SIEMENS

Numerical Overcurrent Time Protection and Overload Protection

7SJ511 v_{3.2}

Instruction Manual

Order No. C53000-G1176-C101-4

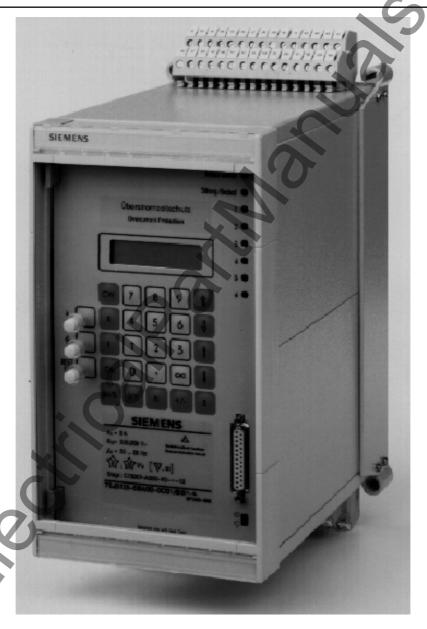


Illustration of the numerical overcurrent time and overload protection relay 7SJ511 (housing for surface mounting)

7SJ511 V3 Conformity

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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).

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NOTE:

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

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

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

7SJ511 v₃ Introduction

1 Introduction

1.1 Application

The 7SJ511 is used as definite time overcurrent protection or inverse time overcurrent protection 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 differential protection. The treatment of the system star point is of no concern.

Type 7SJ512 is available for use in systems with infeed from both sides, in ring feeders as well as in parallel lines or transformers with infeed from one side. This model incorporates directional measuring systems for all types of fault.

A special time stage is suitable for breaker failure detection.

A thermal overload protection is integrated, e.g. for use on cables.

A special protection function can be ordered for detection of intermittent earth faults. This accumulates the earth fault durations and trips when a set limit has been exceeded within a selected time interval.

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

Continuous monitoring of the measured values permits annunciation of faults in the current transformer circuits which lead to asymmetry of the currents. 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 in accordance with VDEW/ZVEI and IEC 60870-5-103 is used, as well as according 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 decision 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 DC converter;
- insensitive against d.c. components, inrush or charging and high frequency transients in the measured currents;
- circuit breaker operation test facility by test trip or trip—close sequence;
- continuous calculation of operational measured values and indication on the front display;
- supplementary functions (see also Section 1.3);
- simple setting and operation using the integrated operation panel or a connected personal computer with menu-guided 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; tripped current log;
- continuous monitoring of measured values as well as hardware and software of the unit;
- communication with central control and storage devices via serial interfaces is possible, optionally with 2 kV insulation or for connection of optical fibre.

7SJ511 v₃ Introduction

1.3 Implemented functions

The unit comprises the following functions:

Overcurrent time 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 and earth current;
- additionally, one user specified current time characteristic can be defined;
- adjustable inrush stabilization for switching of power transformers, selectable for each individual phase or with cross-block function.

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.

Intermittent earth fault protection (optional)

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

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;

The standard functions also include:

- continuous <u>self-monitoring</u> right from the d.c. circuits, through the current 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,
- annunciation storage for the last four <u>network</u> faults, with real time clock;
- data storage and transmission for <u>fault recording</u> giving rapid fault analysis, detailed fault records;
- counting of tripping commands as well as recording of fault data and accumulative addition of the interrupted fault currents;
- commissioning aids such as test record and circuit breaker live test.

7SJ511 _{V3} Introduction

1.4 Application examples

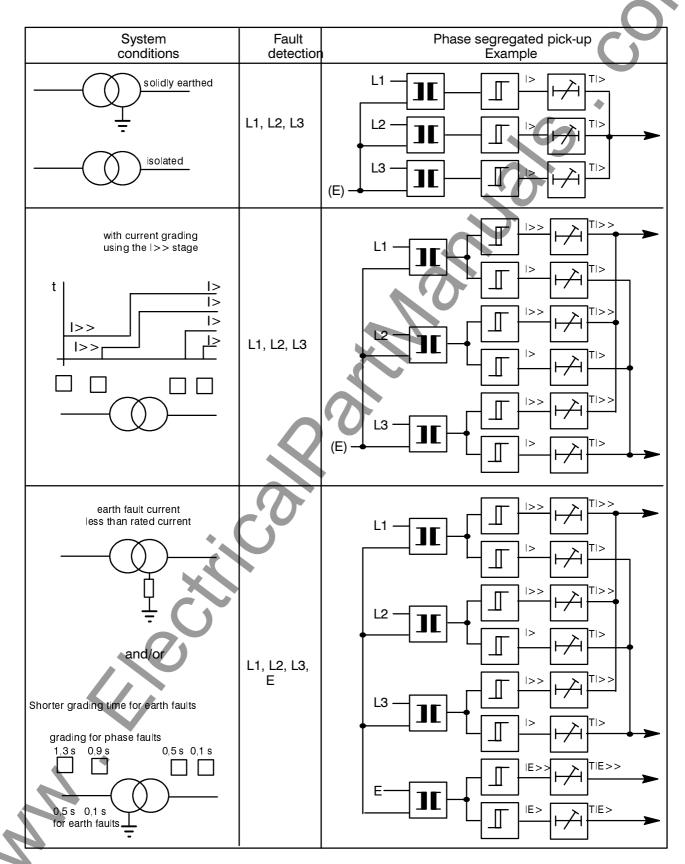


Figure 1.1 Application examples for definite time overcurrent protection

7SJ511 v3 Introduction

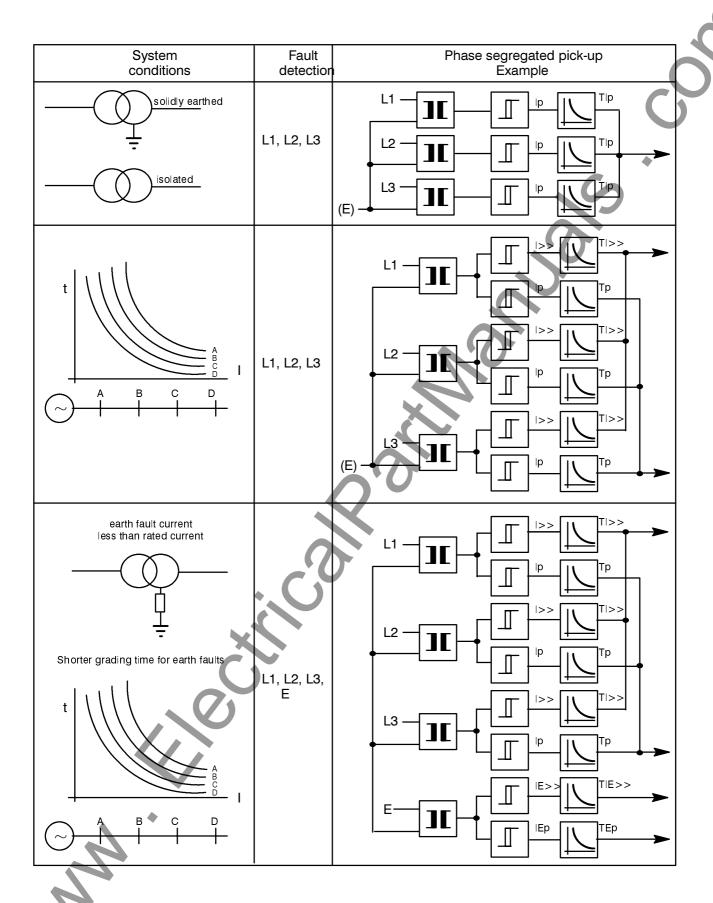


Figure 1.2 Application examples for inverse time overcurrent protection

7SJ511V3 Design

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:

 7SJ511★-★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 isolated interface to a central control and storage unit, an additional coupling facility has been provided. For the hard-wired V.24 (RS232C) serial interface (model 7SJ511*-****-**B), 4 screwed terminals are provided. For the interface for optical fibre connection (model 7SJ511*-****-*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.

 7SJ511★-★C***- in housing 7XP2030-2 for panel flush mounting or 7SJ511*-*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 isolated interface to a central control and storage unit $(7SJ511\star - \star\star\star\star\star - \star \mathbf{B})$ is led to a 4-pole connection module. In the interface for optical fibre connection $(7SJ511\star - \star\star\star\star\star - \star \mathbf{C})$, a module with 2F-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. **1A2**); 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.

7SJ511 V3 Design

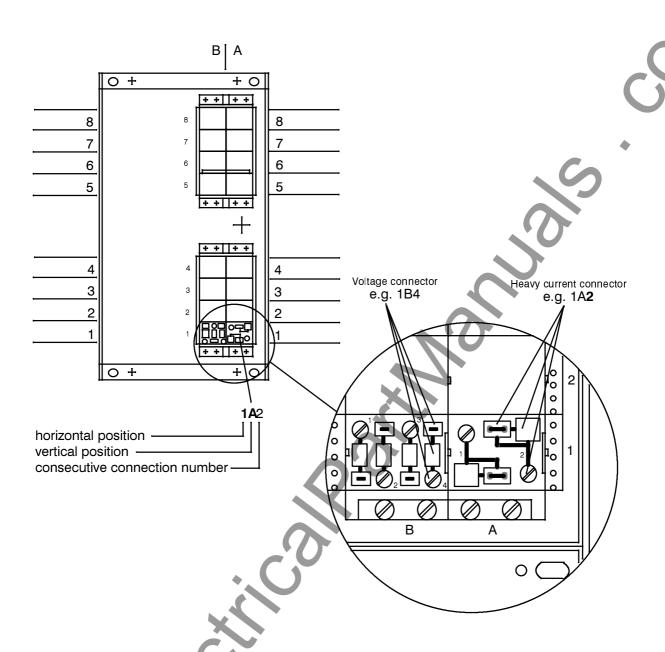


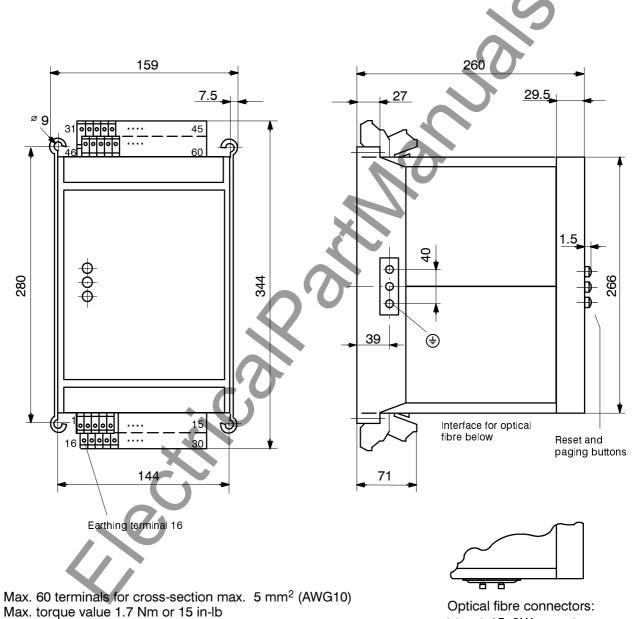
Figure 2.1 Connection plugs (rear view) - housing for flush mounting - example

7SJ511V3 Design

2.2 **Dimensions**

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

7SJ511 Housing for panel surface mounting 7XP2030-1



Max. torque value 1.7 Nm or 15 in-lb

integrated F-SMA connector e.g for glass fibre 62.5/125 jum

Dimensions in mm

Dimensions for housing 7XP2030-1 for panel surface mounting

7SJ511 V3 Design

7SJ511 Housing for panel flush mounting or cubicle installation 7XP2030-2

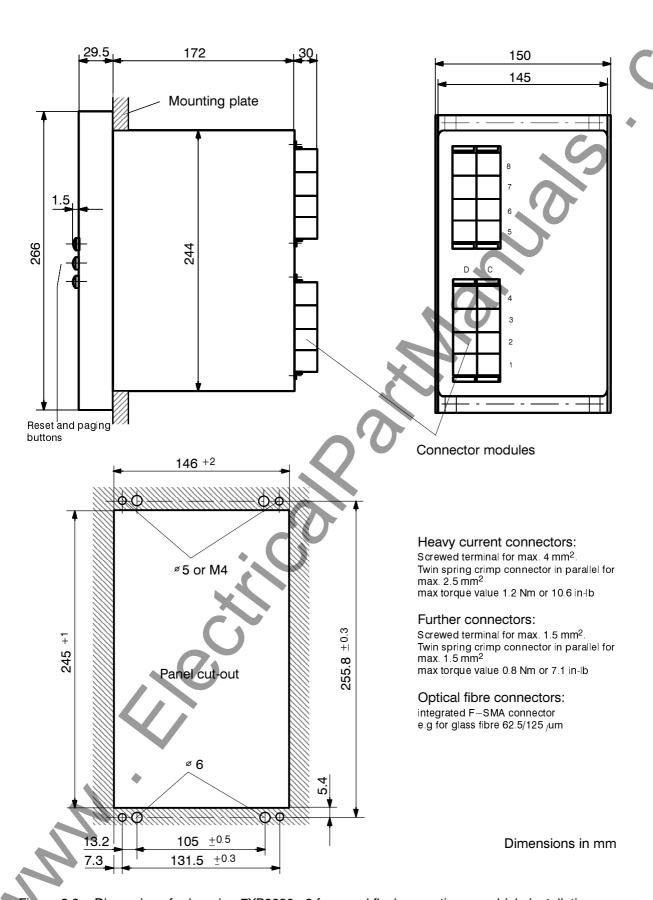
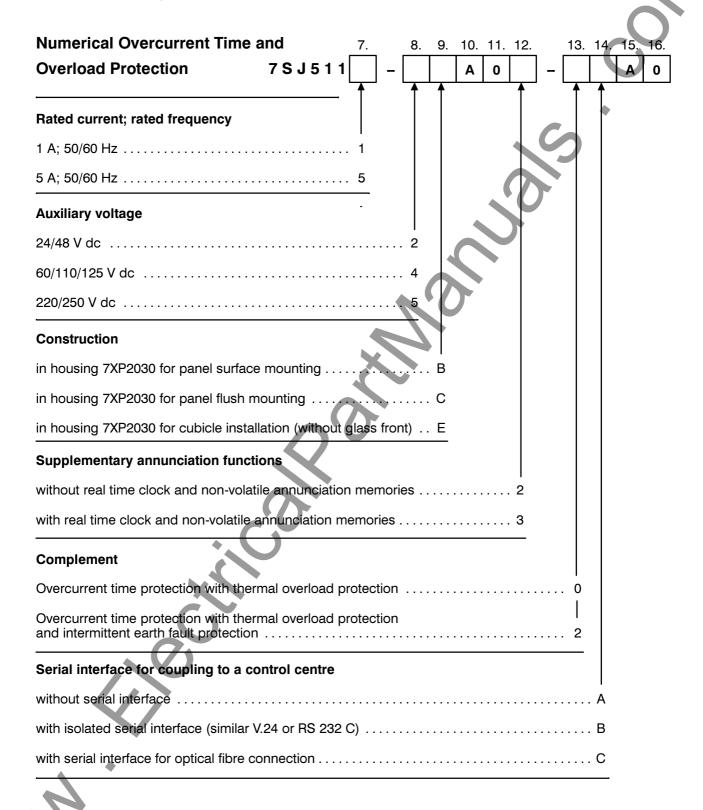


Figure 2.3 Dimensions for housing 7XP2030-2 for panel flush mounting or cubicle installation

7SJ511V3 Design

2.3 Ordering data



C53000 – G1176 – C101

7SJ511 v3 Technical data

3 Technical data

3.1 General data

3.1.1 Inputs/outputs

Magai	ırina	aira	.ita
Measi	urnig	CITC	นแร

Rated current I_N 1 A or 5 A

Rated frequency f_N 50 Hz/60 Hz (selectable)

Power consumption current path at $I_N = 1$ A <0.1 VA per phase and earth path

current path at $I_N = 5 A$ <0.5 VA per phase and earth path

Overload capability current path

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, ≤ 12 % at rated voltage

peak-to-peak ≤ 6 % at limits of admissible voltage

Power consumption quiescent approx. 7 W

energized approx. 11 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 2 (can be marshalled)

Contacts per relays 2 NO

Switching capacity MAKE 1000 W/VA BREAK 30 W/VA

Switching voltage 250 \

Permissible current 5 A continuous 30 A for 0.5 s

Signal contacts

Signal/alarm relays 4 (can be marshalled)/1

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

Binary inputs, number 2 (can be marshalled)

Operating voltage 24 to 250 Vdc

Current consumption approx. 1.7 mA, independent on 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

as delivered 9600 Baud

min. 1200 Baud; max. 19200 Baud

Floating interface for data transfer

to a control centre

Optical wave length

Transmission distance

Permissible line attenuation

- Standards

- Transmission speed

protocol according to VDEW/ZVEI and IEC 60870-

isolated

5-103 or DIN 19244 (selectable)

similar V.24/V.28 to CCITT; RS 232 C to EIA

- 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 mm²

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

820 nm max. 8 dB max. 1.5 km

Normal signal position reconnectable; factory setting: "light off"

3.1.2 Electrical tests

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Insulation tests	
Standards:	IEC 60255-5
 High voltage test (routine test) except d.c. voltage supply input 	2 kV (rms); 50 Hz
 High voltage test (routine test) only d.c. voltage supply input 	2.8 kV dc
 Impulse voltage test (type test) all circuits, class III 	5 kV (peak); 1.2/50 μ s; 0.5 J; 3 positive and 3 negative shots at intervals of 5 s
EMC tests; immunity (type tests)	
Standards:	IEC 60255-6, IEC 60255-22 (product standards) EN 50082-2 (generic standard) VDE 0435 /part 303
High frequencyIEC 60255-22-1, class III	2.5 kV (peak); 1 MHz; τ =15 μ s; 400 shots/s; duration 2 s
 Electrostatic discharge IEC 60255-22-2 class III and IEC 61000-4-2, class III 	4 kV/6 kV contact discharge; 8 kV air discharge; both polarities; 150 pF; $\rm R_i = 330~\Omega$
 Radio-frequency electromagnetic field, non-modulated; IEC 60255-22-3 (report) class 	10 V/m; 27 MHz to 500 MHz III
 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; $R_{\rm i}$ = 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	150 kHz to 30 MHz
CISPR 22, EN 55022, class B 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 sinusoidal

IEC 60255-21-1, class 1 10 Hz to 60 Hz: <u>+</u> 0.035 mm amplitude; IEC 60068-2-6 60 Hz to 150 Hz: 0.5 g acceleration

60 Hz to 150 Hz: 0.5 g acceleration sweep rate 1 octave/min

20 cycles in 3 orthogonal axes

Shock half sine

IEC 60255-21-2, class 1 acceleration 5 g, duration 11 ms, 3 shocks in

each direction of 3 orthogonal axes

- Seismic vibration sinusoidal

IEC 60255-21-3, class 1 1 Hz to 8 Hz; <u>+</u> 3.5 mm amplitude (hor. axis) IEC 60068-3-3 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 sinusoidal

IEC 60255-21-1, class 2 5 Hz to 8 Hz: <u>+</u> 7.5 mm amplitude; IEC 60068-2-6 8 Hz to 150 Hz: 2 g acceleration

sweep rate 1 octave/min
20 cycles in 3 orthogonal axes

Shock half sine

IEC 60255-21-2, class 1 acceleration 15 g, duration 11 ms, 3 shocks in

IEC 60068-2-27 each direction of 3 orthogonal axes

Continuous shock
 half si

IEC 60255-21-2, class 1 acceleration 10 g, duration 16 ms, 1000 shocks

IEC 60068-2-29 each direction of 3 orthogonal axes

3.1.4 Climatic stress tests

- recommended temperature during service -5 °C to +55 °C (> 55 °C decreased - permissible temperature during service -20 °C to +70 °C display contrast)

permissible temperature during storage -25 °C to +55 °C

permissible temperature during transport —25 °C to +70 °C

Storage and transport with standard works packaging!

- Permissible humidity

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

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

3.1.5 Service conditions

The relay is designed for use in industrial environment, for installation in standard relay rooms and compartments so that with proper installation **electro-magnetic compatibility (EMC)** is ensured. The following should also be heeded:

- All contactors and relays which operate in the same cubicle or on the same relay panel as the digital protection equipment should, as a rule, be fitted with suitable spike quenching elements.
- All external connection leads in sub-stations from 100 kV upwards should be screened with a screen capable of carrying power currents and earthed at both sides. No special measures are

normally necessary for sub-stations of lower voltages.

It is not permissible to withdraw or insert individual modules under voltage. In the withdrawn condition, some components are electrostatically endangered; during handling the standards for electrostatically endangered components must be observed. The modules are not endangered when plugged in.

WARNING! The relay is not designed for use in residential, commercial or light-industrial environment as defined in EN 50081.

3.1.6 Design

Housing 7XP20; refer to Section 2.1

Dimensions refer to Section 2.2

Weight

in housing for surface mounting
in housing for flush mounting
approx. 8.0 kg
approx. 6.5 kg

Degree of protection acc. to EN 60529

HousingTerminalsIP 51 *)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)

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)

Delay times T 0.00 s to 60.00 s (steps 0.01 s) or infinite

approx 35 ms

Times

Pick-up times for I>, I>>, $I_E>$, $I_E>>$

Reset times for I>, I>>, I_E >, I_E >>

at 2 x setting value, without meas. repetition
at 2 x setting value, with meas. repetition
approx 33 ms
approx 50 ms
approx 25 ms

at 5 x setting value, with meas. repetition approx 40 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 $0.8 \le U_H/U_{HN} \le 1.15 \\ \le 1~\%$

- Temperature in range

 $0 \, ^{\circ}\text{C} \le \vartheta_{\text{amb}} \le 40 \, ^{\circ}\text{C}$ $\le 0.5 \, \%/10 \, \text{K}$

- Frequency in range $0.98 \le f/f_N \le 1.02 \le 1 \%$

- Frequency in range

 $0.95 \le f/f_N \le 1.05$ $\le 2.5 \%$

- Harmonics
up to 10 % of 3rd harmonic \leq 1 %
up to 10 % of 5th harmonic \leq 1 %

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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 Ip, IEp	T_p	0.05 to 10.00	(steps 0.01) or 0 or ∞
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)

Delay time for I>>, I_E >> T 0.00 s to 60.00 s (steps 0.01 s) or ∞

Trip time characteristics

acc. IEC 60255-3 and BS 142 (refer Figure 3.1)

Normal inverse (IEC 60255-3 type A)
$$t = \frac{0.14}{(I/I_p)^{0.02} - 1}$$
 Tp

Very inverse (IEC 60255-3 type B)
$$t = \frac{13.5}{(I/I_D)^1 - 1} \cdot T_I$$

Extremely inverse (IEC 60255-3 type C)
$$t = \frac{80}{(|I|_p)^2 - 1} \cdot T$$

where:

tripping time
Tp set time multiplier
I fault current
Ip set pickup value

One additional user specified characteristic can be set.

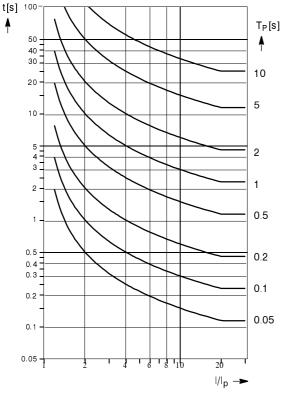
Pick-up threshold approx. $1.1 \cdot I_p$

Tolerances

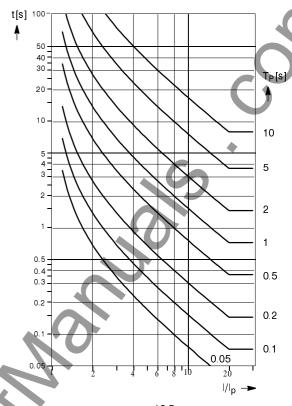
Pick-up values I>>, I_E>>	3 % of setting value
– Delay time for $2 \le I/I_p \le 20$	5 % of setting value
	additionally 2 % or 30 ms

Influence variables

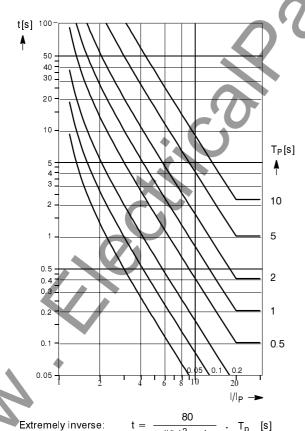
 Auxiliary voltage in range 	
$0.8 \le U_{H}/U_{HN} \le 1.15$	≤1 %
 Temperature in range 	
$0~^{\circ}\text{C} \leq \vartheta_{amb} \leq 40~^{\circ}\text{C}$	\leq 0.5 %/10 K
 Frequency in range 	
$0.95 < f/f_N < 1.05$	< 8 %



Normal inverse: $t = \frac{0.14}{(|I|_p)^{0.02} - 1} \ \cdot \ T_p \quad [s]$



Very inverse: $t = \frac{13.5}{(|I|_p) - 1}$. T_p [s]



 $\begin{array}{ll} t & \text{trip time} \\ T_p & \text{set time multiplier} \\ I & \text{Fault current} \\ I_p & \text{Set pick-up current} \end{array}$

Note: For earth faults read $|_{Ep}$ instead of $|_{p}$ and $|_{Ep}$ instead of $|_{p}$

Figure 3.1 Trip time characteristics of inverse time overcurrent protection

3.4 Thermal overload protection

Setting ranges/steps

Factor k according to IEC 60255-8 0.10 to 4.00 (steps 0.01) Time constant τ 1.0 to 999.9 min (steps 0.1 min)

Thermal warning stage $\Theta_{\text{warn}}/\Theta_{\text{trip}}$ 50 to 100 % referred to trip temperature rise

(steps 1%)

Current warning stage I_{warn}/I_N 0.10 to 4.00 (steps 0.01)

Trip time characteristic $t = \tau \cdot ln \frac{(l/k \cdot l_N)^2 - (l_{pre}/k \cdot l_N)^2}{2}$

 $(I/k \cdot I_N)^2 - 1$

 $\begin{array}{ll} t & \text{trip time} \\ \tau & \text{time constant} \\ I & \text{load current} \\ I_{\text{pre}} & \text{preload current} \end{array}$

k factor according to IEC 60255-8 refer also to Figures 3.2 and 3.3

Reset ratios

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

Tolerances

- referring to $k \cdot I_N$ $\pm 10 \%$ $\pm 10 \% \pm 2 s$

Influence variables referred to k·I_N

- Auxiliary dc voltage in range 0.8 \leq U_H/U_{HN} \leq 1.15 \leq 1 %

- Temperature in range -5 °C ≤ ϑ_{amb} ≤ +40 °C ≤ 0.5 %/10 K

-5 °C \leq $\vartheta_{\rm amb}$ \leq +40 °C \leq 0.5 %/10 K \leq 0.5 %/10 K

 $0.95 \le f/f_N \le 1.05$ $\le 1 \%$

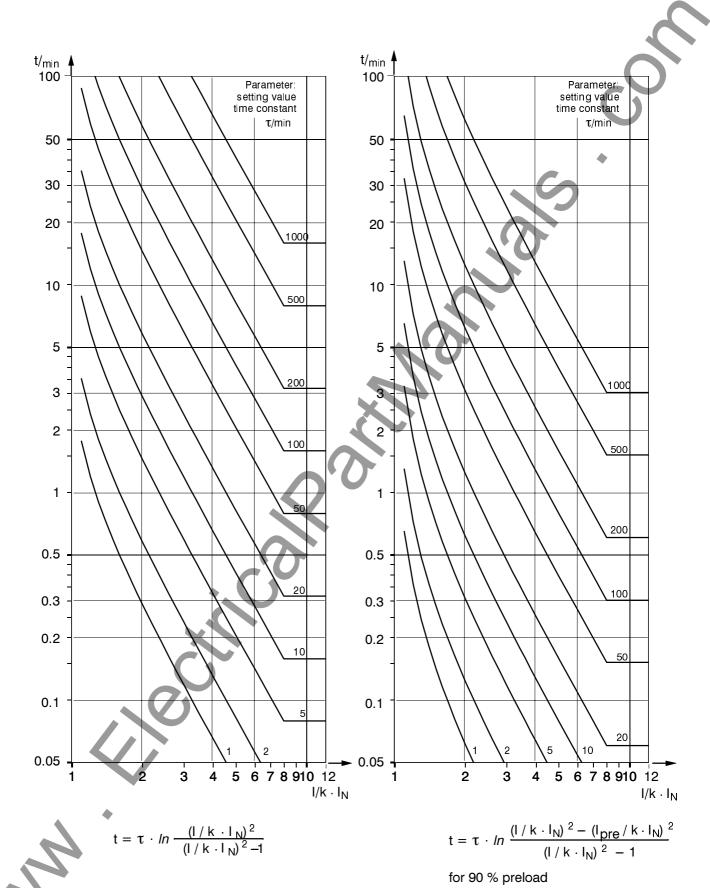


Figure 3.2 Trip time characteristic of overload protection – without preload –

Figure 3.3 Trip time characteristic of overload protection – with 90 % preload –

3.5 Intermittent earth fault protection (optional)

Setting ranges/steps

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_{IF}>
- Times

3 % of setting value

1 % of setting value or 10 ms

Influence variables

- Auxiliary voltage in range $0.8 \le U_H/U_{HN} \le 1.15$
- Temperature in range 0 $^{\circ}$ C $\leq \vartheta_{amb} \leq$ 40 $^{\circ}$ C
- Frequency in range $0.95 \le f/f_N \le 1.05$

≤1 %

 \leq 0.5 %/10 K

 \leq 3 %

3.6 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 ∞ (infinite)

Times

pick-up time

with internal start included in O/C pick-up time

– with external start approx 40 ms

Reset time approx 40 ms

Tolerances

- Pick-up value

- Delay time T

3 % of setting value

1 % of setting value or 20 ms

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3.7 Ancillary functions

Operational value measurements

- operational current values I_{L1} ; I_{L2} ; I_{L3} ; I_{E} measurement range 0 % to 240 % I_{N}

tolerance ≤ 2 % of rated value or of measured value

– thermal overload values $\Theta/\Theta_{\text{trip}}$

measurement range 0 % to 200 % tolerance 3 % referred to $\Theta_{\rm trip}$

Measured values plausibility checks

sum of currentsphases and earth

Steady-state measured value supervision

current unbalance $I_{max}/I_{min} >$ symmetry factor

as long as I > I imit

Fault event data storage

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

Time assignment

resolution for operational annunciations
1 min
resolution for fault event annunciations
1 ms
real time clock (if fitted)
DALL

al time clock (if fitted)

DALLAS type DS 138 – 32k
RAMfield TIMEKEEPER
self-discharging time > 10 years

max time deviation 0.01 %

Data storage for fault recording

storage period (fault detection or trip command = 0 ms)

max. 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

Circuit breaker operation log

number of stored trip events caused by 7SJ511 0 to 65,535 last trip current 0 to $50 \cdot I_N$

total of tripped currents 0 to 6,553.5 \cdot I_N

Annunciations via binary input

4 user definable annunciations
 for annunciation processing

4 Method of operation

4.1 Operation of complete unit

The numerical overcurrent time protection 7SJ511 is equipped with a powerful and proven 16—bit microprocessor. This provides fully digital processing of all functions from data acquisition of measured values to the trip signals for the circuit breakers.

Figure 4.1 shows the base structure of the unit.

The transducers of the measured value input section ME transform the currents from the measure-

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

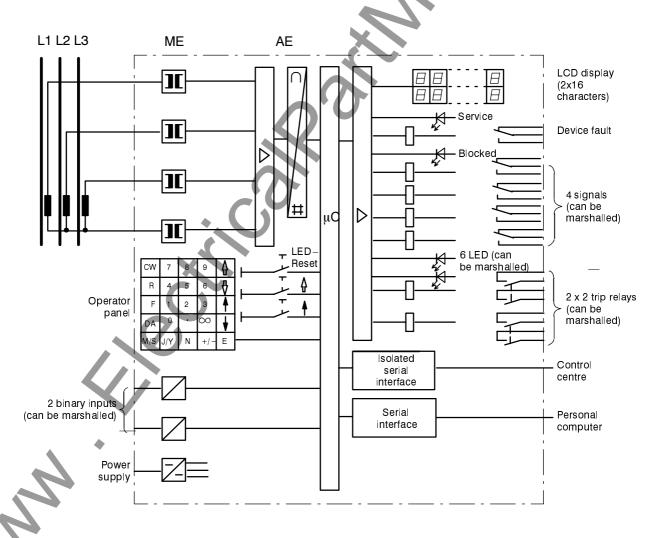


Figure 4.1 Hardware-structure of overcurrent time protection relay 7SJ511

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,
- scanning of limit values and time sequences,
- calculation of the trip time in accordance with the selected characteristic,
- calculation of r.m.s. values for overload detection,
- decision about trip commands,
- storage of measured quantities during a fault for analysis.

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

An integrated membrane keyboard in connection with a built-in alphanumerical LCD display enables communication with the unit. All operational data

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

Via a second serial interface (optional, refer Section 2.3 Ordering data), fault data can be transmitted to a central evaluation unit. During healthy operation, measured values can also be transmitted, e.g. the measured currents at the point of installation. This 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 Overcurrent time protection

The overcurrent time protection can be used as definite time or inverse time overcurrent protection. Three standardized inverse time characteristics according to IEC 60255-3 are available for inverse time mode. The trip time characteristics and the applied formulae are given in the Technical data, refer to Figure 3.1, 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 overcurrent time 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.

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 $T-I_E$ > or $T-I_E$ >> 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 $T-I_E>>$ 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.

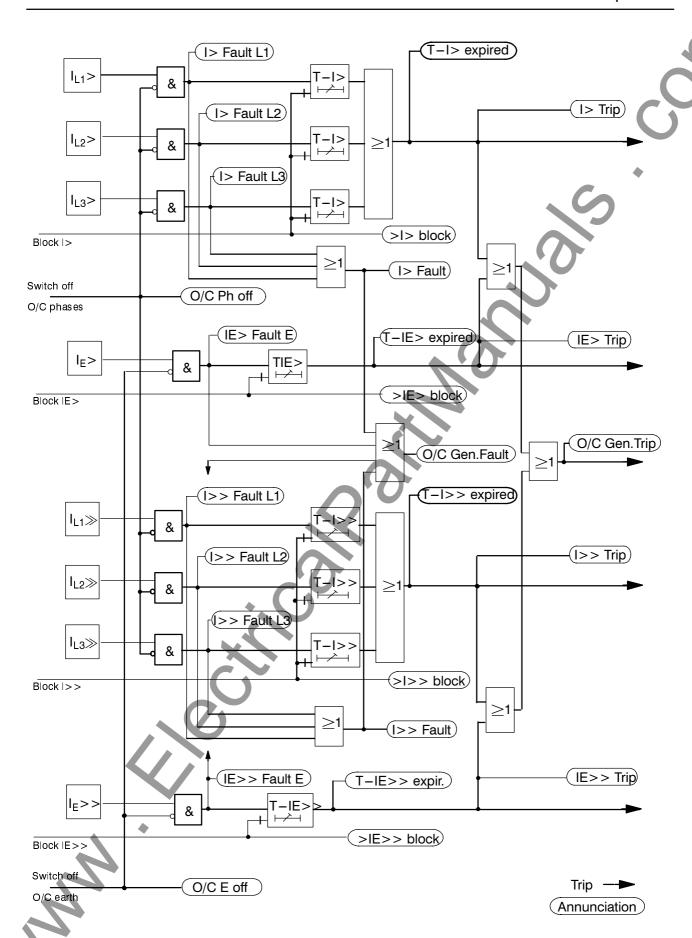


Figure 4.2 Logic diagram of the definite time overcurrent protection

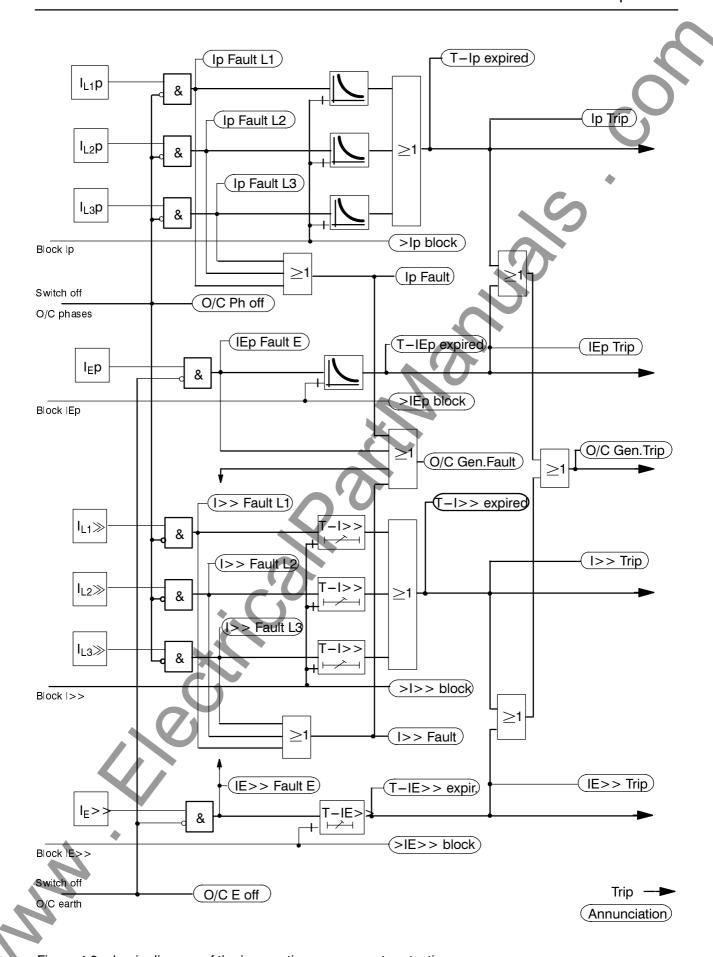


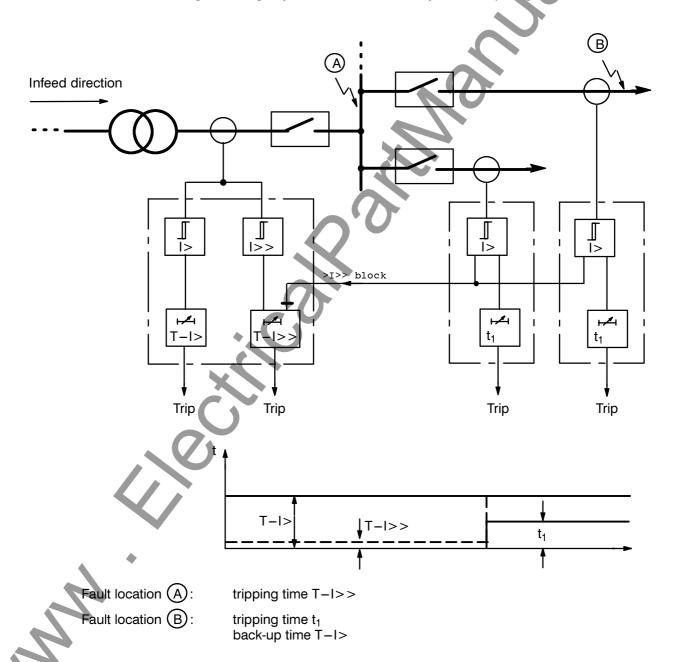
Figure 4.3 Logic diagram of the inverse time overcurrent protection

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 overcurrent time 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 to Figure 4.4).

"Reverse interlocking" means, that the overcurrent time protection can trip within a short time T-I>>, which is independent of the grading time, if it is <u>not</u> blocked by pick-up of one of the next downstream overcurrent time 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.



igure 4.4 Busbar protection using reverse interlocking principle

4.3 Inrush stabilization

If the overcurrent time protection 7SJ511 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 overcurrent time 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.

7SJ511 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 earth current stage, are blocked (so called "cross-block function").

4.4 Thermal overload protection

The thermal overload protection prevents the protected object, e.g. in case of cables, from damage caused by thermal overloading.

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

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

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

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

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

When the temperature rise reaches the first set threshold, a warning alarm is given, in order to render possible an early load reduction. If the second temperature threshold is reached the 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} :

$$I_{max} = k I_N$$

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 alarm stage can give an early annunciation of an impending overload current even if the temperature rise has not yet reached the alarm or trip temperature rise values.

4.5 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.

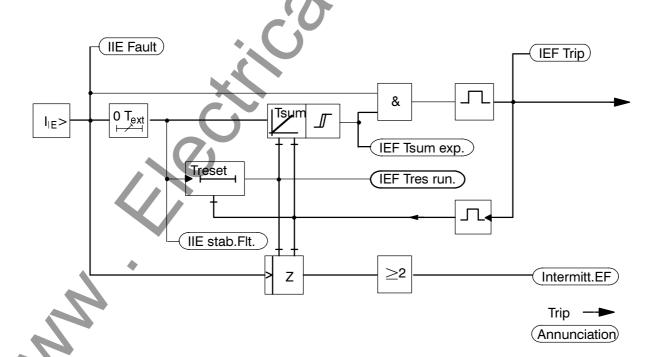
The short duration of the faults is often insufficient to make it cleared by the overcurrent time protection. Only after the fault has burned itself to such an extent that it remains standing, it can be cleared selectively by the short-circuit protection.

Since these intermittent earth faults endanger the power equipment thermally, 7SJ511 provides a protection function which can detect such intermittent earth faults and accumulate the duration of the faults.

When an adjusted pick-up value " $I_{\mid E}$ " (r.m.s. value) is exceeded, pick-up occurs (refer to Figure 4.5). The pick-ups are annunciated ("IIE Fault") and counted. When more than two pick-ups occur (presetting), annunciation "Intemitt.EF" is output. When pick-up is reset, the fault detection signal can be maintained for an adjustable extension time " T_{ext} " (annunciation "IIE stab.Flt.").

The duration of the prolonged fault detection signals is accumulated in the integrator "Tsum". When these accumulated times exceed a set threshold, alarm "IIE Tsum" 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 "IEF 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.



igure 4.5 Logic scheme of the intermittent earth fault protection

4.6 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 feeder protection issues a trip command to the breaker, a timer T-B/F starts to run. The timer continues to run for as long as the trip command is maintained and the current continues to flow which is detected by a settable current stage I> B/F. 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 7SJ511 relay via a binary input. The timer T-B/F is started and continues running as long as the above mentioned current stage I>B/F detects the flowing current. If the time has elapsed and the current has not disappeared, the circuit breaker failure protection function will issue the trip signal for the upstream breaker(s) as above.

Figure 4.6 shows the logic diagram of the circuit breaker failure protection.

4.7 Processing of user definable 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 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.

4.8 Circuit breaker trip test

Numerical overcurrent time protection 7SJ511 allows simple checking of the tripping circuit and the circuit breaker.

Prerequisite for the start of a circuit breaker trip test is that no protective function has picked up.

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

Trip test can also be started by energization of a binary input.

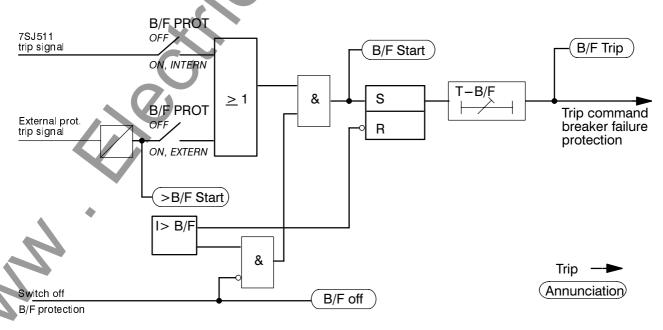


Figure 4.6 Logic diagram of the circuit breaker failure protection

4.9 Ancillary functions

The ancillary functions of the numerical overcurrent time protection 7SJ511 include:

- Processing of annunciations,
- Storage of short circuit data for fault recording,
- Operational measurements and testing routines,
- Monitoring functions.

4.9.1 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.

4.9.1.1 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 are safe against supply voltage failure provided this feature is available. 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 or 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.

4.9.1.2 Information on the display panel or to a personal computer

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

In the quiescent state, i.e. as long as no network faults are present, the display outputs selectable operating information (usually an operational measured value) in each of the two lines. In the event of a network fault, selectable information on the fault appears instead of the operating information, e.g. detected phase(s) and elapsed time from fault detection to trip command. The quiescent information is displayed again once these fault annunciations have been acknowledged. The acknowledgement is identical to resetting of the stored LED displays as in Section 4.9.1.1.

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

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

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

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

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

4.9.1.3 Information to a central unit (optional)

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

4.9.2 Data storage and transmission for fault recording

The instantaneous values of the measured values

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

are sampled at 1 ms intervals (for 50 Hz) and stored in a circulating shift register. In case of a fault, the data are stored over a selectable time period, but max. over 5 seconds. The maximum number of fault records within this time period is 8. These data are then available for fault analysis. For each renewed fault event, the actual new fault data are stored without acknowledgement of the old data.

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

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

When the data are transferred to a central unit, readout can proceed automatically, optionally after each pick-up of the relay or only after a 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.

4.9.3 Operating measurements and conversion

For local recall or transmission of data, the true r.m.s. values of the phase currents and the earth current are always available. When the overload protection is in operation, its thermal value can also be read out.

The following is valid:

- I_{L1}, I_{L2}, I_{L3}, I_E Phase currents and earth (residual) current in amps primary and in % of rated current,
- $\begin{array}{lll} & -\;\Theta/\Theta_{trip} & \quad & \text{calculated temperature rise referred to trip temperature rise.} \end{array}$

4.9.4 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 circuits are also included in the monitoring system.

4.9.4.1 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

$$|i_{L1} + i_{L2} + i_{L3} + k_{|} \times i_{E}| >$$

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

An adjustable factor k_{\parallel} (parameter le/lph) can be set to correct the different ratios of phase and earth current transformers (e.g. summation transformer for earth fault detection). If the residual earth current is derived from the current transformer starpoint, $k_{\parallel} = 1$. SUM.Ithres and SUM.Fact.I are setting parameters (see Section 6.3.9). 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 4.7).

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

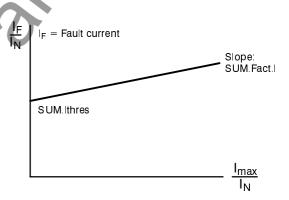


Figure 4.7 Current sum monitoring (current plausibility check)

- Command output channels:

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

- Memory modules:

The memory modules are periodically checked for fault by:

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

4.9.4.2 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.

4.9.4.3 Monitoring of external measuring transformer circuits

To detect interruptions or short circuits in the exter-

nal 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:

$$|I_{min}| / |I_{max}| < SYM.Fact.I$$

if

$$I_{max} / I_{N} > SYM.Ithres / I_{N}$$

 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 4.8). Both parameters can be set (see Section 6.3.9).

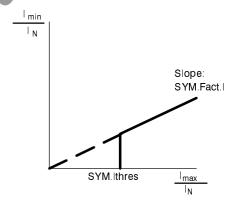


Figure 4.8 Current symmetry monitoring

Monitoring	Failure covered, reaction
Plausibility check of currents i _{L1} + i _{L2} + i _{L3} + le/lph 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 Σ I"
2. Current unbalance $\frac{ I_{min} }{ I_{max} } < \text{SYM.Fact.I}$ and $ I_{max} > \text{SYM.Ithres}$	Single, or phase-to-phase short circuits or broken conductors in the c.t. circuits i_{L1} , i_{L2} , i_{L3} or Unbalanced load delayed alarm "Failure Isymm"

Bolted figures are setting values.

Table 4.1 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 electrostatically endangered components (EEC) must be observed.

In installed conditions, the modules are in no danger.

5.2.1 Mounting and connections

5.2.1.1 Model 7SJ511★-★B★★★ for panel surface mounting

- Secure the unit with four screws to the panel. For dimensions refer Figure 2.3.
- 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 7SJ511★-★C★★★ for panel flush mounting or 7SJ511★-★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 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.

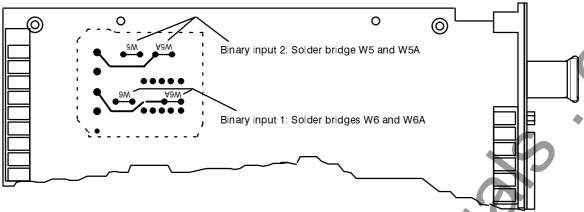
- Open housing cover.
- Loosen the module using the pulling aids provided at the top and bottom.



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 Figure 5.1, 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 newer models only

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

5.2.3 Checking the LSA 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

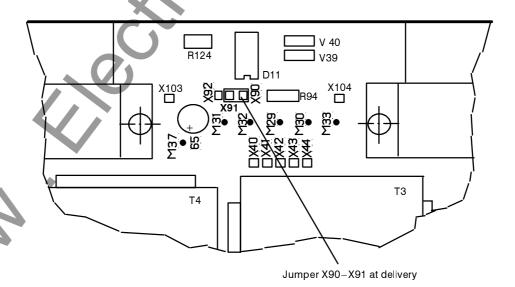


Figure 5.2 Position of the jumper X91 on the CPU board

The conductor screen and the common overall screen must be earthed at <u>one</u> line end only. This prevents circulating currents from flowing via the screen in case of potential differences.

Transmission via optical fibre is recommended. It 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 5.2).

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

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 per sonnel only which is thoroughly familiar with all safety regulations and precautionary measures and pay due attention to them. Non-observance can result in severe per sonal 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 dc supply and the voltage transformer circuits!
- Check the continuity of all the current transformer circuits against the plant and connection diagrams:
 - Are the current transformers correctly earthed?
 - Are the polarities of the current transformer connections consistent?
 - Is the phase relationship of the current transformers correct?
- 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 dc ammeter in the auxiliary power circuit; range approx. 1.5 A to 3 A.
- Close the battery supply circuit breaker; check polarity and magnitude of voltage at the terminals of the unit or at the connector module.
- The measured current consumption should correspond to the quiescent power consumption of approximately 7 W. Transient movement of the ammeter pointer only indicates the charging current of the storage capacitors.
- Open the circuit breaker for the dc power supply.
- Remove dc ammeter; reconnect the auxiliary voltage leads.
- Close the battery supply circuit breaker. 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 most 7 sec.
- Open the circuit breaker for the dc 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.

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5.3 Configuration of operational functions

5.3.1 Operational preconditions and general

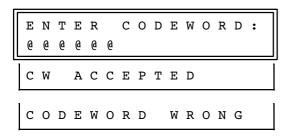
For most operational functions, the input of a codeword is necessary. This applies for all entries via the membrane keyboard or front interface which concern the operation on the relay, for example

- 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 and confirm with E. Codeword entry can also be made retrospectively after paging or direct addressing to any setting address.



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

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

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:



Beginning of the block "Operating system configuration"

The double arrow key \uparrow switches over to the first configuration block (see below). Use the key \uparrow 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 \mathbf{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 operating language and date format to be selected. Messages on the front display can be selected for the quiescent state of the unit or after a fault event. To change any of these parameters, codeword entry is necessary.

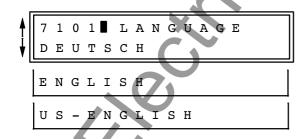
When the relay is delivered from the factory, the de-

vice 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.

When delivered from factory, the date is shown in the European format.

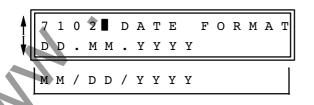


Beginning of the block "Integrated operation"



The available languages can be called up by repeatedly pressing the "No" – key \mathbf{N} . Each language is spelled in the corresponding country's language. If you don't understand a language, you should find your own language, nevertheless.

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

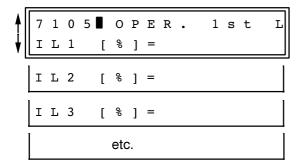


The date in the display is preset to the European format Day.Month.Year. Switch-over to the American format Month/Day/Year is achieved by depressing the "No"-key **N**; then confirm with the entry key **E**.

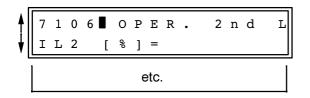
DD two figures for the day MM two figures for the month

YYYY four figures for the year (incl. century)

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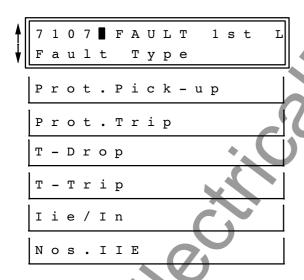
Message to be displayed in the **1st** display line during operation. Any of the operational measured values according to Section 6.4.5 can be selected as messages in the the quiescent state of the relay by repeatedly depressing the "No"-key **N**; The value selected by the entry key **E** under address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



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

Fault event annunciations can be displayed after a fault on the front. These can be chosen under addresses 7107 and 7108. The possible messages can be selected by repeatedly pressing the "No"-key **N**. The desired message is confirmed with the enter key **E**. These spontaneous messages

are acknowledged during operation with the RESET key or via the remote reset input of the device or via the system interface (if fitted). After acknowledgement, the operational messages of the quiescent state will be displayed again as chosen under addresses 7105 and 7106.



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

type of fault (faulty phases),

protection function which has picked up,

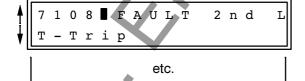
protection function, which has tripped,

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

the elapsed time from pick-up to trip command,

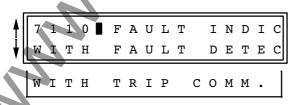
the maximum earth fault current during intermittent earth fault (if available),

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



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

the possibilities are the same as under address 7107.



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

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

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



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



Identification number of the relay within the substation; valid for both the interfaces (operating and system interface). The number can be chosen at liberty, but must be used only once within the plant system

Smallest permissible number: 1
Largest permissible number: 254



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

Smallest permissible number: 1
Largest permissible number: 254



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

Smallest permissible number: 1
Largest permissible number: 254



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

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

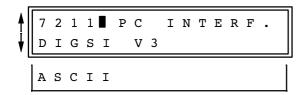


Device type for identification of the device in Siemens LSA 678 and program *DIGSI*[®]. For 7SJ511 V3 no. 23 This address is only for information, it cannot be changed.

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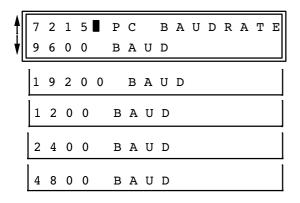
Addresses 7211 to 7216 are valid for the operating (PC) interface on the front of the relay.

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

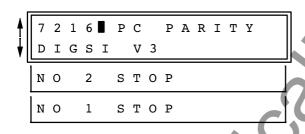


Data format for the PC (operating) interface: format for Siemens protection data processing program *DIGSI*® Version *V3*

ASCII format

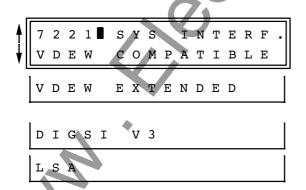


The transmission Baud-rate for communication via the PC (operating) interface at the front can be adapted to the operator's communication interface, e.g. personal computer, if necessary. The available possibilities can be displayed by repeatedly depression of the "No" – key **N**. Confirm the desired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



Parity and stop-bits for the PC (operating) interface: format for Siemens protection data processing program $DIGSI^{\odot}$ Version V3 with even parity and 1 stop-bit transmission with NO parity and 2 STOP-bits transmission with NO parity and 1 STOP-bit, e.g. mo-

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



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

only data in accordance with *VDEW/Z*VEI (IEC 60870-5-103)

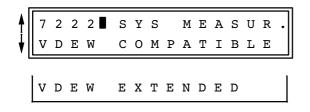
data in accordance with *VDEW/ZVEI* (IEC 60870–5–103), extended by Siemens specified data

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

format of the former Siemens LSA version

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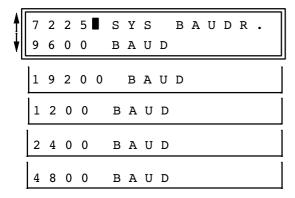
dem



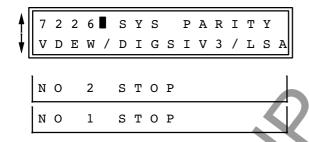
Format of measured values for the system (LSA) interface:

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

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



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



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

format for VDEW-protocol (IEC 60870-5-103) or Siemens protection data processing program $DIGSI^{\odot}$ Version 3 and former LSA

transmission with NO parity and 2 STOP-bits transmission with NO parity and 1 STOP-bit, e.g. mo-

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.



Remote parameterizing via the system interface

NO - is not permitted

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 4.9.2). Distinction must be made between the reference instant and the storage criterion (address 7402). Normally, the general fault detection signal of the protection is the reference instant. The storage criterion can be the general fault detection, too (STORAGE BY FD), or the trip command (STORAGE BY TRIP). Alternatively, the trip command can be selected as reference instant (START WITH TRIP), in this case, the trip command is the storage criterion, too.

A fault event begins with the fault detection of any protection function and ends with drop-off of the latest fault detection. The scope of a fault record is normally this fault event (address 7403). In 7SJ511, distinction between fault event and fault in power system is not made. Thus, both positions of the address 7403 mean the same.

The actual recording time starts with the pre-trigger time T – PRE (address 7411) before the reference in-

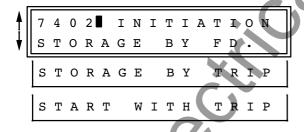
stant and ends with the post-fault time T-POST (address 7412) after the recording criterion has disappeared. The permissible recording time for each record is set as T-MAX under address 7410. Altogether 5 s are available for fault recording. In this time range up to 8 fault records can be stored.

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 max. T—MAX, address 7410. Pre-trigger time and post-fault time are additive to the set values. If the storage time for start via binary input is set to ∞ , then the storage time ends after de-energization of the binary input (statically), but not after T—MAX (address 7410).

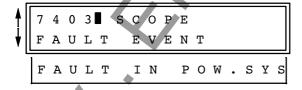


Beginning of block "Fault recordings"



Data storage is initiated:

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



Scope of a fault record:

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

in 7SJ511, the *NETWORK FAULT* has the same meaning like the fault event



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

A	7	4	1	1	T - P R E
$ \downarrow $	0	•	1	0	S

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



Post-fault time after the storage criterion disappears
Smallest setting value:

0.05 s
Largest setting value:
0.50 s



Storage time when fault recording is initiated via a binary input, pre-trigger and post-fault times are additive

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

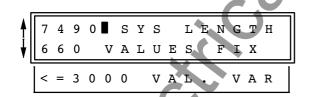
or ∞ , i.e. as long as the binary input is energized (but not longer than T = MAX)



Storage time when fault recording is initiated via the membrane keyboard, pre-trigger and post-fault times are additive

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

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



Only for communication with a former LSA system:

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

660 values fix or

variable length with a maximum of 3000 values

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5.4 Configuration of the protective functions

5.4.1 Introduction

The **device** 7SJ511 provides a series of **protection** and additional functions. The scope of the hard- and firm-ware is matched to these functions. Furthermore, individual functions can be set (configured) to be effective or non-effective by configuration parameters. Additionally, the relay can be adapted to the system frequency.

Example for configuration of the scope of the device:

Assume a network comprising overhead lines and cable sections. All devices are equipped with thermal overload protection. Since overload protection is only reasonable for the cable sections, this function will be "de-configured" for the devices protecting the overhead line sections.

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

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

- press direct address key DA,
- type in address 7800,
- 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 \uparrow or back with \downarrow . 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 \Uparrow 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 CODE-WORD 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 EE-PROMs 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 7SJ511: There will be no annunciations and the associated setting parameters (functions, limit values) will not be requested during setting (Section 6.3). In contrast, **switch-off** of a

function means that the function will be processed, that indication will appear (e.g. "... switched off") but that the function will have no effect on the result of the protective process (e.g. no tripping command).

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

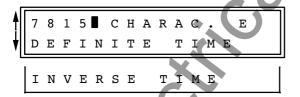


Beginning of block "Scope of functions"

Characteristic for phase overcurrent protection



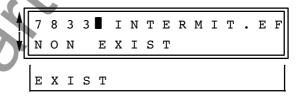
Characteristic for earth overcurrent protection



Thermal overload protection:

```
7 8 2 7 THERMAL OL
NON-EXIST
```

Intermittent earth fault protection:

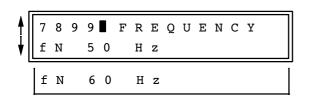


Parameter change-over:

```
7 8 8 5  PARAM. C / O
N O N - E X I S T
```

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



Rated system frequency 50 Hz or 60 Hz

5.4.3 Setting the device configuration - address block 79

The configuration affects the interaction of the protective and additional functions, for 7SJ511, the circuit breaker test program.



Beginning of the block "device configuration"



Circuit breaker test via binary input is carried out

THREE-POLE TRIP will be initiated

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: A fault is registered by the I>> stage in phase L1. This event is generated in the device as an "Annunciation" (logical function) and should be available at certain terminals of the unit as a N.O. contact. Since specific unit terminals are hard-wired to a specific (physical) signal relay, e.g. to the signal relay 3, the processor must be advised that the logical signal "I>> Fault L1" 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 I>> stage) is connected to the unit via a (physical) input

module and should initiate a (logical) function, namely blocking. The corresponding question to the operator is then: **Which** signal from a (physical) input relay should initiate **which** reaction in the device? One physical input signal can initiate up to 10 logical functions.

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

The logical annunciation functions can be used in multiple manner. E.g. one annunciation function can trigger several signal relays, several trip relays, additionally be indicated by LEDs, and be controlled by a binary input unit. The restriction is, that the total of all physical input/output units (binary inputs plus signal relays plus LEDs plus trip relays) which are to be associated with one logical 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 6000,
- 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

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

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

On this selection level the allocated function can be changed by pressing the "No"—key N. By repeated use of the key N all marshallable functions can be paged through the display. Back-paging is possible with the backspace key R. When the required function appears press the execute key E. After this, further functions can be allocated to the same physical input or output module (with further index numbers) by using the key †. 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 $\mathbf{F}\uparrow$ (i.e. depressing the function key \mathbf{F} followed by the arrow key \uparrow). The display shows again the four digit address number of the physical input/output module. Now you can page with key \uparrow to the next input/output module or with \downarrow to the previous to repeat selection procedure, as above.

The logical functions are also provided with function numbers which are equally listed in the tables. If the function number is known, this can be input directly on the selection level. Paging through the possible functions is then superfluous. With direct input of the function number, leading zeros need not be entered. After input of the function number, use **the execute key E**. Immediately the associated identification of

the function appears for checking purposes. This can be altered either by entering another function number or by paging through the possible functions, forwards with the "No"-key N or backwards with the backspace key R. If the function has been changed, another confirmation is necessary with the execute key E.

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

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

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

If one tries to leave the setting range for the configuration blocks (i.e. address blocks 60 to 79) with keys ↑ ↓, 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 2 binary inputs which are designated INPUT 1 and INPUT 2. They can be marshalled in address block 61. The address block is reached by paging in blocks $\Uparrow \Downarrow$ 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 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 $\bf N$ the mode is changed to Nc. After direct input other functions can be selected by paging through the functions forwards with the "No"-key $\bf N$ or backwards with the backspace key $\bf R$. The changed function then must be re-confirmed by the entry key $\bf E$.

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.



Beginning of block "Marshalling binary inputs"

The first binary input is reached with the kev †:



Allocations for binary input 1

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



Reset of stored LED indications, FNo 5; "normally open" operation: LEDs are reset when control voltage present



No further functions are initiated by binary input 1

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Leave the selection level with key combination $\mathbf{F} \uparrow$. You can go then to the next binary input with the arrow key \uparrow .

```
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		
1401	>B/F on	Switch on breaker failure protection		
1402	>B/F off	Switch off breaker failure protection		
1431	>B/F Start	Initiate breaker failure protection from external source		
1501	>0/L on	Switch on thermal overload protection		
1502	>0/L off	Switch off thermal overload protection		
1503	>0/L block	Block thermal overload protection		
1701	>0/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	>0/C E on	Switch on overcurrent time protection for earth currents		
1712	>0/C E off	Switch off overcurrent time protection for earth currents		
1721	>I>> block	Block I>> stage of overcurrent time protection (phase faults)		
1722	>I> block	Block I> stage of definite time overcurrent protection (phase faults)		
1723	>Ip block	Block Ip stage of inverse time overcurrent protection (phase faults)		
1724	>IE>> block	Block IE > stage of overcurrent time protection (earth faults)		
1725	>IE> block	Block IE> stage of definite time overcurrent protection (earth faults)		
1726	>IEp block >IEF on	Block IEp stage of inverse time overcurrent protection (earth faults)		
6901 6902	>IEF on >IEF off	Switch on intermittent earth fault protection		
		Switch off intermittent earth fault protection		
6903	>IEF block	Block intermittent earth fault protection		

Table 5.1 Marshalling possibilities for binary inputs

The complete pre-settings 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 displayed fault indications, LED-test
6102	BINARY INPUT 2 INPUT 2	INPUT 2 >I>> block NO >IE>> block NO	1721 1724	Block stages $I>>$ and $I_E>>$ of overcurrent time protection (phase and earth faults)

Table 5.2 Preset binary inputs

5.5.3 Marshalling of the signal output relays – address block 62

The unit contains 5 signal outputs (alarm relays), 4 of which can be marshalled. These signal relays are designated SIGNAL RELAY 1 to SIGNAL RELAY 4 and can be marshalled in address block 62. The block is reached by paging in blocks with ↑ ↓ or by directly addressing **DA 6200 E**. The selection procedure is carried out as described in Section 5.5.1. Multiple annunciations are possible, i.e. one logical annunciation function can be given to several physical signal relays (see also Section 5.5.1).

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

5.4.2).

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.

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



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

The first signal relay is reached with the key †:



Allocations for signal relay 1

Change over to the selection level with F 1:



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

Leave the selection level with key combination $\mathbf{F}\uparrow$. You can go then to the next signal output relay with the arrow key \uparrow . Signal relays 2 and 3 represent – as preset from the factory – examples for a group annunciation, i.e several logical annunciation functions are given to one output signal relay.

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FNo	Abbreviation	Description	
1	not allocated	No annunciation allocated	1
3	>Time Synchro	Synchronize internal real time clock	
4	>Start FltRec	Start fault recording by external command via binary input	
5	>LED reset	Reset LED indicators	
7	>ParamSelec.1	Parameter set selection 1 (in connection with 8)	
8	>ParamSelec.2	Parameter set selection 2 (in connection with 7)	
11	>Annunc. 1	User definable annunciation 1	
12	>Annunc. 2	User definable annunciation 2	
13	>Annunc. 3	User definable annunciation 3	
14	>Annunc. 4	User definable annunciation 4	
51	Dev.Operative	Protection relay operative	
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 in 15 V internal dc supply circuit	
144	Failure 5V	Failure in 5 V internal dc supply circuit	
145	Failure 0V	Failure in 0 V A/D converter circuit	
161	I supervision	General failure detected by current supervision	
162	Failure Σ I	Failure supervision ΣI (measured currents)	
163	Failure Isymm	Failure supervision symmetry I	
354	>CB Aux.3p cl	Circuit breaker position is ON (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	
561	Manual Close	Manual close indication of circuit breaker	
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	
1401	>B/F on	Switch on breaker failure protection	
1402	>B/F off	Switch off breaker failure protection	
1431	>B/F Start	Start breaker failure protection from external source	
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	Breaker failure protection trip command issued	
1501	>0/L on	Switch on thermal overload protection	
1502	>O/L off	Switch off thermal overload protection	
1503	>0/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	>0/C E on	Switch on overcurrent time protection for earth currents	
1712	>O/C E off	Switch off overcurrent time protection for earth currents	
		I	

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

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FNo	Abbreviation	Description
1721	>I>> block	Block I>> stage of overcurrent time protection (phase faults)
1722	>I> block	Block I> stage of overcurrent time protection (phase faults)
1723	>Ip block	Block Ip stage of overcurrent time protection (phase faults)
1724	>IE>> block	Block IE>> stage of overcurrent time protection (earth faults)
1725	>IE> block	Block IE> stage of overcurrent time protection (earth faults)
1726	>IEp block	Block IEp stage of overcurrent time protection (earth faults)
1751	O/C Ph off	Overcurrent time protection (phase faults) is switched off
1753	O/C Ph active	Overcurrent time protection (phase faults) is active
1756	O/C E off	Overcurrent time protection (earth faults) is switched off
1758	O/C E active	Overcurrent time protection (earth faults) is active
1761	O/C Gen.Fault	Overcurrent time protection: general fault detection
1762	O/C Fault L1	Overcurrent time protection: fault detection phase L1
1763	O/C Fault L2	Overcurrent time protection: fault detection phase L2
1764	O/C Fault L3	Overcurrent time protection: fault detection phase L3
1765	O/C Fault E	Overcurrent time protection: earth fault detection
1791	O/C Gen.Trip	Overcurrent time protection: trip command issued
1800	I>> Fault	Overcurrent time protection: pick-up of I>> stage
1801	I>> Fault L1	Overcurrent time protection: pick-up of I>> stage phase L1
1802	I>> Fault L2	Overcurrent time protection: pick-up of I>> stage phase L2
1803	I>> Fault L3	Overcurrent time protection: pick-up of I>> stage phase L3
1804	T-I>> expired	Overcurrent time protection: time T-I>> expired
1805	I>> Trip	Overcurrent time protection: trip by I>> stage issued
1810	I> Fault	Overcurrent time protection: pick-up of I> stage (definite time)
1811	I> Fault L1	Overcurrent time protection: pick-up of I> stage (definite) phase L1
1812	I> Fault L2	Overcurrent time protection: pick-up of I> stage (definite) phase L2
1813	I> Fault L3	Overcurrent time protection: pick-up of I> stage (definite) phase L3
1814	T-I> expired	Overcurrent time protection: time T-I> (definite time) expired
1815	I> Trip	Overcurrent time protection: trip by I> stage (definite time) issued
1820	Ip Fault	Overcurrent time protection: pick-up of Ip stage (inverse time)
1821	Ip Fault L1	Overcurrent time protection: pick-up of Ip stage (inverse) phase L1
1822	Ip Fault L2	Overcurrent time protection: pick-up of lp stage (inverse) phase L2
1823	Ip Fault L3	Overcurrent time protection: pick-up of Ip stage (inverse) phase L3
1824	T-Ip expired	Overcurrent time protection: time T-lp (inverse time) expired
1825	Ip Trip	Overcurrent time protection: trip by Ip (inverse time) stage issued
1831	IE>> Fault	Overcurrent time protection: pick-up of IE>> stage
1832	T-IE>> expir	Overcurrent time protection: trip by IE>> expired
1833	IE>> Trip	Overcurrent time protection: trip by IE>> stage issued
1834	IE> Fault	Overcurrent time protection: pick-up of IE> stage (definite time) Overcurrent time protection: time T-IE> (definite time) expired
1835 1836	T-IE> expired IE> Trip	Overcurrent time protection: time 1–1E> (definite time) expired Overcurrent time protection: trip by IE> stage (definite time) issued
1837	IEp Fault	Overcurrent time protection: trip by 1E > stage (definite time) issued Overcurrent time protection: pick-up of IEp stage (inverse time)
1838	T-IEp expired	Overcurrent time protection: pick-up of intersections time) Overcurrent time protection: time T-IEp (inverse time) expired
1839	IEP Trip	Overcurrent time protection: time 1–1Ep (inverse time) expired Overcurrent time protection: trip by IEp (inverse time) stage issued
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
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
0505	TEL DIOCK	Dissi intermitent satur ladit protostori

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

FNo	Abbreviation	Description	
6921 6922 6923 6924 6925 6927 6928	IEF off IEF blocked IEF enabled IIE Fault det IIE stab.Flt. Intermitt.EF IEF Tsum exp.	Intermittent earth fault protection is switched off Intermittent earth fault protection is blocked Intermittent earth fault protection is active Intermittent earth fault protection pick-up Intermittent earth fault protection prolonged pick-up Intermittent earth fault detected (more than 2 pickups within Treset) Accumulated earth fault time expired	
6929 6930	IEF Tres run. IEF Trip	Reset time is running 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, i.e. pick-up of either function of O/C time protection
6202	SIGNAL RELAY 2 RELAY 2 RELAY 2 SIGNAL RELAY 3	RELAY 2 I>> Fault L1 I>> Fault L2 I>> Fault L3 RELAY 3 IE>> Fault	1801 1802 1803	Pick-up of the high-set overcurrent stages I>> in any phase or I _E >>
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 faulty"

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 memorized) or unstored mode (nm for "not memorized"). Each annunciation function is displayed with the index m or nm when proceeding with the "N"-key.

The marshallable annunciation functions are the same as those listed in Table 5.3. Annunciation functions are, of course, not effective when the corresponding protection function 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

- 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 $\bf N$ to change to stored mode "m". After direct input other functions can be selected by paging through the functions forwards with the "No"-key $\bf N$ or backwards with the backspace key $\bf R$. The changed function then must be re-confirmed by the enter-key $\bf E$.

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.



Beginning of the block "Marshalling of the LED indicators"

The first marshallable LED is reached with the key †:



Allocations for LED 1, Meaning: "Failure in measured quantities"

Change over to the selection level with F †:







LED 1 has been preset for:

1st: Failure detected by measured current sum monitor, FNo 162

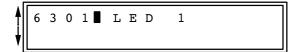
LED 1 has been preset for:

2nd: Failure detected by measured current symmetry monitor, FNo 163

no further functions are preset for LED 1

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



Allocations for LED 1 , Meaning: "Failure in measured quantities"

The complete pre-settings for LED indicators are listed in Table 5.5.

Addr	1st display line	2nd display line	FNo	Remarks
6300	MARSHALLING	LEDs		Heading of the address block
6301	LED 1 LED 1 LED 1	Failure Σ I nm Failure Isymm nm	162 163	Group annunciation of all disturbances in measured quantities
6302	LED 2 LED 2	O/C Fault L1 m	1762	
6303	LED 3 LED 3	O/C Fault L2 m	1763	Fault detection annunciations of the
6304	LED 4 LED 4	O/C Fault L3 m	1764	overcurrent time protection
6305	LED 5 LED 5	O/C Fault E m	1765	
6306	LED 6 LED 6 LED 6 LED 6	Failure 15V nm Failure 5V nm Failure 0V nm	143 144 145	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 2 trip relays which are designated TRIP RELAY 1 and TRIP RELAY 2. Each trip relay can be controlled by up to 10 logical commands. The trip relays can be marshalled in the address block 64. The block is reached by paging in blocks with ↑↓ 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 has been programmed out (deconfigured).

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, the assigned command relay must be triggered by the corresponding command functions.



The first trip relay is reached with the key †:



Change over to the selection level with F †:





Beginning of the block "Marshalling of the trip relays"

Allocations for trip relay 1

Trip relay 1 has been preset for: Trip signal given by the overcurrent time protection (either stage), FNo 1791;

no further functions are preset for trip relay 1

Leave the selection level with key combination $\mathbf{F} \uparrow$. You can go then to the next trip relay with the arrow key \uparrow .

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FNo	Abbreviation	Logical command function
1	not allocated	No function allocated
501	Device FltDet	General fault detection of the device
511	Device Trip	General trip command of the device
1181	CB Test Trip	Trip by internal circuit breaker test function
1455	B/F Fault	Initiation of internal breaker failure protection function
1471	B/F Trip	Trip by internal breaker failure protection function
1521	O/L Trip	Trip by thermal overload protection
1761	O/C Gen.Fault	General fault detection of overcurrent time protection
1791	O/C Gen.Trip	General trip by overcurrent time protection
1800	I>> Fault	Phase overcurrent time protection I>> stage picked up
1805	I>> Trip	Phase overcurrent time protection trip by I>> stage
1810	I> Fault	Phase overcurrent time protection I> stage (definite) picked up
1815	I> Trip	Phase overcurrent time protection trip by I> stage (definite time)
1820	Ip Fault	Phase overcurrent time protection Ip stage (inverse) picked up
1825	Ip Trip	Phase overcurrent time protection trip by Ip stage (inverse time)
1831	IE>> Fault	Earth overcurrent time protection IE>> stage picked up
1833	IE>> Trip	Earth overcurrent time protection trip by IE>> stage
1834	IE> Fault	Earth overcurrent time protection IE> stage (definite) picked up
1836	IE> Trip	Earth overcurrent time protection trip by IE> stage (definite time)
1837	IEp Fault	Earth overcurrent time protection IEp stage (inverse) picked up
1839	IEp Trip	Earth overcurrent time protection trip by IEp stage (inverse time)
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 any overcurrent time protection function
6402	TRIP TRIP REL. 2 TRIP REL. 2	RELAY 2 I>> Trip IE>> Trip	1805 1833	Trip command from any high-set stage

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!

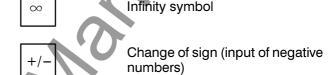
Connection of the device to a battery charger without connected battery may cause impermissibly high voltages which damage the device. See also Section 3.1.1 under Technical data for limits.

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





6.2 Dialog with the relay

Setting, operation and interrogation of digital protection 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.

Yes/No keys for text parameters:

J/Y Yes key: operator affirms the displayed question

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

Keys for paging through the display:

Paging forwards: the next address is displayed

Paging backwards: the previous address is displayed

Block paging forwards: the beginning of the next address block is displayed

Block paging backwards: the beginning of previous address block is displayed

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Confirmation key:



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

Control and special keys:



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



Backspace erasure of incorrect entries



Function key; explained when used



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



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

The three keys ↑ ; ↑ ; 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 menuguided 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 input, LED indicators,
- configuration parameters for operation language, interface and device configuration,
- initiation of test procedures.

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

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

6.2.4 Representation of the relay (front view)

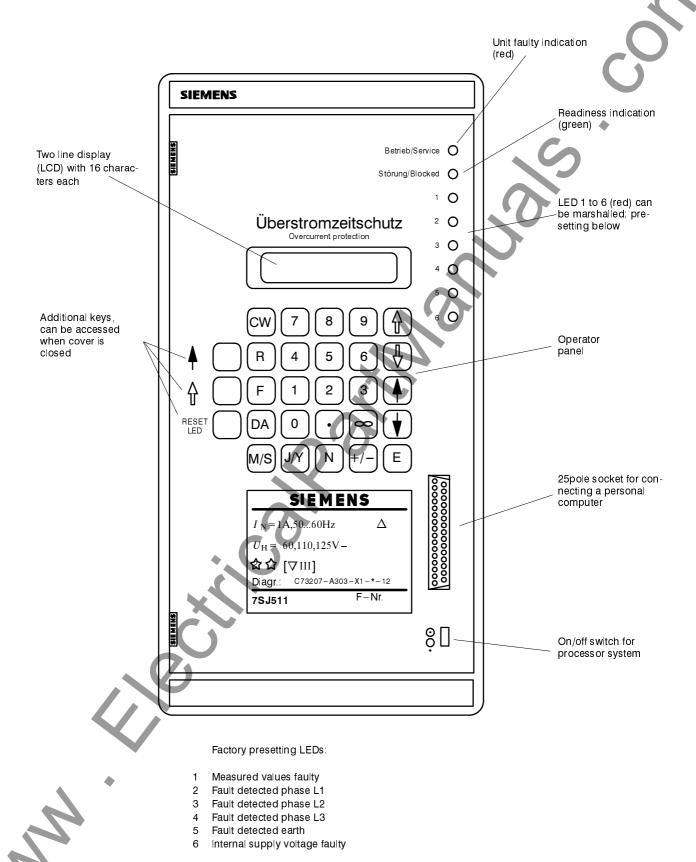


Figure 6.1 Front view of operating key board and display panel

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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 \Uparrow or \Downarrow the next or the previous block can be selected. By using the keys \uparrow or \downarrow the first or last address within the block can be selected and paged.

Addresses which require numerical input

The display shows the four-digit address, i.e. block and sequence number (e.g. 1105 for block 11, sequence number 5). Behind the bar appears the meaning of the required parameter, in the second display line, the value of the parameter. When the relay is delivered a value has been preset. In the following sections, this value is shown. If this value is to be retained, no other input is necessary. One can page forwards or backwards within the block or to the next (or previous) block. If the value needs to be altered, it can be overwritten using the numerical keys and, if required, the decimal point and/or change sign (+/-) or, where appropriate, infinity sign ∞. The permissible setting range is given in the following text, next to the associated box. Entered values beyond this range will be rejected. The setting steps correspond to the last decimal place as shown in the setting box. Inputs with more decimal places than permitted will be truncated down to the permissible number. The value must be confirmed with the entry key **E!** The display then confirms the accepted value. The changed parameters are only saved after termination of parameterizing (refer below).

- Addresses which require text input

The display shows the four-digit address, i.e. block and sequence number (e.g. 1201 for block 12, sequence number 1). Behind the bar appears the meaning of the required parameter, in the second display line, the applicable text. When the relay is delivered, a text has been preset. In the following sections, this text is shown. If it is to be retained, no other input is necessary. One can page forwards or backwards within the block or to the next (or previous) block. If the text needs to be altered, press the "No" key N. The next alternative text, also printed in the display boxes illustrated in the following sections, then appears. If the alternative text is not desired, the N key is pressed again, etc. The alternative which is chosen, is confirmed with the entry key E. The changed parameters are only saved after termination of parameterizing (refer below).

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

If the parameter address is known, then direct addressing is possible. This is achieved by depressing key **DA** followed by the four-digit address and subsequently pressing the enter key **E**. After direct addressing, paging by means of keys $\uparrow \downarrow$ 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. 8500,
- press enter key E.

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

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

8500 PARAMETER CHANGE - OVER

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

	Co	рру
Addr.	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 set which are to be different from the source parameter set.

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

6.3.1.3 Setting of date and time

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

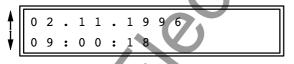
Selection of the individual addresses is by further scrolling using $\uparrow \downarrow$ as shown below. Each modification must be confirmed with the enter key **E**.

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

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



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



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



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



DD.MM.YYYY or MM.DD.YYYY

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

HH.MM.SS

Using the difference time, the clock is set forwards by the entered time, or backwards using the \pm - key. The format is the same as with the time setting above.



6.3.2 Initial displays - address blocks 0 and 10

When the relay is switched on, firstly the address 0 and the type identification of the relay appears. All Siemens relays have an MLFB (machine readable order number). When the device is operative and displays a quiescent message, any desired address can be reached e.g. by pressing the direct address key **DA** followed by the address number.



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

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



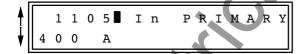
Commencement of setting parameter blocks

6.3.3 Power system data - address block 11

The relay requests basic data of the power system and the switchgear.



Beginning of the block "Power system data"



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

Largest setting value: 50000 A

With addresses 1112, the device is instructed as to how the residual path of current transformers is connected. This information is important for the monitoring of measured values.

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, Figure B.3):

- Connection of the earth current from a separate earth current detection transformer (e.g. window type current transformer, see also Appendix B, Figure B.5).

Address 1112 is set as

le/lph =
$$\frac{\text{ratio of the earth current CT}}{\text{ratio of the phase current CT}}$$

Example:

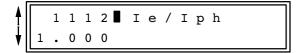
Phase current transformers
Summation current transformer

400A/5A 60A/1A

$$le/lph = \frac{60/1}{400/5} = 0.750$$

Address 1112 is set le/lph = 0.750

The minimum trip command duration can be set under address 1141. It is valid for all protection functions of the relay which can lead to trip.



Matching factor for earth current:

1 for connection in c.t. starpoint;

(window-type) earth c.t. ratio

(phase) c.t. ratio

for connection to separate earth current

transformer

Smallest setting value: 0.001 Largest setting value: 20.000



Minimum trip command duration

Smallest setting value:

0.01 s

Largest setting value:

2.00 s

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



Beginning of the block "Overcurrent time protection for phase faults"



Switching ON of the phase fault overcurrent time protection

Switching OFF of the phase fault overcurrent time 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 I > stage. 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

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

The effect of inrush currents is reduced in 7SJ511 by numerical filters. Nevertheless, the inrush currents contain also increased fundamental wave component. Thus, it may be advisable to set a short delay time even for the I>> stage. Normally, 50 ms to 100 ms are sufficient.

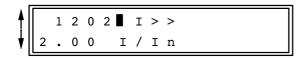
If the relay is intended to operate with an external auto-reclosure device, the I>> stage can be used as a rapid tripping stage before auto-reclosure: As

long as the external auto-reclose device is ready for reclosure, the I>> stage is valid without delay or with short-time delay for the auto-reclosure sequence to be successful. After an unsuccessful auto-reclosure or when the auto-reclose device is not ready for operation, the I>> stage is blocked by the external auto-reclosure device via a binary input. The delayed overcurrent stage I> or Ip (see below) remains effective and, for reasons of selectivity, will clear the fault in accordance with the time grading plan of the network. The pick-up value of the I>> stage need not be different from the overcurrent stage because it is the short tripping time of the I>> stage which is of interest in this case.

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 use for rapid tripping in case of a busbar fault, with only a short safety time. The overcurrent stage is the back-up for fault on an outgoing feeder.

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

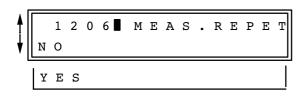
high-set overcurrent stage I >> is not used then set the time T-I >> to ∞ .



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



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



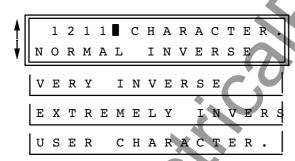
Measurement repetition:

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

7SJ511 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 se-

lected overcurrent time protection.

For **inverse time**, a choice can be made between three tripping time characteristic defined in IEC 60255-3. The characteristic for phase faults is selected in address 1211.



For inverse time overcurrent protection only:

Characteristic of the overcurrent stage I> for phase faults, can be

can be

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

EXTREMELY INVERSe

USER CHARACTER.

VERY INVERSE

time lag acc. IEC 60255-3, type C

time lag acc. IEC 60255-3, type B

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 time delay T-I> depends on the grading plan for the network.

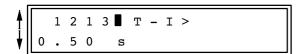
If the overcurrent stage I> is not used then set the time T-I> to ∞ .



For definite time overcurrent protection only:

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

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For definite time overcurrent protection only:

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 Section 5.4.2). It must be considered that, according to IEC 60255-3, the protection picks up

only when at least 1.1 times the set value is exceeded.

If the overcurrent stage Ip is not used then set the time T-Ip to ∞ .

For inverse time overcurrent protection only:



Pick-up value of the inverse time overcurrent stage Ip for phase faults

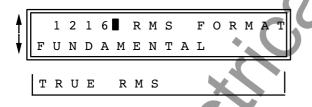
Setting range: **0.10** to **4.00** · I_N



Time multiplier for the inverse time overcurrent stage Ip Setting range: 0.05 s to 10.00 s and 0 (trip after the inherent operating time) and ∞ (no trip with Ip 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** characteristic is chosen, a choice can be made

whether the fundamental waves of the measured currents are evaluated, or if the true r.m.s. values including harmonics and d.c. component are calculated for evaluation.



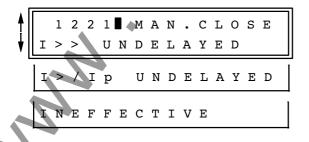
For inverse time overcurrent protection only:

The fundamental waves of the measured currents are evaluated

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

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.



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

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

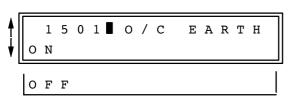
//p i.e. I> stage (definite time, address 1212) or Ip stage (inverse time, address 1214) but without delay (address 1213 or 1215)

INEFFECTIVE, i.e. stages operate as parameterized

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



Beginning of the block "Overcurrent time protection for earth faults"



Switching *ON* of the earth fault overcurrent time protection

Switching *OFF* of the earth fault overcurrent time 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 ∞ . For determination

of the setting values similar considerations are valid as for the phase fault stage I>> (refer to Section 6.3.4).



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



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



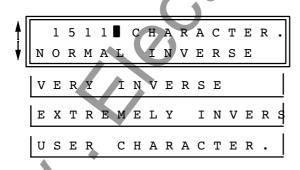
Measurement repetition:

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

7SJ511 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 function

mode of the selected overcurrent time protection for earth faults.

For **inverse time**, a choice can be made between three tripping time characteristic defined in IEC 60255-3. The characteristic for earth faults is selected in address 1511.



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

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

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 $I_F>$.

The time delay T-IE> depends on the grading plan for the network which can be separate for earth faults.

If the overcurrent stage $I_E>$ is not used then set the time T-IE> to $\infty.$

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For definite time overcurrent protection only:

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

Trip time delay for the overcurrent stage I_E > 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). 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 ∞ .

For inverse time overcurrent protection only: 1 5 1 4 IE p Pick-up value of the inverse time overcurrent sta

Pick-up value of the inverse time overcurrent stage $I_{\mbox{\footnotesize Ep}}$ for earth faults

Setting range: 0.10 to $4.00 \cdot I_N$



I / I n

1 0

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 characteristic is chosen, a choice can be made

whether the fundamental wave of the measured current is evaluated, or if the true r.m.s. value including harmonics and d.c. component is calculated for evaluation.



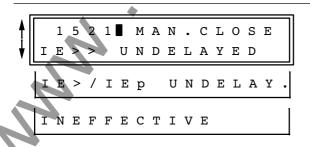
For inverse time overcurrent protection only:

The fundamental waves of the measured currents are evaluated

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

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.



Overcurrent stage 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

6.3.6 Settings for inrush stabilization - address block 20

Although the numerical filters of the overcurrent time 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 7SJ511, 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.

7SJ511 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 pro-

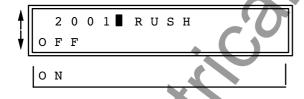
vide for a more sensitive setting (= lower value) in exceptional cases under especially unfavourable switch-in conditions (address 2002).

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").

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.

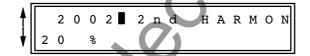


Beginning of the block "Inrush stabilization"

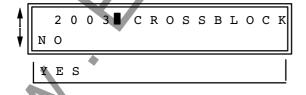


Switching OFF of the inrush stabilization

Switching ON of the inrush stabilization



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



Crossblock function:

NO harmonic stabilization operates for each individual phase

YES harmonic stabilization of one phase blocks also the other phases



Limitation time of blocking after pick-up when 2nd harmonic content has exceeded limit value

Setting range: 0.10 s to 60.00 s

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

Besides the standard characteristics for inverse time overcurrent time 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 $\mathbf{F}\uparrow$, i.e. depressing the function key \mathbf{F} followed by the arrow key \uparrow . During this change-over (i.e. from pressing the \mathbf{F} key until pressing the \uparrow key) the bar behind the address number is replaced by a "F". The display shows, in the upper line, the 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 \star 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 \star 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 \uparrow 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 \uparrow to the next value pair. With \downarrow , 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.

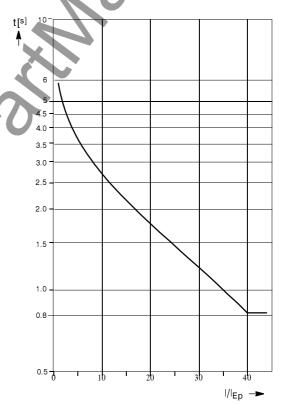
Up to 60 pairs of values can be defined. It is permitted to enter less pairs: In most cases, approxi-

mately 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}). The entered time values can be influenced by the time multipliers (T_{Ip} , T_{IEp}) of the respective protection functions.

You can leave the table definition level by pressing the key combination $\mathbf{F} \uparrow$ (i.e. depressing the function key \mathbf{F} followed by the arrow key \uparrow). 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:
$$t = T_{|\text{Ep}} \cdot \left(5.8 - 1.35 \cdot \text{ln} \left(\frac{\text{I}}{\text{I}_{\text{Ep}}}\right)\right) \text{ [s]}$$

$$t \quad \text{tripping time} \\ \mid \quad \text{earth fault current} \\ \mid_{\text{Ep}} \quad \text{set earth current value}$$

T_{IEp} set time multiplier

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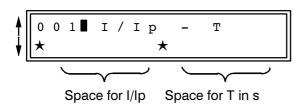
Beginning of the block "User specified current time characteristics"

Page on with key † to address 2501.



Definition of characteristic 1

Switch over to the table definition level with key combination $\mathbf{F} \uparrow$, in order to get access to the first pair of values with index number 001.



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:



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:



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:



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 †



Pair of values No 002; for current I/Ip and time T

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e.g. second current value: I/Ip = 1.10second time value: T = 5.67 s

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



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 4.4). 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 overcurrent time 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 overcurrent time protection relay 7SJ511 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:

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

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

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

Setting value τ [min] =

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

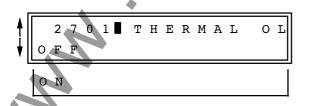
If the short-term overload capacity is stated for a duration other than 1 s, then that short-term current is inserted into the above formula instead of the 1 s current. However, the result is then multiplied with the stated duration, i.e. in case of a 0.5 s current:

$$\frac{0.5}{60} \cdot \left(\frac{\text{permissible 0.5 s current}}{\text{continously permissible current}} \right)^{\frac{1}{2}}$$

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



Beginning of block "Thermal overload protection"



Thermal overload protection can be set to

be switched OFF or

be switched ON i.e. trip and alarms

≬		2	7	0	2	K	_	F	A	С	Т	0	R
$ \downarrow $	1	•	1	0									

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



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 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 set-

ting $\Theta_{warn}/\Theta_{trip}$ 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).

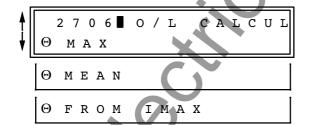


Thermal warning stage, in %of trip temperature rise $\Theta_{\text{warn}}/\Theta_{\text{trip}}$

Setting range: 50 % to 100 %



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



Calculation method decisive for thermal stages MAXimum of the temperature rises of the three conductors

MEAN value of the temperature rises of the three conductors

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

6.3.9 Settings for measured value monitoring – address block 29

The different monitoring functions of the protective relay are described in Section 4.9.4. They partly monitor the relay itself, partly the steady-state measured values of the transformer circuits.

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

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



Beginning of block

"Measured value supervision



Current threshold above which the symmetry moni-

toring is effective (refer Figure 4.8)

Smallest setting value: $0.10 \cdot I_N$ Largest setting value: $1.00 \cdot I_N$



Symmetry factor for the current symmetry = slope of

the symmetry characteristic (see Figure 4.8)
Smallest setting value:

0.10
Largest setting value:
0.95



Current threshold above which the summation monitoring (refer Figure 4.7) reacts (absolute content, referred to I_N only)

Smallest setting value: $0.05 \cdot I_N$ Largest setting value: $2.00 \cdot I_N$



Relative content (referred to the maximum conductor current) for operation of the current summation monitoring (refer Figure 4.7)

Smallest setting value: 0.00 Largest setting value: 0.95

6.3.10 Settings for the intermittent earth fault protection - address block 33

Depending on the model ordered (refer to Section 2.3 Ordering data), the overcurrent time relay 7SJ511 contains a protection function for intermittent earth faults. This sub-section is valid only for models 7SJ511*-****-2*. 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 lie>. 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 4.5 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.



Beginning of the block "Intermittent earth fault protection"



Auto-reclose function is

OFF switched off

ON switched on



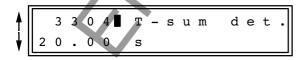
Pick-up value for earth fault current

Smallest setting value: 0.05 · I_N
Largest setting value: 25.00 · I_N



Prolongation time for pick-up

Smallest setting value: 0.00 s Largest setting value: 10.00 s



Accumulated time sum for trip

Smallest setting value: 0.00 s Largest setting value: 100.00 s



Reset time when no renewed earth fault is detected

Smallest setting value: 1 s Largest setting value: 600 s

3 3 0 6 Nos.det.

Number of pick-ups for detection of an intermittent earth fault

Smallest setting value: 2
Largest setting value: 10

6.3.11 Settings for circuit breaker failure protection - address block 39

7SJ511 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 6.2

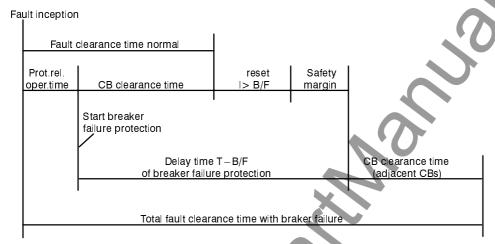
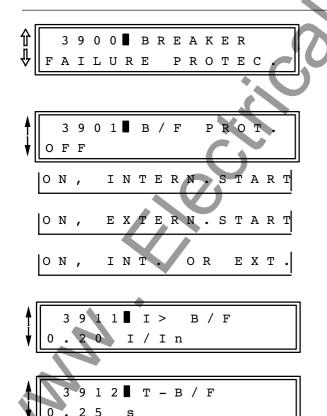


Figure 6.2 Time sequence for normal clearance of a fault, and with circuit breaker failure



Beginning fo the block "Circuit breaker failure protection"

Switching OFF of the circuit breaker failure protection

Switching *ON* of the circuit breaker failure protection, start by internal overcurrent protection

Switching *ON* of the circuit breaker failure protection, start by external protection, via binary input

Switching *ON* of the circuit breaker failure protection, start by internal overcurrent protection or by external protection, via binary input

Pick-up value of the current threshold of the circuit breaker failure protection

Setting range: $0.10 \text{ to } 4.00 \cdot I_{\text{N}}$

Trip delay time of the circuit breaker failure protection Setting range: 0.06 s to 60.00 s and ∞ (no trip)

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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 system interface to local or remote control facilities (optional).

Most of these annunciations can be 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, expired times, or similar. As defined, a network fault begins with pick-up of any fault detector and ends after drop-off of the last protection function.
- Block 53 Event annunciations for the previous network fault, as block 52.
- Block 54 Event annunciations for the last but two network fault, as block 52.
- Block 56 Annunciations for CB operation statistics, that is counters for tripping commands, together with accumulated short circuit currents of the breaker.
- Block 57 Indication of operational measured values.
- Block 59 Indication of measured values of the thermal overload protection.



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 F1t" together with the sequence number of the fault. Detailed information about the history of the fault is contained in blocks "Fault annunciations"; refer Section 6.4.3.

The input of the codeword is not required.

After selection of the address 5100 (by direct selection with **DA 5 1 0 0 E** and/or paging with $\uparrow \uparrow$ or $\downarrow \uparrow$ and further scrolling $\uparrow \uparrow$ or $\downarrow \uparrow$) 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 ($\mathbf{C} = \text{"Coming"}$) or a status is announced "Coming" and "Going" (\mathbf{C}/\mathbf{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.



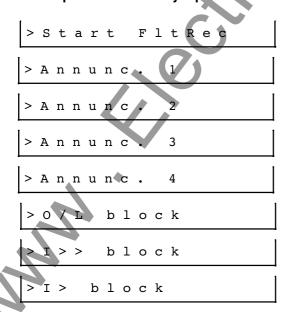
0 2 . 0 5 . 9 6 1 2 : 1 8 B / F off : C Beginning of the block "Operational annunciations"

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

2nd line: Annunciation text, in the example Coming

If the real time clock is not available the date is replaced by $\star\star.\star\star.\star\star$, the time is given as relative time from the last re-start of the processor system.

Direct response from binary inputs:



Fault recording started via binary input (C)

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

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

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

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

Block thermal overload protection via binary input (C/G)

Block I>> stage of phase overcurrent protection from an external device (C/G)

Block I> stage of definite time phase overcurrent protection from an external device (C/G)

>	Ι	р		b	1	0	С	k		
>	I	E	>	>		b	1	0	С	k
>	I	E	>		b	1	0	С	k	
>	I	E	р		b	1	0	С	k	
>	I	E	F		b	1	0	С	k	

Block I_p stage of inverse time phase overcurrent protection from an external device (C/G)

Block $I_E >>$ stage of earth overcurrent protection from an external device (C/G)

Block I_E > stage of definite time earth overcurrent protection from an external device (C/G)

Block I_{Ep} stage of inverse time earth overcurrent protection from an external device (C/G)

Block intermittent earth fault protection (C/G)

General operational annunciations of the protection device:

D	е	v	•	0	р	е	r	a	t	i	v	е		Device operative (C)
I	n	i	t	i	a	1		s	t	a	r	t		Initial start of the processor system (C)
L	Е	D		r	е	s	е	t						Stored LED indications reset (C)
Р	a	r	a	m		r	u	n	n	i	n	g		Parameters are being set (C/G)
Р	a	r	a	m	•		s	е	t		A			Parameter set A is active (C/G)
Р	a	r	a	m	•		S	е	t		В		K	Parameter set B is active (C/G)
Р	a	r	a	m	•		S	е	t		С	0		Parameter set C is active (C/G)
Р	a	r	a	m	•		S	е	t	•	D			Parameter set D is active (C/G)
s	У	s	t	е	m		F	1	t	<				Network system fault (C/G), detailed information in the fault annunciations
М	a	n	u	a	1		С	1	0	s	е		\perp	Manual close command registered (impulse) (C)
С	В		i	n		T	е	s	t					Circuit breaker test is in progress (C/G)
F	1	t	•	R	е	С	D	a	t	D	е	1		Fault recording data deleted (C)
F	1	t		R	е	c	•	v	i	a	В	I		Fault recording triggered via binary input (C)
F	1	t	*	R	е	С	•	v	i	a	K	В		Fault recording triggered via the front keyboard (C)
F	1	t	•	R	е	С	•	v	i	a	P	С		Fault recording triggered via operating (PC) interface (C)

Annunciations of monitoring functions:

Wrong SW-vers

Wrong dev. ID

Annunc. lost

Annu. PC lost

Oper.Ann.Inva

Flt.Ann.Inval

Stat.Buff.Inv

LED Buff. Inva

VDEW StateInv

Chs Error

Chs A Error

Chs B Error

Chs C Error

Chs D Error

Failure 15V

Failure 5 V

Failure 0 V

Failure RKA

LSA disrupted

Failure Σ I

ailure Isymm

Software version of the device is wrong (C)

Device identification number is wrong (C)

Annunciations lost (buffer overflow) (C)

Annunciations for operating (PC) interface lost (C)

Operational annunciations invalid (C/G)

Fault annunciations invalid (C/G)

Buffer for operation statistics invalid (C/G)

Buffer for stored LEDs invalid (C/G)

VDEW state (IEC 60870-5-103) invalid (C/G)

Check-sum error detected (C/G)

Check-sum error detected for parameter set A: no operation possible with this set (C/G)

Check-sum error detected for parameter set B: no operation possible with this set (C/G)

Check-sum error detected for parameter set C: no operation possible with this set (C/G)

Check-sum error detected for parameter set D: no operation possible with this set (C/G)

Failure in internal supply voltage 15 V (C/G))

Failure in internal supply voltage 5 V (C/G))

Failure in offset voltage 0 V (C/G)

Failure detected in input/output p.c.b. (C/G)

LSA-link disrupted (system interface) (C/G)

Failure detected by current plausibility monitor Σ I (C/G)

Failure detected by current symmetry monitor (C/G)

Operational annunciation of overcurrent time protection:

0	/	С		Р	h		0	f	f	
>	I	>	>		b	1	0	С	k	
>	I	>		b	1	0	С	k		
>	I	р		b	1	0	С	k		
0	/	С		E		0	f	f		
>	I	Е	>	>		b	1	0	С	k
>	I	E	>		b	1	0	С	k	

Phase overcurrent time protection is switched of (C/G)

Block I>> stage of phase overcurrent protection from an external device (C/G)

Block I> stage of definite time phase overcurrent protection from an external device (C/G)

Block I_p stage of inverse time phase overcurrent protection from an external device (C/G)

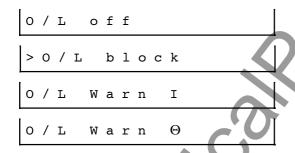
Earth overcurrent time protection is switched off (C/G)

Block $I_E >>$ stage of earth overcurrent protection from an external device (C/G)

Block I_E> stage of definite time earth overcurrent protection from an external device (C/G)

Block I_{Ep} stage of inverse time earth overcurrent protection from an external device (C/G)

Operational annunciations of thermal overload protection:



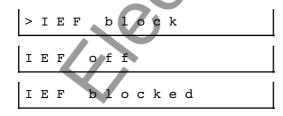
Thermal overload protection is switched off (C/G)

Block thermal overload protection via binary input (C/G)

Thermal overload protection: current warning stage (C/G)

Thermal overload protection: thermal warning stage (C/G)

Operational annunciations of intermittent earth fault protection:



Block intermittent earth fault protection (C/G)

Intermittent earth fault protection is switched off (C/G)

Intermittent earth fault protection is blocked (C/G)

Operational annunciations of circuit breaker failure protection:

B/F off

Circuit breaker failure protection is switched off (C/G)

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Operational annunciations from the circuit breaker test function:

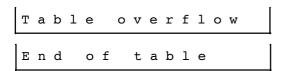
CB in Test

CB Test 3 p

Circuit breaker test in progress (C/G)

Trip three-pole by internal circuit breaker test function (C)

Further messages:



If more messages have been received the last valid message is Table overflow.

If not all memory places are used the last message is End of table.

6.4.3 Fault annunciations - address blocks 52 to 54

The annunciations which occurred during the last three network faults can be read off on the front panel or via the operating interface. The indications are recorded in the sequence from the youngest to the oldest under addresses 5200, 5300 and 5400. When a further fault occurs, the data relating to the oldest are erased. Each fault data buffer can contain up to 80 annunciations.

Input of the codeword is not required.

To call up the **last** fault data, one goes to address 5200 either by direct address **DA 5 2 0 0 E** or by paging with the keys \uparrow or \downarrow . With the keys \uparrow or \downarrow one can page the individual annunciations forwards or backwards. Each annunciation is assigned with a sequence item number.

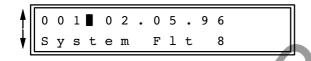
For these purposes, the term "system fault" means the period from short circuit inception up to final clearance. Within one system fault, several fault events can have occurred, i.e. from pick-up of any protection function until drop-off of the last pick-up of a protection function.

If the device is not equipped with the real time clock the date is replaced by **.**, the time is given as relative time related on the first pick-up of any protection function

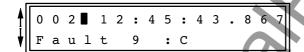
In the following clarification, all the available fault annunciations are indicated. In the case of a specific fault, of course, only the associated annunciations appear in the display. At first, an example is given for a system fault, and explained.



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



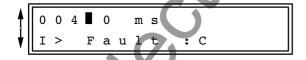
under item 1, the date of the system fault is indicated, in the second line the consecutive number of the system

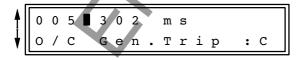


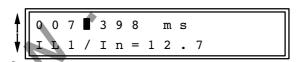
under item 2, the time of the beginning of the fault is given; time resolution is 1 ms



The following items indicate all fault annunciations which have occurred from fault detection until drop-off of the device, in chronological sequence. These annunciations are tagged with the relative time in milliseconds, starting with the fault detection.







```
006 1 398 ms
Dev. Drop-off:C
```

etc.

General fault annunciations of the device:

System Flt

Fault

Flt.Buff.Over

I L 1 / I n =

I L 2 / I n =

I L 3 / I n =

Dev. Drop-off

System fault with consecutive number

Beginning of fault

Fault annunciations lost (buffer overflow)

Interrupted fault current of phase L1

Interrupted fault current of phase L2

Interrupted fault current of phase L3

Drop-off of the device, general

Fault annunciations of overcurrent time protection:

Fault L	1
---------	---

Fault L1E

Fault L2

Fault L2E

Fault L12

Fault L12E

Fault L3

Fault L3E

Fault L13

Fault L13E

Fault L23

Fault L23E

Fau 1 t • L 1 2 3

Fault L123E

Fault E

I > > Fault

Fault detection overcurrent time protection, phase L1

Fault detection overcurrent time protection, phase L1 – E

Fault detection overcurrent time protection, phase

Fault detection overcurrent time protection, phase L2 - E

Fault detection overcurrent time protection, phases L1 – L2

Fault detection overcurrent time protection, phases L1 – L2 – E

Fault detection overcurrent time protection, phase L3

Fault detection overcurrent time protection, phase L3 – E

Fault detection overcurrent time protection, phases L1 – L3

Fault detection overcurrent time protection, phases L1 – L3 – E

Fault detection overcurrent time protection, phases 12 – 13

Fault detection overcurrent time protection, phase L2 - L3 - E

Fault detection overcurrent time protection, phases L1 – L2 – L3

Fault detection overcurrent time protection, phases L1 – L2 – L3 – E

Fault detection overcurrent time protection, earth fault

Fault detection in an I>> phase current stage

T - I > > expired Fault T - I > expired Ιp Fault q I - T expired I E > > Fault T - I E > > expir. I E > Fault T - I E > expired ΙΕρ Fault expired T - I E p Rush Block L 1 BlockL 2 Rush Rush Block L 3 Rush Crossbl

Delay time of I>> phase current stage expired

Fault detection in an I> phase current stage (definite time)

Delay time of I> phase current stage (definite time) expired

Fault detection in an I_p phase current stage (inverse time)

Delay time of I_p phase current stage (inverse time) expired

Fault detection in I_E>> earth current stage

Delay time of I_E>> earth current stage expired

Fault detection in I_E> earth current stage (definite time)

Delay time of I_E earth current stage (definite time) expired

Fault detection in I_{Ep} earth current stage (inverse time)

Delay time of I_{Ep} earth current stage (inverse time) expired

Block of phase L1 by inrush stabilization

Block of phase L2 by inrush stabilization

Block of phase L3 by inrush stabilization

Crossblock function has operated

General trip command of overcurrent time protection

Fault annunciation of thermal overload protection:

0 / L / T r i p

Gen. T

Trip by thermal overload protection

Fault annunciations of intermittent earth fault protection:

IIE Fault det.

Pick-up on earth fault

Intermittent earth fault detected (more than the set number of pick-ups); this annunciations locks further pick-up annunciations for earth faults

Accumulated earth fault time expired

IEF Tsum exp.

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0 / C

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I	E	F		Т	r	е	s	run.	
N	0	s	•	I	I	E	=		
I	i	е	/	I	n	=			
I	E	F		Т	r	i	р		

Reset time is running

Number of earth faults (with value)

Maximum earth fault current (r.m.s.) (with value)

Trip by intermittent earth fault protection

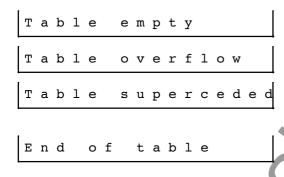
Fault annunciations of circuit breaker failure protection:

B / F	Start	
в / ғ	Trip	

Start on fault of circuit breaker failure protection

Trip by circuit breaker failure protection

Further messages:



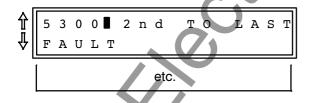
means that no fault event has been recorded

means that other fault data have occurred, however, memory is full

a new fault event has occurred during read-out: page on with † or \(\psi; \) the display shows the first annunciation in the actualized order

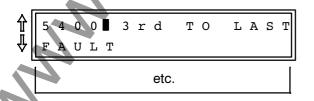
If not all memory places are used the last message is End of table.

The data of the **second to last** system fault can be found under address 5300. The available annunciations are the same as for the last fault.



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

The data of the **third to last** system fault can be found under address 5400. The available annunciations are the same as for the last fault.



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

6.4.4 Circuit breaker operation statistics – address block 56

The number of trip commands initiated by 7SJ511 is counted. Additionally, the interrupted currents are stated for each individual circuit breaker pole and given under the fault annunciations (refer Section 6.4.3) following each trip command. These currents are accumulated and stored. Counter status and stores are secured against auxiliary voltage failure and can be read off under address 5600. The ad-

dress can be reached by direct addressing **DA 5 6 0 0 E** or by paging with the keys ↑ or ↓ until address 5600 is reached. The counters can be called up using the key ↑ for forwards paging or ↓ for backwards paging.

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



Beginning of the block "Circuit breaker operation statistics"



Number of trip commands for circuit breaker, e.g. 23; maximum **65535**

Page on with key † to get further counter states



Accumulated interrupted currents for CB pole L1, e.g. $140.5 \, I_N$



Accumulated interrupted currents for CB pole L2, e.g. $145.9 I_N$



Accumulated interrupted currents for CB pole L3, e.g. $95.3 \, I_N$



Interrupted currents of the last fault for CB pole L1, e.g. 12.7 I_N ; maximum 655.35 I_N



Interrupted currents of the last fault for CB pole L2, e.g. 0.84 I_{N}



Interrupted currents of the last fault for CB pole L3, e.g. 0.86 $\ensuremath{I_N}$

The maximum values of the counters are:

Trip No

 $\Sigma IL1/In$, $\Sigma IL2/In$, $\Sigma IL3/In$

LAST IL1/In, LAST IL2/In, LAST IL3/In

9 digits

7 digits plus 1 decimal digit

7 digits plus 1 decimal digit

The counters can be reset to 0 in block 82 (see Section 6.5.2).

6.4.5 Read-out of operational measured values - address blocks 57 and 59

The steady state rms 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 \uparrow or \downarrow . The individual measured values can be found by further paging with \uparrow or \downarrow . Entry of the codeword is not necessary. The values will be updated in approximately 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 example values have been inserted. In practice the actual values appear.



Beginning of the block "Operational measured values"

Use † key to move to the next address with the next measured value.



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

One address is available for each measured value. The values can be reached also by direct addressing using key **DA** followed by the address number and execute with **E**.

```
5 7 0 2 M E A S . V A L U E I L 2 [ % ] = 8 0 . 8
```

The percentage is referred to rated relay current

```
5 7 0 3 M E A S . V A L U E I L 3 [ % ] = 7 8 . 8
```





The primary values (addresses 5710 to 5713) are based on the primary rated values as parameterized under address 1105 (refer to Section 6.3.3).







The correct matching factor according to address 1112 (Section 6.3.3) is a precondition for correct calculation of the primary earth current (address 5713)

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 5 9 0 0 E** or by paging with \uparrow or \downarrow . The individual measured values can be found by further paging with \uparrow or \downarrow . Entry of the codeword is not necessary.

The values are available as long as the thermal overload protection is configured as THERMAL OL = EX-IST (address 7827) and switched on (address 2701). Page on with the \uparrow key to read off the next address with the next measured value, or page back with \downarrow .



The calculated temperature rises of the individual phases are not presented if the measuring method Θ FROM IMAX has been selected (address 2706)







The percentage is referred to the trip temperature rise according to the measurement method as selected in address 2706

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. 7SJ511 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 functions can be controlled from the operating panel on the front of the device, via the operating interface in the front 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 from the operating pad 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 8000 and execute with key E.



Beginning of the block "Device control"

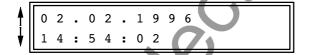
6.5.1 Adjusting and synchronizing the real time clock - address block 81

The date and time can be adjusted at any time during operation as long as the real time clock is operative. Setting is carried out in block 81 which is reached by direct addressing **DA 8 1 0 0 E** or by paging with ↑ and ↓. Input of the codeword is required to change the data.

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



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



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



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



DD.MM.YYYY or MM.DD.YYYY

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

HH.MM.ŠS



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

6.5.2 Erasing stored annunciations and counters – address block 82

The statistical indications (Section 6.4.4, address 5600) are stored in EEPROMs in 7SJ511. 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 $\uparrow \downarrow$. Erasure requires confirmation with the key \mathbf{J}/\mathbf{Y} . The display then confirms the erasure. If erasure is not required, press key \mathbf{N} or simply page on.



Beginning of block "Reset"



Request whether the LED memories should be reset



Request whether the operational annunciation buffer store should be erased



Request whether the fault annunciation buffer and fault recording stores should be erased



Request whether the CB operation counters should be set to zero



Request whether the total of switched short-circuit currents should be set to zero

During erasure of the stores (which may take some time) the display shows TASK IN PROGRESS. After erasure the relay acknowledges erasure, e.g.

8202 RESET SUCCESSFUL

6.5.3 Off/On control of part functions of the device

During operation of overcurrent time protection 7SJ511 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. Examples may be the switching off the circuit breaker failure protection function during maintenance or repair of the circuit breaker.

7SJ511 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 partial function is switched *ON* when the on—command has been given by both the binary input <u>AND</u> also from the operator panel or interface.

A partial function is switched *OFF* when the off-command is given by <u>EITHER</u> the binary input <u>OR</u> 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 a partial function must equally be 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:

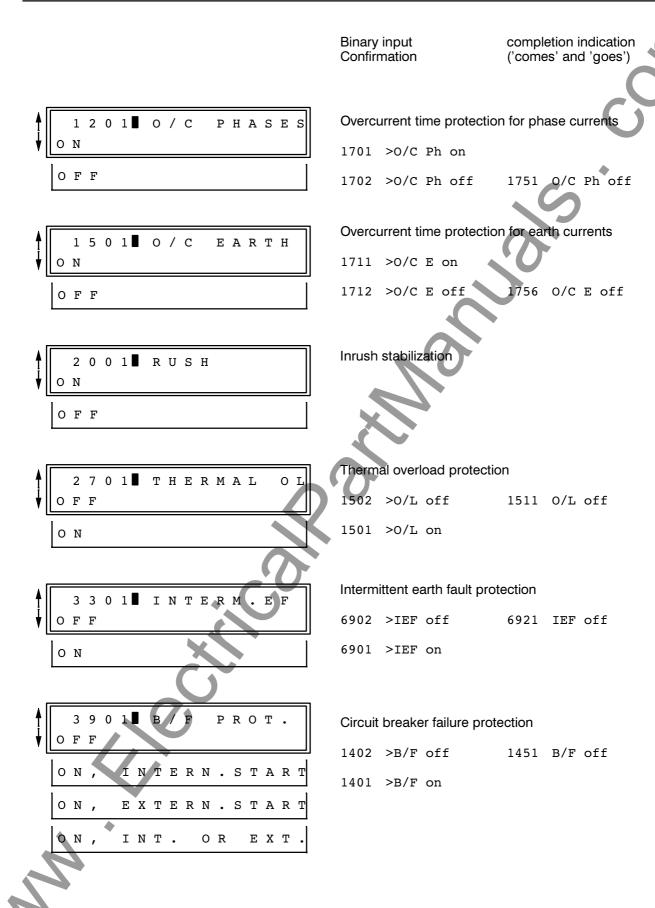
- "(function) off" Comes at the instant of switch-off,
- "(function) off" Goes at the instant that it is switched on.

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 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) 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.



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.

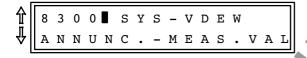
The standardized protocol allows all annunciations, messages, and measured values to be tagged with the origin "test operation", which occur while the relay is tested. Thus, these messages can be distinguished from those which occur during real operation.

This features can be accomplished using the integrated operating keyboard or via the operating (PC) interface.

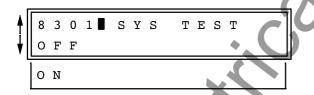
In order to carry out switch-over by the operator, entry of the codeword is necessary (refer to Section 5.3.1). For this purpose, address block 83 is available provided the VDEW/ZVEI protocol (IEC

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.



Beginning of block "Annunciations and measured values for the system interface with VDEW/ZVEI compatible protocol (IEC 60870-5-103)"



Only for VDEW/ZVEI compatible protoco (IEC 60870 – 5 – 103)I:

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 the system interface or binary inputs. A pre-requisite is, that during configuration of the scope of functions address 7885 has been set to PARAM. C/O = EXIST (refer 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 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 \mathbf{E} , or by paging through the display with \Uparrow or \Downarrow . You can switch-over to look up a different parameter set, e.g.

 Press key combination F 2, i.e. first the function key F and then the number key 2. All displayed parameters now refer to parameter set B.

The parameter set is indicated in the display by a leading character (A to D) before the address number indicating the parameter set identification.

The corresponding procedure is used for the other parameter sets:

- Key combination **F 1**:
 - access to parameter set A
- Key combination F 2:
 - access to parameter set B
- Key combination F 3:
 - access to parameter set C
- Key combination 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 \uparrow or \downarrow . The heading of the block will appear:



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

It is possible to scroll through the individual addresses using the \uparrow key or to scroll backwards with \downarrow .

Address 8501 shows the actually active parameter set with which the relay operates.

In order to switch-over to a different parameter set scroll on with † 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.

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SET BY BIN.INPUT

SET BY LSA CONTR

Address 8501 shows the actually active parameter set

Use the "No" – key **N** to page through the alternative possibilities. The desired possibility is selected by pressing the enter key **E**.

If you select *SET BY BIN.INPUT*, then the parameter set can be changed-over via binary inputs (see Section 6.5.5.3)

If you select SET BY LSA CONTR, then the parameter set can be changed-over via the system interface

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), ACTIVATION must be switched to SET BY BIN.INPUT (refer Section 6.5.5.2).
- 2 logical binary inputs are available for control of the 4 parameter sets. These binary inputs are designated ">ParamSelec.1" and ">Param Selec.2".
- 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 6.3. Of coarse, the binary inputs must be declared in normally open ("NO") mode.

	y 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

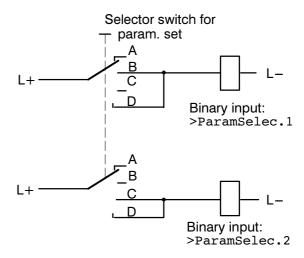


Figure 6.3 Connection scheme for parameter change-over via binary inputs

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.

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.

If unsymmetrical currents occur during the tests it is likely that the asymmetry monitoring will frequently operate. This is of no concern because the condition of steady-state measured values is monitored and, under normal operating conditions, these are symmetrical; under short circuit conditions these monitoring systems are not effective.

NOTE! The accuracy which can be achieved during testing depends on the accuracy of the testing equipment. The accuracy values specified in the Technical data can only be reproduced under the reference conditions set down in IEC 60255 resp. VDE 0435/part 303 and with the use of precision measuring instruments. The tests are therefore to be looked upon purely as functional tests.

During all the tests it is important to ensure that the correct command (trip) contacts close, that the proper indications appear at the LEDs and the output relays for remote signalling. If the relay is connected to a central memory device via the serial interface, correct communication between the relay and the master station must be checked.

After tests which cause LED indications to appear, these should be reset, at least once by each of the possible methods: the reset button on the front plate and via the remote reset relay (see connection diagrams, Appendix A). If the reset functions have been tested, resetting the stored indications is no moreecessary as they are erased automatically with each new pick-up of the relay and replaced by the new annunciations.

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6.6.2 Testing the high-set overcurrent time protection stages I>>, I_E>>

In order to test the high-set overcurrent time 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, twophase 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 at factory setting).

After expiry of the time delay (address 1503 T $_{-}$ IE>> for the earth current path, factory setting 0.5 s; address 1203 T $_{-}$ I>> for the phase path, factory setting 0.1 s), 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 time protection stages I>, $I_E>$

For these tests the related functions must be switched on, furthermore, the *DEFINITE TIME* mode must be selected in addresses 7812 and/or address 7815 (as delivered).

Testing can be performed with single-phase, two-phase or three-phase test current.

For test current below $4 \times I_N$, slowly increase the test current over one phase and earth until the protection picks up.



Caution!

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

For test currents above $4 \times I_N$ 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 $1 \times I_N$) is exceeded the pick-up indication for IE> appears, with further increase above the pick-up value of the phase current stage (address 1212 I>, factory setting $1 \times I_N$) 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).

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.

It must be noted that the set times are pure delay times; operating times of the measurement functions are not included.

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6.6.4 Testing the inverse time overcurrent time protection stages I_D, I_{ED}

For these tests the related functions must be switched on (address 1201 and/or 1501), furthermore, the *INVERSE TIME* modes must be selected in addresses 7812 and/or address 7815 (contrary to delivered setting).

Testing can be performed with single-phase, twophase or three-phase test current.

For test current below $4 \times I_N$, slowly increase the test current over one phase and earth until the protection picks up.



Caution!

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

For test currents above $4 \times I_N$ 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 $0.1 \times I_N$) is exceeded the pickup indication for IEp appears, with further increase above the pick-up value of the phase current stage (address 1214 Ip, factory setting $1 \times I_N$) 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).

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 Figure 3.1 (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 is not exceeded. Check that the assigned signal relay and trip relay contacts close.

6.6.5 Testing the thermal overload protection

The overload function can only be tested if it has been configured as THERMAL OL = EXIST (address 7827, refer 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 the rated current (factory settings) tripping must not occur. After an appropriate time (approximately $5\,x\,\tau$) a steady-state temperature rise according to the following relationship is established:

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

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

To check the time constant, the current input is simply subjected to 1.6 x the pick-up value, i. e. $1.6 \times k \times l_N$. 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 3.2). 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 reactivating 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 .

6.6.6 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 of delivery).

The trip commands of the overcurrent time protection functions must not interrupt the test current but the test current continues flowing after trip command of the overcurrent time 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 B/F I> (address 3911) but smaller than any setting value of the overcurrent time protection is injected so that the overcurrent time protection functions will not operate but the breaker failure protection function will.

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.

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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 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 circuit checks

Connections to current 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 block 51).

For current 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 6.3.9).

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. If substantial deviations occur or if the unit indicates a considerable earth current, then the current transformer connections are incorrect. Short-circuit the current transformers and make corrections.

No further tests are required for overcurrent time protection; these functions have been tested under 6.6.2 to 6.6.4. For checking the trip circuits at least one circuit breaker live trip should be performed (refer to Section 6.7.4).

6.7.2 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.

Reverse interlocking can be used in "normally open mode", i.e. the I>> stage is blocked when the binary input ">I>> block" is energized, or "normally closed" mode, i.e. the I>> stage is 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> or according to T-Ip.

If applicable repeat test for the earth current stages.

These tests have simultaneously proved that the wiring between the protection relays is correct.

6.7.3 Checking the circuit breaker failure protection

The protection function itself has already been tested according to Section 6.6.6.

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 are connected to 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.

6.7.4 Tripping test including circuit breaker – address block 44

Overcurrent time protection 7SJ511 allows simple checking of the tripping circuit and the circuit breaker. For this, the circuit breaker can be tripped by initiation from the operator keyboard or via the front operator interface.

Tests are listed from address 4000, the live tripping of the circuit breaker after address 4400.

The address is reached:

- directly with key **DA** followed by address number
 4 4 0 0 and finally operation of the enter key **E** or
- by paging through the blocks with ↑ or ↓ until address 4200 is reached.



Beginning of block "Tests"

If the circuit breaker auxiliary contacts advise the relay, through a binary input, of the circuit breaker position, the test can only be started when the circuit breaker is closed. This additional security feature should not be omitted when an external auto-reclose relay is present.

During marshalling of the binary inputs (refer to Section 5.5.2) the relay has been informed which binary input indicates the circuit breaker position. If the auxiliary contact is assigned to a binary input it must

be connected, too. If it is not assigned to any binary input then the device will perform tripping test without interrogation of the circuit breaker position!

Initiation of the test can be given from the operator keyboard or from the front operator interface. A codeword input is necessary. The procedure is started with address 4400 which can be reached by direct dialling **DA 4 4 0 0 E** or by paging with ↑ or ↓. In this block you find the address 4404 as shown in the following boxes.



DANGER!

A successfully started test cycle may lead to closing of the circuit breaker if auto-reclosure is used!

A further prerequisite for starting the test is that no protection function of the relay be picked up.



Beginning of the block "Circuit breaker live trip test"



Trip circuit breaker three-pole? Confirm with "J/Y" – key or abort with page-on key \uparrow

Confirm with "J/Y" – key that circuit breaker is closed or abort with page-on key \uparrow

6.7.5 Starting a test fault record - address block 49

A fault record storage 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").

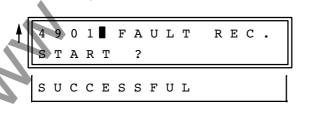
The configuration parameters as set in address block 74 are decisive for this fault recording (refer to Section 5.3.4): address 7431 concerns triggering via

binary input, address 7432 triggering via the operating keyboard or via the operating interface. The pretrigger time was set under address 7411.

Manual starting of a fault record is carried out in address block 49, which can be reached by paging with \uparrow or \downarrow , or by direct dialling with **DA 4 9 0 0 E**. The start address is reached with \uparrow :



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



Start fault recording? Confirm with "J/Y" – key or abort with page-on key †

The relay acknowledges successful completion of the test recording

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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 and ancillary 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 overcurrent time 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 least 10 years of operation. (refer to Section 7.2). This recommendation is valid independent on whether the battery has been discharged by occasional supply voltage failures or not.

As the protection is almost completely self-monitored, from the measuring inputs to the command output relays, hardware and software faults are automatically annunciated. This ensures the high availability of the relay and allows a more corrective rather than preventive maintenance strategy. Tests at short intervals become, therefore, superfluous.

With detected hardware faults the relay blocks itself; drop-off of the availability relay signals "equipment fault". If there is a fault detected in the external measuring circuits, generally an alarm is given only.

Recognized software faults cause the processor to reset and restart. If such a fault is not eliminated by restarting, further restarts are initiated. If the fault is still present after three restart attempts the protective system will switch itself out of service and indicate this condition by the red LED "Blocked" on the front plate. Drop-off of the availability relay signals "equipment fault".

The reaction to defects and indications given by the relay can be individually and in chronological sequence read off as operational annunciations under the address 5100, for defect diagnosis (refer to Section 6.4.2).

If the relay is connected to a local substation automation system (LSA), defect indications will also be transferred via the serial interface to the central control system.



Warning

Ensure that the connection modules are not damaged when removing or inserting the device modules! Hazardous voltages may occur when the heavy current plugs are damaged!

7.1 Routine checks

Routine checks of characteristics or pick-up values are not necessary as they form part of the continuously supervised firmware programs. The planned maintenance intervals for checking and maintenance of the plant can be used to perform operational testing of the protection equipment. This maintenance serves mainly for checking the interfaces of the unit, i.e. the coupling with the plant. The following procedure is recommended:

- Read-out of operational values (address block 57) and comparison with the actual values for checking the analog interfaces.
- Simulation of an internal short-circuit with 4 x I_N for checking the analog input at high currents.



Warning

Hazardous voltages can be present on all circuits and components connected with the supply voltage or with the measuring and test quantities!



Caution!

Test currents larger than 4 times I_N may overload and damage the relay if applied continuously (refer to Section 3.1.1 for overload capability). Observe a cooling down period!

 Circuit-breaker trip circuits are tested by actual live tripping. Respective notes are given in Section 6.7.4.

7.2 Replacing the clock module

If the device is equipped with the clock option (model 7SJ511*-***3-**, refer to Section 2.3 Ordering data), the device annunciations are stored in NV-RAMs. The clock module contains also the back-up battery so that the annunciations are retained even with a longer failure of the d.c. supply voltage.

The clock module should be replaced at the latest after 10 years of operation.

Recommended clock module:

DALLASDS 1386 – 32 KRAMfied 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 clock module 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 can be present in the device even after disconnection of the supply voltage or after removal of the modules from the housing (storage capacitors)! Loosen the draw-out 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 the 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 PCB 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 clock module has thus been completed.

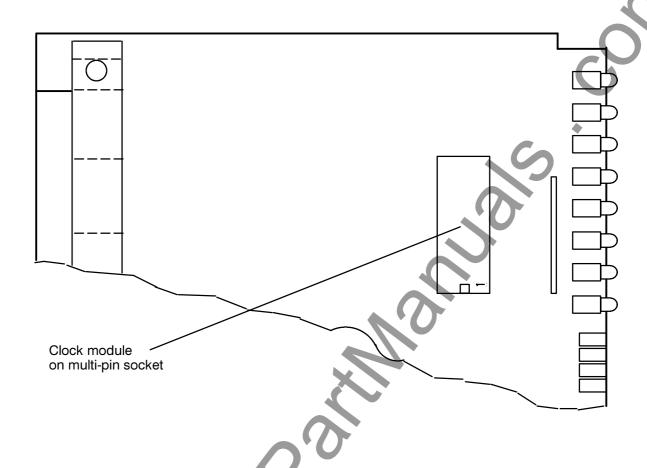


Figure 7.1 Position of the clock module

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 processor system off and on again (by means of the switch on the front plate). This, however, results in loss of fault data and messages if the relay is not equipped with the clock module, 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 can be present in the device even after disconnection of the supply voltage or after removal of the modules from the housing (storage capacitors)!

 Loosen the module using the pulling aids provided at the top and bottom. (Figure 7.3).

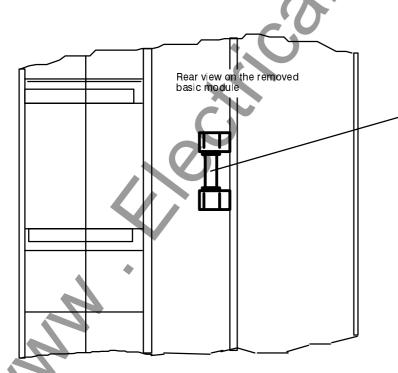


Caution!

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 the 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 draw-out 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

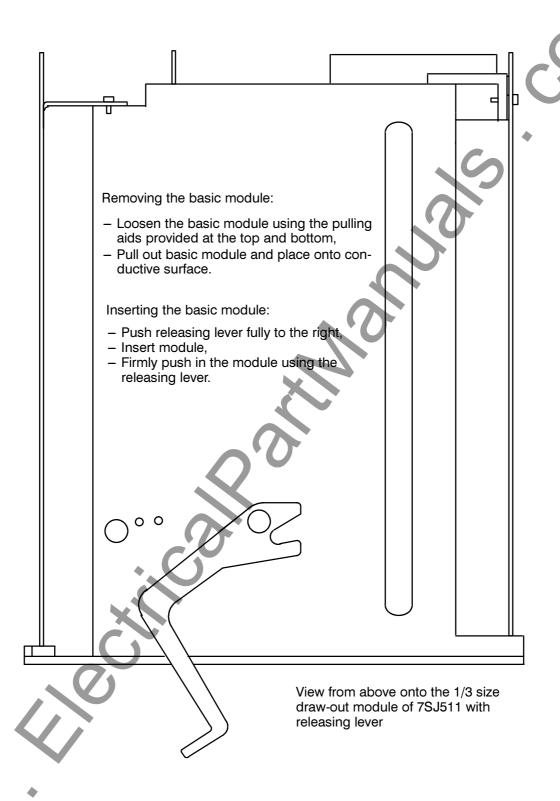


Figure 7.3 Aid for removing and inserting the draw-out module

7SJ511v3 Repairs, Storage

8 Repairs

Repair of defective modules is not recommended at all because specially selected electronic components are used which must be handled in accordance with the procedures required for Electrostatically Endangered Components (EEC). Furthermore, special manufacturing techniques are necessary for any work on the printed circuit boards in order to do not damage the bath-soldered multilayer boards, the sensitive components and the protective finish.

Therefore, if a defect cannot be corrected by operator procedures such as described in Chapter 7, it is recommended that the complete relay should be returned to the manufacturer. Use the original transport packaging for return. If alternative packing is used, this must provide the degree of protection against mechanical shock, as laid down in IEC 60255-21-1 class 2 and IEC 60255-21-2 class 1.

If it is unavoidable to replace individual modules, it is imperative that the standards related to the handling of Electrostatically Endangered Components are observed.



Warning

Hazardous voltages can be present in the device even after disconnection of the supply voltage or after removal of the module from the housing (storage capacitors)!



Caution!

Electrostatic discharges via the component connections, the PCB tracks or the connecting pins of the modules must be avoided under all circumstances by previously touching an earthed metal surface. This applies equally for the replacement of removable components, such as EPROM or EEPROM chips. For transport and returning of individual modules electrostatic protective packing material must be used.

Components and modules are not endangered as long as they are installed within the relay.

Should it become necessary to exchange any device or module, the complete parameter assignment should be repeated. Respective notes are contained in Chapter 5 and 6.

9 Storage

Solid state protective relays shall be stored in dry and clean rooms. The limit temperature range for storage of the relays or associated spare parts is -25 °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.

7SJ511v3 Appendix

Appendix

A General diagrams

B Connection diagrams

C Tables

C53000-G1176-C101

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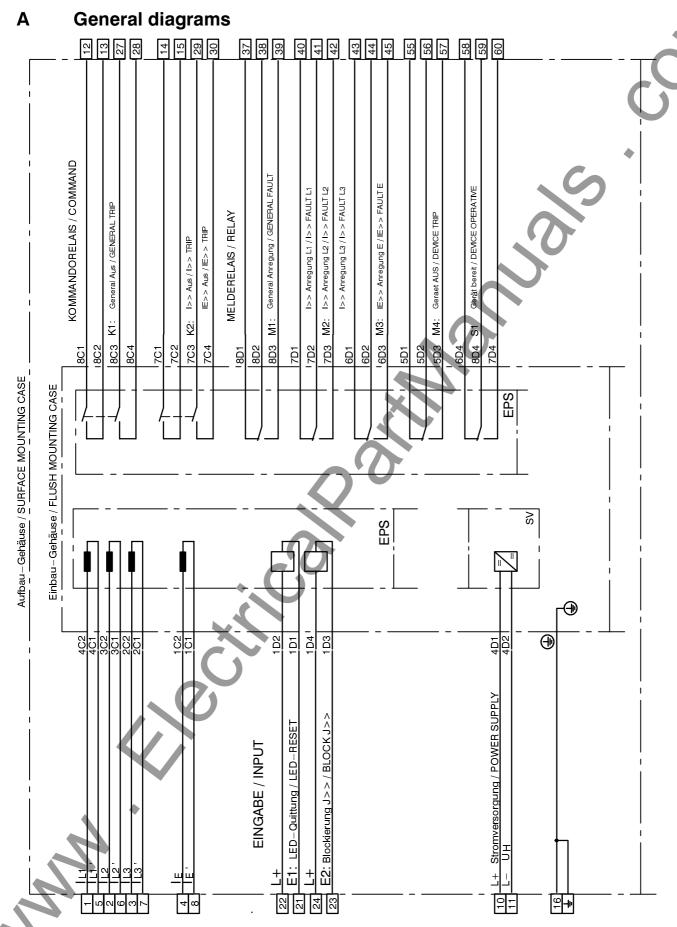


Figure A.1 General diagram of overcurrent time protection 7SJ511 (sheet 1 of 2)

7SJ511v3 Appendix

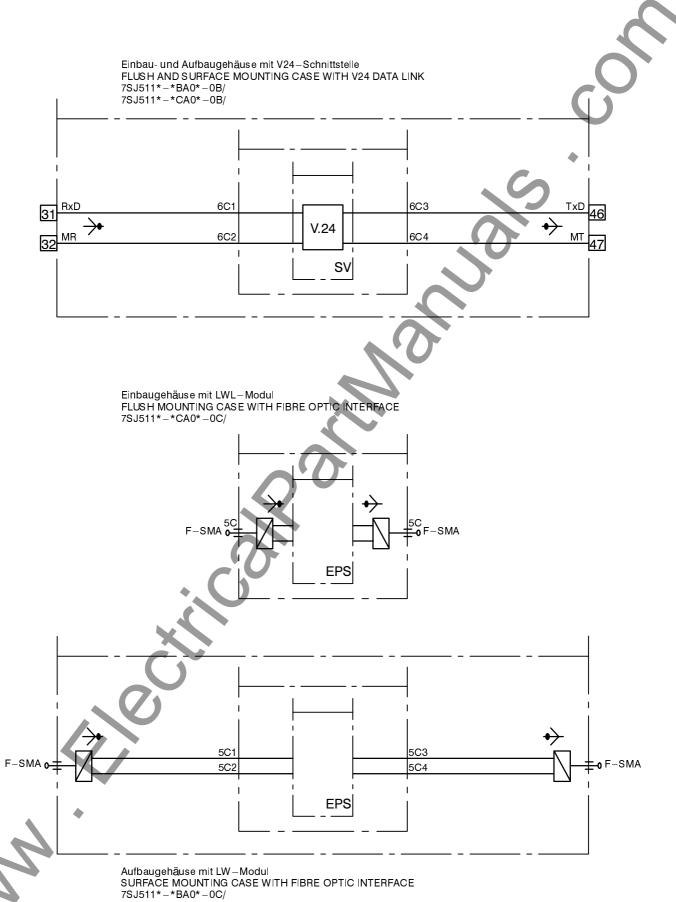


Figure A.2 General diagram of overcurrent time protection 7SJ511 (sheet 2 of 2)

B Connection diagram

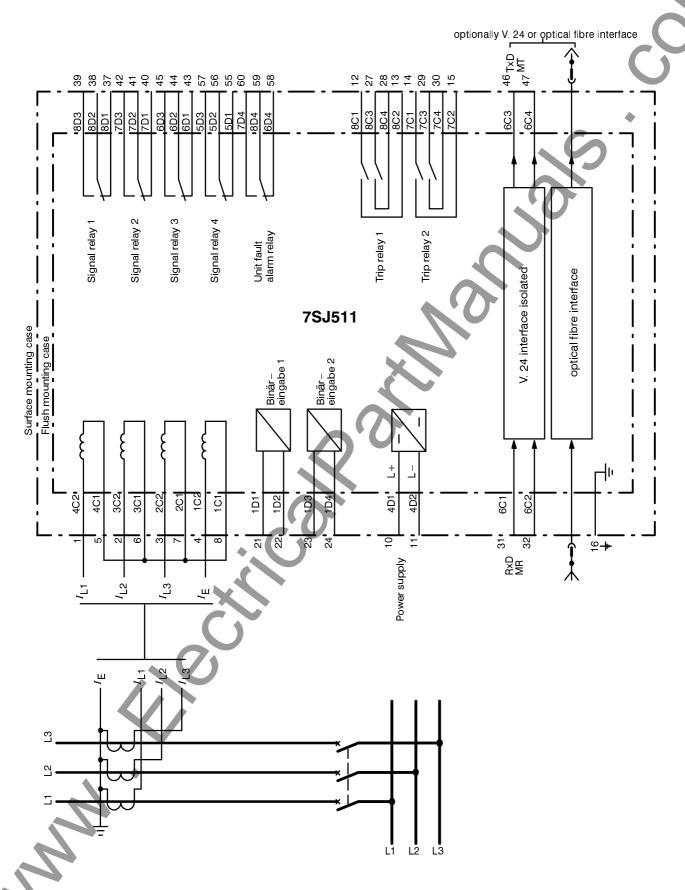


Figure B.1 Connection diagram of overcurrent time protection relay 7SJ511

7SJ511v3 Appendix

B Current transformer circuits

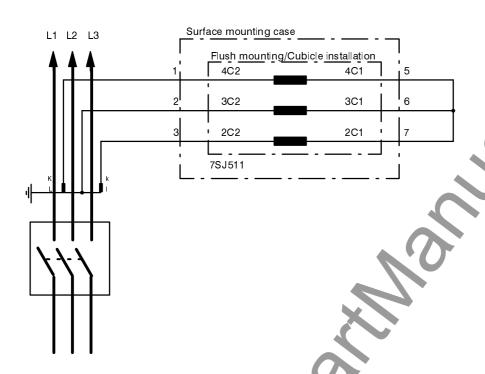


Figure B.2 2 c.t. connection only for isolated or compensated systems

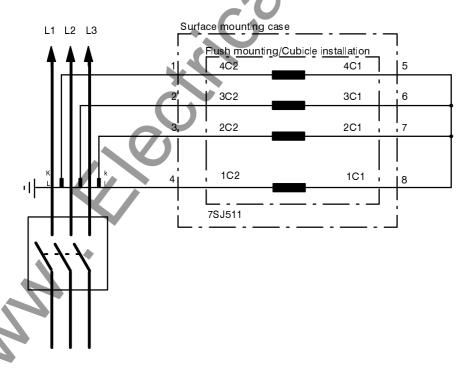


Figure B.3 3 c.t. connection with higher sensitivity for earth faults

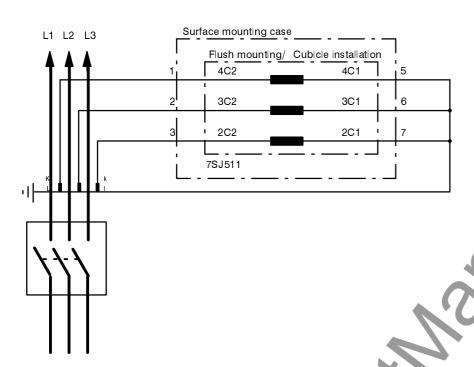


Figure B.4 3 c.t. connection with equal sensitivity for all kinds of fault

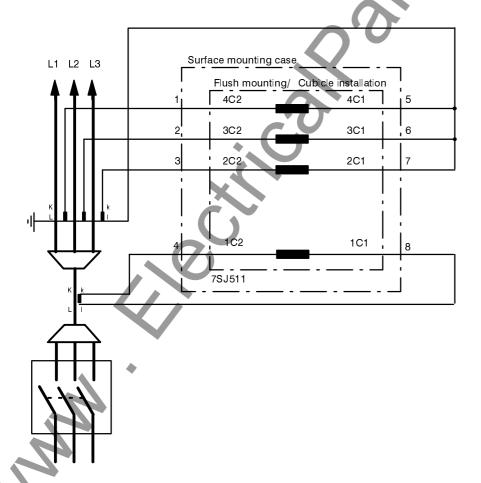


Figure B.5 **3 c.t.** connection with separate summation c.t. for earth faults

7SJ511v3 Appendix

C Tables

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		♦	
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NOTE: The following tables list all data which are available in the maximum complement of the device. Dependent on the ordered model, only those data may be present which are valid for the individual version.

NOTE: The actual tables are attached to the purchased relay.

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Annunciations 7SJ511 for LSA (DIN 19244 and according VDEW/ZVEI)

- Function number of annunciation FNo. Op/Ft - Operation/Fault annunciation

C/CG: Coming/Coming and Going annunciation

: Annunciation with Value

: Measurand

LSA No.- Number of annunciation for former LSA (DIN 19244)

according to VDEW/ZVEI:

- Compatible Annunciation

- Annunciation for General Interrogation GΙ

BT

- Binary Trace for fault recordings
- Function type (p: according to the configured "Function") Тур

- Information number Inf

					-		_		
		Aı	nn.	LSA				ZVEI	Ì
FNo.	Meaning	Ор	Ft	No.	CA	GI	ВТ	Тур	Inf
	>User defined annunciation 1 >User defined annunciation 2	CG CG		24 25	CA CA	GI GI	BT BT	p p	27 28
13	>User defined annunciation 3	CG		26	CA	GI		p	29
	>User defined annunciation 4	CG		27	CA	GI	ВТ	р	30
	Device operative / healthy	CG		1		GI		135	81
	Any protection operative	CG			CA	GI	ļ	р	18
55	Re-start of processor system	C		8	CA			р	4
	Initial start of processor system	C			CA			р	5
	Real time response to LSA	C	ļ	6					1.0
60	LED Reset	C	ļ	13	CA			р	19
62	Most mode		ļ						21
	Test mode PC operation via system interface	CG			CA	GI		р 135	83
	Parameters are being set	CG		11	CA	GI	ł	,	22
	Parameter set A is active	CG		++	CA	GI		p p	23
	Parameter set B is active	CG		•	CA	GI		p p	24
1	Parameter set C is active	CG			CA	GI		p	25
	Parameter set D is active	CG			CA	GI		p	26
	Annunciations lost (buffer overflow)	С		9			\	135	130
	Annunciations for LSA lost	С		10	İ	İ	İ	135	131
	Fault tag lost		1		İ	İ	ВТ	135	136
140	General internal failure of device	CG			CA	GI	ĺ	р	47
143	Failure of internal 15 VDC power supply Failure of internal 5 VDC power supply	CG	l	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	ļ	GI		135	165
	Failure in the RKA module	CG		100	ı	GI		р	36
	Common alarm	CG			CA	GI		р	46
	Measured value supervision of currents	CG		104	CA	GI		1 2 F	32 182
162	Failure: Current summation supervision	CG CG				GI		135	183
103	Failure: Current symmetry supervision Fault recording initiated via bin.input	CG		107		GI	ВТ	135 135	204
204	Fault recording initiated via keyboard						ВТ	135	204
	Fault recording initiated via PC interf						BT	135	206
301	Fault in the power system		CG	2	}	}	"	135	
302	Flt. event w. consecutive no.		C	~					232
302	1110. Gvene w. combeductive no.	1	<u>ا</u>		l	l	İ	133	2.52
501	General fault detection of device	ĺ	CG	142	ľ	ľ	вт	150	151
	General drop-off of device		C	252	\	\		150	152
511	General trip of device		С	143	ĺ	ĺ	вт	150	161
521	Interrupted current: Phase L1(I/In)	1	V	249	1	1	1	150	171
522	Interrupted current: Phase L2(I/In)	İ	V	250]]]	150	172
				Ĺ	Ĺ	Ĺ	[Ĺ	لـــــــا

			nn.	LSA				ZVEI
FNo.	Meaning	Op	Ft	No.	CA	GI	ВТ	Typ Inf
523	<pre>Interrupted current: Phase L3(I/In)</pre>		V	251	\ 	\ 		150 173
561	Circuit breaker manually closed (pulse)	С	İ	18	İ	İ	İ	150 211
601	Current in phase IL1 [%] =	M	İ		İ	İ	İ	134 133
	Current in phase IL2 [%] =	M			CA	ĺ		134 133
	Current in phase IL3 [%] =	M			<u> </u>	1	1	134 133
	IE[%]=	M	1	1				134 133
	Circuit breaker test in progress	CG		21		GI)		151 74
1181		С		110			ľ	151 81
	Breaker fail protection is switched off	CG		56		GI		166 151
1455	Breaker failure : fault detection	İ	С	227			ВТ	166 155
1471	Trip by breaker failure protection	1	С	228	CA		ВТ	p 85
1511		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		CG		63		GI		167 16
1521	Thermal overload protection trip		C	64			ВТ	167 21
1721	>Overcurrent protection:block stage I>>	CG		31		GI		60 1
1722		CG	•	33		GI		60 2 60 3
	>Overcurrent protection:block stage Ip	CG		35		GI		
1724	>Overcurrent protec.: block stage IE>>	CG		32		GI		60 4
	>Overcurrent protection:block stage IE>	CG		34		GI		60 5
1726		CG		36		GI		60 6
1751	Overcurrent prot. phase is switched off	CG		50		GI		60 21
	O/C protection earth is switched off	CG		51		GI		60 26
1761			CG					p 84
	O/C fault detection phase L1		CG					p 64
1763	O/C fault detection phase L2		CG					p 65
	O/C fault detection phase L3		CG	ı		GΙ	BT	p 66
	O/C fault detection earth		CG		CA	GI	BT	p 67
	O/C fault detection L1 only		С	161		ļ		60 31
	O/C fault detection 11-E		С	162		ŀ		60 32 60 33
	O/C fault detection L2 only		C	163 164				60 33 60 34
	O/C fault detection L2-E O/C fault detection L1-L2		С	165	-	ŀ		60 35
	O/C fault detection L1-L2-E		C	166				60 36
1777			C	167		ŀ		60 37
	O/C fault detection L3-E		C	168	ŀ	ł		60 38
1779			C	169				60 39
1780		1	C	170	•	ŀ		60 40
	O/C fault detection L2-L3	1	C	171	ł	ł		60 41
	O/C fault detection L2-L3-E	l	C	172				60 42
	O/C fault detection L1-L2-L3		C	173	i	İ		60 43
	O/C fault detection L1-L2-L3-E		C	174				60 44
	O/C fault detection E only		C	175	İ	İ		60 45
	O/C general trip command		C	149	CA	ĺ	ВТ	p 68
	O/C fault detection stage I>> phase L1		CG	,))	60 46
1802	O/C fault detection stage I>> phase L2		CG		İ	İ		60 47
1803	O/C fault detection stage I>> phase L3		CG					60 48
	O/C time TI>> expired		С	195				60 49
	O/C protection I>> phase trip		С	198	CA		ВТ	p[91
1811	O/C fault detection stage I> phase L1		CG					60 50
	O/C fault detection stage I> phase L2		CG					60 51
1813	O/C fault detection stage I> phase L3		CG					60 52
	O/C time TI> expired		С	155]			60 53
	O/C protection I> phase trip		С	158	CA	ļ	ВТ	p 90
	O/C fault detection Ip phase L1			181				60 54
11822	O/C fault detection Ip phase L2		CG	182				60 55
	<u> </u>	L		L	L	L		

FNo.	Meaning		LSA No.				ZVEI Typ	Inf
1824 1825 1831 1832 1833 1834 1835 1836 1837 1840 1841 1842 1843 6903 6921 6922 6923 6926 6927 6928 6929 6930 6931	O/C fault detection Ip phase L3 O/C time TIp expired O/C protection Ip phase trip O/C fault detection IE>> earth O/C time TIE>> expired O/C protection IE>> earth trip O/C fault detection IE> earth O/C time TIE> expired O/C protection IE> earth trip O/C fault detection IEp earth O/C time TIE> expired O/C protection IE> earth trip O/C fault detection IEp earth O/C time TIEp expired O/C protection IEp earth trip Phase L1 blocked by inrush detection Phase L2 blocked by inrush detection Phase L3 blocked by inrush detection Cross blocking by inrush detection >Block interm. E/F prot. Interm. E/F prot. is switched off Interm. E/F prot. is slocked Interm. E/F prot. is active Interm. E/F detected Counter of det. times elapsed Interm. E/F: reset time running Interm. E/F: trip Max RMS current value of fault = No. of detections by stage Iie>=	CG CG CG CG CG CG CG CG CG CG CG CG CG C	177	CA	GI GI GI GI	BT BT	60 60 60 60 60 60 60 60 60 60 60 152 152 152 152 152 152 152	56 57 58 59 60 61 62 63 92 64 65 66 101 102 103 104 11 12 13 14 15 16 17 18 19

Annunciations 7SJ511 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

Μ : Measurand

- Earth fault annunciation

IOT

- Earth fault annunctation
- 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
		>Time synchronization >Start fault recording >Reset LED indicators	С			IO IO IO
7		>Parameter set selection 1 (with No.8)				IO
8		>Parameter set selection 2 (with No.7)				IO
	>Annunc. 1	>User defined annunciation 1 >User defined annunciation 2	CG			IOT
	>Annunc. 3	>User defined annunctation 3	CG			IOT
	>Annunc. 4	>User defined annunciation 4	CG			IOT
51	Dev.operative	Device operative / healthy	CG		1	0
56	Initial start	Initial start of processor system	С			[
	LED reset	LED Reset	С			_
		Parameters are being set	CG			0
	Param. Set A	Parameter set A is active Parameter set B is active	CG			0
		Parameter_set C is active	CG			0
		Parameter set D is active	CG			Ö
	Wrong SW-vers	Wrong software-version	С			
	Wrong dev. ID		С			
	Annunc. lost	Annunciations lost (buffer overflow)	С			
	Annu. PC lost	Annunciations for PC lost Fault annunciation buffer overflow	С	C		
1 113	ric.buil.over	rault annunctation buller overflow				
120	Oper.Ann.Inva	Operational annunciations invalid	CG	1	1	
	Flt.Ann.Inval	Fault annunciations invalid	CG			
]	
	Stat.Buff.Inv	Statistic annunciation buffer invalid	CG			
	LED Buff.Inva	LED annunciation buffer invalid VDEW state invalid	CG CG	1	١.	
	Chs Error	Error in check sum	CG			
	Chs.A Error	Error in check sum for parameter set A	CG			
	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			
	Chs.D Error	Error in check sum for parameter set D	CG			0.5
	Failure 15V Failure 5V	Failure of internal 15 VDC power supply Failure of internal 5 VDC power supply	CG CG			OT OT
145	Failure OV	Failure of internal 0 VDC power supply	CG			OT
	Failure RKA	Failure in the RKA module	CG			
159	LSA disrupted	LSA (system interface) disrupted	CG			
	I supervision					0
	Failure ∑I	Failure: Current summation supervision	CG			TO
		Failure: Current symmetry supervision	CG C			OT
		Fault recording data deleted Fault recording initiated via bin.input	C			
		Fault recording initiated via keyboard	C			
		Fault recording initiated via PC interf				
L		L	L			

FNo.	Abbreviation	Meaning	Ор	Ft	Е	IOT]
	D Time=	Diff. time of clock synchronism	М				1
	Syst.Flt Fault	Fault in the power system Flt. event w. consecutive no.	CG	C C			
354	>CB Aux.3p cl	>CB aux. contact:3poles closed (series)]]		IOT	1
356	>Manual Close	>Manual close				IOT	
		General fault detection of device		_ /		ОТ	l
		General drop-off of device	4	C) 	
	Device Trip IL1/In=	General trip of device		C	4	OT	١
	IL1/IN= IL2/In=	<pre>Interrupted current: Phase L1(I/In) Interrupted current: Phase L2(I/In)</pre>		C			ł
	IL3/In=	Interrupted current: Phase L3(I/In)	•	Č)			l
	T-Drop	Time from fault detection to drop-off					١
	T-Trip	Time from fault detection to trip			ĺ		ı
	Manual Close	Circuit breaker manually closed (pulse)	C	ĺ		ОТ	ĺ
601	IL1[%] =	Current in phase IL1 [%] =	M				
	IL2[%] =	Current in phase IL2 [%] =	M				١
603	IL3[%] =	Current in phase IL3 [%] =	M	ļ			
	IE[%]= IL1 =	<pre>IE[%]= Current in phase IL1 =</pre>	M M	ŀ			
	IL1 = IL2 =	Current in phase IL1 = Current in phase IL2 =	M				
	IL3 =	Current in phase IL3 =	M				l
	IEa =	Operational measurement: IEa=	M				l
	Θ/Θtrip =	Temperat. rise for warning and trip	M	İ			l
	Θ/ΘtripL1=	Temperature rise for phase L1	М	İ			١
803	Θ/ΘtripL2=	Temperature rise for phase L2	M				
804	Θ/ΘtripL3=	Temperature rise for phase L3	M				١
1000	Trip No =	Number of trip commands issued	M	ļ			1
1004	∑IL1/In=	Summated current tripped IL1/In	M M				
1005	$\sum IL2/In=$ $\sum IL3/In=$	Summated current tripped IL2/In Summated current tripped IL3/In	M M				١
1015		Last trip current L1 IL1/In=	M	l I			ł
	IL2/In=	Last trip current L2 IL2/In=	M				l
1017	IL3/In	Last trip current L3 IL3/In=	М				١
1156	>CB Test	>CB test start		İ	1	IOT	İ
1174	CB in Test	Circuit breaker test in progress	CG	[ОТ	
1181	CB Test Trip	Circuit breaker test: General trip	С			ОТ	
	>B/F on	>Switch on breaker fail protection				IOT	
	>B/F off	>Switch off breaker fail protection	ļ			IOT	
	>B/F Start B/F off	>ext. start breaker failure protection Breaker fail protection is switched off	ارد	ŀ		TOI	-
	B/F active	Breaker failure protection is active				OT	- 1
	B/F fault	Breaker failure : fault detection		CG		OT	ι
1471	B/F Trip	Trip by breaker failure protection		С	\	OT	Ì
	>0/L on	>Switch on thermal overload protection	j	Ī		IOT	
	>O/L off	>Switch off thermal overload protection	ļ			IOT	- 1
	>0/L block	>Block thermal overload protection	CG			IOT	- 1
		Thermal overload prot. is switched off	CG			TO	-1
	O/L blocked O/L active	Thermal overload protection is blocked Thermal overload protection is active				TO T	L
	O/L active O/L Warn I	Thermal overload protection is active Thermal overload prot.: Current warning	l CG	ł		OT	,
	O/L Warn Θ	Thermal overload prot.: Thermal warning				OT	- 1
	O/L Trip	Thermal overload protection trip	~~	С	\ \	OT	
1701	>O/C Ph on	>Switch on O/C protection phase	1	1		IOT	J
1702	>O/C Ph off	>Switch off O/C protection phase	İ	[IOT	
1711	>0/C E on	>Switch on overcurrent protection earth	l	l		IOT	L
	>O/C E off	>Switch off overcurrent protec. earth		ļ		IOT	J
1721	>I>> block	>Overcurrent protection:block stage I>>	CG			IOT	

FNo.	Abbreviation	Meaning	Op	Ft	Е	IOT
	>I> block	>Overcurrent protection:block stage I>	CG			IOT
	>Ip block	>Overcurrent protection:block stage Ip	CG			IOT
	>IE>> block	>Overcurrent protec.: block stage IE>>	CG			IOT
	>IE> block >IEp block	>Overcurrent protection:block stage IE>	CG CG			TOI TOI
	O/C Ph off	>Overcurrent protection:block stage IEp Overcurrent prot. phase is switched off	CG	-	1	OT
	O/C Ph active	Overcurrent prot. phase is active				OT
	O/C E off	O/C protection earth is switched off	CG			OT
	O/C E active	O/C protection earth is active				OT
	O/C Gen.Fault					ОТ
	Fault L1	O/C fault detection phase L1				OT
	Fault L2	O/C fault detection phase L2				OT
	Fault L3	O/C fault detection phase L3				OT
	Fault E Fault L1	O/C fault detection earth O/C fault detection L1 only		C		OT
	Fault L1E	O/C fault detection L1 only		C		
	Fault L2	O/C fault detection L2 only		C		
	Fault L2E	O/C fault detection L2-E		C		
	Fault L12	O/C fault detection L1-L2		С		
	Fault L12E	O/C fault detection L1-L2-E		С		
	Fault L3	O/C fault detection L3 only		С		
	Fault L3E	O/C fault detection L3-E		С		
	Fault L13	O/C fault detection L1-L3		С		
	Fault L13E Fault L23	O/C fault detection L1-L3-E		C		
	Fault L23	O/C fault detection L2-L3 O/C fault detection L2-L3-E		С		
	Fault L123	O/C fault detection L1-L2-L3		C		
	Fault L123E	O/C fault detection L1-L2-L3-E		C		
	Fault E	O/C fault detection E only		C		
1791	O/C Gen.Trip	O/C general trip command		С		OT
	I>> Fault	O/C fault detection stage I>>		С		OT
	I>> Fault L1	O/C fault detection stage I>> phase L1				OT
	I>> Fault L2	O/C fault detection stage I>> phase L2				TO
	I>> Fault L3	O/C fault detection stage I>> phase L3 O/C time TI>> expired		C	,	TO
	I>> Trip	0/C time 11>> expired 0/C protection I>> phase trip				TO TO
	I> Fault	O/C fault detection stage I>		С	1	OT
	I> Fault L1	O/C fault detection stage I> phase L1				OT
	I> Fault L2	O/C fault detection stage I> phase L2				OT
	I> Fault L3	O/C fault detection stage I> phase L3				ОТ
	T-I> expired	O/C time TI> expired		С		OT
	I> Trip	O/C protection I> phase trip				OT
	Ip Fault	O/C fault detection Ip		С		OT
	Ip Fault L1	O/C fault detection Ip phase L1				TO
	Ip Fault L2 Ip Fault L3	O/C fault detection Ip phase L2				TO
	T-Ip expired	O/C fault detection Ip phase L3 O/C time TIp expired		С		OT
	Ip Trip	O/C time lip expired O/C protection Ip phase trip				OT
	IE>> Fault	O/C fault detection IE>> earth		С		OT
1832	T-IE>> expir	O/C time TIE>> expired		С		ОТ
1833	IE>> Trip	O/C protection IE>> earth trip				ОТ
	IE> Fault	O/C fault detection IE> earth		С		OT
		O/C time TIE> expired		С		ОТ
	IE> Trip	O/C protection IE> earth trip				OT
	IEp Fault	O/C fault detection IEp earth O/C time TIEp expired		С		TO TO
	IEp Trip	O/C time liep expired O/C protection IEp earth trip				OT
1840	Rush Block I.1	Phase L1 blocked by inrush detection		CG		OT
1 - 5 - 5	=====================================	==			1	

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FNo.	Abbreviation	Meaning	Op	Ft	Е	IOT
1842 1843 6901 6902	Rush Block L3 Rush Crossbl. >IEF on >IEF off	Phase L2 blocked by inrush detection Phase L3 blocked by inrush detection Cross blocking by inrush detection >Switch on interm. E/F prot. >Switch off interm. E/F prot. >Block interm. E/F prot.	CG	CG CG CG		OT OT OT IOT IOT
6922 6923 6924 6925 6926 6927 6928 6929 6930 6931	IEF OFF IEF blocked IEF enabled IIE Fault det IIE stab.Flt. IIE Fault det Intermitt.EF IEF Tsum exp. IEF Tres run. IEF Trip Iie/In= Nos.IIE=	<pre>Interm. E/F stab. detection Interm. E/F detection stage lie> Interm. E/F detected Counter of det. times elapsed</pre>	CG	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		OT OT OT OT OT OT OT

Reference Table for Functional Parameters 7SJ511

1000 PARAMETERS

```
1100 POWERSYSTEM DATA
1105 In PRIMARY
                           Primary rated current
     min. 10
     max. 50000
1112 Ie/Iph
                           Matching factor Ie/Iph for earth current
     min. 0.001
     max. 20.000
1141 T TRIP
                           Minimum trip command duration
     min. 0.01 max. 32.00
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
max. 25.00
                           I/In
1203 T-I>>
                                time delay of the high-set stage I>>
     \min.\ 0.00
     max. 60.00/\infty
1206 MEAS.REPET
                           Measurement repetition
     NO
     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
                           I/In
     max.
     T-I>
                           Trip time delay of the overcurrent stage I>
     min.
          0.00
     max. 60.00/∞
                           Pick-up value inverse time O/C stage Ip
1214 Ip
     min. 0.10
                           I/In
     max. 4.00
     qI-T
                           Trip time delay inverse time O/C stage Ip
     min. 0.00
     max. 10.00/\infty
```

```
1216 RMS FORMAT
                          RMS format for inverse time O/C protection
                       [ ] Fundamental [ ] True rms
     FUNDAMENTAL
     TRUE RMS
1221 MAN.CLOSE
                           Manual close
     I>> UNDELAYED
                       [ ] I>> undelayed
                       [ ] I>/Ip undelayed
     I>/Ip UNDELAYED
     INEFFECTIVE
                       [ ] Ineffective
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
     \min. 0.05
                           I/In
     max. 25.00
1503 T-IE>>
                           Trip time delay of the
                                                   high-
                                                             stage IE>>
     min. 0.00
     max. 60.00/∞
1506 MEAS.REPET
                           Measurement repetiti
                       [ ] no
     NO
     YES
                       [] yes
1511 CHARACTER.
                           Characteristic of
                                              the O/C stage IEp
                       [ ] Normal inverse
[ ] Very inverse
     NORMAL INVERSE
     VERY INVERSE
     EXTREMELY INVERS [ ] Extremely inverse
     USER CHARACTER. [ ] User characteristics
1512 IE>
                           Pick-up value of the overcurrent stage IE>
     min. 0.05
                           I/In
     max. 25.00
1513 T-IE>
                                 time delay of the overcurrent stage IE>
     \min. 0.00
    max. 60.00/\infty
1514 IEp
                           Pick-up value inverse time O/C stage IEp
                            I/In
    min. 0.10
     max. 4.00
1515 T-IEp
                           Trip time delay inverse time O/C stage IEp
     min. 0.00
     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
```

2000	INRUSH STABILIZA	TION	
2001	RUSH OFF ON	[]	Inrush stabilization off on
2002	2nd HARMON min. 10 max. 45		Content of Ph current which initiates blocking
2003	CROSSBLOCK NO YES	[]	Blocking all phase fault detec (crossblock) no yes
2004	T-RUSH min. 0.10 max. 60.00		Time limit of blocking after pick-up s
2500	SPECIFIC CHARACTI	ERIST	PICS
2501	CHARACTERISTIC 1		Characteristic curve 1
2700	THERMAL OVERLOAD	PROT	Γ.
2701	THERMAL OL OFF ON	[]	State of thermal overload protection off on
2702	K-FACTOR min. 0.10 max. 4.00		K-factor for thermal overload protection
2703	T-CONSTANT min. 1.0 max. 999.9	9	Time constant for thermal overload protection min
2704	<pre></pre>	<u>\</u>	Thermal warning stage %
2705	I WARN min. 0.10 max. 4.00		Current warning stage I/In
2706	O/L CALCUL MAX MEAN FROM IMAX		Calculation method for thermal stages Theta max Theta mean Theta from Imax
2900	MEAS.VALUE SUPER	/ISIC	DN
2903	SYM.Ithres min. 0.10 max. 1.00		Symmetry threshold for current monitoring I/In

```
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
3300 INTERMITT. EARTH-FAULT PROT
                           Intermittent earth fault protection
3301 INTERM.EF
     OFF
                       [ ] off
     ON
3302 Iie>
                           Pick-up value of interm.
                                                            age
     min. 0.05
                           I/In
     \max. 25.00
3303 T-det.ext.
                           Extension time for earth fault detection
     min. 0.00
     max. 10.00
3304 T-sum det.
                           Sum of detection
                                             times
     min. 0.00
                           S
     max. 100.00
3305 T-reset
                           Reset tim
     min. 1
     max. 600
                                        for start of int. E/F prot
3306 Nos.det.
     min. 2
     max. 10
3900 BREAKER FAILURE PROTEC
3901 B/F PROT.
                            Circuit breaker failure protection
     OFF
     ON, INTERN.START
                         1 On, internal start
                         ] On, external start
] On, int.or ext.start
     ON, INT. OR EXT
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 $7 \mathrm{SJ} 511$

4000 TESTS

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. 7SJ511

5000 ANNUNCIATIONS

5100 OPERATIONAL ANNUNCIATIONS

5200 LAST FAULT

5300 2nd TO LAST FAULT

5400 3rd TO LAST FAULT

```
5600 CB OPERAT. STATISTICS
```

5700 OPERATIONAL MEASURED VALUES

```
5701 IL1[%] = Current in phase IL1 [%] = 5702 IL2[%] = Current in phase IL2 [%] = 5703 IL3[%] = Current in phase IL3 [%] = 1E[%] = 5714 IL2 = Current in phase IL1 = 5715 IL3 = Current in phase IL2 = 5716 IEa = Operational measurement: IEa=
```

5900 OVERLOAD MEASURED VALUES

```
5901 \Theta/\ThetatripL1= Temperature rise for phase L1 
5902 \Theta/\ThetatripL2= Temperature rise for phase L2 
5903 \Theta/\ThetatripL3= Temperature rise for phase L3 
5904 \Theta/\Thetatrip = Temperat. rise for warning and trip
```

Reference Table for Configuration Parameters 7SJ511 6000 MARSHALLING 6100 MARSHALLING BINARY INPUTS 6101 BINARY INPUT 1 Binary input 1 6102 BINARY INPUT 2 Binary input 2 6200 MARSHALLING SIGNAL RELAYS Signal relay 1 6201 SIGNAL RELAY 1 6202 SIGNAL RELAY 2 Signal relay 2 6203 SIGNAL RELAY 3 Signal relay 3 6204 SIGNAL RELAY 4 Signal relay 4

6205	SIGNAL RELAY 5	Signal relay 5
6300	MARSHALLING LED INDI	CATORS
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
Ċ.	7	

6400	MARSHALLING TRIP REI	AYS
6401	TRIP RELAY 1	Trip relay 1
		•
6402	TRIP RELAY 2	Trip relay 2
7000	OP. SYSTEM CONFIGURA	ATION
7100	INTEGRATED OPERATION	
7101	ENGLISH []	Language German English US-English
7102	DATE FORMAT DD.MM.YYYY [] MM/DD/YYYY []	Date format dd.mm.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 WITH FAULT DETEC [] WITH TRIP COMM. []	Fault indication: LED and LCD With fault detection With trip command
	>	

7200 PC/SYSTEM INTERFACES

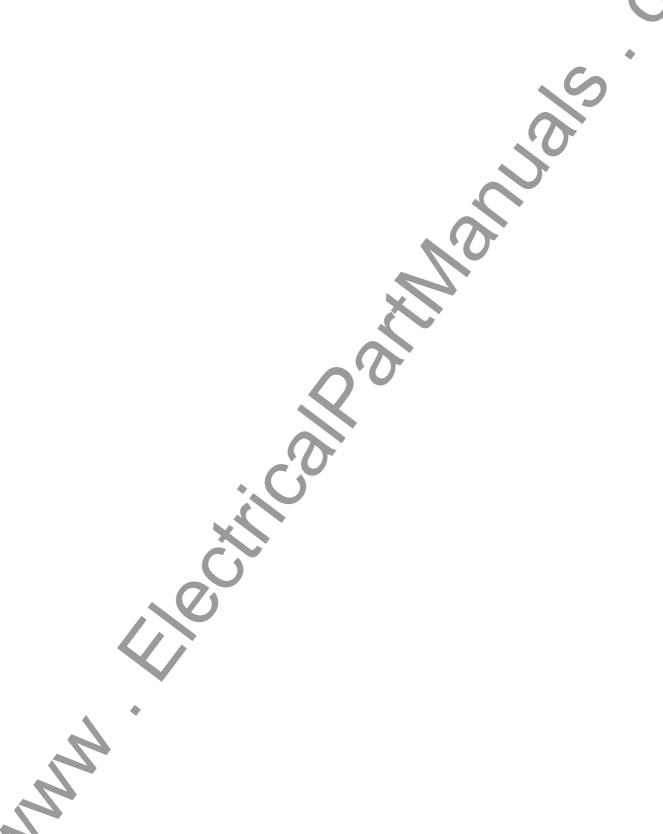
7201 DEVICE ADD. Device address min. 1 max. 254 ——

7202	FEEDER ADD. min. 1 max. 254			Feeder address
7203	SUBST. ADD. min. 1 max. 254			Substation address
7208	FUNCT. TYPE min. 1 max. 254			Function type in accordance with VDEW/ZVEI
7209	DEVICE TYPE min. 0 max. 255			Device type
7211	PC INTERF. DIGSI V3 ASCII	[]	Data format for PC-interface DIGSI V3 ASCII
7215	19200 BAUD	[[[]	Transmission baud rate for PC-interface 9600 Baud 19200 Baud 1200 Baud 2400 Baud 4800 Baud
7216	DIGSI V3	[]	Parity and stop-bits for PC-interface DIGSI V3 No parity,2 stopbits No parity,1 stopbit
7221	SYS INTERF. VDEW COMPATIBLE VDEW EXTENDED DIGSI V3 LSA] [[]	
7222	SYS MEASUR. VDEW COMPATIBLE VDEW EXTENDED			Measurement format for system-interface VDEW compatible VDEW extended
7225	SYS BAUDR. 9600 BAUD 19200 BAUD 1200 BAUD 2400 BAUD 4800 BAUD			Transmission baud rate for system-interface 9600 Baud 19200 Baud 1200 Baud 2400 Baud 4800 Baud
7226	SYS PARITY VDEW/DIGSIV3/LSA NO 2 STOP NO 1 STOP	[]	Parity and stop-bits for system-interface VDEW/DIGSI V3/LSA No parity,2 stopbits No parity,1 stopbit
7235	SYS PARAMET NO YES	[-	Parameterizing via system-interface no yes

```
7400 FAULT RECORDINGS
7402 INITIATION
                           Initiation of data storage
                      [ ] Storage by fault det
     STORAGE BY FD.
     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
                                                           recording
                          Maximum time period of a fault
     min. 0.30 max. 5.00
                          Pre-trigger time for fault
7411 T-PRE
                                                       recording
     \min. 0.05
     max. 0.50
7412 T-POST
                           Post-fault time for
                                                fault recording
    min. 0.05
     max. 0.50
7431 T-BINARY IN
                                            initiation via binary input
                           Storage time by
     min. 0.10 max. 5.00/\infty
                           Storage time by initiation via keyboard
7432 T-KEYBOARD
     min. 0.10
    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
7815 CHARAC. E
                          Characteristic O/C protection earth
     DEFINITE TIME
                       [ ] Definite time
     INVERSE TIME
                       [ ] Inverse time
7827 THERMAL OL
                           Thermal overload protection
                       [ ] Non-existent
[ ] Existent
     NON-EXIST
     EXIST
     INTERMIT.EF
                           Intermittent earth fault protection
                       [ ] Non-existent
     NON-EXIST
                       [ ] Existent
     EXIST
                          Parameter change-over
7885 PARAM. C/O
     NON-EXIST
                       [ ] Non-existent
     EXIST
                      [ ] Existent
    FREQUENCY
                          Rated system frequency
                      [ ] fN 50 Hz
     fN 50 Hz
                      [ ] fN 60 Hz
     fN 60 Hz
```

7900 DEVICE CONFIGURATION

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



Operational Device Control Facilities 7SJ511

8000 DEVICE CONTROL

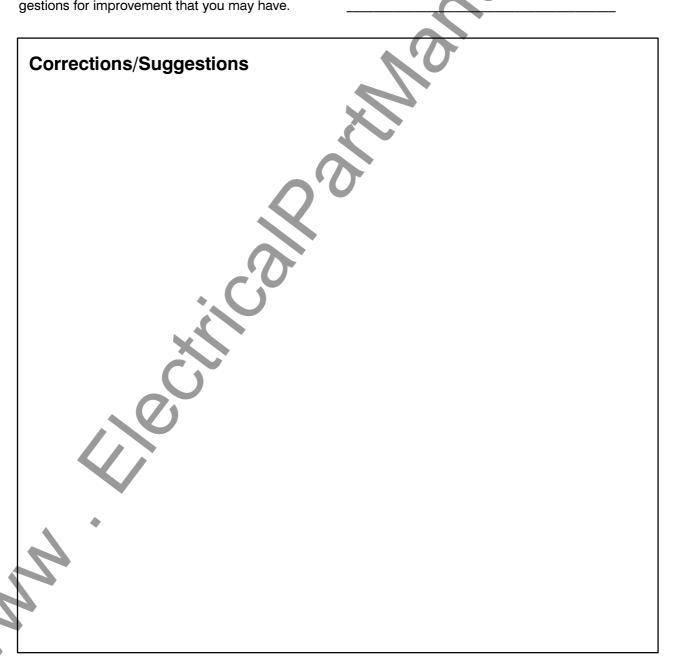
8100	SETTING REAL TIME CLO	OCK •
8101	DATE / TIME	Actual date and time
8102	DATE	Setting new date
8103	TIME	Setting new time
8104	DIFF. TIME	Setting difference time
8200	RESET	
8201	RESET	Reset of LED memories
8202	RESET	Reset of operational annunciation buffer
8203	RESET	Reset of fault annunciation buffer
8204	RESET	Reset of CB operation counters
8205	RESET	Reset of the total of interrupted currents
8300	SYS-VDEW ANNUNCMEAS	S.VAL
8301	SYS TEST OFF [1] ON [1]	Testing via system-interface off on
8500	PARAMETER CHANGE-OVER	R
8501	ACTIV PARAM	Actual active parameter set
8503	ACTIVATING SET A [] SET B [] SET C [] SET D [] SET BY BIN.INPUT [] SET BY LSA CONTR []	Activation of parameter set Set a Set b Set c Set d Set via binary input 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

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Copy parameter set A to set B

8515	COPY	Сору	parameter	set	Α	to	set	С
8516	COPY	Сору	parameter	set	A	to	set	D
8517	COPY	Сору	parameter	set	В	to	set	A
8518	COPY	Сору	parameter	set	В	to	set	С
8519	COPY	Сору	parameter	set	В	to	set	D
8520	COPY	Сору	parameter	set	С	to	set	A
8521	COPY	Сору	parameter	set	С	to	set	В
8522	COPY	Сору	parameter	set	С	to	set	D
8523	COPY	Сору	parameter	set	D	to	set	Α
8524	COPY	Сору	parameter	set	D	to	set	В
8525	COPY	Сору	parameter	set	D	to	set	С
						-	L '(

То	From
SIEMENS AKTIENGESELLSCHAFT	Name
Dept. PTD PA D PSN	
D-13623 BERLIN	Company/Dept.
Germany	•
Dear reader,	Address
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	Telephone no.



Substantial alterations against previous issue:

Alterations in DTP-platform, character fonts, and layout

Actualization of standard designations

Div. errors corrected

Subject to technical alteration

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