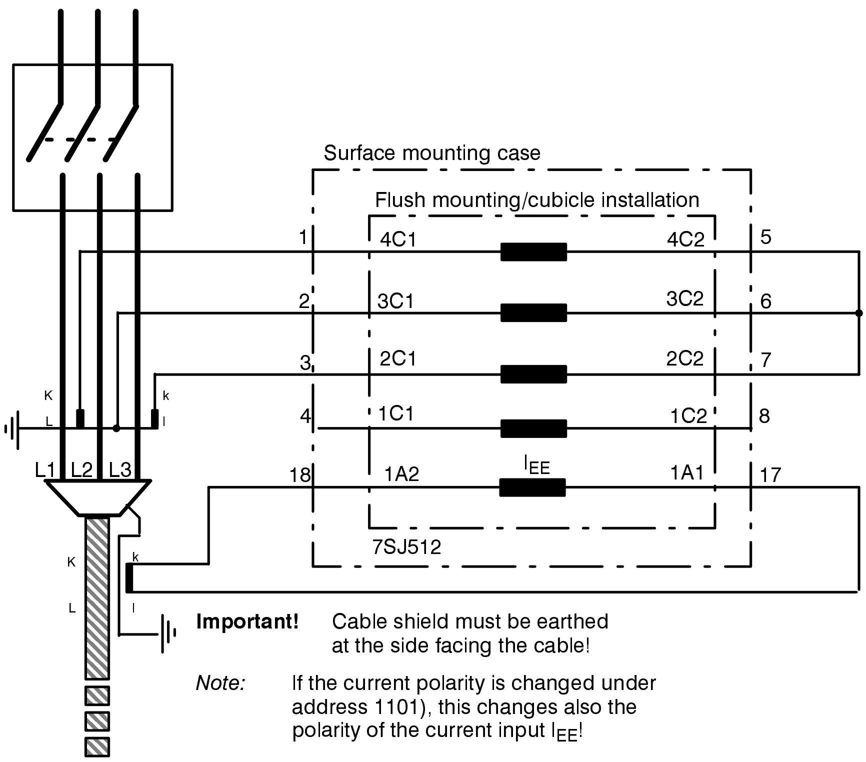


Figure B.6 Connections to two current transformers – additional summation c.t. for highly sensitive earth fault detection, only for isolated or compensated systems

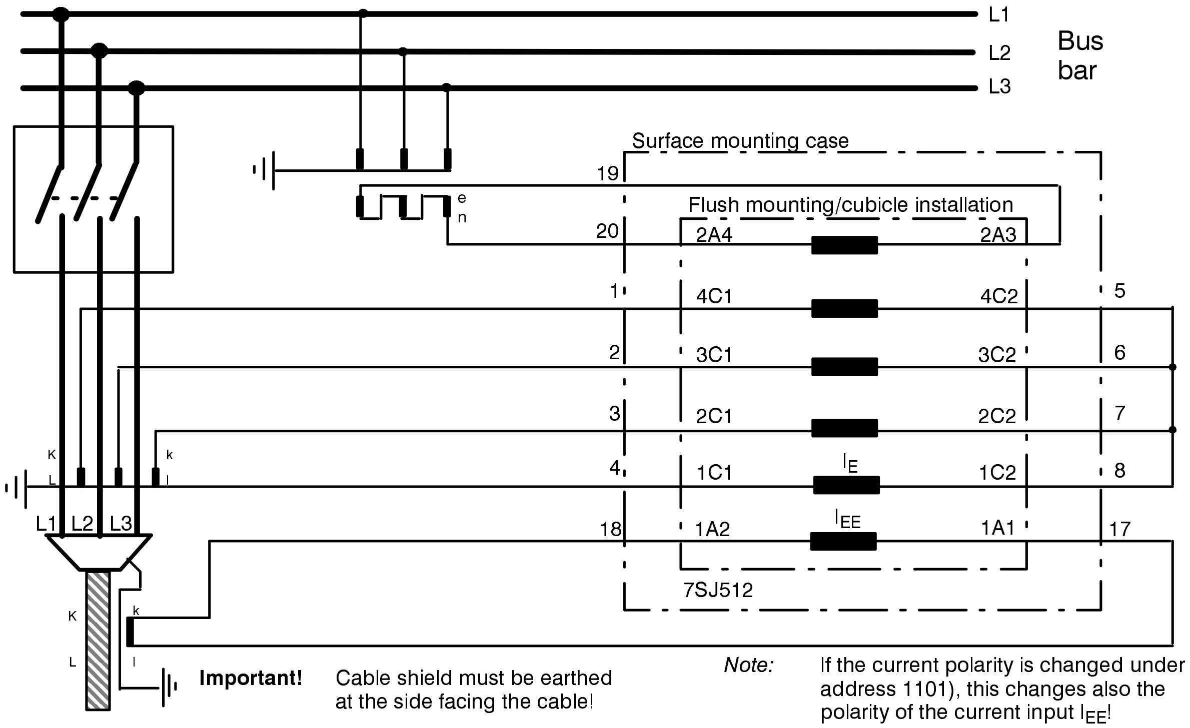


Figure B.7 Connections to three current transformers with star-point (residual current) – additional summation c.t. and open-delta v.t. for highly sensitive earth fault detection

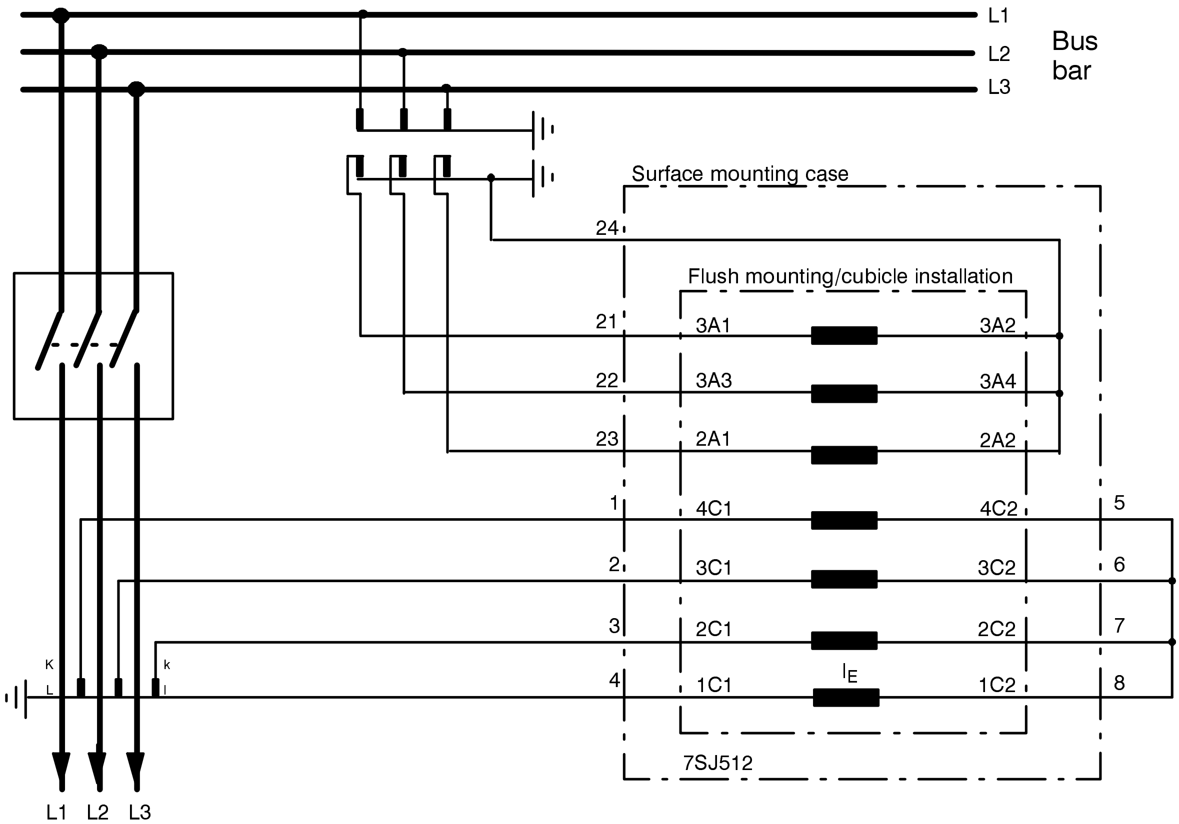


Figure B.8 Connections to three current transformers and three voltage transformers – standard connection with directional determination (7SJ512★–★★★★★–**1**★), suitable for all systems

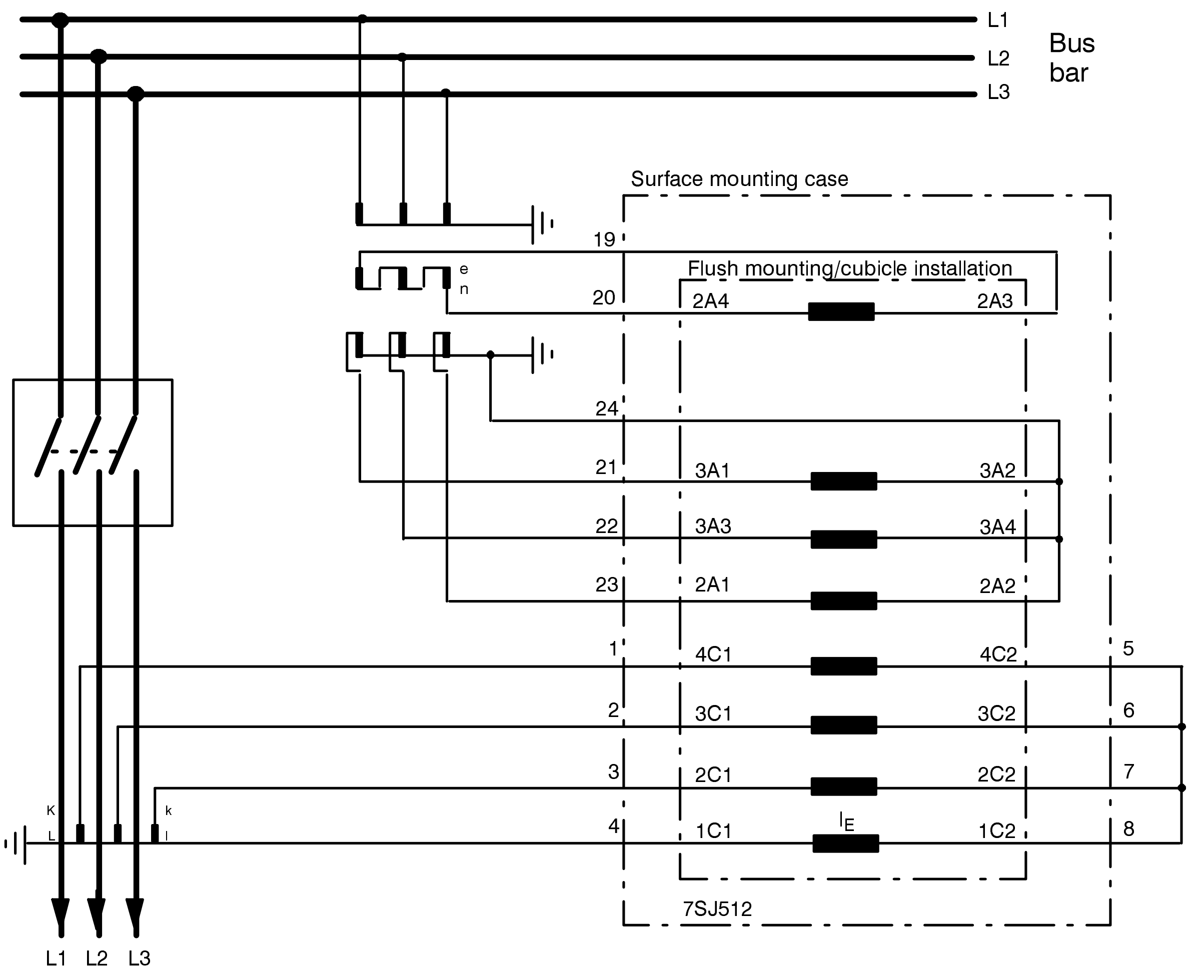


Figure B.9 Connections to three current transformers and three voltage transformers with open-delta windings (e−n) − optimum precision for directional determination (7SJ512★−★★★★★−**1**★), suitable for all systems

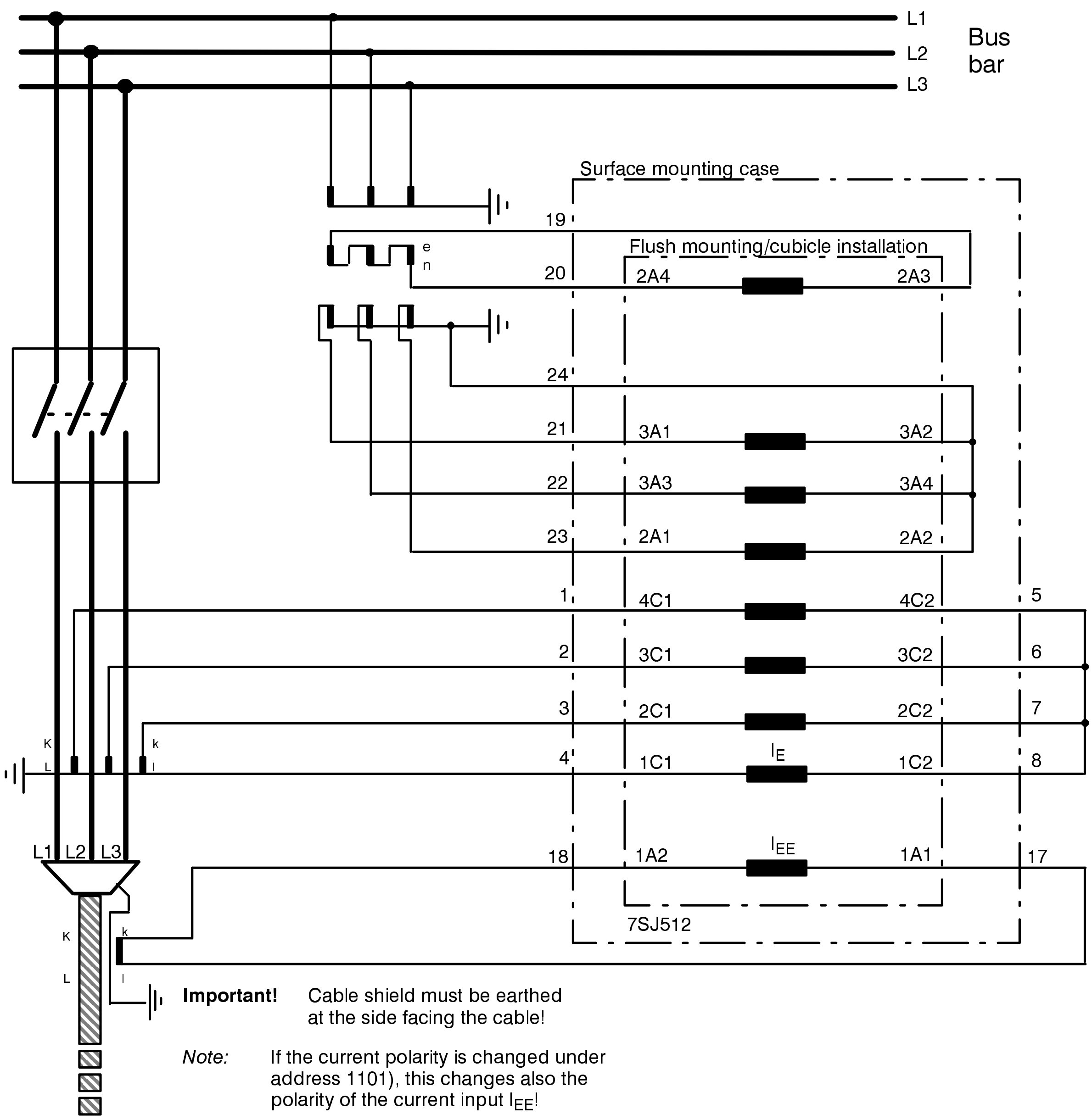


Figure B.10 Connections to three current transformers and three voltage transformers with open-delta windings (e–n) – additional summation c.t.for highly sensitive earth fault detection and directional earth fault discrimination – optimum precision for directional determination (7SJ512★–★★★★★–**1**★), suitable for all systems

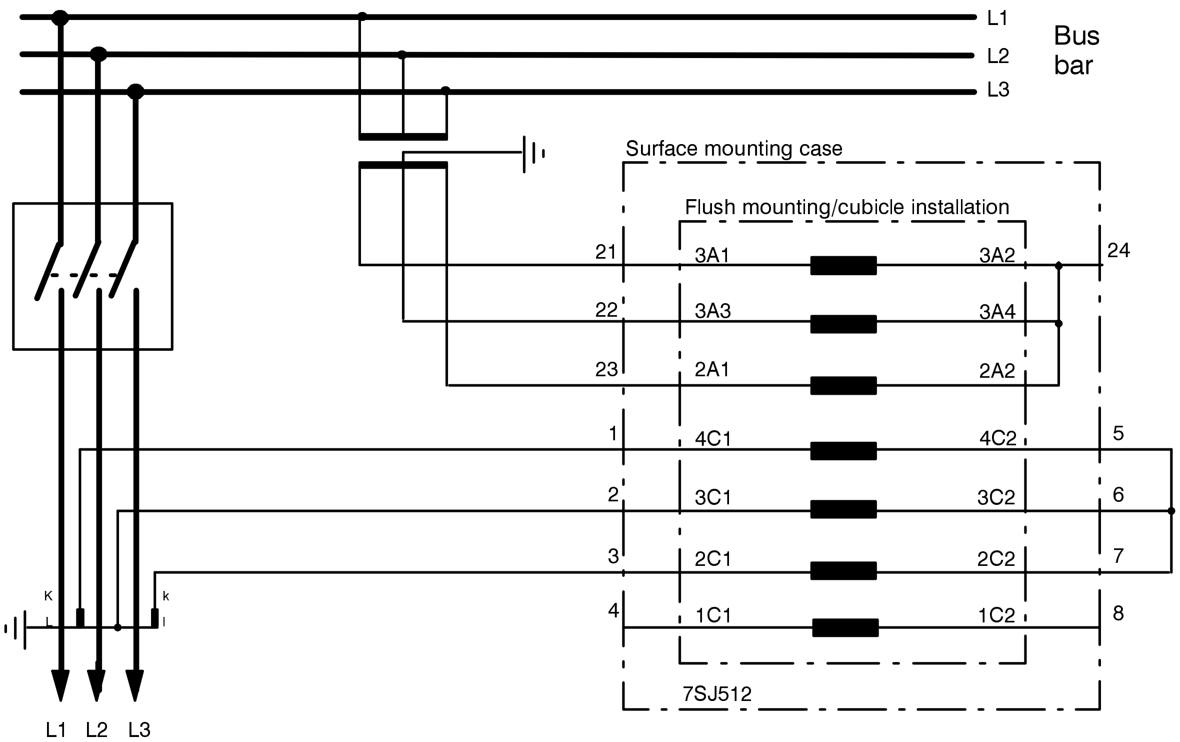


Figure B.11 Connections to two current transformers and two voltage transformers with directional determination (7SJ512★−★★★★★−1★), only for isolated or compensated systems

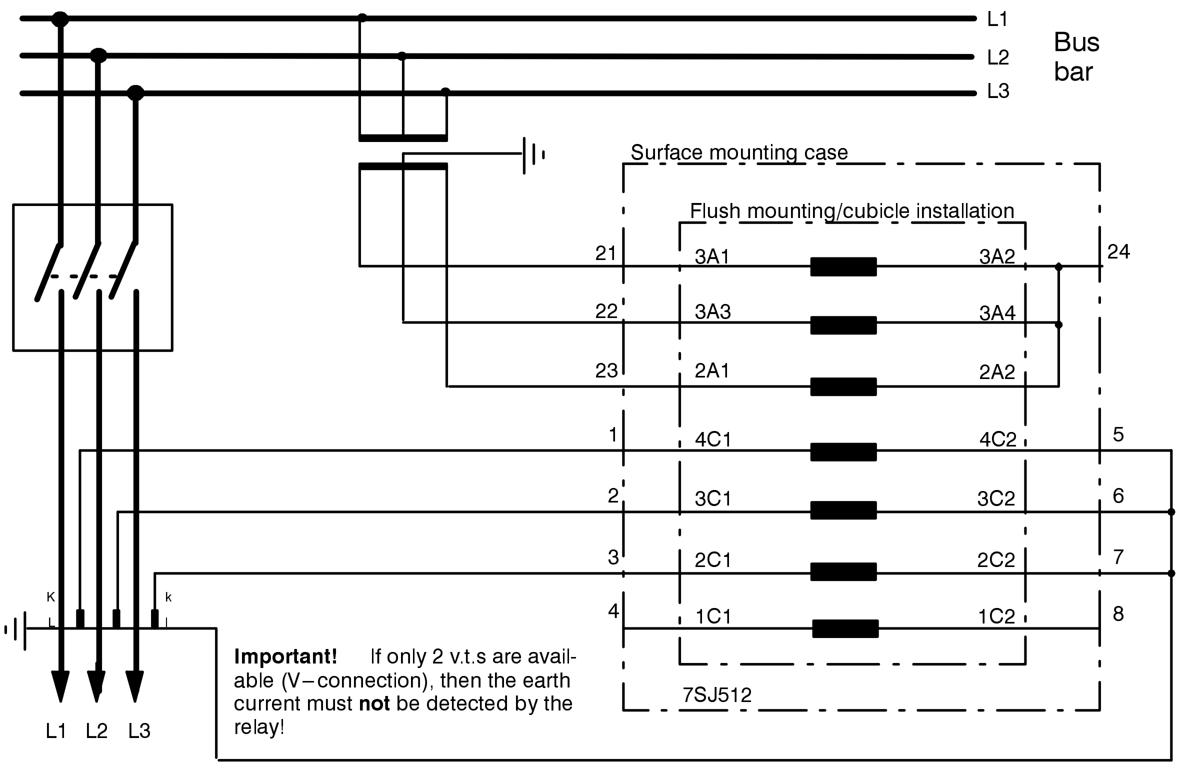


Figure B.12 Connections to three current transformers and two voltage transformers with directional determination (7SJ512★−★★★★★−1★), only for isolated or compensated systems

C Tables

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 7SJ512 for LSA (DIN 19244 and according VDEW/ZVEI)

FNo. - Function number of annunciation
Op/Ft - Operation/Fault annunciation
C/CG: Coming/Coming and Going annunciation
V : Annunciation with Value
M : Measurand
LSA No.- Number of annunciation for former LSA (DIN 19244)
according to VDEW/ZVEI:
CA - Compatible Annunciation
GI - Annunciation for General Interrogation
BT - Binary Trace for fault recordings
Typ - Function type (p: according to the configured "Function type")
Inf - Information number

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	GI	BT	Typ	Inf
11	>User defined annunciation 1	CG		24	CA	GI	BT	p	27
12	>User defined annunciation 2	CG		25	CA	GI	BT	p	28
13	>User defined annunciation 3	CG		26	CA	GI	BT	p	29
14	>User defined annunciation 4	CG		27	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		13	CA			p	19
62	Test mode	CG			CA	GI		p	21
63	PC operation via system interface	CG						135	83
95	Parameters are being set	CG		11	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		9				135	130
112	Annunciations for LSA lost	C		10				135	131
113	Fault tag lost						BT	135	136
140	General internal failure of device	CG			CA	GI		p	47
143	Failure of internal 15 VDC power supply	CG		97		GI		135	163
144	Failure of internal 5 VDC power supply	CG		98		GI		135	164
145	Failure of internal 0 VDC power supply	CG		99		GI		135	165
150	Failure in I/O module	CG		101		GI		135	170
154	Failure in the RKA module	CG		100	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
164	Measured value supervision of voltages	CG			CA	GI		p	33
165	Failure: Voltage sum superv. (ph-e)	CG		105		GI		135	184
167	Failure: Voltage symmetry supervision	CG		108		GI		135	186
171	Failure: Phase sequence supervision	CG		111	CA	GI		p	35
173	Failure: Current sum superv. (IEE)	CG		106		GI		135	190
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	Flt. event w. consecutive no.		C					135	232

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	GI	BT	Typ	Inf
303	E/Flt.detection in isol/comp.network	CG				GI		135	233
501	General fault detection of device		CG	142			BT	150	151
502	General drop-off of device		C	252				150	152
511	General trip of device		C	143			BT	150	161
516	General trip for fault in forward dir.		C	126	CA		BT	p	74
517	General trip for fault in reverse dir.		C	127	CA		BT	p	75
521	Interrupted current: Phase L1(I/In)		V	249				150	171
522	Interrupted current: Phase L2(I/In)		V	250				150	172
523	Interrupted current: Phase L3(I/In)		V	251				150	173
561	Circuit breaker manually closed (pulse)	C		18				150	211
601	Current in phase IL1 [%] =	M						134	133
602	Current in phase IL2 [%] =	M			CA			134	133
603	Current in phase IL3 [%] =	M						134	133
604	IE[%]=	M						134	133
621	UL1E [%]=	M						134	133
622	UL2E [%]=	M			CA			134	133
623	UL3E [%]=	M						134	133
627	UE[%]=	M						134	133
641	Active power Pa [%] =	M						134	133
642	Reactive power Pr [%] =	M						134	133
644	Frequency f [%] =	M						134	133
645	Apparent power S[%]=	M						134	133
713	IEEw[%]LSA	M						134	133
714	IEEb[%]LSA	M						134	133
900	Power factor cos phi[%]	M							
901	Power factor cos phi	M						134	133
1174	Circuit breaker test in progress	CG		21		GI		151	74
1181	Circuit breaker test: General trip	C		110				151	81
1201	>Block UE stage of sensitive E/F prot.	CG		41		GI		151	101
1202	>Block IEE>> stage of sensit. E/F prot.	CG		42		GI		151	102
1203	>Block IEE> stage of sensit. E/F prot.	CG		43		GI		151	103
1204	>Block IEEp stage of sensit. E/F prot.	CG		44		GI		151	104
1205	>Earth fault detection switch on	CG				GI		151	105
1206	>Earth fault detection switch off	CG				GI		151	106
1211	Earth fault detection switched off	CG		95		GI		151	111
1212	Earth fault detection active	CG				GI		151	112
1213	Fault detection of sensitive E/F prot.		CG	125			BT	151	113
1214	Trip by sensitive E/F protection		C	141			BT	151	114
1215	Earth flt. det. by displacement voltage		CG	137				151	115
1216	Time for displacement voltage expired		C	139				151	116
1217	Trip by displacement voltage stage		C	140				151	117
1218	Magnitude of earth current		V	255				151	118
1219	Active component of earth current		V	253				151	119
1220	Reactive component of earth current		V	254				151	120
1221	Fault detec. of sensitive IEE>> stage		CG	128				151	121
1222	Time of sensitive IEE>> stage expired		C	131				151	122
1223	Trip by sensitive IEE>> stage		C	134				151	123
1224	Fault detec. of sensitive IEE> stage		CG	129				151	124
1225	Time of sensitive IEE> stage expired		C	132				151	125
1226	Trip by sensitive IEE> stage		C	135				151	126
1227	Fault detec. of sensitive IEEp stage		CG	130				151	127
1228	Time of sensitive IEEp stage expired		C	133				151	128
1229	Trip by sensitive IEEp stage		C	136				151	129
1271	Earth fault in isol./comp. net detected	CG		3					
1272	Earth fault (isol./comp.) L1 detected	CG		89	CA	GI		p	48
1273	Earth fault (isol./comp.) L2 detected	CG		90	CA	GI		p	49
1274	Earth fault (isol./comp.) L3 detected	CG		91	CA	GI		p	50

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	GI	BT	Typ	Inf
1276	Earth fault (isol./comp.) forward dir.	CG		92	CA	GI		p	51
1277	Earth fault (isol./comp.) reverse dir.	CG		93	CA	GI		p	52
1451	Breaker fail protection is switched off	CG		56		GI		166	151
1455	Breaker failure : fault detection		C	227			BT	166	155
1471	Trip by breaker failure protection		C	228	CA		BT	p	85
1511	Thermal overload prot. is switched off	CG		60		GI		167	11
1512	Thermal overload protection is blocked	CG		61		GI		167	12
1515	Thermal overload prot.: Current warning	CG		62		GI		167	15
1516	Thermal overload prot.: Thermal warning	CG		63		GI		167	16
1521	Thermal overload protection trip		C	64			BT	167	21
1721	>Overcurrent protection:block stage I>>	CG		31		GI		60	1
1722	>Overcurrent protection:block stage I>	CG		33		GI		60	2
1723	>Overcurrent protection:block stage Ip	CG		35		GI		60	3
1724	>Overcurrent protec.: block stage IE>>	CG		32		GI		60	4
1725	>Overcurrent protection:block stage IE>	CG		34		GI		60	5
1726	>Overcurrent protection:block stage IEp	CG		36		GI		60	6
1751	Overcurrent prot. phase is switched off	CG		50		GI		60	21
1756	O/C protection earth is switched off	CG		51		GI		60	26
1761	General fault detection O/C		CG	144	CA	GI	BT	p	84
1762	O/C fault detection phase L1		CG	145	CA	GI	BT	p	64
1763	O/C fault detection phase L2		CG	146	CA	GI	BT	p	65
1764	O/C fault detection phase L3		CG	147	CA	GI	BT	p	66
1765	O/C fault detection earth		CG	148	CA	GI	BT	p	67
1771	O/C fault detection L1 only		C	161				60	31
1772	O/C fault detection L1-E		C	162				60	32
1773	O/C fault detection L2 only		C	163				60	33
1774	O/C fault detection L2-E		C	164				60	34
1775	O/C fault detection L1-L2		C	165				60	35
1776	O/C fault detection L1-L2-E		C	166				60	36
1777	O/C fault detection L3 only		C	167				60	37
1778	O/C fault detection L3-E		C	168				60	38
1779	O/C fault detection L1-L3		C	169				60	39
1780	O/C fault detection L1-L3-E		C	170				60	40
1781	O/C fault detection L2-L3		C	171				60	41
1782	O/C fault detection L2-L3-E		C	172				60	42
1783	O/C fault detection L1-L2-L3		C	173				60	43
1784	O/C fault detection L1-L2-L3-E		C	174				60	44
1785	O/C fault detection E only		C	175				60	45
1791	O/C general trip command		C	149	CA		BT	p	68
1801	O/C fault detection stage I>> phase L1		CG	191				60	46
1802	O/C fault detection stage I>> phase L2		CG	192				60	47
1803	O/C fault detection stage I>> phase L3		CG	193				60	48
1804	O/C time TI>> expired		C	195				60	49
1805	O/C protection I>> phase trip		C	198	CA		BT	p	91
1811	O/C fault detection stage I> phase L1		CG	151				60	50
1812	O/C fault detection stage I> phase L2		CG	152				60	51
1813	O/C fault detection stage I> phase L3		CG	153				60	52
1814	O/C time TI> expired		C	155				60	53
1815	O/C protection I> phase trip		C	158	CA		BT	p	90
1821	O/C fault detection Ip phase L1		CG	181				60	54
1822	O/C fault detection Ip phase L2		CG	182				60	55
1823	O/C fault detection Ip phase L3		CG	183				60	56
1824	O/C time TIp expired		C	185				60	57
1825	O/C protection Ip phase trip		C	188			BT	60	58
1831	O/C fault detection IE>> earth		CG	194				60	59
1832	O/C time TIE>> expired		C	196				60	60
1833	O/C protection IE>> earth trip		C	199			BT	60	61

FNo.	Meaning	Ann.		LSA	VDEW/ZVEI				
		Op	Ft	No.	CA	GI	BT	Typ	Inf
1834	O/C fault detection IE> earth		CG	154				60	62
1835	O/C time TIE> expired		C	156				60	63
1836	O/C protection IE> earth trip		C	159	CA		BT	p	92
1837	O/C fault detection IEp earth		CG	184				60	64
1838	O/C time TIEp expired		C	186				60	65
1839	O/C protection IEp earth trip		C	189			BT	60	66
1840	Phase L1 blocked by inrush detection		CG	176				60	101
1841	Phase L2 blocked by inrush detection		CG	177				60	102
1842	Phase L3 blocked by inrush detection		CG	178				60	103
1843	Cross blocking by inrush detection		CG	179				60	104
1844	>Change over pick-up value by bin. inp.	CG				GI		60	111
2621	>Block O/C I> directional stage phase	CG		37		GI		63	1
2622	>Block O/C Ip directional stage phase	CG		38		GI		63	2
2623	>Block O/C IE> directional stage earth	CG		39		GI		63	3
2624	>Block O/C IEp directional stage earth	CG		40		GI		63	4
2661	O/C prot. fault detection I> phase L1		CG	201				63	21
2662	O/C prot. fault detection I> phase L2		CG	202				63	22
2663	O/C prot. fault detection I> phase L3		CG	203				63	23
2664	Time for directional I> stage expired		C	205				63	24
2665	Trip by directional O/C I> stage		C	208				63	25
2671	O/C prot. fault detection Ip phase L1		CG	211				63	31
2672	O/C prot. fault detection Ip phase L2		CG	212				63	32
2673	O/C prot. fault detection Ip phase L3		CG	213				63	33
2674	Time for directional Ip stage expired		C	215				63	34
2675	Trip by directional O/C Ip stage		C	218				63	35
2681	O/C prot. fault detection IE>		CG	204				63	41
2682	Time for directional IE> stage expired		C	206				63	42
2683	Trip by directional O/C IE> stage		C	209				63	43
2684	O/C prot. fault detection IEp		CG	214				63	44
2685	Time for directional IEp stage expired		C	216				63	45
2686	Trip by directional O/C IEp stage		C	219				63	46
2701	>AR: Switch on auto-reclose function	CG				GI		40	1
2702	>AR: Switch off auto-reclose function	CG				GI		40	2
2704	>AR: Reset auto-reclose function	C		74				40	4
2709	>AR: Block delayed auto-reclose	CG		73		GI		40	9
2781	AR: Auto-reclose is switched off	CG		79					
2782	AR: Auto-reclose is switched on	CG			CA	GI		p	16
2783	AR: Auto-reclose is blocked	CG		72		GI		40	83
2784	AR: Auto-reclose is not ready	CG			CA	GI		p	130
2785	AR: Auto-reclose is dynamically blocked	C		225				40	85
2787	AR: Circuit breaker not ready	C		78				40	87
2801	AR: Auto-reclose in progress	CG		224		GI		40	101
2813	RAR dead time after earth fault running	C		220				40	113
2814	RAR dead time after phase fault running	C		221				40	114
2833	DAR dead time after earth fault running	C		222				40	133
2834	DAR dead time after phase fault running	C		223				40	134
2851	AR: Close command from auto-reclose	C		229	CA		BT	p	128
2854	Reclose command after DAR	C			CA			p	129
2863	AR: Definitive trip		C					40	163
6903	>Block interm. E/F prot.	CG		47		GI		152	1
6921	Interm. E/F prot. is switched off	CG		230		GI		152	10
6922	Interm. E/F prot. is blocked	CG		231		GI		152	11
6923	Interm. E/F prot. is active	CG		232		GI		152	12
6926	Interm. E/F detection stage Iie>	C		233				152	13
6927	Interm. E/F detected	CG		234		GI		152	14
6928	Counter of det. times elapsed	C		235				152	15
6929	Interm. E/F: reset time running	CG		236		GI		152	16

FNo.	Meaning	Ann. Op	Ann. Ft	LSA No.	VDEW/ZVEI CA	GI	BT	Typ	Inf
6930	Interm. E/F: trip		C	237				152	17
6931	Max RMS current value of fault =		V	238				152	18
6932	No. of detections by stage Iie>=		V	239				152	19

Annunciations 7SJ512 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	>Reset LED indicators				IO
7	>ParamSelec.1	>Parameter set selection 1 (with No.8)				IO
8	>ParamSelec.2	>Parameter set selection 2 (with No.7)				IO
11	>Annunc. 1	>User defined annunciation 1	CG			IOT
12	>Annunc. 2	>User defined annunciation 2	CG			IOT
13	>Annunc. 3	>User defined annunciation 3	CG			IOT
14	>Annunc. 4	>User defined annunciation 4	CG			IOT
51	Dev.operative	Device operative / healthy	CG			O
56	Initial start	Initial start of processor system	C			
60	LED reset	LED Reset	C			
95	Param.running	Parameters are being set	CG			O
96	Param. Set A	Parameter set A is active	CG			O
97	Param. Set B	Parameter set B is active	CG			O
98	Param. Set C	Parameter set C is active	CG			O
99	Param. Set D	Parameter set D is active	CG			O
100	Wrong SW-vers	Wrong software-version	C			
101	Wrong dev. ID	Wrong device identification	C			
110	Annunc. lost	Annunciations lost (buffer overflow)	C			
111	Annu. PC lost	Annunciations for PC lost	C			
115	Flt.Buff.Over	Fault annunciation buffer overflow		C		
116	E/F Buff.Over	E/F buffer overflow			E	
120	Oper.Ann.Inva	Operational annunciations invalid	CG			
121	Flt.Ann.Inval	Fault annunciations invalid	CG			
122	E/F.Prot Inva	Earth fault annunciations invalid	CG			
123	Stat.Buff.Inv	Statistic annunciation buffer invalid	CG			
124	LED Buff.Inva	LED annunciation buffer invalid	CG			
129	VDEW-StateInv	VDEW state invalid	CG			
135	Chs Error	Error in check sum	CG			
136	Chs.A Error	Error in check sum for parameter set A	CG			
137	Chs.B Error	Error in check sum for parameter set B	CG			
138	Chs.C Error	Error in check sum for parameter set C	CG			
139	Chs.D Error	Error in check sum for parameter set D	CG			
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 ∑I	Failure: Current summation supervision	CG			OT
163	Failure Isymm	Failure: Current symmetry supervision	CG			OT
164	U supervision	Measured value supervision of voltages				O
165	Failure ∑Up-e	Failure: Voltage sum superv. (ph-e)	CG			OT
167	Failure Usymm	Failure: Voltage symmetry supervision	CG			OT

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
171	Fail.PhaseSeq	Failure: Phase sequence supervision	CG			OT
173	Fail.∑I (IEE)	Failure: Current sum superv. (IEE)	CG			OT
203	Flt.RecDatDel	Fault recording data deleted	C			
204	Flt.Rec.viaBI	Fault recording initiated via bin.input	C			
205	Flt.Rec.viaKB	Fault recording initiated via keyboard	C			
206	Flt.Rec.viaPC	Fault recording initiated via PC interf	C			
244	D Time=	Diff. time of clock synchronism	M			
301	Syst.Flt	Fault in the power system	CG	C		
302	Fault	Flt. event w. consecutive no.		C		
303	E/F Det.	E/Flt.det. in isol/comp.netw.	CG		E	
354	>CB Aux.3p cl	>CB aux. contact:3poles closed (series)				IOT
356	>Manual Close	>Manual close				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
516	Dev.Trip forw	General trip for fault in forward dir.		C		OT
517	Dev.Trip rev.	General trip for fault in reverse dir.		C		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	IL1[%] =	Current in phase IL1 [%] =	M			
602	IL2[%] =	Current in phase IL2 [%] =	M			
603	IL3[%] =	Current in phase IL3 [%] =	M			
604	IE[%]=	IE[%]=	M			
621	UL1E[%]=	UL1E [%]=	M			
622	UL2E[%]=	UL2E [%]=	M			
623	UL3E[%]=	UL3E [%]=	M			
627	UE[%]=	UE[%]=	M			
641	Pa[%]=	Active power Pa [%] =	M			
642	Pr[%]=	Reactive power Pr [%] =	M			
644	f [%]=	Frequency f [%] =	M			
645	S[%]=	Apparent power S[%]=	M			
651	IL1 =	Current in phase IL1 =	M			
652	IL2 =	Current in phase IL2 =	M			
653	IL3 =	Current in phase IL3 =	M			
654	IEa =	Operational measurement: IEa=	M			
671	UL1E=	Voltage UL1E =	M			
672	UL2E=	Voltage UL2E =	M			
673	UL3E=	Voltage UL3E =	M			
677	UE=	Voltage UE=	M			
691	Pa=	Active power Pa =	M			
692	Pr=	Reactive power Pr =	M			
695	S=	Apparent power S=	M			
701	IEEa[mA]=	Iea [mA] =	M			
702	IEEr[mA]=	Ier [mA] =	M			
711	IEEa =	Iea =	M			
712	IEEr =	Ier =	M			
801	Θ/Θtrip =	Temperat. rise for warning and trip	M			
802	Θ/ΘtripL1=	Temperature rise for phase L1	M			
803	Θ/ΘtripL2=	Temperature rise for phase L2	M			
804	Θ/ΘtripL3=	Temperature rise for phase L3	M			
901	COS PHI=	Power factor cos phi	M			
1000	Trip No =	Number of trip commands issued	M			
1004	∑IL1/In=	Summated current tripped IL1/In	M			

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
1005	∑IL2/In=	Summated current tripped IL2/In	M			
1006	∑IL3/In=	Summated current tripped IL3/In	M			
1011	AR 1pole=	No. of auto-reclose commands:1p RAR	M			
1012	AR 3pole=	No. of auto-reclose commands:3p RAR	M			
1013	DAR 3pol=	No. of auto-reclose commands:3p DAR	M			
1015	Il1/In=	Last trip current L1 IL1/In=	M			
1016	IL2/In=	Last trip current L2 IL2/In=	M			
1017	IL3/In	Last trip current L3 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	C			OT
1201	>UE block	>Block UE stage of sensitive E/F prot.	CG			IOT
1202	>IEE>> block	>Block IEE>> stage of sensit. E/F prot.	CG			IOT
1203	>IEE> block	>Block IEE> stage of sensit. E/F prot.	CG			IOT
1204	>IEEp block	>Block IEEp stage of sensit. E/F prot.	CG			IOT
1205	>E/F Det. on	>Earth fault detection switch on				IOT
1206	>E/F Det. off	>Earth fault detection switch off				IOT
1211	E/F Det. off	Earth fault detection switched off	CG			OT
1212	E/F Det.activ	Earth fault detection active				OT
1213	E/F Fault	Fault detection of sensitive E/F prot.				OT
1214	E/F Trip	Trip by sensitive E/F protection		C		OT
1215	UE Fault	Earth flt. det. by displacement voltage		C		OT
1216	T-UE expired	Time for displacement voltage expired		C		OT
1217	UE Trip	Trip by displacement voltage stage				OT
1218	IEE=	Magnitude of earth current		C	E	
1219	IEEa=	Active component of earth current		C	E	
1220	IEEr=	Reactive component of earth current		C	E	
1221	IEE>> Fault	Fault detec. of sensitive IEE>> stage		C		OT
1222	T-IEE>> expir	Time of sensitive IEE>> stage expired		C		OT
1223	IEE>> Trip	Trip by sensitive IEE>> stage				OT
1224	IEE> Fault	Fault detec. of sensitive IEE> stage		C		OT
1225	T-IEE> expir	Time of sensitive IEE> stage expired		C		OT
1226	IEE> Trip	Trip by sensitive IEE> stage				OT
1227	IEEp Fault	Fault detec. of sensitive IEEp stage		C		OT
1228	T-IEEp expir	Time of sensitive IEEp stage expired		C		OT
1229	IEEp Trip	Trip by sensitive IEEp stage				OT
1271	E/F Detection	Earth fault in isol./comp. net detected				OT
1272	E/F Detec. L1	Earth fault (isol./comp.) L1 detected		C	E	OT
1273	E/F Detec. L2	Earth fault (isol./comp.) L2 detected		C	E	OT
1274	E/F Detec. L3	Earth fault (isol./comp.) L3 detected		C	E	OT
1276	E/F forwards	Earth fault (isol./comp.) forward dir.		C	E	OT
1277	E/F reverse	Earth fault (isol./comp.) reverse dir.		C	E	OT
1401	>B/F on	>Switch on breaker fail protection				IOT
1402	>B/F off	>Switch off breaker fail protection				IOT
1431	>B/F Start	>ext. start breaker failure protection				IOT
1451	B/F off	Breaker fail protection is switched off	CG			OT
1453	B/F active	Breaker failure protection is active				OT
1455	B/F fault	Breaker failure : fault detection		CG		OT
1471	B/F Trip	Trip by breaker failure protection		C		OT
1501	>O/L on	>Switch on thermal overload protection				IOT
1502	>O/L off	>Switch off thermal overload protection				IOT
1503	>O/L block	>Block thermal overload protection	CG			IOT
1511	O/L Prot. off	Thermal overload prot. is switched off	CG			OT
1512	O/L blocked	Thermal overload protection is blocked				OT
1513	O/L active	Thermal overload protection is active				OT
1515	O/L Warn I	Thermal overload prot.: Current warning	CG			OT
1516	O/L Warn Θ	Thermal overload prot.: Thermal warning	CG			OT
1521	O/L Trip	Thermal overload protection trip		C		OT

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
1701	>O/C Ph on	>Switch on O/C protection phase				IOT
1702	>O/C Ph off	>Switch off O/C protection phase				IOT
1711	>O/C E on	>Switch on overcurrent protection earth				IOT
1712	>O/C E off	>Switch off overcurrent protec. earth				IOT
1721	>I>> block	>Overcurrent protection:block stage I>>	CG			IOT
1722	>I> block	>Overcurrent protection:block stage I>	CG			IOT
1723	>Ip block	>Overcurrent protection:block stage Ip	CG			IOT
1724	>IE>> block	>Overcurrent protec.: block stage IE>>	CG			IOT
1725	>IE> block	>Overcurrent protection:block stage IE>	CG			IOT
1726	>IEp block	>Overcurrent protection:block stage IEp	CG			IOT
1751	O/C Ph off	Overcurrent prot. phase is switched off	CG			OT
1753	O/C Ph active	Overcurrent prot. phase is active				OT
1756	O/C E off	O/C protection earth is switched off	CG			OT
1758	O/C E active	O/C protection earth is active				OT
1761	O/C Gen.Fault	General fault detection O/C				OT
1762	Fault L1	O/C fault detection phase L1				OT
1763	Fault L2	O/C fault detection phase L2				OT
1764	Fault L3	O/C fault detection phase L3				OT
1765	Fault E	O/C fault detection earth				OT
1771	Fault L1	O/C fault detection L1 only		C		
1772	Fault L1E	O/C fault detection L1-E		C		
1773	Fault L2	O/C fault detection L2 only		C		
1774	Fault L2E	O/C fault detection L2-E		C		
1775	Fault L12	O/C fault detection L1-L2		C		
1776	Fault L12E	O/C fault detection L1-L2-E		C		
1777	Fault L3	O/C fault detection L3 only		C		
1778	Fault L3E	O/C fault detection L3-E		C		
1779	Fault L13	O/C fault detection L1-L3		C		
1780	Fault L13E	O/C fault detection L1-L3-E		C		
1781	Fault L23	O/C fault detection L2-L3		C		
1782	Fault L23E	O/C fault detection L2-L3-E		C		
1783	Fault L123	O/C fault detection L1-L2-L3		C		
1784	Fault L123E	O/C fault detection L1-L2-L3-E		C		
1785	Fault E	O/C fault detection E only		C		
1791	O/C Gen.Trip	O/C general trip command		C		OT
1800	I>> Fault	O/C fault detection stage I>>		C		OT
1801	I>> Fault L1	O/C fault detection stage I>> phase L1				OT
1802	I>> Fault L2	O/C fault detection stage I>> phase L2				OT
1803	I>> Fault L3	O/C fault detection stage I>> phase L3				OT
1804	T-I>> expired	O/C time TI>> expired		C		OT
1805	I>> Trip	O/C protection I>> phase trip				OT
1810	I> Fault	O/C fault detection stage I>		C		OT
1811	I> Fault L1	O/C fault detection stage I> phase L1				OT
1812	I> Fault L2	O/C fault detection stage I> phase L2				OT
1813	I> Fault L3	O/C fault detection stage I> phase L3				OT
1814	T-I> expired	O/C time TI> expired		C		OT
1815	I> Trip	O/C protection I> phase trip				OT
1820	Ip Fault	O/C fault detection Ip		C		OT
1821	Ip Fault L1	O/C fault detection Ip phase L1				OT
1822	Ip Fault L2	O/C fault detection Ip phase L2				OT
1823	Ip Fault L3	O/C fault detection Ip phase L3				OT
1824	T-Ip expired	O/C time TIp expired		C		OT
1825	Ip Trip	O/C protection Ip phase trip				OT
1831	IE>> Fault	O/C fault detection IE>> earth		C		OT
1832	T-IE>> expir	O/C time TIE>> expired		C		OT
1833	IE>> Trip	O/C protection IE>> earth trip				OT
1834	IE> Fault	O/C fault detection IE> earth		C		OT
1835	T-IE> expired	O/C time TIE> expired		C		OT

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
1836	IE> Trip	O/C protection IE> earth trip				OT
1837	IEp Fault	O/C fault detection IEp earth		C		OT
1838	T-IEp expired	O/C time TIEp expired		C		OT
1839	IEp Trip	O/C protection IEp earth trip				OT
1840	Rush Block L1	Phase L1 blocked by inrush detection		CG		OT
1841	Rush Block L2	Phase L2 blocked by inrush detection		CG		OT
1842	Rush Block L3	Phase L3 blocked by inrush detection		CG		OT
1843	Rush Crossbl.	Cross blocking by inrush detection		CG		OT
1844	>Param BI	>Change over pick-up value by bin. inp.	CG			IOT
2621	>I> Block dir	>Block O/C I> directional stage phase	CG			IOT
2622	>Ip Block dir	>Block O/C Ip directional stage phase	CG			IOT
2623	>IE>Block dir	>Block O/C IE> directional stage earth	CG			IOT
2624	>IEpBlock dir	>Block O/C IEp directional stage earth	CG			IOT
2640	forward dir.	Forward direction				OT
2641	reverse dir.	Reverse direction				OT
2660	I> Fault dir.	O/C prot. fault detection I>		C		OT
2661	I> Flt dir.L1	O/C prot. fault detection I> phase L1				OT
2662	I> Flt dir.L2	O/C prot. fault detection I> phase L2				OT
2663	I> Flt dir.L3	O/C prot. fault detection I> phase L3				OT
2664	T-I> dir.exp.	Time for directional I> stage expired		C		OT
2665	I> dir. Trip	Trip by directional O/C I> stage				OT
2670	Ip Fault dir.	O/C prot. fault detection Ip		C		OT
2671	Ip Flt dir.L1	O/C prot. fault detection Ip phase L1				OT
2672	Ip Flt dir.L2	O/C prot. fault detection Ip phase L2				OT
2673	Ip Flt dir.L3	O/C prot. fault detection Ip phase L3				OT
2674	T-Ip dir.exp.	Time for directional Ip stage expired		C		OT
2675	Ip dir. Trip	Trip by directional O/C Ip stage				OT
2681	IE>Fault dir.	O/C prot. fault detection IE>		C		OT
2682	T-IE> dir.exp	Time for directional IE> stage expired		C		OT
2683	IE> dir. Trip	Trip by directional O/C IE> stage				OT
2684	IEpFault dir.	O/C prot. fault detection IEp		C		OT
2685	T-IEp dir.exp	Time for directional IEp stage expired		C		OT
2686	IEp dir. Trip	Trip by directional O/C IEp stage				OT
2701	>AR on	>AR: Switch on auto-reclose function				IOT
2702	>AR off	>AR: Switch off auto-reclose function				IOT
2703	>AR block	>AR: Block auto-reclose function				IOT
2704	>AR reset	>AR: Reset auto-reclose function	C			IOT
2709	>DAR block	>AR: Block delayed auto-reclose	CG			IOT
2730	>CB ready	>AR: Circuit breaker ready for reclose				IOT
2781	AR off	AR: Auto-reclose is switched off	CG			OT
2783	AR inoperativ	AR: Auto-reclose is blocked	CG			OT
2784	AR not ready	AR: Auto-reclose is not ready				OT
2785	AR block.dyn.	AR: Auto-reclose is dynamically blocked				OT
2787	CB not ready	AR: Circuit breaker not ready	CG			OT
2801	AR in prog.	AR: Auto-reclose in progress				OT
2812	RAR T-act.run	AR: Action time for RAR is running				OT
2813	RAR T-E run.	RAR dead time after earth fault running				OT
2814	RAR T-Ph run.	RAR dead time after phase fault running				OT
2817	RAR Zone Rel.	AR: Zone extension for rapid reclosing				OT
2832	DAR T-act.run	AR: Action time for DAR is running				OT
2833	DAR T-E run.	DAR dead time after earth fault running				OT
2834	DAR T-Ph run.	DAR dead time after phase fault running				OT
2837	DAR Zone Rel.	AR: Zone extension for delayed reclose				OT
2851	AR Close Cmd.	AR: Close command from auto-reclose		C		OT
2853	RAR Close	Reclose command after RAR				OT
2854	DAR Close	Reclose command after DAR				OT
2861	AR T-Recl.run	AR: Reclaim time is running				OT
2862	AR successful	AR: Auto-reclose cycle successful				OT

FNo.	Abbreviation	Meaning	Op	Ft	E	IOT
2863	Definit.Trip	AR: Definitive trip				OT
6901	>IEF on	>Switch on interm. E/F prot.				IOT
6902	>IEF off	>Switch off interm. E/F prot.				IOT
6903	>IEF block	>Block interm. E/F prot.	CG			IOT
6921	IEF OFF	Interm. E/F prot. is switched off	CG			OT
6922	IEF blocked	Interm. E/F prot. is blocked	CG			OT
6923	IEF enabled	Interm. E/F prot. is active				OT
6924	IIE Fault det	Interm. E/F detection stage Iie>				OT
6925	IIE stab.Flt.	Interm. E/F stab. detection				OT
6926	IIE Fault det	Interm. E/F detection stage Iie>		C		
6927	Intermitt.EF	Interm. E/F detected		CG		OT
6928	IEF Tsum exp.	Counter of det. times elapsed		C		OT
6929	IEF Tres run.	Interm. E/F: reset time running		CG		OT
6930	IEF Trip	Interm. E/F: trip		C		OT
6931	Iie/In=	Max RMS current value of fault =		C		
6932	Nos.IIE=	No. of detections by stage Iie>=		C		

Reference Table for Functional Parameters 7SJ512

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1000 PARAMETERS
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```
1100 POWERSYSTEM DATA

1101 CT STARPNT            Current transformer polarity
     TOWARDS LINE      [ ] Towards line
     TOWARDS BUSBAR    [ ] Towards busbar

1103 Un PRIMARY            Primary rated voltage
     min. 1                kV
     max. 400         ____

1104 Un SECOND.            Secondary rated voltage
     min. 100              V
     max. 125         ____

1105 In PRIMARY            Primary rated current
     min. 10               A
     max. 50000       ____

1109 VT DELTA              VT open delta windings connected ?
     CONNECTED         [ ] Connected
     NOT CONNECTED     [ ] Not connected

1110 Uph/Udelta            Matching factor Uph/Udelta (sec.earth voltage)
     min. 0.10
     max. 9.99        ____

1112 Ie/Iph                Matching factor Ie/Iph for earth current
     min. 0.001
     max. 20.000      ____

1114 IEE/IPH               Matching factor Iee/Iph
     min. 0.001
     max. 20.000      ____

1135 T-CLOSE               Maximum close command duration
     min. 0.01             s
     max. 32.00       ____

1141 T TRIP                Minimum trip command duration
     min. 0.01             s
     max. 32.00       ____

1150 PHASE ROT.            Direction of phase rotating field
     CLOCKWISE         [ ] clockwise
     ANTI-CLOCKWISE    [ ] anti-clockwise
```

```
1200 O/C PROT. PHASES

1201 O/C PHASES            O/C protection for phase faults
     ON                [ ] on
     OFF               [ ] off
```

```
1202 I>>                     Pick-up value of the high-set stage I>>
     min. 0.05               I/In
     max. 25.00          ____

1203 T-I>>                   Trip time delay of the high-set stage I>>
     min. 0.00               s
     max. 60.00/∞        ____

1206 MEAS.REPET              Measurement repetition
     NO                  [ ] no
     YES                 [ ] yes

1211 CHARACTER.              Characteristic of the O/C stage Ip
     NORMAL INVERSE      [ ] Normal inverse
     VERY INVERSE        [ ] Very inverse
     EXTREMELY INVERS    [ ] Extremely inverse
     USER CHARACTER.     [ ] User characteristics

1212 I>                      Pick-up value of the overcurrent stage I>
     min. 0.05               I/In
     max. 25.00          ____

1213 T-I>                    Trip time delay of the overcurrent stage I>
     min. 0.00               s
     max. 60.00/∞        ____

1214 Ip                      Pick-up value inverse time O/C stage Ip
     min. 0.10               I/In
     max. 4.00           ____

1215 T-Ip                    Trip time delay inverse time O/C stage Ip
     min. 0.00               s
     max. 10.00/∞        ____

1216 RMS FORMAT              RMS format for inverse time O/C protection
     FUNDAMENTAL         [ ] Fundamental
     TRUE RMS            [ ] True rms

1221 MAN.CLOSE               Manual close
     I>> UNDELAYED       [ ] I>> undelayed
     I>/Ip UNDELAYED     [ ] I>/Ip undelayed
     INEFFECTIVE         [ ] Ineffective

1222 DIREC. I>               Operating direction of the dir. O/C I> stage
     FORWARDS            [ ] Forwards
     REVERSE             [ ] Reverse

1223 CHAR.DIREC              Characteristic of the dir. O/C stage phase
     NORMAL INVERSE      [ ] Normal inverse
     VERY INVERSE        [ ] Very inverse
     EXTREMELY INVERS    [ ] Extremely inverse
     USER CHARACTER.     [ ] User characteristics

1224 T-I> DIREC              Delay time T-I> of the dir. O/C stage
     min. 0.00               s
     max. 60.00/∞        ____

1225 T-Ip DIREC              Time multipl. T-Ip of the dir. inv. O/C stage
     min. 0.00               s
     max. 10.00/∞        ____
```

```
1500 O/C PROT. EARTH

1501 O/C EARTH               O/C protection for earth faults
     ON                  [ ] on
     OFF                 [ ] off

1502 IE>>                    Pick-up value of the high-set stage IE>>
     min. 0.05               I/In
     max. 25.00        ____

1503 T-IE>>                  Trip time delay of the high-set stage IE>>
     min. 0.00               s
     max. 60.00/∞      ____

1506 MEAS.REPET              Measurement repetition
     NO                  [ ] no
     YES                 [ ] yes

1511 CHARACTER.              Characteristic of the O/C stage IEp
     NORMAL INVERSE      [ ] Normal inverse
     VERY INVERSE        [ ] Very inverse
     EXTREMELY INVERS    [ ] Extremely inverse
     USER CHARACTER.     [ ] User characteristics
     LONG EARTH FAULT    [ ] Long earth fault

1512 IE>                     Pick-up value of the overcurrent stage IE>
     min. 0.05               I/In
     max. 25.00        ____

1513 T-IE>                   Trip time delay of the overcurrent stage IE>
     min. 0.00               s
     max. 60.00/∞      ____

1514 IEp                     Pick-up value inverse time O/C stage IEp
     min. 0.10               I/In
     max. 4.00         ____

1515 T-IEp                   Trip time delay inverse time O/C stage IEp
     min. 0.00               s
     max. 10.00/∞      ____

1516 RMS FORMAT              RMS format for inverse time O/C protection
     FUNDAMENTAL         [ ] Fundamental
     TRUE RMS            [ ] True rms

1521 MAN.CLOSE               Manual close
     IE>> UNDELAYED      [ ] IE>> undelayed
     IE>/IEp UNDELAY.    [ ] IE>/IEp undelayed
     INEFFECTIVE         [ ] Ineffective

1522 DIREC. IE>              Operating direction of the dir. O/C IE> stage
     FORWARDS            [ ] Forwards
     REVERSE             [ ] Reverse

1523 CHAR.DIREC              Characteristic of the dir. O/C stage earth
     NORMAL INVERSE      [ ] Normal inverse
     VERY INVERSE        [ ] Very inverse
     EXTREMELY INVERS    [ ] Extremely inverse
     USER CHARACTER.     [ ] User characteristics
     LONG EARTH FAULT    [ ] Long earth fault
```

```
1524 T-IE> DIRE              Time delay T-IE> of the dir. O/C stage
     min. 0.00               s
     max. 60.00/∞      ____

1525 T-IEp DIRE              Time multipl. T-IEp of the dir. inv. O/C stage
     min. 0.00               s
     max. 10.00/∞      ____
```

```
2000 INRUSH STABILIZATION

2001 RUSH                    Inrush stabilization
     OFF                 [ ] off
     ON                  [ ] on

2002 2nd HARMON              Content of Ph current which initiates blocking
     min. 10                 %
     max. 45           ____

2003 CROSSBLOCK              Blocking all phase fault detec (crossblock)
     NO                  [ ] no
     YES                 [ ] yes

2004 T-RUSH                  Time limit of blocking after pick-up
     min. 0.10               s
     max. 60.00        ____
```

```
2500 SPECIFIC CHARACTERISTICS

2501 CHARACTERISTIC 1        Characteristic curve 1
```

```
2600 BIN-INPUT PARAMETERS

2601 BE: I>>                 Alternative pick-up value high-set I>> stage
     min. 0.05               I/In
     max. 25.00        ____

2602 BE: I>                  Alternative pick-up value def. O/C I> stage
     min. 0.05               I/In
     max. 25.00        ____

2603 BE: Ip                  Alternative pick-up value inv. O/C Ip stage
     min. 0.10               I/In
     max. 4.00         ____

2604 BE: IE>>                Alternative pick-up value high-set IE>> stage
     min. 0.05               I/In
     max. 25.00        ____

2605 BE: IE>                 Alternative pick-up value def. O/C IE> stage
     min. 0.05               I/In
     max. 25.00        ____

2606 BE: IEp                 Alternative pick-up value inv. O/C IEp stage
     min. 0.10               I/In
     max. 4.00         ____
```

2607 BE: IEE>> — Alternative pick-up value high-set IEE>> stage
min. 0.003 — A
max. 1.000 _____

2608 BE: IEE> — Alternative pick-up value def. O/C IEE> stage
min. 0.003 — A
max. 1.000 _____

2609 BE: IEEp — Alternative pick-up value inv. O/C IEEp stage
min. 0.003 — A
max. 1.000 _____

2700 THERMAL OVERLOAD PROT.

2701 THERMAL OL — State of thermal overload protection
OFF [ ] off
ON [ ] on

2702 K-FACTOR — K-factor for thermal overload protection
min. 0.10
max. 4.00 _____

2703 T-CONSTANT — Time constant for thermal overload protection
min. 1.0 — min
max. 999.9 _____

2704 Θ WARN — Thermal warning stage
min. 50 — %
max. 100 _____

2705 I WARN — Current warning stage
min. 0.10 — I/In
max. 4.00 _____

2706 O/L CALCUL — Calculation method for thermal stages
Θ MAX [ ] Theta max
Θ MEAN [ ] Theta mean
Θ FROM IMAX [ ] Theta from Imax

2800 DELAYTIMES ANNUNCIATIONS

2801 T-Annunc.1 — Delay time for 1st user defined annunciation
min. 0.00 — s
max. 10.00 _____

2802 T-Annunc.2 — Delay time for 2nd user defined annunciation
min. 0.00 — s
max. 10.00 _____

2803 T-Annunc.3 — Delay time for 3rd user defined annunciation
min. 0.00 — s
max. 10.00 _____

2804 T-Annunc.4 — Delay time for 4th user defined annunciation
min. 0.00 — s
max. 10.00 _____

```
2900 MEAS.VALUE SUPERVISION

2901 SYM.Uthres              Symmetry threshold for voltage monitoring
     min. 10                 V
     max. 100          ____

2902 SYM.Fact.U              Symmetry factor for voltage monitoring
     min. 0.58
     max. 0.95         ____

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. 0.05               I/In
     max. 2.00         ____

2906 SUM.Fact.I              Factor for current summation monitoring
     min. 0.00
     max. 0.95         ____
```

```
3000 EARTHFAULT DETECTION

3001 EARTHFAULT              High-sensitivity earth fault protection
     ALARM ONLY          [ ] Alarm only
     ON                  [ ] on
     OFF                 [ ] off

3002 CT ERR. I1              Second. current I1 for max error angle of C.T.
     min. 0.003              A
     max. 1.600        ____

3003 CT ERR. F1              Error angle of C.T. at I1
     min. 0.0                °
     max. 5.0          ____

3004 CT ERR. I2              Second. current I2 for max error angle of C.T.
     min. 0.003              A
     max. 1.600        ____

3005 CT ERR. F2              Error angle of C.T. at I2
     min. 0.0                °
     max. 5.0          ____

3006 Uph<                    Phase-earth voltage of faulted phase Uph<
     min. 10                 V
     max. 100          ____

3007 Uph>                    Phase-earth voltage of healthy phases Uph>
     min. 10                 V
     max. 100          ____

3010 Ue>                     Displacement voltage level Ue>
     min. 2                  V
     max. 130          ____
```

```
3011 T-E/F                  Duration of displacement voltage for E/F det.
     min. 0.04              s
     max. 320.00/∞    _____

3012 T-UE                   Delay time T-UE of the UE> stage
     min. 0.10              s
     max. 320.00/∞    _____

3013 IEE>>                  IEE>> stage of high-sensitivity E/F prot.
     min. 0.003             A
     max. 1.000       _____

3014 T-IEE>>                Delay time T-IEE>> of the IEE>> stage
     min. 0.00              s
     max. 320.00/∞    _____

3015 IEE>> DIR.             Dir. IEE>> stage of high-sensitivity E/F prot.
     FORWARDS           [ ] Forwards
     REVERSE            [ ] Reverse
     NON-DIRECTIONAL    [ ] Non-directional

3016 CHARACTER.             Charakteristic of the sensitivity earth fault
     NORMAL INVERSE     [ ] Normal inverse
     VERY INVERSE       [ ] Very inverse
     EXTREMELY INVERS   [ ] Extremely inverse
     USER CHARACTER.    [ ] User characteristics
     LONG EARTH FAULT   [ ] Long earth fault

3017 IEE>                   IEE> stage of high-sensitivity E/F prot.
     min. 0.003             A
     max. 1.000       _____

3018 T-IEE>                 Delay time T-IEE> of the IEE> stage
     min. 0.00              s
     max. 320.00/∞    _____

3019 IEEp                   IEEp stage of high-sensitivity E/F prot.
     min. 0.003             A
     max. 1.000       _____

3020 T-IEEp                 Delay time T-IEEp of the IEEp stage
     min. 0.00              s
     max. 10.00/∞     _____

3022 IEE> DIR.              Dir. IEE> stage of high-sensitivity E/F prot.
     FORWARDS           [ ] Forwards
     REVERSE            [ ] Reverse
     NON-DIRECTIONAL    [ ] Non-directional

3023 IEE>/pDIR.             Operating direction of the IEE> or IEEp stage
     min. 0.003             A
     max. 1.000       _____

3024 PHI CORR               Correction angle for direc. determination
     min. -45.0             °
     max. 45.0        _____

3025 E/F MEAS.              Measurement mode for direc. determination
     COS PHI            [ ] Cos phi
     SIN PHI            [ ] Sin phi
```

```
3300 INTERMITT. EARTH-FAULT PROT

3301 INTERM.EF                 Intermittent earth fault protection
     OFF                   [ ] off
     ON                    [ ] on

3302 Iie>                      Pick-up value of interm. E/F stage
     min. 0.05                 I/In
     max. 25.00           ____

3303 T-det.ext.                Extension time for earth fault detection
     min. 0.00                 s
     max. 10.00           ____

3304 T-sum det.                Sum of detection times
     min. 0.00                 s
     max. 100.00          ____

3305 T-reset                   Reset time
     min. 1                    s
     max. 600             ____

3306 Nos.det.                  No. of det. for start of int. E/F prot
     min. 2
     max. 10              ____
```

```
3400 AUTORECLOSE FUNCTION

3401 AR FUNCT                  Auto-reclose function
     ON                    [ ] on
     OFF                   [ ] off

3402 AR BLO REV                Auto-reclose block with reverse faults
     NO                    [ ] no
     YES                   [ ] yes

3403 MC BLOCK                  Auto-reclose block with manual close
     YES                   [ ] yes
     NO                    [ ] no

3405 T-RECLAIM                 Reclaim time after successful AR
     min. 0.50                 s
     max. 320.00          ____

3406 T-LOCK                    Lock-out time after unsuccessful AR
     min. 0.50                 s
     max. 320.00/∞        ____

3407 T-BLOCK MC                Blocking duration with manual close
     min. 0.50                 s
     max. 320.00          ____

3424 RAR T-ACT.                Rapid auto-reclose action time
     min. 0.01                 s
     max. 320.00          ____

3425 RAR T-PHA.                Dead time after trip by phase fault stage
     min. 0.01                 s
     max. 320.00          ____
```

```
3426 RAR T-EAR.                Dead time after trip by earth fault stage
     min. 0.01                 s
     max. 320.00        ____

3443 DAR SHOT E                Permissible DAR shots after earth faults
     min. 0
     max. 9             ____

3444 DAR SHOT P                Permissible DAR shots after phase faults
     min. 0
     max. 9             ____

3445 DAR T-ACT.                Delayed auto-reclose action time
     min. 0.01                 s
     max. 320.00        ____

3446 DAR T-EAR.                Dead time after trip by earth fault stage
     min. 0.01                 s
     max. 1800.00       ____

3447 DAR T-PHA.                Dead time after trip by phase fault stage
     min. 0.01                 s
     max. 1800.00       ____
```

```
3500 O/C PROT. PHASES AR

3503 RAR T-I>>                 Trip time delay of high-set I>> before RAR
     min. 0.00                 s
     max. 60.00/∞       ____

3513 RAR T-I>                  Trip time delay of def. O/C I> before RAR
     min. 0.00                 s
     max. 60.00/∞       ____

3515 RAR T-Ip                  Time multiplier of inv. O/C Ip before RAR
     min. 0.00                 s
     max. 10.00/∞       ____

3524 RAR T-I> D                Trip time delay dir. def. O/C I> before RAR
     min. 0.00                 s
     max. 60.00/∞       ____

3525 RAR T-Ip D                Time multiplier dir. inv. O/C Ip before RAR
     min. 0.00                 s
     max. 10.00/∞       ____

3526 RAR I>>                   High-set I>> for phase faults initiate RAR
     WITH AR               [ ] With AR
     WITHOUT AR            [ ] Without AR

3527 RAR I>Ip                  O/C I> or Ip for phase faults initiate RAR
     WITH AR               [ ] With AR
     WITHOUT AR            [ ] Without AR

3528 RAR I>Ip D                Dir. O/C I> or Ip for Ph faults initiate RAR
     WITH AR               [ ] With AR
     WITHOUT AR            [ ] Without AR
```

```
3529 RAR I>> Bl                RAR is blocked by I>> stage pick-up phase
     NO                    [ ] no
     YES                   [ ] yes

3533 DAR T-I>>                 Trip time delay of high-set I>> before DAR
     min. 0.00                 s
     max. 60.00/∞       ____

3543 DAR T-I>                  Trip time delay of def. O/C I> before DAR
     min. 0.00                 s
     max. 60.00/∞       ____

3545 DAR T-Ip                  Time multiplier of inv. O/C Ip before DAR
     min. 0.00                 s
     max. 10.00/∞       ____

3554 DAR T-I> D                Trip time delay dir. def. O/C I> before DAR
     min. 0.00                 s
     max. 60.00/∞       ____

3555 DAR T-Ip D                Time multiplier dir. inv. O/C Ip before DAR
     min. 0.00                 s
     max. 10.00/∞       ____

3556 DAR I>>                   High-set I>> for phase faults initiate DAR
     WITH AR               [ ] With AR
     WITHOUT AR            [ ] Without AR

3557 DAR I>Ip                  O/C I> or Ip for phase faults initiate DAR
     WITH AR               [ ] With AR
     WITHOUT AR            [ ] Without AR

3558 DAR I>Ip D                Dir. O/C I> or Ip for Ph faults initiate DAR
     WITH AR               [ ] With AR
     WITHOUT AR            [ ] Without AR

3559 DAR I>> Bl                DAR is blocked by I>> stage pick-up phase
     NO                    [ ] no
     YES                   [ ] yes

3563 END T-I>>                 Trip time delay I>> phase before final trip
     min. 0.00                 s
     max. 60.00/∞       ____

3573 END T-I>                  Trip time delay I> phase before final trip
     min. 0.00                 s
     max. 60.00/∞       ____

3575 END T-Ip                  Time multiplier Ip phase before final trip
     min. 0.00                 s
     max. 10.00/∞       ____

3584 END T-I> D                Trip time delay dir. I> Ph before final trip
     min. 0.00                 s
     max. 60.00/∞       ____

3585 END T-Ip D                Time multiplier dir. Ip Ph before final trip
     min. 0.00                 s
     max. 10.00/∞       ____
```

```
3600 O/C PROT. EARTH AR

3603 RAR T-IE>>              Trip time delay of high-set IE>> before RAR
     min. 0.00               s
     max. 60.00/∞      _____

3613 RAR T-IE>               Trip time delay of def. O/C IE> before RAR
     min. 0.00               s
     max. 60.00/∞      _____

3615 RAR T-IEp               Time multiplier of inv. O/C IEp before RAR
     min. 0.00               s
     max. 10.00/∞      _____

3624 RAR T-IE>D              Trip time delay dir. def. O/C IE> before RAR
     min. 0.00               s
     max. 60.00/∞      _____

3625 RAR T-IEpD              Time multiplier dir. inv. O/C IEp before RAR
     min. 0.00               s
     max. 10.00/∞      _____

3626 RAR IE>>                High-set IE>> for earth faults initiate RAR
     WITH AR             [ ] With AR
     WITHOUT AR          [ ] Without AR

3627 RAR IE>IEp              O/C IE> or IEp for earth faults initiate RAR
     WITH AR             [ ] With AR
     WITHOUT AR          [ ] Without AR

3628 RAR IE>/pD              Dir. O/C IE> or IEp for E faults initiate RAR
     WITH AR             [ ] With AR
     WITHOUT AR          [ ] Without AR

3629 RAR IE>>Bl              RAR is blocked by IE>> stage pick-up earth
     NO                  [ ] no
     YES                 [ ] yes

3633 DAR T-IE>>              Trip time delay of high-set IE>> before DAR
     min. 0.00               s
     max. 60.00/∞      _____

3643 DAR T-IE>               Trip time delay of def. O/C IE> before DAR
     min. 0.00               s
     max. 60.00/∞      _____

3645 DAR T-IEp               Time multiplier of inv. O/C IEp before DAR
     min. 0.00               s
     max. 10.00/∞      _____

3654 DAR T-IE>D              Trip time delay dir. def. O/C IE> before DAR
     min. 0.00               s
     max. 60.00/∞      _____

3655 DAR T-IEpD              Time multiplier dir. inv. O/C IEp before DAR
     min. 0.00               s
     max. 10.00/∞      _____

3656 DAR IE>>                High-set IE>> for earth faults initiate DAR
     WITH AR             [ ] With AR
     WITHOUT AR          [ ] Without AR
```

```
3657 DAR IE>IEp               O/C IE> or IEp for earth faults initiate DAR
     WITH AR              [ ] With AR
     WITHOUT AR           [ ] Without AR

3658 DAR IE>/pD               Dir. O/C IE> or IEp for E faults initiate DAR
     WITH AR              [ ] With AR
     WITHOUT AR           [ ] Without AR

3659 DAR IE>>Bl               DAR is blocked by IE>> stage pick-up earth
     NO                   [ ] no
     YES                  [ ] yes

3663 END T-IE>>               Trip time delay IE>> earth before final trip
     min. 0.00                s
     max. 60.00/∞        ____

3673 END T-IE>                Trip time delay IE> earth before final trip
     min. 0.00                s
     max. 60.00/∞        ____

3675 END T-IEp                Time multiplier IEp earth before final trip
     min. 0.00                s
     max. 10.00/∞        ____

3684 END T-IE>D               Trip time delay dir. IE> E before final trip
     min. 0.00                s
     max. 60.00/∞        ____

3685 END T-IEpD               Time multiplier dir. IEp E before final trip
     min. 0.00                s
     max. 10.00/∞        ____
```

```
3700 EARTH FAULT AR

3703 R T-IEE>>                Trip time delay of IEE>> before RAR
     min. 0.00                s
     max. 320.00/∞       ____

3713 R T-IEE>                 Trip time delay of IEE> before RAR
     min. 0.00                s
     max. 320.00/∞       ____

3715 R T-IEEp                 Time multiplier of IEEp before RAR
     min. 0.00                s
     max. 10.00/∞        ____

3726 R IEE>>                  High-set IEE>> stage for earth faults initiate
     WITH AR              [ ] With AR
     WITHOUT AR           [ ] Without AR

3727 R IEE>/p                 O/C IEE> or IEEp for earth faults initiate RAR
     WITH AR              [ ] With AR
     WITHOUT AR           [ ] Without AR

3729 R IEE>> Bl               RAR is blocked by IEE>> stage pick-up earth
     NO                   [ ] no
     YES                  [ ] yes
```

```
3733 D T-IEE>>              Trip time delay of IEE>> before DAR
     min. 0.00              s
     max. 320.00/∞    _____

3743 D T-IEE>               Trip time delay of IEE> before DAR
     min. 0.00              s
     max. 320.00/∞    _____

3745 D T-IEEp               Time multiplier of IEEp before DAR
     min. 0.00              s
     max. 10.00/∞     _____

3756 D IEE>>                High-set IEE>> stage for earth faults initiate
     WITH AR            [ ] With AR
     WITHOUT AR         [ ] Without AR

3757 D IEE>/p               O/C IEE> or IEEp for earth faults initiate DAR
     WITH AR            [ ] With AR
     WITHOUT AR         [ ] Without AR

3759 D IEE>> Bl             DAR is blocked by IEE>> stage pick-up earth
     NO                 [ ] no
     YES                [ ] yes

3763 E T-IEE>>              Trip time delay IEE>> earth before final trip
     min. 0.00              s
     max. 320.00/∞    _____

3773 E T-IEE>               Trip time delay IEE> earth before final trip
     min. 0.00              s
     max. 320.00/∞    _____

3775 E T-IEEp               Time multiplier IEEp earth before final trip
     min. 0.00              s
     max. 10.00/∞     _____
```

```
3900 BREAKER FAILURE PROTEC.

3901 B/F PROT.              Circuit breaker failure protection
     OFF                [ ] off
     ON, INTERN.START   [ ] On, internal start
     ON, EXTERN.START   [ ] On, external start
     ON, INT. OR EXT.   [ ] On, int.or ext.start

3911 I> B/F                 Pick-up threshold of current detector I>B/F

     min. 0.10              I/In
     max. 4.00        _____

3912 T-B/F                  Delay time T-B/F
     min. 0.06              s
     max. 60.00/∞     _____
```

Tests and Commissioning Aids 7SJ512

4000 TESTS

4200 DIRECTIONAL TESTS

4201 DIREC. TEST	Direction test L1-E
4203 DIREC. TEST	Direction test L2-E
4205 DIREC. TEST	Direction test L3-E

4300 CB TEST TRIP-CLOSE CYCLE

4304 CB TEST	Circuit breaker test with AR 3pole

4400 CB TEST LIVE TRIP

4404 CB TRIP	Circuit breaker trip test 3pole

4900 TEST FAULT RECORDING

4901 FAULT REC.	Initiation of fault recording

Annunciations, Measured Values etc. 7SJ512

5000 ANNUNCIATIONS

5100 OPERATIONAL ANNUNCIATIONS

5200 LAST FAULT

5300 2nd TO LAST FAULT

5400 3rd TO LAST FAULT

5500 ISOLATED EARTH FLT DATA

5600 CB OPERAT. STATISTICS

5602 AR 3pole=	No. of auto-reclose commands:3p RAR
5603 DAR 3pol=	No. of auto-reclose commands:3p DAR
5604 Trip No =	Number of trip commands issued
5607 ∑IL1/In=	Summated current tripped IL1/In
5608 ∑IL2/In=	Summated current tripped IL2/In
5609 ∑IL3/In=	Summated current tripped IL3/In
5610 Il1/In=	Last trip current L1 IL1/In=
5611 IL2/In=	Last trip current L2 IL2/In=
5612 IL3/In	Last trip current L3 IL3/In=

5700 OPERATIONAL MEASURED VALUES

5701 IL1[%] =	Current in phase IL1 [%] =
5702 IL2[%] =	Current in phase IL2 [%] =
5703 IL3[%] =	Current in phase IL3 [%] =
5704 IE[%]=	IE[%]=
5705 UL1E[%]=	UL1E [%]=
5706 UL2E[%]=	UL2E [%]=
5707 UL3E[%]=	UL3E [%]=
5708 UE[%]=	UE[%]=
5709 Pa[%]=	Active power Pa [%] =
5710 Pr[%]=	Reactive power Pr [%] =
5711 S[%]=	Apparent power S[%]=
5712 f [%]=	Frequency f [%] =
5713 IL1 =	Current in phase IL1 =
5714 IL2 =	Current in phase IL2 =
5715 IL3 =	Current in phase IL3 =
5716 IEa =	Operational measurement: IEa=
5717 UL1E=	Voltage UL1E =
5718 UL2E=	Voltage UL2E =
5719 UL3E=	Voltage UL3E =

```
5720 UE=                     Voltage UE=
5721 Pa=                     Active power Pa =
5722 Pr=                     Reactive power Pr =
5723 S=                      Apparent power S=
5724 COS PHI=                Power factor cos phi
```

```
5800 ISOL. E/F MEASURED VALUES

5801 IEEa =                  Iea =
5802 IEEr =                  Ier =
5803 IEEa[mA]=               Iea [mA] =
5804 IEEr[mA]=               Ier [mA] =
```

```
5900 OVERLOAD MEASURED VALUES

5901 Θ/ΘtripL1=              Temperature rise for phase L1
5902 Θ/ΘtripL2=              Temperature rise for phase L2
5903 Θ/ΘtripL3=              Temperature rise for phase L3
5904 Θ/Θtrip =               Temperat. rise for warning and trip
```

Reference Table for Configuration Parameters 7SJ512

6000 MARSHALLING

6100 MARSHALLING BINARY INPUTS

6101 BINARY INPUT 1 Binary input 1

6102 BINARY INPUT 2 Binary input 2

6103 BINARY INPUT 3 Binary input 3

6104 BINARY INPUT 4 Binary input 4

6105 BINARY INPUT 5 Binary input 5

6106 BINARY INPUT 6 Binary input 6

6107 BINARY INPUT 7 Binary input 7

6108 BINARY INPUT 8 Binary input 8

6200 MARSHALLING SIGNAL RELAYS

6201 SIGNAL RELAY 1 Signal relay 1

6202 SIGNAL RELAY 2 Signal relay 2

6203 SIGNAL RELAY 3 Signal relay 3

6204 SIGNAL RELAY 4 Signal relay 4

6205 SIGNAL RELAY 5 Signal relay 5

6206 SIGNAL RELAY 6 Signal relay 6

6207 SIGNAL RELAY 7 Signal relay 7

6208 SIGNAL RELAY 8 Signal relay 8

6209 SIGNAL RELAY 9 Signal relay 9

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 TRIP RELAYS

6401 TRIP RELAY 1 Trip relay 1

6402 TRIP RELAY 2 Trip relay 2

6403 TRIP RELAY 3 Trip relay 3

6404 TRIP RELAY 4 Trip relay 4

```
7000 OP. SYSTEM CONFIGURATION
____________________________________________________________________________

7100 INTEGRATED OPERATION

7101 LANGUAGE                 Language
     DEUTSCH              [ ] German
     ENGLISH              [ ] English
     US-ENGLISH           [ ] US-English

7102 DATE FORMAT              Date format
     DD.MM.YYYY           [ ] dd.mm.yyyy
     MM/DD/YYYY           [ ] mm/dd/yyyy

7105 OPER. 1st L              Operational message for 1st display line

     _________________        _______________________________________

7106 OPER. 2nd L              Operational message for 2nd display line

     _________________        _______________________________________

7107 FAULT 1st L              Fault message for 1st display line

     _________________        _______________________________________

7108 FAULT 2nd L              Fault message for 2nd display line

     _________________        _______________________________________

7110 FAULT INDIC              Fault indication: LED and LCD
     WITH FAULT DETEC     [ ] With fault detection
     WITH TRIP COMM.      [ ] With trip command
____________________________________________________________________________

7200 PC/SYSTEM INTERFACES

7201 DEVICE ADD.              Device address
     min. 1
     max. 254            ____

7202 FEEDER ADD.              Feeder address
     min. 1
     max. 254            ____

7203 SUBST. ADD.              Substation address
     min. 1
     max. 254            ____

7208 FUNCT. TYPE              Function type in accordance with VDEW/ZVEI
     min. 1
     max. 254            ____

7209 DEVICE TYPE              Device type
     min. 0
     max. 255            ____

7211 PC INTERF.               Data format for PC-interface
     DIGSI V3             [ ] DIGSI V3
     ASCII                [ ] ASCII
```

```
7215 PC BAUDRATE              Transmission baud rate for PC-interface
     9600 BAUD           [ ] 9600 Baud
     19200 BAUD          [ ] 19200 Baud
     1200 BAUD           [ ] 1200 Baud
     2400 BAUD           [ ] 2400 Baud
     4800 BAUD           [ ] 4800 Baud

7216 PC PARITY                Parity and stop-bits for PC-interface
     DIGSI V3            [ ] DIGSI V3
     NO 2 STOP           [ ] No parity,2 stopbits
     NO 1 STOP           [ ] No parity,1 stopbit

7221 SYS INTERF.              Data format for system-interface
     VDEW COMPATIBLE     [ ] VDEW compatible
     VDEW EXTENDED       [ ] VDEW extended
     DIGSI V3            [ ] DIGSI V3
     LSA                 [ ] LSA

7222 SYS MEASUR.              Measurement format for system-interface
     VDEW COMPATIBLE     [ ] VDEW compatible
     VDEW EXTENDED       [ ] VDEW extended

7225 SYS BAUDR.               Transmission baud rate for system-interface
     9600 BAUD           [ ] 9600 Baud
     19200 BAUD          [ ] 19200 Baud
     1200 BAUD           [ ] 1200 Baud
     2400 BAUD           [ ] 2400 Baud
     4800 BAUD           [ ] 4800 Baud

7226 SYS PARITY               Parity and stop-bits for system-interface
     VDEW/DIGSIV3/LSA    [ ] VDEW/DIGSI V3/LSA
     NO 2 STOP           [ ] No parity,2 stopbits
     NO 1 STOP           [ ] No parity,1 stopbit

7235 SYS PARAMET              Parameterizing via system-interface
     NO                  [ ] no
     YES                 [ ] yes
```

```
7400 FAULT RECORDINGS

7402 INITIATION               Initiation of data storage
     STORAGE BY FD.      [ ] Storage by fault det
     STORAGE BY TRIP     [ ] Storage by trip
     START WITH TRIP     [ ] Start with trip

7403 SCOPE                    Scope of stored data
     FAULT EVENT         [ ] Fault event
     FAULT IN POW.SYS    [ ] Fault in power syst.

7410 T-MAX                    Maximum time period of a fault recording
     min. 0.30                s
     max. 5.00           ____

7411 T-PRE                    Pre-trigger time for fault recording
     min. 0.05                s
     max. 0.50           ____

7412 T-POST                   Post-fault time for fault recording
     min. 0.05                s
     max. 0.50           ____
```

```
7431 T-BINARY IN          Storage time by initiation via binary input
     min. 0.10            s
     max. 5.00/∞      ____

7432 T-KEYBOARD           Storage time by initiation via keyboard
     min. 0.10            s
     max. 5.00        ____

7490 SYS LENGTH           Length of fault record (former LSA)
     660 VALUES FIX   [ ] 660 values fix
     <=3000 VAL. VAR  [ ] <=3000 val. var
```

```
7800 SCOPE OF FUNCTIONS

7812 CHARAC. PH           Characteristic O/C protection phases
     DEFINITE TIME    [ ] Definite time
     INVERSE TIME     [ ] Inverse time

7815 CHARAC. E            Characteristic O/C protection earth
     DEFINITE TIME    [ ] Definite time
     INVERSE TIME     [ ] Inverse time

7826 PARAM. BI            Dyn. parameter change-over via binary input
     NON-EXIST        [ ] Non-existent
     EXIST            [ ] Existent

7827 THERMAL OL           Thermal overload protection
     NON-EXIST        [ ] Non-existent
     EXIST            [ ] Existent

7830 EARTH FAULT          Configuration: earth fault protection
     NON-EXIST        [ ] Non-existent
     EXIST            [ ] Existent

7833 INTERMIT.EF          Intermittent earth fault protection
     NON-EXIST        [ ] Non-existent
     EXIST            [ ] Existent

7834 INTERNAL AR          Internal auto-reclose function
     NON-EXIST        [ ] Non-existent
     EXIST            [ ] Existent

7842 DIRECTION            Configuration: directional O/C protection
     NON-EXIST        [ ] Non-existent
     EXIST            [ ] Existent

7885 PARAM. C/O           Parameter change-over
     NON-EXIST        [ ] Non-existent
     EXIST            [ ] Existent

7899 FREQUENCY            Rated system frequency
     fN 50 Hz         [ ] fN 50 Hz
     fN 60 Hz         [ ] fN 60 Hz
```

```
7900 DEVICE CONFIGURATION

7901 I>>                    With trip by I>> stage phase faults
     WITH AR            [ ] With AR
     WITHOUT AR         [ ] Without AR

7902 I>/Ip                  With trip by I> or Ip stage phase faults
     WITH AR            [ ] With AR
     WITHOUT AR         [ ] Without AR

7903 I>/Ip GER.             With trip by dir. I> or Ip stage phase faults
     WITH AR            [ ] With AR
     WITHOUT AR         [ ] Without AR

7904 IE>>                   With trip by IE>> stage earth faults
     WITH AR            [ ] With AR
     WITHOUT AR         [ ] Without AR

7905 IE>/IEp                With trip by IE> or IEp stage earth faults
     WITH AR            [ ] With AR
     WITHOUT AR         [ ] Without AR

7906 IE>/IEp GER            With trip by dir. IE> or IEp stage earth fault
     WITH AR            [ ] With AR
     WITHOUT AR         [ ] Without AR

7907 IEE>>                  With trip by IEE>> stage earth faults
     WITH AR            [ ] With AR
     WITHOUT AR         [ ] Without AR

7908 IEE>/IEEp              With trip by IEE> or IEEp stage earth faults
     WITH AR            [ ] With AR
     WITHOUT AR         [ ] Without AR

7909 AR CYCLES              Trip time delay of the AR-cycles
     IDENTICAL CYCLES   [ ] Identical cycles
     RAR/DAR/END DIFF   [ ] RAR/DAR/end diff

7910 CB TEST BI             CB test via binary input program
     THREE-POLE TRIP    [ ] Three-pole trip
     TRIP-CLOSE 3POLE   [ ] Trip-close 3pole
```

Operational Device Control Facilities 7SJ512

```
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

8206 RESET                Reset of earth fault report buffer
```

```
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

To

SIEMENS AKTIENGESELLSCHAFT

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From

Name

Company/Dept.

Address

Telephone no.

Dear reader,

printing errors can never be entirely eliminated: therefore, should you come across any when reading this manual, kindly enter them in this form together with any comments or suggestions for improvement that you may have.

Corrections/Suggestions

Substantial alterations against previous issue:

Revision with regard to firmware version V3.2

Subject to technical alteration

Siemens Aktiengesellschaft

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